Human Computer Interaction in Museums as Public Spaces:

A research of the Impact of Interactive Technologies on Visitors' Experience

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Certificate of Authorship/Originality

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Abstract

More and more museums are incorporating interactive technologies into their exhibition environment in order to enhance their audiences' visiting experiences and satisfy their expectations. Since museums are public spaces, interactions with and within the technological environment are mainly social, many times unexpected and significantly different to those taking place in a private context. The accelerated development of technologies and their increasing availability, both for the general public and the corporative world, represent a myriad of challenges and opportunities for museums. This doctoral research investigates interrelated aspects in the domain of museum interactive exhibitions from the perspectives of the converging fields of Human Computer Interaction and Museum Studies. The research project aims to generate a comprehensive understanding of the influence that interactive technologies have on museum visitors' experiences with technologically-enhanced exhibition environments. Furthermore, given the social nature of the museum visiting experience, particular emphasis is put on the social implications of the incorporation of interactive technologies in the exhibition space.

The research approach of this project is an experience-centred field exploration informed by the development of three case studies in different exhibition settings and with different types of audiences. The purpose of the case study approach is to obtain first-hand accounts of visitors' experiences with interactive exhibits, exploring their physical, emotional and cognitive responses to these. Throughout the conduction of the case studies the work of HCI researchers John McCarthy, Peter Wright and Lisa Meekison on visitors' experiences in interactive exhibitions is used as a reflective tool. A mixed set of existing quantitative and qualitative tools is applied in each case study and new techniques are devised as the cases develop, in a responsive research approach to the existing field conditions. The exhibition settings that comprise this research project are: the *I See What You Mean* exhibition at the DAB Lab Research Gallery, the *Facets Kids* installation at the Powerhouse Museum, and the *Dangerous Australians* exhibit at the Australian Museum, all of them in Sydney, Australia.

The main outcome of this doctoral research is a referential model for the study of visitors' experiences with interactive exhibits. This model is proposed for design and museum practitioners to use as a guide in their research process for the development of new interactive exhibition environments. The conclusions of this research emphasise the need for more comprehensive understanding of visitors' experiences with technologies in the museum as a public space and the particular social interactions that occur in it.

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Foreword

My academic background is in Industrial Design and I hold a permanent contract position as lecturer and researcher in the School of Design at the Metropolitan Technological University (UTEM) Chile, lecturing in Semiotics, Design Fundamentals and Interaction Design. In 2008 I was awarded a competitive Mecesup Scholarship extended by the Chilean Ministry of Education to undertake doctoral research in the field of Human Computer Interaction.

As an active member of UTEM's research centre ProteinLab (UTEM's Prospective and Technological Innovation Program) I became interested in interactive technologies and engaged in research projects that explored these applied in areas as varied as mobile communications, marketing, distributed workspaces and domestic environments. Through this research I was able to observe the interaction between users and technologies in public spaces and identify that this particular context affected both the physical dynamics and the social behaviours. I saw in the conduction of post graduate research the opportunity to research a topic I felt warranted closer attention. Consequently, my research topic explores the interaction resulting of the relationship between public spaces, their users and supporting technologies.

Cultural heritage institutions such as museums are my particular area of interest. In the time it has taken to develop this doctoral research I have been able to analyse how progressively museums are integrating new technologies in their exhibitions, as a way of enhancing visitors' experience. Within this context I have observed several gaps between the intended purpose of the exhibits and spaces and the expectations and actual experiences of their visitors. My research premise is that museums may find in new technologies a useful tool for the fulfilment of visitors' new demands if these are addressed understanding visitors' needs and expectations in a more comprehensive way.

Museums are places in which the study of both social and technology-aided interactions take place in a natural and reliable environment, as opposed to a controlled laboratory research setting. Museums provide the potential for insight into visitors' encounters, explorations and discoveries within their visiting experience. An integrating research approach centred on the conveyance of meaning through social interactions comes into sight as the most consistent approach for the future design of meaningful and engaging visiting experiences.

Chapter 1. Introduction

This research work aims to contribute to the continuously growing body of work in the field of Human-Computer Interaction and in the discipline of Interaction Design. It examines how the integration of interactive technologies in public spaces influences the interactions of people with their environment and how this, subsequently, influences their interactions with others. Framed within the domain of museum studies, the project focuses on interactive museum exhibits as distinct types of interfaces between cultural heritage content and visitors in order to explore their impact on the museum visiting experience. From the perspective of Interaction Design and with the help of various convergent disciplines' theories this research incorporates a holistic understanding of the visitor's experience in the museum, considering the physical, cognitive and emotional components as an intertwined whole.

1.1. Outline of the Research Problem

The fast development of technologies places our everyday lives in exceptional continuous change. We live surrounded and supported by several technological products and services that facilitate our daily work tasks and enhance the enjoyment of our recreational time. Our whole environment has changed: the space we move about and its objects, the way we use these and the way we behave when interacting with them and other people. For the diverse Design sub-disciplines this continuous change challenges practitioners to help improve people's lives through the development of products that can assist them in the achievement of their everyday goals while interacting in meaningful and natural ways (Dix et al. 2006; Heath & Luff 2000; Sharp, Rogers & Preece 2006). As argued by Donald Norman, researcher in cognitive sciences, design and usability engineering, consumers and users have changed together with these technologies, putting on them new demands and expectations (Norman 2005). These demands and expectations bring along new market opportunities and one of the industries that have benefitted the most from the advancements on interactive technologies has been the entertainment one (Brouwer & Mulder 2007; Griffiths 2008; Saffer 2007). As a result, consumers of entertainment have benefited as well enjoying of a wider and increasing palette of products and services to choose from.

Cultural heritage institutions in general and museums in particular, have found in the new technological scenario a complex challenge. Just as it happens in many different fields, these institutions are inevitably influenced by the evermore evolving and promising technologies. According to the 2002 DigiCULT Report, in a society demanding constant novelty in their everyday interactions, public spaces such as art galleries, natural parks and museums may find in new technologies a useful way to fulfil the new society's demands (European Commission 2002). As expressed by Simon Knell in the journal *Museums and Societies*, what he calls a 'technology-driven mutation' in the evolution of cultural heritage institutions will redefine the sector and blur institutional boundaries (Knell 2003, p. 132). Literature shows that the concept of heritage has evolved accordingly to the new cultural and technological contexts of the last fifteen years. Nowadays, activities such as conservation and exhibition increasingly benefit from new the developments in interactive technologies facilitating new forms of content delivery (Geser et al. 2004; Marty & Burton Jones 2008). In the last two decades museums have increasingly incorporated new technologies into their institutional activities with the purpose of enhancing the service they provide to their audiences. Some examples of these developments are museums' online services (e.g. access to virtual collections, extended educational activities, thematic-specific communities), the use of virtual reality for a more immersive visit experience, the access to augmented contextual backgrounds through the use of audio-guides, and the increasing collaboration between institutions thanks to the many new computer supported collaboration tools. Digital and interactive technologies are affecting the way contemporary cultural heritage institutions address their communities, demands and needs. One of the keys for success in any enterprise, either private or public, is given by the wise management of changes. As stated by museum informatics experts Paul Marty, Boyd Rayward and Michael Twidale (2003), museums cannot keep serving their audiences through a cultural-only perspective; they need to broaden it into complementary disciplines, especially into technology-driven ones.

Getting familiar with the new dynamics of the museum environment, which every day more integrates digital technologies to its structure, is not necessarily easy for every visitor. Different aspects such as age, educational background, disability, personal interests, among many others, conjugate in a same context resulting in many different individual experiences. Although interactive technologies are increasingly present in our daily lives, they are predominantly accessed in a private context. When these technologies cross the threshold from the private sphere into the public one individual experiences may be somehow affected. The public space is an entirely different realm to that of the private space: in a public space we are exposed to others, we are performing on stage. In this sense, museums are an interesting example of public spaces. Museums are spaces for social gathering and communication, for particular interactions between people and culture through tangible and intangible artefacts. People in public spaces tend to act in less individual ways and become more conscious of their condition as members of a community. This condition is particularly relevant and interesting in exhibition environments as audiences in the last two decades have gradually shifted from passive spectators to active participants (Black 2005; Falk & Dierking 2000, 2008; Hooper-Greenhill 1999b, 2000; Sandell 1998). Some recent research illustrates how the adoption of new technologies has on occasions derived in a significantly individualised museum experience rather than in a social one (Aoki et al. 2002; Rowland & Rojas 2006). Accordingly, special attention should be given to audiences' relationship with digital and interactive technologies and the impact these have on their overall visiting experience.

1.2. Research Questions

Museums are entities dedicated to public service and, consequently, their relationship with their audience is of core interest. Extensive research has been conducted on audiences, their characteristics, needs and expectations; however the way new technologies in the museum environment may influence audiences' experiences has only recently started to be covered (Benford et al. 2011; Black 2005; Falk & Dierking 2008; Hooper-Greenhill 2000; Marty & Burton Jones 2008). For the discipline of Interaction Design, the use of interactive technologies in the exhibition environment is a rich area of research as these technologies are significantly changing the way visitors experience their museum visits. As explained earlier, the interaction with technology in a public context is completely different to that in a private one; in museums in particular, interaction with and within the technological environment is mostly social. Consequently, understanding the ways people interact with technologies in public spaces and how those technologies can inform their experiences within them was the starting point of my research.

My initial research question was '*How does the application of interactive technologies in exhibition design impact on the experience of museum visitors?*'. Looking for answers to this initial research question I consulted several authors and disciplines addressing the topic of interactive exhibits in museums. From an Interaction Design perspective, I explored the museum visitor experience through the notions of audience research, user experience and engagement, and social interaction. This initial theoretical research led me to a more thorough exploration of the social connotations of the museum visit and to a better understanding of how social interactions could be influenced by a technologically-enhanced museum context. As a consequence, the final set of research questions established for this project was:

> *How do visitors perceive interactive exhibitions and how does that perception influence their engagement with them? Does social interaction influence this perception in any way? If so, is there a social negotiation and common understanding in order to make sense of the exhibition content?*

In order to address these questions thoroughly, I embarked on the review of the literature of two central fields of research: Human Computer Interaction (HCI) and Museum Studies. From the field of HCI I extracted the knowledge needed to understand the influence that interactive technologies have in our everyday engagement with our physical environment. From the field of Museum Studies I took on the knowledge necessary to understand the dynamics of the museum's activities and structure, as well as the role exhibitions play in the learning and recreational experience of the museum visit. The research questions were complementarily addressed with field enquiry which allowed me to further my knowledge on the lived experiences of visitors in their interactions with computer-based exhibits. Together, primary and secondary research helped me produce the main contribution of this project, as introduced later in this chapter.

1.3. Research Approach

This research project points towards the examination of the interrelated issues of interactive experiences in the museum from the perspective of my own disciplinary background so as to unveil new implications of Human-Computer Interaction in public spaces. Exhibition design decisions in terms of content, planning and delivery do not depend exclusively on museum professionals; none of the museums professionals (e.g. curators, designers, historians, administrators) can individually listen to the voice of visitors to appropriately design for their visiting experiences. Accordingly, it is a primary task of cultural heritage institutions to be in total acquaintance of the effectiveness of their exhibitions' message and interpretative approaches as informed by their audiences.

Given the essential role visitors' direct accounts of their visiting experiences have in the design of interactive exhibits I considered that this project would significantly benefit from field research. The exploration of museums as spaces of high social interaction and the study of the influence interactive technologies have on visitors' experience was conducted through three case studies. Qualitative research methods such as observations, interviews and surveys allowed the collection of rich research data. The work of HCI researchers John McCarthy, Peter Wright and Lisa Meekison on visitors' experiences in interactive exhibitions was of great influence in the development of my case studies (McCarthy, Wright & Meekison 2003). I took their human-centred approach to the understanding of user experience with digital technologies, based on the observation, discussion and association of all comprising components of the interactive experience, as the lens through which I could study the visiting experiences of my case study's participants.

My case studies methodological approach allowed me to focus on the characteristics, circumstances, and complexities of a limited yet diverse number of cases. The case studies were conducted in exhibition context of diverse nature which permitted the gathering of varied data from different types of audiences, each presenting distinctive ways of interacting with their exhibition environments.

1.4. Research Contributions

As explained earlier in this chapter, the set of research questions that informed this project led to the theoretical and practical exploration of two main fields of enquiry, Human Computer Interaction and Museum Studies. Throughout this dissertation I demonstrate how these two fields converge in the mutual interest of researching users' experiences with interactive technologies and how a comprehensive understanding of this intertwined relationship leads to the main contribution of the project.

Through my research project I argue that for us designers to effectively contribute to the fields of HCI and Museum Studies from our disciplinary standpoint it is essential to develop a close relationship with museum visitors as both existing and potential users of interactive exhibits. I sustain that field research is of core relevance in the understanding of visitors' experiences and that a comprehensive exploration of all aspects of the interaction, including the individual and the social experiencing of the visit may lead to much better design results. Based on the findings from the project's literature review and case studies I propose a referential model for the study of visitors' experiences with interactive exhibits that can be used by designers and museum practitioners in their development of future interactive exhibitions.

1.5. Structure of the Thesis

This thesis is roughly divided in three main areas: a review of the literature of the main two fields of enquiry, an account of the three case studies conducted throughout the project, and the contributions to the body of knowledge in the research problem area. What follows is an outline of the structure of the dissertation with a brief summary of each chapter.

Chapter 2. Experiencing Interactive Technologies.

In this chapter I review the literature from the field of Human Computer Interaction with a particular focus on the experience of interactive technologies in public spaces. I argue that users' experiences with technologies are influenced by the social conditions of the interaction space and that by understanding the ways this influence occurs we can design for better experiences.

Chapter 3. The Shaping World of the Museum

In this chapter I review the literature from the field of Museum Studies, particularly the public role of museums as learning and recreational institutions. I argue that today's visitors are of great influence in the kind of experiences museums provide and that they expect to achieve a meaningful experience through a stimulating physical exploration of the museum space and content.

Chapter 4. Interacting with Technologies at the Museum

In this chapter I complement the previous two literature reviews with the converging topic of socially- and technologically-driven interactions in the museum environment. I discuss the concept of engagement in the museum visiting experience and argue that interactive technologies can be of great assistance in the exhibition environment when considered as tools rather than experiences themselves.

Chapter 5. Methodology

In this chapter I describe the experience-based research approach that oriented the field work of this project as well as the case studies methodology approach that facilitated the understanding of visitors' experiences in real exhibition contexts. I put particular emphasis on how each case study informed the next one in a sequential improvement of field research techniques and approach to participants.

Chapters 6, 7 and 8. Case Studies

These chapters present the background of each case study, including the specific exhibition contexts and audiences, as well as the theoretical frameworks that informed the development and/or analysis of each exhibition. The particular methods applied and created for each case are described, followed by an overview of data collected. Each case study chapter concludes with the most significant findings of the field work analysis and interpretation, leading to the answering of the project's research questions.

Chapter 9. Research Contribution and Conclusions

In this chapter I introduce the main contribution of the research project, a referential model for the study of visitors' experiences with interactive exhibits aimed to assist design practitioners in the development of new interactive exhibitions. This model is the result of significant findings drawn from the literature review and the case studies. In order to demonstrate how this model can be applied I draw together the outcomes of the case studies and explore their most relevant aspects with the help of the referential model. Finally, I present the main conclusions drawn from the research and possible directions for the future development of the research.

Chapter 2. Experiencing Interactive Technologies

In order to understand visitors' engagement with and through technology in the museum context it is necessary to survey the most relevant concepts associated with the interaction between people and technology. The purpose of this chapter is to introduce and describe the essentials of the field of Human Computer Interaction (HCI) and the discipline of Interaction Design (part of the comprising field of Design), both of great relevance to this research project. The core of the chapter is on the concepts of experience and engagement with technology, particularly in the context of public interaction. The main research approaches and contributions to the field are discussed, providing the theoretical foundations for understanding the nature and dynamics of the museum visiting experience.

2.1. The Relationship between Humans and Computers

The study of the interactions between humans and their technological environment has been approached, since its rather recent origin as an independent topic of research interest, by an increasing number of disciplines. Human Computer Interaction (HCI) is a field that originated as a sub-discipline of the human and computer sciences (Carrol 1997; Dix et al. 2006; Sharp, Rogers & Preece 2006). HCI can be essentially defined as the research field that studies the relationship between humans and their technological environment. In particular, it explores the interactions between people and the various technologies they use in their everyday tasks. The body of knowledge and practice of HCI contributes to the development of interfaces which aim to enable these interactions. The many disciplines that build up the field of HCI relate to aspects as varied as psychology, electronics, linguistics, information technologies, design and ergonomics, and can be grouped in the human sciences, engineering sciences and design (Bongers 2004).

The early stages of HCI research in the 1980s were mostly concerned with the investigation of computer interfaces and their role in the optimisation of specific tasks performed through intelligent systems (Bannon 2000). The process of research on computer interfaces was typically conducted in artificial settings (i.e. laboratories) in which participants were asked to perform specific tasks alternately with and without the support of computer-based tools and their cognitive effort needed to execute such tasks was measured. The traditional focus of HCI was based mainly on the measurement, timing and optimisation of tasks. As Human Computer Interaction researcher Paul Dourish explains, the models for understanding the ways humans used computers and computer-based machines were based on scientific reduction and generalisation, guided by plans, procedures, fixed tasks and goals (Dourish 2001).

In the following years computers gained more power and ubiquity, becoming an integral part of more people's lives. Progressively, organisations would introduce computerised systems in the workplace and individuals would acquire computers for personal use in the home and other social contexts (Dix et al. 2006). The computer was no longer associated only to industrial purposes and machinery but also to common everyday tasks. Technology in general and computers in particular were increasingly taking part of the interactions between humans (Grudin 1990). This development triggered new research trends to study computers as user interfaces. As IBM researchers Marie-Claire Karat and John Karat (2003) explain, this shift from machine-centred to user-centred changed the approach of HCI research from mainly individual and cognitive aspects to group and social ones; from the interface to the interaction taking place in its use; from proficient users to virtually anyone as users. This new approach in researching Human Computer Interaction is known as User-Centred Design (UCD) and has its core research subject the usefulness and usability of products from the perspective of the user (Dix et al. 2006). According to Dourish (2001) the late 1990s were characterised by a further shift in the study of human-computer interactions as the concept of 'usability' was increasingly being understood not only as a practical term but also as a reflection of the experience of use. For Dourish, interaction was to be considered a 'situated activity', intrinsically related to a physical and social context, to the particular nature and motivations of real people in a real world. Sharp, Rogers and Preece (2006) further assert that although usability still remained as an essential focus in HCI, aspects of enjoyment, aesthetics and affect in the interaction with technologies were becoming increasingly important.

The developments within the field of Human Computer Interaction and its resulting evolution are reflecting the involvement of the diverse yet complementary disciplines that have continuously contributed to the shaping of basic notions of people's relationship with technology. This advancement of the field has been made possible by the people engaged in industrial and academic research as well as the actual developments in computer technologies, from the first computing devices to the pervasive ubiquitous technologies we interact with daily. As discussed by Sharp, Rogers and Preece (2006) within the field of HCI broader and more flexible approaches to researching interaction have been developed as a response of the many technological changes and their associated social-cultural effects. With technologies reaching out of the box and more into the environment the focus of HCI has also been extended in order to encompass the new contexts that now shape the interactions between humans and technology (Dix et al. 2006; Grudin 1990).

2.1.1. Designing for Interactions

Current literature in the field emphasises the role of computer technologies as instruments to support people in their daily activities and the increasing interest shown by the disciplines of design in contributing to the development of better and new interfaces that facilitates these activities (Bannon 2011; Dix et al. 2006; Moggridge 2007; Saffer 2007; Sharp, Rogers & Preece 2006). As it would be expected from concepts that rely on constantly evolving contexts, the term Interaction Design has shown to be difficult to define in exact terms; nonetheless, the literature validates its origins in the Human Computer Interaction tradition (Bannon 2011; Carrol 1997; Norman 2011; Saffer 2007; Sharp, Rogers & Preece 2006). In a broad sense, Interaction Design is the discipline that studies and develops "interactive products to support the way people communicate and interact in their everyday and working lives" (Sharp, Rogers & Preece 2006, p. 8) yet the concept implies many aspects beyond its definition. As argued by Sharp, Rogers and Preece, Interaction Design plays a fundamental role in all disciplines, fields and approaches related to the research and design of computer-based systems for people, including the practices of user interface design, software design, experience design, product design, and architecture, among many others. Although Interaction Design may not always rely on the use of digital technologies for all of its purposes, digital technologies play a prominent role in the development of the field. Indeed, the continuous developments in Interaction Design are tightly related to technological developments (Saffer 2007; Sharp, Rogers & Preece 2006). Nonetheless, Interaction Design is distinguished within the field of Human Computer Interaction by virtue of being a design discipline marked by a distinctly projecting practice that is informed by particular ways of thinking, knowing and acting (Buxton 2007a; Dix et al. 2006; Moggridge 2007).

Dan Saffer (2007) argues that Bill Moggridge, Industrial Designer and co-founder of the firm IDEO, identified Interaction Design as a practice back in the early 1990s when developing products that would help people connect with each other, facilitating human interactions through their use (Saffer 2007). But the term Interaction Design had not formally become a mainstream until the late 1990s. As Interaction Designer and researcher Jonas Lowgren (2001) explains, in the 1990s not only the Design community regarded the elements of the digital world as inherent to the discipline of Industrial Design but the Information and Communication Technologies community had most of their attention on issues related to usability and human factors engineering. Consequently, the concept of Interaction Design remained somewhat unattended. It can be argued that the term 'Interaction Design' was first coined by Terry Winograd (1997) in his essay *The Design of Interaction*, which appeared in the book *Beyond Calculation: The Next Fifty Years of Computing*. In this work, the author reflects on the ongoing developments within the computer sciences identifying trends that flow from computing to communication, from machinery to habitat, and from aliens to agents (Winograd 1997). Consistent with the then occurring change of approach in the field of Human Computer Interaction, Winograd argues there would be an "expansion in those aspects of computing that are focused on people, rather than machinery" (Winograd 1997, p. 157). He then goes on to affirm that the methods, skills, and techniques commonly utilised in the development of products from a computer science stand would need to shift "from their historical root to create a new field of 'interaction design'" (Winograd 1997, p. 157). This addressing of the interplay taking place between humans and computer systems was being made manifest and positioned within the field of HCI.

It is important to underline that many of the core elements that Terry Winograd was suggesting in the late 1990s as part of this new disciplinary manifestation in the development of products for the interaction between humans and computer systems had already been addressed by other authors. Liam Bannon (1992), for instance, had pointed at the social and contextual factors as critical to the technologies in use and had envisioned a move from human factors to human actors in which the user was no longer a stranger within the system but an active agent of change. On the other hand, with the propagation of multimedia, communication and connectivity technologies new work dynamics started to emerge and many activities related to computers were no longer confined to the limitations of a desk. The concept of Computer Supported Cooperative Work (CSCW), the understanding of the ways people work in collaboration with the support of specific communication-enabling technologies, emerged in the mid-1980s. The research interest on this subject gained strength in the 1990s becoming a formal field of study within HCI (Dix et al. 2006).

In the last two decades numerous advancements in the research of the relationship between humans and computer-based systems have been achieved within the field of Human Computer Interaction and the discipline of Interaction Design. In the area of distributed computing, for instance, the introduction of Media Spaces at Xerox PARC, in which continuous audio and video links were realised to connect people in distributed workspaces, is noteworthy (Bly, Harrison & Irwin 1993). So is the study of the emotions and personal perceptions when working with complex systems, which led to the development of frameworks based on informal forms of communication and the notion of Calm Computing, systems aiming to be always-on yet gentle in terms of attentional demands (Weiser & Brown 1997). The work of Toni Robertson is another significant contribution to the field as she called researchers' attention to a new sensibility regarding users and their interaction with technology, prioritising the agency and quality of experience rather than the sole concepts of use and usability (Robertson 2006). A complete review of significant research developments in the field is beyond the scope of this dissertation; however, two specific advancements related to HCI and Interaction Design are of particular interest to this research project as they offer a valuable starting point in the path to the understanding of visitors' experiences with interactive museum exhibitions. These advancements are the development of the concept of Ubiquitous Computing (UbiComp) and the expansion of technologies in the public realm.

The notion of Ubiquitous Computing was coined by a research group at Xerox PARC, led by Mark Weiser, when working towards the moving of human-computer interactions from the limited desk space out into everyday spaces (Dix et al. 2006). UbiComp denotes a paradigm of computing in which technologies and their processing are distributed into everyday spaces, objects and practices (Weiser 1991). With technology permeating most aspects of life (e.g. work, transport, entertainment, health, etc.) it becomes increasingly necessary to study the ways these relate to their surroundings and affect users' actions and behaviours. UbiComp has facilitated the exploration of the new ways in which people engage with technologies through virtual, tangible and kinaesthetic forms of interaction. In the museum context in particular, some research has been conducted from the perspective of Ubiquitous Computing as a valuable framework for the study and development of engaging exhibiting experiences. This research has covered diverse areas and topics, such as context aware museum guides (Falk & Dierking 2008; Ghiani et al. 2009), hand-held devices and game applications (Benford et al. 2011; Cao, Massimi & Balakrishnan 2008), augmented reality (Brombach, Bruns & Bimber 2009; Reeves, Fraser, et al. 2005), and various forms of mixed reality that blend physical and digital content in the exhibit space (Ciolfi & Bannon 2007; Geller 2006; Sparacino 2004).

The last two decades have shown a sustained movement from considering technologies mainly as tools for work contexts to understanding them in their deployment of other domains of everyday life, particularly the public space (Davenport & Turner 2005; Day 2005; Hindmarsh et al. 2005; Jensen et al. 2005). Home settings, public spaces, leisure environments and cultural heritage spaces such as museums have caught the attention of researchers both in the Human

Computer Interaction field and the Interaction Design discipline. Susanne Bødker (2006), in her keynote paper presented at the 4th Nordic Conference on Human-Computer Interaction NordiCHI'06, raised the concern regarding the extent to which the traditional design notions derived from workplace settings, such as effectiveness, usability and convenience, are comprehensive enough for a now broader and more diverse context technological applications. Many authors refer to this new reality in which the context of use and the types of applications are not only broader but also intermixed, presenting both challenges and opportunities (Ciolfi 2004; Ciolfi & Bannon 2005; Dix et al. 2006; Greenfield 2006; Rébola W., Komor & Gilliand 2010; Selwyn 2003). Computers are increasingly being used in the private and public realms, becoming part of our lives, habits, tasks and expectations. As argued by Bødker, this implies that "new elements of human life are included in the human computer interaction such as culture, emotion and experience" (2006, p. 1) and, consequently, new approaches to understanding these interactions with technology as lived experiences are necessary (McCarthy & Wright 2004).

2.1.2. The Lively World of Interactivity

As it has been discussed so far, the many and significant advancements in the field of HCI and the discipline of Interaction Design, both from the technology and human perspectives, have helped introduce new approaches and design responses to the issue of matching users and their technological environment. These contributions have addressed the diverse and complex component of the interaction process, including underpinning technologies, physical and behavioural human factors, social implications, spatial considerations, among many others. The concept of interaction between humans and computers is a very dynamic one. While some authors argue the key attribute of interaction is placed on the digital nature of artefacts current trends both in HCI and Interaction Design point towards the fact that interaction fundamentally concerns the many ways people relate to each other through interfaces (Bongers 2006; Buchanan 2001; Hornecker 2011; Lowgren 2001; Moggridge 2007; Norman 2011; Sharp, Rogers & Preece 2006).

Interaction is a two-way process in which the actions of one entity lead to changes of the other in an iterative dynamic of control and feedback (Bongers 2006; Dix et al. 2006; Norman 2011). These entities may be people, computers or systems. Interaction is not a concept exclusive to any of these entities in particular. Humans have always been interacting with each other and computers are capable of performing automated tasks - yet with at least an initial intervention of humans. In the case of human-computer interaction, these entities are typically represented by an artefact or system provided with some computer-based components and a user or group of users. A given action by a user over the system "would lead to a change of state of the machine and then the requirement to do some new action" would follow (Norman 2011, p. 143). Occasionally, user and system need to engage in a form of dialogue so as to establish the right parameters under which the desired action will take place; once the parameters are established such dialogue continues in the form of new actions and reactions which also imply internal processes on both entities. As argued by Bert Bongers, "most 'interaction' [of humans] with computers is merely a 'reaction', due to the asymmetrical capabilities between the two parties involved" (2006, p. 103).

As it occurs with humans' interactions with their outside world, in which information is received and sent in an input-output mode, interactions between humans and computers (e.g. digital artefacts, embedded systems, computer-based appliances) are also based on the transferal of information from one party to the other through effectors and controls (Dix et al. 2006). In general terms, in a human-computer interaction process the human can control the computer through his/her output capabilities (e.g. physical manipulation through body actions, verbal manipulation through verbal commands) while the computer receives these commands through its input devices (e.g. a series of tangible buttons, a microphone, motion sensors). Upon receiving the input information, the computer processes the request and acts accordingly, displaying new information through output channels (e.g. a screen, a particular motion, and speakers). In return, this delivery of information, or system response, is perceived by the human through its input channels (i.e. human senses) and a new processing stage takes place. Although most interactions are typically initiated with the human elaborating a mental model of the processes to be performed (i.e. an intention of what is needed from the system), occasionally it can be the system that performs the first action and offers it to the user (e.g. an interactive exhibit that 'calls' the visitor to approach).

As stated by Dix et. al. in their seminal book *Human Computer Interaction*[1], the human can be considered as "an information processor, receiving inputs from the world, storing, manipulating and using information, and reacting to the information received" (2006, p. 55). Information about the world (the natural and human-made environments) is perceived by humans through senses and processed in order to make sense of it. Such processing occurs after information is stored in our memory, either temporarily or permanently, to be used later in reasoning and problem solving. In any given interactive process, communication takes place via different channels or modalities; we perceive and effect our environment by means of human input (senses) and output (actions). Since our body and mind are capable of carrying out various tasks at the same time (e.g. walking through a door to another room while laughing at a joke) and our brain works so quickly that complex processes can take place simultaneously (e.g. thinking about what made you laugh while noticing it smells differently in the other room) it is possible to assert that rarely an interaction with our environment occurs through a single modality.

Multimodal interaction denotes a communication process in which combined modalities are used, often simultaneously, in a physical space. In 2005, Bert Bongers and Gerrit van der Veer at the HCI Research Group of the Vrije Universiteit in Amsterdam started developing what would later be published as the Multimodal Interaction Space (MIS) framework for the design, description and analysis of interactions (Bongers 2007a). Rather than addressing the computer side of the interaction process (i.e. the input and output modalities of the system), the MIS framework is concerned with the human. Consistently, the framework is based on the human interaction dimensions of modes, sensory modalities and levels, and focuses particularly on the physical interaction layer. The physical interaction layer acts "as a firm base for the other layers

[1] *Human Computer Interaction* was first published in 1993 by Prentice Hall International (UK). Two new editions have been published since then, each with revised and restructured content.

of the interaction" (Bongers 2006, p. 101). Considering interactions as spatiotemporal - distributed and networked throughout space and time - these take place in many simultaneous and intertwined phases. The authors assert that a more intuitive and flexible linking between human modalities and system functions is possible when the interaction is considered within a multimodal space. Furthermore, in designing for multimodal interactions a "higher bandwidth of interaction between people and their technologies" may be achieved (Bongers 2007a, p. 610).

Although literature tends to depict the human-computer interaction process in a single-human-single-device fashion it is also widely emphasised that this is comprised of highly complex and intertwined elements (Blair-Early & Zender 2008; Clubb 2007; Dix et al. 2006; Saffer 2007; Sharp, Rogers & Preece 2006). Multiple users may interact with a single system or device, while single users may interact with several devices at a time. Likewise, users may make use of one or several devices to moderate their own social interactions. On the other hand, it is important to emphasise on the multitasking nature of both sides of the interaction; while computer systems are increasingly improving their performance in terms of processing and action power, humans have the ability to exchange information through multiple channels and in multiple ways simultaneously. Furthermore, interactions are not only contextual but situated, hence effected by and effecting the natural and human-made environment. The surrounding space and its physical and social components are both passively and actively involved in the interaction process and take a substantial role in its process. In this respect, Bongers proposes an 'e-cological' approach to designing for interactions that considers the technological environment "as a whole, rather than the wide variety of separate interactions with all different technologies currently taking place" (2006, p. 41). The term 'e-cological' derives from the author's observations of the natural environment in which entities and system co-exist not in isolation but relating with each other. Bongers argues that in the natural environment information is available in an implicit way (tacit knowledge) and that it is in the interaction process with the surroundings that we creatures make sense of it. In a similar way, information can be accessed and generated in our human-made and technological environments. Finally, Bongers associates his e-cological approach to the ongoing and increasing trends of technological miniaturisation and connectivity. He explains that, as computer technologies become more embedded in our everyday environments, they also become more invisible, to an extent in which almost only the interface is left for us humans to interact with the environment (Bongers 2006, p. 42).

2.1.3. Facing Interactions

Interfaces are the physical elements that make our engagement with the technological environment possible, the intermediary to communicate between us and our digital artefacts. Interfaces are among the most important parts of the interaction process; without them, no control or feedback can take place (Saffer 2007; Sharp, Rogers & Preece 2006). As asserted by Saffer, the interface "is where the invisible functionality of a product is made visible and can be accessed and used" (Saffer 2007, p. 122).

In the early stages of personal computer developments of the 1980s, the concept of 'interface' was the conventional shorthand to describe the organisation of the screen, the keyboard and later on the mouse, which enabled users to operate the computer (Leggett 1999). The initial meaning of the word 'interface' described the function for which the interface had been created, that is, the input-process-output sequence. As the prevailing paradigm in human-computer interaction was concerned with the design of applications for the desktop computer, the first interfaces focused on the windows, icons, menus and pointer model (WIMP). This model soon evolved to the graphical user interface model (GUI), when technological developments allowed for a more visual representation of interaction possibilities with the system (Sharp, Rogers & Preece 2006, p. 225). The accelerated development of technology in the 1990s led to a much richer and flexible generation of interfaces consistent with the new technological advancements. Among many others, virtual reality, distributed agents, eye-movement-based interfaces and tangible interfaces quickly permeated the interaction space, offering a "higher degree of interactivity and parallel input/output exchanges" (Sharp, Rogers & Preece 2006, p. 218). The expansion of human-computer interactions beyond the desk realm generated a myriad of new challenges, questions and phenomena to be researched and subsequent novel theoretical approaches as well as practical advancements. Human-computer interaction had become social, emotional, ubiquitous and networked. Since the 2000s onwards, interfaces are not only more flexible and consistent with the new technological scenarios but also aim to provide a better experience of use (Hornecker & Shaer 2010; Saffer 2008; Sharp, Rogers & Preece 2006).

As discussed throughout this chapter, the development of computer technologies in the last three decades has derived in an omnipresence of computers in our everyday environments but at the same time its presence has been removed off the visible planes. What we users get in contact with is merely the interface through which we interact with these technologies. Bongers (2006) affirms that the main two reasons for this change in the technological landscape is the increasing networking capability of systems (devices, computers, appliances, etc.) and the continuous miniaturisation of both underlying and containing technologies (i.e. electronic components and devices). It can be argued that this disappearance of the computer from the sensorial scope has been the result of research and industrial efforts to simplify our tasks and processes; paradoxically, the removal of clear information off the interactive process palette is conversely generating more complexity as well (Hjelm 2005; Norman 1998, 2011; Saffer 2008). As asserted by Bongers, "due to the miniaturisation devices can become so small that we can barely hold them in our hands, let alone operate them" (Bongers 2006, p. 28). This is of crucial relevance for the discipline of Interaction Design as the interface is one of the most important components in the design of interactive experiences; the interface is the designer's medium to accomplish his/her disciplinary aim. By designing reliable and efficient interfaces that facilitate products' optimal behaviour we are designing for meaningful, pleasurable and satisfying user experiences.

2.2. Experiencing the Interactive World

Earlier in this chapter it was argued that research on the design, evaluation and effects of interactive interfaces within the Human Computer Interaction field has traditionally focused on issues regarding their usability, effectiveness and efficiency, as well as on the tasks and goals users accomplish through them. It has also been argued that researchers with a particular focus on the practice of design disciplines have contributed to the forming of a new approach, one that is instead centred on the experiences of users and on the aesthetical and emotional nature of these experiences. The area of 'experience' as a matter of interest has rapidly grown in the last decade, a research phenomenon reflected by the numerous recent journal articles and conference themes available all over the world. Journals such as *Interactions*, *Design Issues* and *Personal and Ubiquitous Computing*, and conferences such as the *International Conference on Tangible, Embedded and Embodied Interaction (TEI)*, the *ACM International Conference on Intelligent User Interfaces (IUI)*, and *Conference on Designing for User Experience* (DUX), to name just a few, offer a rich ground for researchers to discuss emerging concerns and ongoing advancements in the development of human-computer interactions. Recent publications covering experience from different perspective, such as *Where the Action is: The Foundations of Embodied Interaction* (Dourish 2001), *Tangible User Interfaces* (Hornecker & Shaer 2010), *Designing Interactions* (Moggridge 2007), and *Living with Complexity* (Norman 2011) complement this growth in the field.

Art curator and researcher Lizzie Muller argues that one of the reasons behind this research awareness on experience within human-computer interaction is the increasing interest on the subject from the corporate sector (Muller 2008). Muller explains that the concept of 'user experience' has become an important commercial component of the accelerated expanding market of digital entertainment and end user computing, with a strong influence in current sales dynamics. However, the use of 'experience' as a commercial concept is not a recent movement. Back in the late 1990s, marketing experts Joseph Pine and James Gilmore officially coined the concept of 'experience economy' in an article published in the *Harvard Business Review* journal (Pine & Gilmore 1998). The authors argued that 'consumer experience' was an economic offering that could help corporations boost their sales, the same way commodities, goods and services do. In their book *The Experience Economy*, Pine and Gilmore (1999) indicate the development of Disneyland in the mid-1950s as the origins of the 'experience expansion' in commercial enterprise and enterprises such as the Hard Rock Café and Planet Hollywood restaurants as followers of the trend, this time as part of the 'eatertainment' industry. What was common to these examples of 'experience providers', the authors go on to explain, was their comprehensive multi-sensory scope of productions, which included sounds, sights, tastes, aromas and textures in one single experience. Furthermore, what is more relevant of Pine and Gilmore's argument to this research, particularly from the perspective of museum visiting experiences, is that these industries were ultimately aiming to engage their customers and provide them with a 'personal and memorable experience', a purpose comparatively close to that of museums regarding their visitors. Consumers, visitors and users are particular labels used by marketing, museum and design disciplines, respectively, to refer to their end product or service subject. Whilst John McCarthy and Peter Wright, interaction design researchers and experts in user experience, recognise that it is important to consider the 'consumer' side of users in Human Computer Interaction research, they also advice to monitor the thin line between understanding experience from the simplistic technologically determinist position and understanding the complex agency of people interacting with technologies (McCarthy & Wright 2004). In this respect, Jodi Forlizzi and Katja Battarbee (2004), thinking of product designers and their many challenges when designing both for a client and a user, explore experience from three different perspectives (i.e. product-focused, user-focused and interaction-focused) and develop an interaction-focused framework for product design.

Given that experience is inherent and unique to each human being it might not be addressed by design with total precision. As McCarthy and Wright (2004) affirm, we cannot design experiences but we can design *for* experiences. In affirming this, the variable nature of users is recognised as well as the important effect this variability has on the dynamics and resulting character of an interactive experience. The authors' affirmation is also consistent with the aspiration of researchers and designers of user experience, as argued in this chapter, to move the focus from technology itself and concentrate instead on making use of it to create meaningful and engaging experiences; a focus on what can be created from the relationship between users and technology. An experiential view of technology takes design efforts and outcomes beyond technological objects and artefacts, towards new human expressions and forms of experience.

2.2.1. Academic Discussions around Experience

Reactions to the above discussed broadened scope of Human Computer Interaction and Interaction Design have come from a range of traditions, each addressing the issue of interaction from various propositions and perspectives. Many of the contributions from the discipline of Interaction Design fall within an approach based on the concept of experience exploring agendas as diverse as aesthetics of the interaction (Blythe et al. 2003; Petersen et al. 2004), and lived experiences (Loke, Robertson & Mansfield 2005; McCarthy & Wright 2004). These contributions also adopt a variety of perspectives in the study of experiential aspects of technology, among which the most prominent perspectives adopted are those from the situated action theory, and the pragmatist and phenomenological philosophies.

With her influential book *Plans and Situated Actions: The Problem of Human-Machine Communication*, Lucy Suchman (1987) contributes to the human-centred approach in Human Computer Interaction by proposing a view of interaction as a dynamic personal and social negotiation of meaning. As Muller contends, Suchman's contribution to the understanding of experience in HCI research "was to draw attention to the way technology was embedded in people's everyday lives" (Muller 2008, p. 72). Through her work, Suchman argues that the production of meaning is, rather than a fact in itself, a process; therefore, interaction and its associated experiences are situated in action. Under this approach, the source of meaning is the action undertaken by users in a particular context, in which planning and goals settings are of present less influence on the interactive process. In this respect, the author claims that "it is frequently only on acting in a present situation that its possibilities become clear" (Suchman 1987, p. 52). She goes on to explain that meaning is constructed or achieved throughout people's interactions with artefacts and that the meaning of these artefacts and the ways by which their meaning is conveyed are directly related to the concrete circumstances of action. Of particular relevance to this research project is Suchman's reflections on the implications of situated actions for the research of experiences in human-computer interaction. Under the situated actions theory the nature of interaction needs to be studied within an empirical approach and placing the core research efforts on studying the actual interactions as they occur in the real world, "building generalisations inductively from records of particular, naturally occurring activities, and maintaining the theory's accountability to that evidence" (Suchman 1987, p. 179).

Another viewpoint to experience relevant to the design of interactive products and environments is the philosophical tradition of pragmatism, which reflects on experience as an everyday component of human life. Accordingly, pragmatists predominantly study human action and engagement with the world, along with their practical and material implications (Muller 2008). In the last decade a considerable number of HCI and Interaction Design researchers have turned to pragmatism in order to substantiate their understandings of human experience on richer lived-experience foundations. Such is the case of Danish researchers Petersen et. al. (2004) who use notions from pragmatist philosophers John Dewey (1959) and Richard Shusterman (2000) to reflect on the notion of aesthetics in interaction, identifying socio-cultural, instrumental, and kinaesthetic aspects in it. Likewise, Forlizzi & Battarbee (2004) take a pragmatist perspective to address the notion of co-experience and develop frameworks for the design of interactive products. Another line of research of particular interest for this project is that of McCarthy & Wright (2004) who examine technology as experience and from their approach propose a framework of four threads central to understanding experience; this framework has been thoroughly explored and adopted in this doctoral project, as developed in the Methodology Chapter. McCarthy & Wright build on the work of pragmatist philosopher Dewey as well and acknowledge the contribution of Suchman to the field of HCI of addressing experience and meaning-making as situated processes. However, McCarthy & Wright go further in their study of experience and place their attention on "an experiential account of technology that addresses itself to felt life" (McCarthy & Wright 2004, p. 24). The authors are rather critical of the current research and development trends in interaction design arguing that many accounts of experience are based on generalised research procedures and simplified findings that barely cover the felt dimension of experience, the voices and feelings of the actual people involved in the interactions (McCarthy & Wright 2004). For the authors, experience is lived and felt, it is built on and generates emotions, it is expressive, and unique.

Many researchers have also found inspiration and guidance from phenomenology, a philosophy that underlines the central role of the body and lived experience in the process of knowing the world. In Interaction Design, researchers and developers study experience prioritising direct accounts of research subjects and the acquisition of experiential data from the relationships between subjects and technology in use. In his seminal work *Phenomenology of Perception*, Maurice Merleau-Ponty (1962) argues that the world before us is perceived not just by our senses in direct contact with it but also through the artefacts we utilise to interact with it. The author uses the example of a blind man for whom the walking stick becomes an extension of his body in order to feel the surrounding environment (Merleau-Ponty 1962, p. 165). As Human-Computer Interaction researchers Astrid Larssen, Toni Robertson and Jenny Edwards assert "tools extend our potential for action emerging from our interactions with the physical world" (2007, p. 273). The authors' statement builds on the work of German philosopher Martin Heidegger (1977) who affirmed that while exploring the world (i.e. interacting with it) we are inattentive of the artefacts' properties and absorbed in the interaction until something changes or fails; then we again become aware of the artefact as such. The concept of awareness has also been addressed by Toni Robertson from a phenomenological approach through her research in virtual cooperative environments (Robertson 2002). The author emphasises the functional creation of meaning by participants in cooperative work contexts through the use of technologies, with interaction taking place between participants and their technological environment. Paul Dourish, on the other hand, takes a phenomenological approach to designing for interactions in which the technological artefacts involved in the interaction are moved to a secondary layer and the actual "ways in which people engage with them in different settings" become the primary one (Dourish 2001, p. 184). Through his work, he proposes the concept of 'embodied interaction', in which the experience of the everyday world is lived through the body and in continuous flows of active and participative actions.

Although the extensive research works within the experience-based approach, of which only some has been reviewed in this section, varies considerably in terms of scope and tradition, they all share the same interest in reflecting on the implications of the introduction of technologies in our everyday environments. Together, authors representing disciplines as varied as art practice and curatorship, information technologies, architecture and visual communication, explore new agendas and ideals for conceptualising and shaping peoples' relationships with the world through technology. These works are placed at the heart of Interaction Design as they not only explore digital technologies as design material but also people's engagement with each other and their surroundings through them.

2.2.2. A Breaking-Down of Experience

Given the high subjectivity of experiences due to their intrinsic connection with the each person's unique individuality, research efforts on defining experiences have derived in rather alternative definitions and categorisations of their associated aspects. As asserted by Dix et. al. ,"experience is a difficult thing to pin down" (Dix et al. 2006, p. 156) yet approaching it from the appropriate angles and with the right lenses may facilitate designing for it. Those angles and lenses, however, must always consider the final user, as ultimately the success of the experience is linked to the way in which individuals respond to it.

In his book *Flow: The Psychology of Optimal Experience*, Mihaly Csikszentmihalyi (1990) looked at several experiences in order to understand the diverse levels of engagement that may take place throughout them. In doing so, the author identified a stage in which a balance between the states of boredom and anxiety is reached. He called this balance 'flow', a state of being and doing in which actions produce in people a sense of satisfaction and achievement. According to Csikszentmihalyi intrinsic motivation is a fundamental factor for the realisation of optimal experiences, when individuals have actively sought the experience or task. Consequently, if motivation is present the outcomes during and after the tasks are completed are more likely to entail positive emotional and sensory responses. Attention is another significant component of experience identified by Csikszentmihalyi. In any given opportunity for an experience (e.g. using a tool, reading a book, loading the washing machine, and attending an exhibition) individuals are required to present at least a minimal degree of attention in order to retain the information and knowledge gained during and through the experience. For the author, the term 'attention' refers to the ability of an individual to select the incoming stimuli for further analysis, as in the case of focusing on selected objects in a visually complex environment or discriminating between what is relevant and what is circumstantial. As asserted by Csikszentmihalyi, through the process of attention the relevant bits of information can be selected for focus and the appropriate references can then move forward. Attention determines what will or will not appear in the consciousness, including thinking, feeling and remembering, and is determined by the individual patterns that people develop to structure it. In the particular context of museum interactive exhibitions, as will be discussed in Chapters 3 and 4, aspects such as motivation, previous knowledge, individualities and attention are consistently taken into account when planning for new visiting experiences. The aim of cultural heritage institutions is to provide their visitors with meaningful, memorable learning experiences and many of them have successfully integrated these concepts both from the museum interpretative practice and the technological innovation standpoints.

From the perspective of Interaction Design, the works of design researchers Katja Battarbee, Jodi Forlizzi and Shannon Ford is of particular relevance to this doctoral project (Forlizzi & Battarbee 2004; Forlizzi & Ford 2000). In an attempt to provide multidisciplinary design teams with a useful tool for the reflection on and design of user-product interaction experiences, the authors progressively developed a framework that presents types of interactions, types of experiences and the dynamics that take place during experiences. At the *Conference on Designing Interactive System*s in 2000, Forlizzi and Ford presented the paper *The Building Blocks of Experience: An Early Framework for Designers* in which they proposed an initial interaction-centred framework "to talk about experience in a way that is meaningful for designers" (Forlizzi & Ford 2000, p. 421). The framework focused on the notion of 'products' and the various experiences that result from users' interactions with them. In their way to creating a framework of experience the authors defined two main areas to talk about experience: the qualities of experiences and what influences experiences. In respect to qualities of experiences, the authors refer to previous works derived mainly from the fields of Psychology, Ergonomics and HCI and conclude that experiences occur in different levels and amplitude of predisposition and emotional engagement, brought in by each individual in particular. In terms of what influences experiences, Forlizzi and Ford break down the user-product interaction and its surroundings to identify user, product and interactions as the three main threads of influence. While the user influences experience by bringing to the interaction a set of prior experiences, including "emotions and feelings, values, and cognitive models of hearing, seeing, touching and interpreting" (Forlizzi & Ford 2000, p. 420), the product or artefact influences experience by the interactions they afford. The interaction itself, as a contextual instance, influences the experience in a particular different way with each different social, cultural and physical context. Taking these aspects into the museum context and visitors encounters with interactive exhibits, it becomes clear that museum visiting experiences are directly related to user-product experiences.

Outlined in *The Building Blocks of Experience: An Early Framework for Designers* (Forlizzi & Ford 2000) but further developed in *Understanding Experience in Interactive Systems* (Forlizzi & Battarbee 2004) a categorisation of experience is provided through their creation of an interaction-centred framework of experience. In this new work for the study of and design for experience, Katja Battarbee and Jodi Forlizzi assert that experience can be understood according to three sorts: experience as a constant flow that takes place when interacting with a product (e.g. walking around in the museum visiting different exhibition rooms and other museum facilities), an experience as a concrete situation, articulated within a set time framework and inspiring behavioural and emotional change (e.g. attending one particular exhibit and learning new information from it), and co-experience as the creation of meaning and emotion in a social manner (e.g. interacting with other visitors at the same exhibit, exchanging opinions and exploring together). As it can be inferred from the examples, these types of experience are all present in the museum context and, ideally, they are all taken into consideration when designing new interactive exhibitions. Of particular relevance in the museum context is the understanding of experience from the social perspective as meaning-making in a social manner is one of the most significant outcomes of the visiting experience process. Co-experiences arise from experiences that are created together or shared with others, allowing a range of new interpretations. As the authors clearly put, “expressing meaning is invited by, and the meanings are elaborated in, co-experience through social interaction (Forlizzi & Battarbee 2004, p. 263).

Through the interaction-centred framework of experience Forlizzi and Battarbee identify three forms of interaction between users and interactive products: the fluent, the cognitive and the expressive interactions (Forlizzi & Battarbee 2004). Fluent interactions are those relationships with products which actions need no conscious thinking and are frequently informed by previously acquired skills. As the authors affirm, these types of interactions “do not compete for our attention; instead, they allow us to focus on the consequences of our activities or other matters” (Forlizzi & Battarbee 2004, p. 262). In a museum visit context a fluent interaction can be represented by the browsing of information on a touchscreen by a visitor familiar with touchscreen based every-day-use products such as smartphones. Cognitive interactions are those relationships with products which do require us to consciously reflect and think about the situation in order to achieve our goals. Using a similar example as the above given, if the visitor is not familiar with the particular technological settings or design aspects of an exhibit, he or she might need to pay additional attention to the interaction process and operational requirements in order to retrieve the expected information from it. A design that understands the diversities between the first and the second type of visitor presented in these examples will make the difference between a positive and a negative visiting experience. Finally, expressive interactions are those which help users build a relationship with the product through its use, in a personalised fashion. In such experiences users may affect (e.g. modify, change, construct) the product’s features or contents “investing effort in creating a better fit between person and product” (Forlizzi & Battarbee 2004, p. 262). As it will be discussed later in Chapters 3 and 4, new technologies are increasingly allowing museums to development exhibits that engage visitors in this form of interactions. As an example, today visitors may contribute additional content to exhibits and share experiences with the use of social networks and mobile devices. On a final note regarding these three forms of interactions, Forlizzi and Batarbee further explain that interactions can migrate from one form to the other depending on the context and the particular characteristics of individuals engaging in them. This is true as per everyday use products or those with which users have the opportunity to construct a flow of relationships with. For instance, on acquiring a new express coffee machine a user will need to learn how to operate the product through its diverse features (i.e. cognitive user-product interaction) and achieve a higher level of confidence and operational skills after a period of continuous use (i.e. fluent user-product interaction). If the machine allows users to prepare a great variety of coffees or personalise their presentations, then a closer relationship with the machine may be achieved (i.e. expressive user-product). Yet achieving these dynamics of user experiences is much harder in a museum context as the visiting frequency may not allow visitors to migrate from one form of interaction to the other with such ease.

In interactive experiences, various pathways between different dimensions of experience take place. By breaking down experience in types, components, contexts and dynamics, as the authors discussed in this section suggest, a better understanding of the implications interaction in the experience of products may be achieved. As emphasised throughout this chapter, and as Forlizzi and Ford note, "as designers trying to craft an experience, we can only design situations, or levers that people can interact with, rather than neatly predicted outcomes" (Forlizzi & Ford 2000, p. 420). By designing products that invites users to engage through a story of use - a flow of dynamic experiences - these can reach a higher level of meaning and significance.

2.3. Interactive Experiences in Public Spaces

Human-computer interactions are always situated within a physical context, even when mediated by virtual tools: there is always a physical space and a physical interface or number of interfaces. In addition, people's relationships with this space and their interfaces are multifaceted, varied and on many occasions unpredictable. In order to design experiences that can enhance and support people's interactions with and within these physical contexts it is necessary to understand these relationships thoroughly. As argued throughout this chapter, the discipline of Interaction Design has become aware of this need in the last two decades and has placed its research and development efforts in gathering meaningful insight about the circumstances in which people interact with their technological environment (Ciolfi 2004;

Ciolfi & Bannon 2005; Davenport & Turner 2005; Day 2005; Dourish 2001; Hindmarsh et al. 2005; Jensen et al. 2005; Stenglin 2011). As a result, several lines of theory and approaches have been developed through research and publication, many of which have demonstrated the benefits of applying these when designing digital products for their use in public spaces.

In their paper *Re-place-ing Space: the Roles of Place and Space in Collaborative Systems*, Steve Harrison and Paul Dourish (1996) reflected on the role 'place' has in the understanding of people's situated experiences. The focus of their work is on the meaning of place within virtual and digital spaces. This early exploration of place in the literature of Interaction Design represents the starting point of the discipline's need to give greater consideration to the context of the interaction from a human perspective rather than from the traditional architectural geometrical perspective. Harrison and Dourish's work provides important insight of the lived experience in the environment and what it means to act in the physical realm. A few years later, Dourish would revisit these initial concepts of space and place and would focus on the activities that occur in them through 'embodied interaction' (Dourish 2001). According to the author, meaning is created through the actions that people perform within a context of interaction. Accordingly, context should be considered as a dynamic interactional process where people "evolve systems of practice and meaning in the course of their interaction with information systems" (Dourish 2004, p. 28).

In a similar stance, Luigina Ciolfi and Liam Bannon (Ciolfi 2004, 2007; Ciolfi & Bannon 2005, 2007) have produced an extensive body of work around the role of place in the discipline of Interaction Design offering an inclusive approach to understanding people's complex situated realities. Their approach tends to be more technology-inclusive, exploring how the concept of place can be effectively used to enhance the physicality of ubiquitous systems (Ciolfi & Bannon 2005). For the authors, place refers to the lived attributes of the environment whilst space refers to its structural and material dimension (Ciolfi 2007; Ciolfi & Bannon 2005). In this respect, they argue that, in order to thoroughly understand people's experience their interactions in the physical space and design accordingly, the personal, social, cultural and structural aspects of place need to be fully understood and analysed. Their work is a call for interaction design professionals to engage with people's experiencing of space and place as a methodological approach to inform the design practice. Through her individual research work, Ciolfi also explores a place-centred perspective to designing interactive experiences as a facilitator and supporter of existing aspects of people's experiences (Ciolfi 2004, 2007). With the help of several case studies, many of which included heritage and cultural spaces such as museums, Ciolfi identifies the personal, social, cultural and physical dimensions of place experiences and develops on particular research methods to study each in relation to specific experiential contexts.

Interaction Design researcher and expert in interactions mediated by technology, Eva Hornecker has developed a comprehensive work focused mainly on the interrelation between space and place with emphasis on its implications for tangible interactions (Hornecker 2005, 2010, 2011, 2012; Hornecker & Shaer 2010). Rather than moving away from the role of geometric space in humans' interactions with their physical environment like Harrison and Dourish once did (1996), Hornecker embraces its meaning and relevance and argues that geometric space and its structural relations affect the ways people experience place and the interactions that occur in them (Hornecker 2005). Furthermore, through her work Hornecker proposes the concept of 'embodied facilitation' which refers to the ability of tangible interactive systems to enable people's bodily expressions and orientate their situated actions. Hornecker's work is particularly relevant to this doctoral project as most of her work explores the social embodiment in public spaces, many of them museums, galleries and cultural centres, and the bodily structures and behaviours resulting of the interactions taking place in these spaces (Hornecker 2012; Hornecker & Dünser 2009; Hornecker, Moritsch & Stifter 2004; Hornecker & Stifter 2006).

What I have presented here are only some of the most significant perspectives from the field of Interaction Design that focus on understanding spatial experiences of people's interaction and on how this understanding can inform the design practice. Although discussing from different perspectives and approaches, the common argument made by all these authors is the need to understand the interaction space not as a mere container but as a lived experience environment that holds meanings for its users both at individual and at socio-cultural levels.

2.3.1. Engaging in Public

A large body of research has been produced in the last few years regarding interactions in the public sphere, particularly in public installations, and the engagement of public with and within them. Most of this work has been developed based on case studies of real world situations (e.g. art installations, museum exhibitions). These empirical accounts have resulted in research contributions for the development of future interactive systems in the public realm.

During the 2003 *Interact Conference*, Harry Brignull and Yvonne Rogers (2003) presented *Opinionizer*, a large-scale display designed to support a community in their social activities. As explained by the authors, previous research had informed of a behavioural phenomenon in which public showed a prevalent resistance to interact in public, mainly due to social embarrassment. With this insight as a starting point, Brignull and Rogers analysed the different levels and types of engagement taking place around *Opinionizer* and developed a theory of conduct they named 'Honey Pot Effect' and a framework of distinct activity spaces around the installation (Brignull & Rogers 2003). Their research work resulted in an outline of design recommendations for practitioners to take into account that would facilitate public's transition from a remote activity space (where no engagement occurs) to a close activity space (where active engagement takes place). Although the authors contribute considerably to understanding the physicality of social interactions with technology in public, the design recommendations focused on positioning and physical attributes of the display, and no exploration of the emotional social responses was sufficiently undertaken.

A much deeper and comprehensive work on the social interactions occurring around public installations has been developed by researchers from the University of Nottingham and the University of Bristol and presented through two papers at the *2005 Conference on Human Factors in Computing Systems CHI* (Reeves, Benford, et al. 2005; Reeves, Fraser, et al. 2005). In one of their projects, Reeves et. al. studied the behaviours of audiences towards an augmented reality installation called *One Rock* (Reeves, Fraser, et al. 2005). The project aimed to explore the forms of interaction around the installation and helped produce an outline of different levels of social engagement that spanned between 'augmented users' and 'bystanders' (maximum engagement and minimum engagement, respectively) (Reeves, Fraser, et al. 2005, p. 9). The authors also identified active social collaboration and individual transitions across these levels. The other research project presented by Reeves et. al. explicitly explores audiences' social interactions around and with a public interface. Through field work, the authors found that people's engagement with an installation is directly related to the viewing of others interacting with it. According to Reeves, Benford et. al. (2005) those visitors who are directly engaged in the interaction with an interactive installation or exhibit are perceived by others as performers; conversely, those observing these performers are spectators of the interaction. The authors conclude that the manifestations and perceptions of interactions by performers and spectators, respectively, influence the ways in which the overall interactive experience unfolds. The main relevance of the work of Reeves et. al. is that it offers design practitioners a framework for understanding how social relationships affect and inform individual's engagement with technology in public spaces.

Since the 1990s, interaction and technology researchers Christian Heath, Paul Luff, Dirk vom Lehn and Jon Hindmarsh, from the *Work, Interaction and Technology Research Centre* (King's College London, UK) have been conducting research on social and public contexts of use of technologies, with their most recent works focusing on the particular interactions resulting from experiences with interactive exhibits and installations (Heath & Luff 2000; Hindmarsh et al. 2005; Luff, Heath & Pitsch 2009; vom Lehn, Heath & Hindmarsh 2001; vom Lehn et al. 2007). In *Engaging Constable: Revealing Art with New Technology*, vom Lehn et. al. (2007) research two installations in a museum exhibition at the Tate Britain art gallery (UK) and the effects of the surrounding spatial and social configuration on audiences' encounters with technology-enhanced artwork displays. Through this study and others of similar characteristics (Hindmarsh et al. 2005; vom Lehn, Heath & Hindmarsh 2001) the authors have found that social configurations and interactions in exhibition contexts are core elements in the complex process of engagement, having a great influence on the shaping of audiences' interactions. Going beyond the works of Reeves et. al. mentioned earlier, Heath, Hindmarsh, Luff, and vom Lehn argue that properties of interaction are not individually static and straightforward but highly variable and dynamically configured through the presence and interactions of other 'witnessing' visitors (vom Lehn et al. 2007, p. 1489). The authors conclude that individual decisions and actions are identified by others throughout the interaction and interpreted as personal possibilities of action which, once undertaken, are perceived by others as new possibilities of actions.

2.3.2. Social Exchange of Experiences

The review of the literature suggests that the study of the role of social interactions in the engagement with interactive public displays (e.g. installations, products, exhibitions) has become increasingly relevant in the research area of Interaction Design. Likewise, the value of supporting social exchange and negotiation in these contexts has been subject to a large amount of research.

As stated in the previous section, one of the most significant contributions in the research subject of social interchange in technologically enhanced public spaces has been that of Heath, Hindmarsh, Luff, and vom Lehn (Hindmarsh et al. 2005; vom Lehn, Heath & Hindmarsh 2001; vom Lehn et al. 2007). Several of the authors' works consisted of the generation of low-tech installations or exhibits as public interaction design probes out of which insightful research findings emerged. Through the examination of collaboration and social conduct of the audience of two installations, *Ghost Ship* and *Deus Oculi*, the authors reached two major research findings (Hindmarsh et al. 2005). The first finding regarded design aspects and how some attributes of the exhibits would prompt interaction among visitors. In particular, they identified that placement, arrangement, ordering and organisation of artefacts, parts and themes as an 'assembly' would coherently support visitors' experiences and allow them to progressively make sense of the exhibit. The second finding regarded the embodied experience of the visit. The authors identified that the incorporation of aspects of the audience's lived experience into the exhibit allowed for creative engagement. As a result, this would prompt social collaboration and participation, which was deemed by the authors as particularly successful in the process of engaging visitors with the displays. In *Creating Assemblies in Public Environments: Social Interaction, Interactive Exhibits and CSCW*, Hindmarsh et. al. call for a greater attention on the different forms of participation that can be facilitated through design and place particular emphasis on the value of well-organised assemblies of objects for the interaction and co-participation of public (Hindmarsh et al. 2005). They go on to argue that artefacts within an interactive assembly ought to be considered as part of a whole ecosystem of interaction and with relevant interactional relationships between them. This, they conclude, helps to emphasise the content of an exhibit over the efforts needed to interact with it.

A multi-institutional interaction research group developed in the UK the public display *Dynamo* to enable the sharing and exchange of a wide variety of digital media in sociable spaces such as common areas at universities and conferences, cafes, and hotel foyers (Izadi et al. 2005). The aim of the research project was to explore how existing communities make use of multimedia and interactive technologies within their own established physical and social setting. The authors found that digital information from participants' personal devices (e.g. mobile phones, computers) became a rich resource to spur dialogue and cooperation among participants interacting directly with the display and even with those close to it. Similarly to other research experiences (Brignull & Rogers 2003; Hindmarsh et al. 2005), Izadi et. al. found that the embodiment of aspects of participants' personal experiences into the interaction dynamic would typically draw participants towards the installation and support social exchange. The most relevant contribution of the work by Izadi et. al. to this doctoral research is the role of social exchange in the interaction with technologically-enhanced public installations as it strongly supports the individual engagement with the system and sense-making process.

2.4. Summary

This chapter has discussed the main technological, human and social aspects that interplay in the relationship of people with computer-based systems, particularly in public settings such as everyday shared spaces and museums. A review of the latest literature in the field of Human Computer Interaction and the discipline of Interaction Design, including conference presentations, journal articles and books has been presented, depicting the rich and comprehensive body of work available for the theoretical understanding of visitors' experiences with interactive exhibits. The central aspects of experience, engagement and meaning, both from an individual and social perspective have been covered. In addition, a specific review of the latest research on interaction in public spaces with particular emphasis on the context of the museum has been produced in order to connect the subject of technological developments with the subject of museums and audience's experiences with interactive exhibition environments.

The body of work examined in this chapter has mainly focused on the understanding of the nature of people's interaction with and within the technological world and the effects each element of the interaction (i.e. system, user, context and interaction itself) has on the other. As it will be argued in the next two chapters, more and more emphasis is being placed in museums on the importance of their visitors' experiences. In this respect, the work the discipline of Interaction Design can do to support such experiences with the help of innovative interactive technologies can be of considerable relevance if developed in harmony with the needs of both cultural heritage institutions and their audiences as users and consumers of technology and culture. The challenge rests on making proper use of the emerging technologies to add value to the museum situated activities by developing interactive systems in tune with who the users will be.

Chapter 3. The Shaping World of the Museum

As an interaction designer my relationship with the museum environment has mostly been informed by a professional interest in their physical configuration and the dynamics associated with it. In order to familiarise myself with the diverse attributes of the museum's mission, message, audience and activities and appropriately position my research within the field I have conducted a thorough review of the existing literature in museum studies. Through this chapter I emphasise the ever-changing nature of the museum as a public cultural heritage institution and the ways it responds to an audience that increasingly demands a novel experience out of their visit. The museum audience is here discussed as a party that not only attends the institution to acquire new knowledge but also contributes to its identity through its particular comprising individualities that inform the ways the museum delivers its message to the community. This message, on the other hand, is discussed from the perspective of its delivery media (the exhibition space and displays) and format (the museum artefact), constituting together the physical platform on which the learning experience develops.

3.1. A Museum Definition

The International Council of Museums (ICOM)[2] regularly revises the definition of what constitutes a museum as a way to truthfully reflect the role these have in a society marked by continuous change. In 1998, ICOM defined its strategic objectives, two being the most important: the adaptation of the museum profession to changing global situations and a stronger support to museums as institutions of social and cultural development (International Council of Museums 2005). In 2001 a museum was defined by ICOM as an institution of no profit and open to the public, in permanent service of society and its development; an institution "which acquires, conserves, researches, communicates and exhibits, for purposes of study, education and enjoyment, material evidence of people and their environment" (The

[2] The International Council of Museums is an international network of museum professionals and experts that comprises approximately 14,000 cultural heritage institutions around the world. The organization not only provides the most widely accepted and adopted definitions of museums but also is an international forum for the discussion and promotion of museum practices. For more information about ICOM see their institutional website: http://www.icom.org

International Council of Museums 2001, p. 2). The most recent version of a museum definition was updated at the 22nd ICOM General Assembly of 2007 in Vienna as the following:

> *(…) a non-profit, permanent institution in the service of society and its development, open to the public, which acquires, conserves, researches, communicates and exhibits the tangible and intangible heritage of humanity and its environment for the purposes of education, study and enjoyment.*
>
> *ICOM Statutes, Article II (The International Council of Museums 2007)*

As it can be inferred from both definitions, a slight yet significant change to the characterisation of museums was introduced in the *2007 ICOM Statutes*: a differentiation between tangible and intangible heritage was made explicit. In recognising that humanity's heritage is both tangible and intangible, acknowledgement of the many forms of cultural content transfer in the institution has been materialised. In addition, the statement stresses the displaying or exhibiting focus of the institution as a key attribute of its unique cultural institution mission. Another key attribute of the museum, as declared through this definition, is its accessibility: museums are public spaces, open and equally accessible to all members of society[3].

Theorists around the world complement ICOM's museum definition from different perspectives within the field of Museum Studies (e.g. curatorial practice, exhibition design, management, educational programs, audience research, etc.). Upon a review of the rich literature available, museums are further defined as free-choice or informal learning environments that provide an extensive range of tools for visitors to construct cultural meaning, both individually and as part of a community (Anderson 2004; Falk & Dierking 1992, 2000; Graham 1997; Hein 1998; Hein & Alexander 1998; Hein 2000; Kelly 2007b; Stenglin 2006). As opposed to other institutions whose main purpose focuses on the provision of education in

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[3] Through this dissertation I make no definite distinction between different types of museums (e.g. science centres, natural history museums, historic houses, art galleries, etc.) as this is not the purpose of my research. As my primary research interest is concerned with the notions of interactive exhibitions and visitors' experiences with them, I herein refer to museums in the broader sense of the definition above presented yet with a strong focus on its understanding of collection display and their audiences' relationship with it.

formal ways (e.g. schools and universities), museums offer a self-directed learning environment to which audiences attend voluntarily driven by their own interests and needs (Black 2005; Falk & Dierking 1992; Lang, Reeve & Woollard 2006). However, as it will be argued through this chapter, people visit museums in search of more than just a complementary, flexible acquisition of knowledge. People visit museums in search of a new experience in which learning and entertainment coexist and are attained through an active engagement with the physical and social environment. This is today's museum audience, an audience that has evolved through history shaped by cultural, technological and social changes (Bennett 1995; Jones-Garmil 1997; Knell 2003; Message 2006). In order to better understand today's audience and keep responding for an audience of tomorrow, it is essential to deeply familiarise with the many elements that comprise the museum context today, starting with its history.

3.1.1. From Cabinets of Curiosity to Engaging Experiences

Museums as relatively public depositories of objects deemed relevant for their historical, aesthetic or cultural value can be traced a long way back in history. As Edward Alexander and Mary Alexander explain in their book *Museums in Motion. An Introduction to the History and Functions of Museums* (2008) the Hellenistic civilisation witnessed the first centres of western cultural, scientific, and artistic activities, in which several items were kept and utilised for purposes of educational and philosophical nature. Later, during the extensive Roman Empire period, artefacts of aesthetic worth were highly appreciated, collected and to some extent exhibited to a selected audience. Although not considered museums as such, these collections shared a common attribute with one of the main characteristics of modern-day museums: they were available to a public. The authors go on to explain how in the European Medieval Period (5th century to 15th century) the Christian churches took the collecting role over from the State, developing rich collections particularly in their premises of worship (Alexander & Alexander 2008). This meant a step backwards from collections available to public to rather secluded ones.

In the light of the Renaissance movement, new elements in the collection of artefacts arose. In particular, collections would now have a dedicated space for protection and display: the cabinet of curiosities. This is regarded by many authors as the moment in history when modern museum institutions began to take shape (Alexander & Alexander 2008; Bennett 1995; Hooper-Greenhill 1992). Cabinets of curiosity emerged in higher classes of society (i.e. the wealthy merchant class) and were commonplace all over Europe. In the book *Museum and the Shaping of Knowledge* Eilean Hooper-Greenhill (1992) explains that the people of these classes would frequently acquire and collect 'curious' objects - mainly of cultural or natural history value - and make them available for other wealthy citizens to appreciate in semi-exclusive instances. Cabinets of curiosities, therefore, were mainly related to a social process of private glorification. Museum theorist Tony Bennett affirms that the real purpose behind this collecting practice was to emphasise the wealth of the own class and proclaim a position within society (1995). Nonetheless, the acquisition of these unique and rare artefacts and specimens was still driven by a sense of curiosity. When the thirst for status lessened towards the 16th century, a variation of the cabinets of curiosities surfaced. Cabinets of the world, as they were called, focused more on the collections' phenomena (Hooper-Greenhill 1992). In particular, the extensive imperialist explorations further stimulated the existing collecting practices and allowed the generation of world-wide representations in one single cabinet. As the author describes, cabinets became encyclopaedic collections that somehow helped understand and explain natural phenomena.

Several authors regard the Enlightenment as the period in which the public nature of the museum started to take a more definite shape (Alexander & Alexander 2008; Anderson 2004; Bennett 1995; Hooper-Greenhill 1992). According to Maroević in *Introduction to Museology - The European Approach* (1998, cited in Dindler 2010), many collections were first trusted to universities to be made available to the academic and general public. In the 18th century museums entered the public sphere as established institutions with the commitment of collecting, preserving, studying and displaying objects of scientific, artistic, or cultural value. Consequently, early museums were both places of study and of public display. This was the time in which museums such as the Louvre Museum and the British Museum were established.

Numerous other public and national museums were established, many reaching a highly specialised nature within a couple of centuries (Bennett 1995). The Age of Enlightenment was marked by an appeal to logic, reason and science for which museums became a means. Its purpose was to civilise and educate the citizens by teaching them through the display of objects, which were considered the actual sources of knowledge (Bennett 1995; Hooper-Greenhill 2000). The museum as a pedagogical institution was, according to Bennett, one of the many public institutions of the 18th century that was not only providing mass education but encouraging the 'lower classes' to visit them (Bennett 1995, p. 19). Of particular interest is the way material was delivered in the 18th century museum. The educational goal of enlightening the masses was achieved through didactic and logically organised exhibitions, based on sequences of themes in space and time (Hooper-Greenhill 2000).

From the 18th century on, museums remained public and pedagogical in their core mission, as affirmed by several authors (Black 2005; Caulton 1998; Falk & Dierking 1992; Hein & Alexander 1998; Hein 2000; Kelly 2007b). In the 'postmodern' museum the educational goals are still achieved by means of organised narratives in varied forms such as recounts, reports, interpretations and blends of these. Yet, as explained by Maree Stenglin in her analysis of the spatial and social evolution of museums throughout history (2006), several other elements came to play in the closing decades of the 20th century leading museums to a hybridisation. The 'hybrid' museum maintains the educational purpose; however, rather than imposing behaviours it aims to provide platforms for social change. On the other hand, the 'hybrid' museum embraces the concept of entertainment in its mission discourse. The increasing perception of museums as participants of the leisure market has been a significant factor in the rising of the 'hybrid' museum (Australian Bureau of Statistics 2010; Bennett 1995; Scott 2000; Stenglin 2006). As a result, museums have engaged in the realisation of several additional functions with the purpose of improving the quality and range of their institutional offer (e.g. hiring facilities for external use, strengthening retail, increasing services, etc.). Additionally, museums have diversified their exhibitions' repertoire and tenor by integrating higher interactive relationships between their collections and visitors, incorporating active participation of their audiences in research and development processes, extending their services beyond the venue's physical limits, to name a few responses (Caulton 1998; Chatterjee 2008; Jones-Garmil 1997; Keene 1998; Knell 2003). This entertaining aspect of the museum has vividly fed the debate on the social purpose of the museum (Anderson 2004; Black 2005; Caulton 1998; Griffiths 2008; Lang, Reeve & Woollard 2006; Thomas & Mintz 1998). A particular concern in this respect, for example, is the confronting realities of certain sensitive exhibited topics (e.g. indigenous communities, human rights violations, war-related presentations, etc.) and the new museum's emphasis on entertainment and leisure servicing as they call for most usually conflicting emotional responses.

3.1.2. A New Museum, New Challenges

Much more could be written about the evolving aspects of the museum's identity and the different paths it has taken throughout history. As an institution whose reason to exist has always been society, every change occurring outside its walls has been certainly to affect what happens inside those walls as well. The concept of museums as repositories of untouchable relics and curious formerly living beings, with its thick veil of respect and distance, has been disappearing swiftly in the last two decades. As it will be argued throughout this chapter, museum audiences are no longer comprised of passive guests but demanding, active participants. In what is essentially called the "new museum" audiences can expect to encounter open spaces for active exploration and discovery, and to build, through collections and together with other visitors, their own personal experiences (Hooper-Greenhill 1992, 1999a; Kelly 2007b; Lang, Reeve & Woollard 2006; Weil 2002).

As the role of the museum has evolved, so have its functions. Graham Black (2005) in *The Engaging Museum. Developing Museums for Visitor Involvement* describes the different parties that have contributed to the shaping of the new museum, these being overall governmental agencies, the public and the museum itself. Black acknowledges the supporting nature of the governmental apparatus in terms of museums' development and structure of their educational programs; this is mainly due to the confidence they have on these institutions as promoters of economic, social and local innovation. Nonetheless, Black also underlines the fact that the state no longer assumes the total responsibility of funding museums; today the pressure is on museums to either become self-funding or be fully accountable to the governments that founded them. This view is further supported by other authors who, in addition, explain how an important part of their audience affiliation is driven by the substantial contribution they mean to their budget (Anderson 2004; Lord & Lord 1999; Sandell 1998; Scott 2000).

Black sees in the new museum's audience as a better educated population with higher expectations both in terms of what they get and what they can contribute (Black 2005). As an audience with more access to information thanks to new technologies, they are also aware of how much value they can get from their money and how much that money can produce in the museum environment. Moreover, audience research and development specialist Carol Scott argues that today's visitors are led by an accelerating pace of a society that is "favouring fun and entertainment over leisure that requires intellectual commitment" (Scott 2001, cited in Stenglin 2006). Nonetheless, Scott believes museums are not only aware of this but also well prepared to respond. In this respect, Black agrees with Scott and further contests that museums know their audiences well: who they are, what they want and what they expect of their experiences (Black 2005). According to Black (2005), museums are deeply engaged with their audiences, feeling a growing obligation to meet their demands, particularly those related to their local perspectives. Corresponding with this view is Kylie Message's approach to visitors' individualities in which she sees a socio-political challenge of cohering the "local context, state and global flows of politics" into a single narrative (Message 2006, p. 34). In the new museum, both internal and external practitioners (e.g. curators, exhibition designers, educational program developers, researchers, etc.) have become co-responsible for building the foundations of local identities and cultural development. It is no longer the representation of information through their collection that drives this but the mediation of the visitors' interpretive experiences to ensure a more engaging and meaningful visiting encounter.

As briefly introduced so far, today's museums are public institutions with a strong educational role in whose physical and virtual domains a broad range individuals find a free-choice learning environment as well as a leisure alternative. Through their collections, museums facilitate in their audiences a process of cultural self-reflection and shaping of both individual and collective identities. The museum artefact - the interface between visitors and new knowledge - becomes a tool for meaning-making, learning and building of social connections (Anderson 2004; Falk & Dierking 2000; Hein & Alexander 1998; Kelly 2007b; Weil 2002). From a heritage perspective, museums treasure and protect the legacy of a culture, deemed as significant by its community, at the time they mediate its renewal in an ever-changing context. They do so with an inclusive approach, making their collections accessible to everyone and consequently improving society's cultural advancement. Museums do not simply provide an educational and entertaining service; they provide an experience that changes peoples' lives. This experience develops within a dynamic process that involves an individual, a social and a physical context. These core components of the museum visiting experience are explored in the following sections.

3.2. The Museum Audience

In the last 25 years many studies have been conducted in order to define a profile of museums' visitors. Whilst the British museum visitor, for instance, was portrayed in the publication of a study conducted by Nick Merriman (1989), the museum audience in the United States of America was later researched by Marilyn Hood (1995). Both studies reported similar findings regarding visitors' characteristics which revealed that their particular educational backgrounds were the common indicator of their visiting behaviour. This finding is consistent with other publications concerned with museum visiting performance around the world (Anderson 2004; Lang, Reeve & Woollard 2006; Lynch et al. 2000; Message 2006; Stenglin 2006). In Australia, on the other hand, research on museum audience's profiles has been conducted by individual specialists as well as by institutions, showing that the local audience is not much different from their overseas counterparts. Tony Bennett (1994) surveyed different characteristics, attitudes, behaviours, and patterns of both visiting and non-visiting audiences, and concluded that museum visitors have higher levels of education than those who do not visit museums; furthermore, the author found that art gallery visitors' educational profiles were even higher. A research project commissioned in 2000 by the Australia Council to the market research agency Saatchi & Saatchi Australia also revealed a strong connection between audience's educational levels and their attitude towards visiting museums. Australian citizens are indeed more familiar with the museum environment the higher their educational qualifications are (Costantoura 2000).

More recent studies have been further inclusive in terms of audience's background diversity. Graham Black's seminal book *The Engaging Museum. Developing Museums for Visitor Involvement* (2005) presents findings from numerous case studies performed in Canada, the United States of America, Australia and England since the 1990s along with an extensive review of the literature. In his work Black contests that most museums' audiences are comprised of groups of two or more persons, mainly family and friends. Consistent with the above mentioned researches' outcomes, his study also reveals that museum audiences are highly educated; on average, 60% of American, Canadian and Australian visitors have achieved a higher education degree. Black also contends that this is a group more likely to be interested in art galleries and art-related activities such as temporary installations and outdoors art events, which typically encourage this group's sense of cultural discovery, learning and understanding.

Diversity of audience and their particular characteristics are well explored in the work of two renowned Australian museums and their audience research units: the Australian Museum, in Sydney, and the National Museum of Australia, in Canberra. These institutions, through studies conducted by their widely-specialised research staff members, address issues as varied as disability, ethnical background, educational needs, and age groups. The Australian Museum, for instance, has developed a meaningful work with its Indigenous audiences, both researching their particular needs, expectations and feelings, and making them part of their exhibition development process through participatory design strategies and straight collaborations (Kelly, Bartlett & Gordon 2002; Kelly & Gordon 2002). The same institution, in collaboration with the National Museum of Australia, conducted research on two particular audience groups: family and elderly (Kelly et al. 2004; Kelly et al. 2002). Research on families' museum attendance reveal, among many other findings, that this group enjoys learning together and sharing knowledge and experiences, they have a strong preference for exhibitions that engage them both physically and intellectually, and they value being able to select content throughout their visit according to their interests and needs. Older audiences, on the other hand, show to be a group in steady growth henceforth highly relevant for museums' attendance rates, they are a group that genuinely enjoys learning more and on their own interest and pace, and they tend to revisit the museum when there are new exhibitions presented.

From these research examples it can be concluded that, on a generalised international scale, public attendance to museums is strongly driven by the public's socio-cultural backgrounds. Within this scope, what concrete factors influence the public and their decision to either visit or not visit museums? The following section explores museum attendance and the socio-cultural factors that inform this decision-making.

3.2.1. Overview of Museum Attendance

As described earlier in this chapter, one of the main challenges museums encounter nowadays is the need to capture an audience large enough to ensure a successful balance between budget and performance. Visitor attendance is widely used by governments and the internal administration of cultural heritage institutions as a performance indicator to assess the ongoing viability of the institutions (Australian Museum 2011; Falk & Sheppard 2006; Lord & Lord 1999; Scott 2000; Weil 2002). In order to respond to this challenge, museums have adopted several strategies such as staging more varied exhibitions, generating special events, introducing novel exhibiting techniques and expanding their services through new platforms such as internet and social networks. These strategies, as suggested by the literature, have been successful in the upholding of visitors numbers yet there show insufficient in capturing those less likely to attend.

Tony Bennett has identified through his work several groups of visitors based on their museum attendance behaviour. He argues that since there is a strong connection between educational background and museum visiting inclination, there might always be a group of people who will remain unlikely to visit museums (Bennett 1994, 1995). This group was labelled by Bennett as "confirmed non-goers" as they directly declare not been interested in cultural activities or the institutions they house them.

Towards a more optimistic categorisation of audience are the remainder groups, which can be broadly defined as "goers". Once again, the work of Graham Black provides a substantial understanding of audiences and their visiting trends (Black 2005). The author identifies five categories of museum audience according to their visiting frequency and motivations. According to Black, there is a group of visitors that regards the museum as a place for social, recreational and educational activities; this group, known as the "informal visitors", expect good facilities and an enjoyable experience for all ages and cognitive levels. "Family and children" are categorised by Black in a separate group; this group seeks an educational experience, complementary to formal education, based on a sense of discovery, active engagement and recreation. Those visitors who tend to attend the museum more than once are called the "repeat visitors"; their re-visiting experience is informed by either previous successful experiences or the interest on new exhibitions. "Regular visitors" consider museum visiting as part of their regular activities agenda; they are mostly eager to constantly learn or highly interested in particular topics and tend to become actively involved in diverse museum's activities (e.g. they become members, join special events, contribute with donations, etc.). Finally, the "special interest visitor", as Black calls them, has a specialised knowledge in the museum or exhibition field and tends to have some influence on the content displayed; this group may have dedicated or special access to part of the museum's collection that is not displayed due to their particular expertise (e.g. scientists, researchers, governmental units).

Although Black's categorisation is rather comprehensive, it omits the "non-goer visitor" and another visitor which is highly relevant for museums as well: the potential visitor. This group of potential visitors was identified by Nick Merriman and presented in the book chapter *Museum Visiting as Cultural Phenomenon* (Merriman 1989). After interviewing both "museum goers" and “museum non-goers” he identified that a “potential visitor” was arising as the result of a general expansion in secondary education and a better financial situation of society in general, which meant more time and budget for leisure activities. In addition to this social phenomena, museums were becoming more numerous and their quality was improving considerably, which led the author to allege that “more people than ever before have the structural and intellectual opportunity to take advantage of heritage presentations” (Merriman 1989, p. 169). In the study conducted for the particular field of arts in Australia mentioned earlier, *Australians and the Arts: What do the Arts Mean to Australians?*, the potential visitors are labelled as “sleeping giants”, rather indifferent to museums and the arts yet with great potential of becoming visitors (Costantoura 2000, p. 20). Although focusing on a visiting attitude towards art-centred museums, “sleeping giants” are significant to the overall museum sector since research evidence shows that once introduced to the museum dynamics, visitors tend to increase the frequency of visit and expand their interests (Costantoura 2000; Falk & Dierking 2000; Lynch et al. 2000; Merriman 1989).

3.2.2. Factors Influencing Visitors’ Attendance

For potential visitors or sleeping giants to become museums visitors of some range museums need to facilitate an initial visit and maintain the interest for further visits. In this respect, Merriman’s research suggests that a sense of relevance is fundamental for visitors to attain interest in what the museum has to offer (Merriman 1989). According to the author 55% of non-visitors and 38% of the British population who rarely attend museums state that they consider museums provide content with little or no relevance to their lives (Merriman 1989, p. 156). In the Australian context, on the other hand, 35% of Costantoura’s research participants informed that, although content was deemed appropriate, it was mostly irrelevant to them (Costantoura 2000, p. 13). Considering that until the early 21st century institutions with an educational role would mostly deliver content for the sole sake of imparting knowledge, relevance is a concept has contributed enormously to the feeling of belonging of museum audiences. Today’s museums work towards the design of a program that makes a connection with their audiences, which addresses their everyday interests, needs and expectations.

Similarly to relevance, the concept of prior experience is highly influential in the decision-making of visiting museums and remaining as regular audience. Several authors highlight the role prior knowledge and individual perceptions have on the shaping of visiting behaviour (Falk 1998; Falk & Dierking 1992, 2000; Hooper-Greenhill 1992; Kelly 1999, 2007b; Lang, Reeve & Woollard 2006). In the category of adults, for example, Lynda Kelly has found that an upbringing that includes museum visiting in some degree has a great influence for a future positive visiting behaviour (Kelly 2007b). The desire to further knowledge is also regarded in literature as an influential factor in the visiting behaviour, even when most visitors are not necessarily conscious of this motivation as part of a learning-driven experience (Falk & Dierking 2000; Hein 1998; Hooper-Greenhill 1999a).

In her work on semiotics of space within the museum context, Maree Stenglin explores the nexus between public access and public displays and how these influence the process of new visitors becoming regular visitors (Stenglin 2011). Drawing from several case studies, the author concludes that the initial challenge for museums is to make newcomers feel welcome and comfortable in the space by providing a clear spatial language that evokes exploration, belonging, and opportunities for attaining the content offered as well as the social connections available. In a previous research, Stenglin also identified the influence schools - as formal education institutions - have in the forming of this sense of bonding (Stenglin 2006). In her opinion, "many schools do not regard museums as integral to the school curriculum" and even "regard museum visits merely as 'fun' outings" (Stenglin 2006, p. 8). Nonetheless, the author argues that generating a lasting disposition towards museum visiting is not a task restricted to schools or families, but an essential role of the museum itself.

3.2.3. What Visitors Expect and What They Do

Drawing from the review of literature presented so far it is possible to delineate a set of needs and expectations visitors bring to the museum to be fulfilled. Irrespective of the type of visitor or the category to which they fall, all museum visitors expect to find a safe and comfortable place in which to freely learn by choice, yet given a certain level of guidance in the process (Black 2005;

Hooper-Greenhill 1992; Stenglin 2011). Today's museum visitors expect to be amused, surprised, and somehow tickled by new knowledge, yet they expect there to be a structure, logic and quality in the content (Falk & Dierking 2000; Hooper-Greenhill 1999a). Visitors expect to be taught something, yet have fun in the process (Black 2005; Caulton 1998). Visitors expect to have a social experience, yet find the mental and emotional space for an individual experience (Belting 2006; Black 2005; Kelly & Gordon 2002). Visitors expect to find something new every time they visit the museum, yet they also expect their favourite exhibitions to still be waiting for them (Lorentz 2006; Stenglin 2006; Thomas & Mintz 1998). Visitors expect to be shown the past and the possibilities of the future, both through ancient artefacts and novel display formats (Chatterjee 2008; Keene 1998; Lynch et al. 2000). In summary, museum visitors expect a unique experience - a balanced mix of cognitive, emotional, social and physical experiences - which will not be available anywhere else but in the museum.

The variables of human nature, more specifically needs, expectations and behaviours, are impossible to predict with total certainty as social realities are too complex to be revealed without understanding personal meanings of experience (Gilbert 2008; Ihde 1977; Kuniavsky 2003; Mack et al. 2005; Silverman 2010). The individual and social realities of museum visitors vary throughout the visit, prior to it and afterwards. The museum visiting experience is a constantly changing reality, transformed by the individual and guided by the museum space and its parts. In the book *Learning in the Museum*, George Hein (1998) introduces several research techniques for the study of audience's behaviour within the museum visiting process. Of particular interest is his mentioning of John Falk's categorisation of museum visiting behaviour in an analogy with department store shopping behaviours (Falk 1982, cited in Hein 1998). Falk identified "serious shoppers", those visitors who attend the museum with a clear, predetermined notion of what they want and expect to encounter; the "window shoppers", those visitors who attend to explore possibilities and could eventually turn into "serious shoppers"; and the "impulse shoppers", those visitors who explore a few exhibits and find them unexpectedly interesting, so that they become more engaged with the visit. This seemingly marketing-like metaphor of museum visiting behaviour, albeit with an added scent of humour, is an early reflection of what would soon be widely referred to as "the experience economy", the understanding of experience as a commodity, a good or service (Pine & Gilmore 1998). Another interesting metaphor for representing visitors' behaviour in museums presented by Hein is that of Veron and Lavasseur (1989, cited in Hein 1998). In this case, the authors used a metaphor consistent with the actual case study context: a natural history museum. Veron and Lavasseur categorised their research subjects according to animals' behaviours. Thus, visitors who methodologically moved from one object to another were represented by ants; visitors who moved randomly among the exhibits just to alighting on a few were represented by butterflies; visitors who chose to pay attention to specific artefacts, hopping from one to another were represented by grasshoppers; and those visitors who glided in and out of the exhibition space stopping on a limited exhibits were represented by fish. Hein explains that the classification of visitors' behaviours focuses mostly "on generalizing and providing quantitative, comparable data" (Hein 1998, p. 105); however, as it will be argued both in the Methodology Chapter and through the primary data collection of this research (Case Study Chapters 6, 7 and 8), audience behaviour can only be truly understood by means of mixed qualitative and quantitative research.

3.3. The Museum Space

3.3.1. The Material of Stories

As claimed by museologist Hans Belting in his essay *Place of Reflection or Place of Sensation?* (Belting 2006) the museum is today a redeemer of the material world, representing through their displayed artefacts a microcosm of it. In his own words, museums have been "chosen to rescue from the fast tempo of progress that which would have been irretrievably sacrificed to the idol of the constantly new" (Belting 2006, p. 75). The museum objects, commonly referred to in the field literature as the artefact, are a physical expression of a human connection with past and current history, geography and society, which meaning, according to Eilean Hooper-Greenhill, is constructed within social relationships (Hooper-Greenhill 2000). Accordingly, the museum artefact is regarded as the memory of humanity positioned throughout the world's history and embedded with both tangible and intangible attributes (Belting 2006; Crane 2000; Hooper-Greenhill 2000).

Despite of the fundamental role the artefact has within the museum' interpretative context, the information which the institution intends to convey is not the artefact itself, but rather the currents of thought and meaning connected to it. In this respect, Susan Crane suggests in *Museums and Memory* that in the museum displaying practice memories are "removed from the mental world and literally placed in the physical world" (Crane 2000, p. 3). Memory and the acts of remembering and recollecting are intrinsically connected to the museum artefact and, subsequently, to the museum as an institution to the service of society. As contested by Hans Belting, museums are thus "places of stored time where the collective memory lies" on the material and immaterial connection between artefact and human activity (Belting 2006, p. 77). Crucial to understanding the meaning of the museum artefact in its cultural transmission role is the work of French philosopher and sociologist Maurice Halbwachs. As explained by Kay Edge and Frank Weiner, Halbwachs was a pioneer in addressing the issue of sociocultural memory and the dichotomy between collective and historical memories (Edge & Weiner 2006). Collective memory, according to Halbwachs, is based on a shared framework of remembering the past, comprised of common symbols and beliefs and supported by a social structure through oral transmission, or storytelling (Halbwachs 1925, cited in Sandino 2006). These collective frameworks of memory represent currents of thought and experience beyond factual information such as names, dates, or formulas. Conversely, historical memory comprises a much extensive span of time, commonly on a global scale, and is typically deprived of a personal voice. As opposed to collective memory, in historical memory the past is constrained in comparable terms: memory is demarcated into a time-based representation providing a mere summarised vision of the past. Edge and Weiner claim that these two concepts continue to be a source of conflict among contemporary history and museum theorists, and informing the different approaches museums take in their delivery of interpretive material through objects (Edge & Weiner 2006).

Through his work, museum theorist Tony Bennett has been emphatic in demarcating the limit line between artefact as an object and artefact as means for recollection. According to Bennett, in the process of abstraction and dissemination of its intangible cultural essence to safeguard an objective representation, the artefact loses its connection with living history and effective memory (Bennett 1993, 1995, 2006). He states that once placed in the museum the artefact dissipates and becomes a rhetorical object "lacquered with layers of interpretation" (Bennett 1993, p. 72). He further explains that the visitor "is never in a relation of direct, unmediated contact with the 'reality of the artefact' and, hence, with the 'real stuff' of the past" (Bennett 1995, p. 146). This reflection is often discussed in the museum literature as a challenge for cultural heritage institutions in regards to a meaningful delivery of content through museum artefacts and displays (Bennett 2006; Crane 2000; Hooper-Greenhill 1999a, 2000; Knell 2003; Weil 2002). Drawing on Bennett's observations, the museum needs to guarantee its displayed collections are not just preserving or petrifying past in 'mausoleums' of objects but rather carrying it into the present through active inscriptions of real historical forces (Bennett 2006).

Since the formal recognition of museums as public institutions in the early 19th century, and up until recently, the display of interpretative material has mostly followed the lines of a historical memory framework. As explained earlier, this approach takes the audience along a narrative-based experience in which one event generates and/or follows another in a temporal sequence. Tony Bennett calls this mode of representation "sequential locomotion" (Bennett 1995). This cognitive and physical arrangement of content tends to neglect intimate details of the society represented. In the museum curatorial and design context, practitioners have the opportunity to evoke emotion and impart conceptual and intuitive knowledge in their audiences, giving collective memory a more appropriate place. With new and emerging display technologies new interpretative approaches are emerging in which the simple disposition of objects for display give room to a more continuous and meaningful presence for the public. As suggested by social theorist Barbara Mistzal, this may not only invigorate the collective memory but also facilitate visitors' impregnation with knowledge throughout the museum experience (Misztal 2003).

3.3.2. Communicating Through Displays

Exhibitions, or public displays, are the main means by which museums present their collections to their audiences. They are the one feature that is common to all types of museums and that makes them unique within the context of public pedagogical and cultural institutions (Hooper-Greenhill 2000; Kelly & Gordon 2002). In his book *The Birth of the Museum. History, Theory, Politics* Tony Bennett (1995) argues that the museum's focus on learning and education is what distinguishes it from other display-driven institutions such as fairs, theme parks and circuses. As simply yet truthfully put by Kathleen McLean, "the most prominent and public of all museum offerings, exhibitions are the soul of a museum experience for the millions of people who visit them" and for anyone who is involved in the process of developing them (McLean 1999, p. 83). Public displays play a crucial role in supporting the museum artefact, its selection and grouping. Using a wide range of media museums develop unique carefully constructed spatial compositions to make their collections accessible to the general audience in their public spaces (Belcher 1991; Jones-Garmil 1997; Stenglin 2006; Thomas & Mintz 1998). The social and institutional purpose of displaying publicly is that this facilitates undifferentiated access as well unique learning and social experiences (Caulton 1998; Falk & Dierking 2000; Hooper-Greenhill 2000; Scott 2000).

As supports for the transfer of knowledge, exhibitions become communicational tools. As claimed by Hooper-Greenhill in her book *Museums and the Interpretation of Visual Culture* (Hooper-Greenhill 2000) even the most advanced museums sometimes fail in utilising appropriate models of communication in their exhibitions as they display information in a linear model from an expert authority to an uninformed receiver. Although museums are institutions with clear authority in their particular fields of expertise, and as it has been argued visitors do expect to receive from them new knowledge, such communicational model might jeopardise the way in which visitors engage with the exhibitions' topics. Hooper-Greenhill's concern about the linear transfer model still adopted by some museums in their exhibitions finds resonance within an increasing number of museum theorists and practitioners who reflect on the current role of the museum and invite for a dialogical relationship between the institution, its visitors and the society as a whole (Kelly 2007b; Lorentz 2006; Message 2006; Stenglin 2011; Weil 2002).

3.3.3. Displayed and Spatial Narratives

Museum artefacts are material and immaterial elements that represent the particular attributes of a culture. These objects are displayed to the public as they have some meaning attached to them. In today's museums, this meaning is presented and communicated to visitors for their discovery in some form of narrative. We humans use narrative structures to build our ideas of culture, place and history - to make sense of the world (Lacey 2000). Since cultures started making use of some mode of communication (e.g. graphic, spoken, written language) people have used stories to represent events, remember them and learn from them. Media theorist Nick Lacey (2000) argues that narrative is the one thing that differentiates us humans from other species. Narratives are typically associated with storytelling traditions taking the form of varied media such as poetry, music and films.

The museum is another way of narrating stories about us and others, about our past history and our current context. In the museum stories are not only told, they are also built through the meaning-making process visitors embark on in their engagement with the museum content (Kelly 2007b). Unlike a lesson, a story allows its receptors to reflect and discuss along as it unfolds. As Leslie Bedford argues, narratives facilitate personal connections between the museum visitor and the content presented as they "enable people to imagine themselves in an unfamiliar world" (Bedford 2001, p. 31). The author goes on to assert that they "inspire wonder and awe; they allow a listener to imagine another time and place, to find the universal in the particular, and to feel empathy for others" (Bedford 2001, p. 33). In other words, narratives as an interpretative approach assist museums in the engaging of their audience with the cultural and educational content they deliver.

According to Hooper-Greenhill (2000) museum narratives are achieved by bringing onto one same space a variety of artefacts ranging from different sources; these are put together, sorted, classified and organised through display into a predominantly visual narrative. The physical proximity of the artefacts increases their significance as part of a larger, more comprehensive whole. The museum experience is generally embedded in a narrative structure that involves some form of potential information transfer to the audience members. As argued by Diana Lorentz in her research on immersion and museum exhibitions, narratives are not only to be considered as a final outcome (i.e. the exhibition or display) but as a constant approach to the designing of the visiting experience, particularly "during the planning stage to create a thematic breakdown of the exhibition" (Lorentz 2006, p. 95). The designer, she alleges, is responsible for creating a narrative that will add value to the sensory nature of the experience. From a design practitioner's perspective, understanding the communicational value of narratives makes it possible to guide visitors to easily attain information, creating physical and emotional engagement with it.

Kerstin Dautenhahn (Dautenhahn 1993) asserts that storytelling in the museum contributes to the building up of social interactions as visitors receive information both as individuals and groups. Yet the success of such interaction and information capture will depend, she adds, on visitors' perception and organisation of the information, their cognitive processes and their ability to emotionally respond. According to Dautenhahn, a complete and successful narrative structure follows a 'who, what and why' format: it introduces its character(s), develops a sequence of events that can convey meaning, provides a temporary platform for interpreting the past or envisioning the future, provides a high point or resolution, and presents unusual events or situations.

3.3.4. Space in Narrative

In his work on Virtual Reality (VR) as a tool for educational purposes, Christopher Wickens (1992) explains that a rhythm of elements structure literary narratives in a way that maintains the interest of the receiver; some of those elements that may be included in the narrative are plot developments, complications, turnarounds or obstacles to be overcome. This structure of narratives can also be extrapolated to physical contexts, such as museum exhibitions. In such spatial contexts visitor encounter experiences as revealed in similar ways literary narratives unfold: there are all sorts of transitions between spaces (physical, cognitive and emotional), spatial attributes dress the scene with varying lighting and ambience, surprising content is revealed, etc.

Spatial narratives can be defined and analysed in a similar way to literary ones. In the book chapter *Spatial Narratives* Mark Rakatansky (1991) explains that the difference between spatial and literary narratives is given by the subjectivity or objectivity implied through the presence or absence of who articulates the discourse. According to the author, in understanding narrative as a construct, interior architecture - which includes exhibition design - needs to be linear yet centred on an event, and needs to have an objective structure and plot. As proposed by Lorentz (2006) a well-designed spatial narrative enables visitors to more easily access and engage with the museum content. For such structure, she goes on to explain, it is important to facilitate in visitors the identification of relationships between different sets of information and spatial forms and present graceful transitions between them. Through her research, Lorentz has identified two main types of narrative in the museum exhibition environment: the textual and the visual narratives (Lorentz 2006, pp. 102 - 3). While textual narratives are associated directly with literary narratives, visual narratives relate to the three-dimensional display of objects and graphic material. As the author explains, visitors move freely throughout the exhibition space selecting aspects of the narrative according to their interests, which allows them to create their own meaning and experiences even when some aspects of the narrative have been skipped. In addition, interaction with the displayed material is enhanced with visitors' potential revisiting of the narratives.

The research on the semiotics of three-dimensional space by Maree Stenglin (2006, 2011) also contributes greatly to the understanding of spatial narratives. Based on her professional practice and academic experience she states that "the organisation of three-dimensional museum spaces is a challenging undertaking" as these present a flexible nature above all (Stenglin 2006, p. 12). During the visiting experience people move through a series of interconnected spaces which unfold in both place and time - spaces that may also vary widely in terms of tone and content.

The different scales of space, on the other hand, affect the spatial feel and therefore the disposition of audience towards the exhibition. In addition, and as revealed by an exhibition evaluation at the Australian Museum, the particular "design of individual stages creates certain atmospheres and triggers emotional reactions" (White 1994, cited in Stenglin 2006). Most importantly, Stenglin claims that each of these choices made by the visitor has a meaning as important as the overall meaning of the exhibition. The various aspects of exhibition design (e.g. lighting and sound, interiors, spatial organisation, multimedia, etc.) have a great influence on the way visitors respond to and interpret the displayed content.

As literature suggests, narrative structures help museums communicate their content clearly and effectively to its varied audience, both individually and as part of a group. Museum visitors can find in narratives' structures an aid for their construction of meaning, their development of thoughts and reflections as well as the fulfilment of a complete sensorial experience. The following of narratives within the museum visiting experience may well be an unconscious act of information intake, particularly in adults' experiences who have learned that experiences lead to understanding (Falk & Dierking 2000; Hein & Alexander 1998; Hooper-Greenhill 1999a). Furthermore, in the current technology-driven and multimedia world in which we develop our everyday activities it is possible to presume that visitors are more information-media literate than they used to be more than a decade ago (Hooper-Greenhill 2000; Jones-Garmil 1997; Keene 1998; Thomas & Mintz 1998). As visitors are each unique individuals, with distinctive cultural and psychological characteristics, the outcomes of their experiences cannot always be anticipated or ensured. Consequently, although the spatial narrative may present a consistent, logical and meaningful structure, not all visitors may choose to follow it, learn from it and be delighted by it (Lorentz 2006; Stenglin 2006). For exhibition designers it is necessary to have a comprehensive understanding of narrative and the ways they can lead to a meaningful experience for a varied range of visitors. The combination of the experience and knowledge of the design practitioner or team can directly affect the outcomes of this experience.

3.4. The Museum Message

3.4.1. Construction of Meaning

Eilean Hooper-Greenhill has defined 'exhibition interpretation' as the process in which construction of meaning in museum visitors is facilitated through the design of exhibitions that enable audience to understand content (Hooper-Greenhill 2000, p. 172). This content or exhibition ideas is presented using visual narratives in combination with textual information. Visitors' prior knowledge is highly relevant in the process of making meaning. Audience attends museums with an already rich package of knowledge on which the new content builds fresh, advanced knowledge. In order to achieve a meaningful learning experience, visitors "must integrate new knowledge into his or her conceptual structure" (Jeffrey-Clay 1997, cited in Kelly 2007b).

The concept and process of meaning-making has been widely addressed and developed in the field of museum studies in the last few decades as learning in the museum context has been increasingly understood as an active cognitive and emotional process (Falk & Dierking 1992; Hein 1998; Hooper-Greenhill 2000; Silverman 1995; Weil 2002). Throughout her extensive work on visitors' learning in the museum experience, Lynda Kelly amalgamates different educational and experiential theories and provides a comprehensive definition of what making meaning is in the museum context (Kelly 1999, 2001, 2004, 2007b). Meaning-making is the process of making sense of different forms of information through the understanding of individual's own experiences, in an evolving and revisiting process of attaining and building knowledge. The making of meaning is typically facilitated by the interaction and engagement with the physical environment, in the forms of cultural artefacts, instruments and information - an interaction process in which information is not only accessed but may also be modified individually or with the participation of others. Thus, the process of making meaning can also take place in a social context; in such case two or more individuals share and negotiate information, creating together knowledge out of information rather than just receiving it. In this respect, social and cultural norms, as well as attitudes and values, play a fundamental role (Silverman 1995, cited in Kelly 2007b).

The making of meaning is possible through several levels of engagement with the museum artefact and through the narratives that the museum space offers to the visitor. As explained earlier in this chapter, the museum artefact has the dual ability to carry and communicate messages, particular meanings (Hooper-Greenhill 1995, 2000). It has been also explained that given the rich variety of characters within the museum audience, with varied cognitive and psychological individualities, these meanings are inevitably acquired from a number of different perspectives. As meaning making is the base of the learning process, visitors' acquisition of meaning through their interaction with the museum content added to the previous experiences they bring along with them will inexorably lead to some degree of learning (Falk & Dierking 2000; Hein 1998; Hooper-Greenhill 1999a).

3.4.2. Learning at the Museum

In several of her publications on audience research, informed by both professional practice and literature review, Lynda Kelly reports that the main reason why people visit museums is to obtain some sort of learning experience (Kelly 2001, 2003, 2007b, 2007c). As argued earlier in the section *The Museum Audience*, people who include visiting museums as part of their regular activities usually possess a higher level of education and regard the learning process as valuable (Falk 1998). Yet visitors do not disregard the value of leisure. In their accounts on motivations for visiting museums visitors usually express that acquiring new information and expanding their knowledge during their leisure time is worthwhile (Kelly 2007b, 2007c).

This mixed expectation of both a learning and an enjoyable experience have widely been explored in literature, particularly in respect to the role audiences have in the making of the museum visiting experience (Anderson 2004; Caulton 1998; Hein 2000; Lang, Reeve & Woollard 2006; Message 2006; Weil 2002). In sight of the cultural and social challenges presented by the new audience, as it has been discussed, museums have adapted their communication strategies in order to meet their visitors' expectations. Today's visitors expect the museum collection to provide an experience along with the information. They want to be challenged by what they explore, they want to connect with their memories and emotions, they want to enjoy, and they want to be fulfilled all through the flow of the visiting experience.

Although the museum visiting has developed into a leisure-based experience in the last few decades the primary purpose of the museum still is to facilitate and enhance the public's learning process through its activities of research, documentation, collection, preservation, and display of cultural tangible and intangible heritage. The museum's space offers visitors the opportunity to interact with artefacts that deliver plentiful learning- and leisure-based experiences. Therefore, learning in the museum is intrinsically experiential, as opposed to passive. In this respect, a tendency to differentiate the concepts of 'learning' and 'educating' has gained solid terrain in museum audience research in the last two decades. As Kelly elaborates, "there has been a conceptual change from thinking about museums as places of education to places for learning" (Kelly 2007b, p. 15). This approach implies, as contended by Stephen Weil, shifting the public educational service's focus from the content delivered to the receiver of that content (Weil 1999, cited in Kelly 2007b). In the book *The Educational Role of the Museum,* Eilean Hooper-Greenhill (1999a) explains that the concept of education is regarded by some as the accumulation of facts and information, which she considers to be a view too narrow and inappropriate for the museum reality. The author suggests that alternative meanings for education emphasise the actual process of learning rather than its outcomes, and include affective as well as cognitive elements. In this respect, Hooper-Greenhill adds that it is this mix of affective and cognitive responses which derives in attitudes, values and perceptions that lead to the acquisition of knowledge (Hooper-Greenhill 1999a).

Museums make use of use of diverse learning theories or approaches in order to provide a structure within which to interpret and communicate cultural value for their visitors to acquire. In the book *Learning in the Museum*, George Hein (1998) identifies four essential learning approaches relevant to museum-based learning: the didactic approach, the stimulus response model, discovery learning, and constructivist learning. Hein contests that museum exhibitions are designed according to one of these approaches. It is possible then to argue that the physical presentation of content and information in an exhibition is determined by a learning approach and, therefore, so is the way visitors interact and engage with them. Both the didactic and the stimulus response learning theories recommend straightforward narratives sequentially presented in hierarchy-based arrangements of content. Although in exhibitions based on these theories there is abundant didactic material, interaction is rarely observed. Conversely, the constructivist and discovery learning styles encourage a rich dialogue between content and visitor. The discovery learning theory explains that learning implies a dynamic participation of learners, which include processes of reflection and action, usually taking place simultaneously. In exhibitions based on this approach the content is provided in theme-based sections or groups and visitors are invited to explore these at their own pace and will, with no sequence required. In addition, visitors are challenged in the process of unfolding content by diverse interactive means. Hein concludes his learning theories presentation with the constructivist learning approach. The author explains that similarly to the discovery based approach, the constructivist approach encourages the learner to actively participate yet this participation is expected to be expressed in both the way the mind is used to understand information and in the way it is used to build knowledge. In this learning style, rather than acquiring information, the learning is making sense of it. According to Hein, exhibitions based on these last two learning approaches are very similar and claim no objective truth; instead, they present a generous range of points of view through varied artefacts, spatial possibilities and activities. What differentiates a discovery-led exhibition from a constructivism-led exhibition is that the latter offers visitors some sort of additional resource for them to validate the outcomes of the learning process and provides a more active build-up of knowledge.

As presented earlier in this chapter, a specific and definite profile of museum visitors is nearly impossible to produce. Accordingly, when it comes to designing exhibitions for effective learning experiences, the wide variety of visitors' behaviours frequently becomes an issue as not all visitors are motivated to learn in the same ways. In *The Educational Role of the Museum,* Hooper-Greenhill (1999a) explores the work of education expert Bernice McCarthy on teaching-learning styles and extrapolates them to the museum learning context. Based on McCarthy's 4MAT learning method, Hooper-Greenhill identifies four learning styles in the museum according to the ways visitors approach the exhibitions. According to McCarthy, the 'type one learner' approaches information asking the question 'why?', and reflects on the information perceived directly (McCarthy 1987, cited in Hooper-Greenhill 1999a). In the museum, 'type one visitors' learn in a social fashion, sharing ideas and listening to others' points of view. Not only are these visitors reflective learners but also imaginative as they can enjoy a direct experience from different perspectives. The 'type two learner' asks the question 'what?' when approaching information, perceives it in an abstract manner and then reflects on it. In the museum context, this type of learner becomes the 'type two visitor', a kind of visitor that likes facts, details and objectivity. These visitors tend to be highly theoretical and analytical. 'How does it work?' is the type of question a 'type three learner' would ask, while perceiving information abstractly and processing it actively. The 'type three visitors' look for information that demonstrates to be applied and useful, they show a practical common sense and are typically skill-oriented visitors. The 'type four learner' faces information in a concrete manner and process it actively, asking questions based on 'if'. In the museum context, these learners become the 'type four visitors', flexible in terms of experiences and enjoying variety in a dynamic and intuitive way. Hooper-Greenhill concurs with McCarthy in that in order to provide a meaningful learning experience to all museum visitors these four type of learners, and consequently these four types of visitors, need to be considered and understood (Hooper-Greenhill 1999a, p. 290).

3.4.3. Learning is a Social Experience

Back in the first half of the 20th century, pragmatist philosopher and educator John Dewey was already fostering a major change in the then current paradigms of education and a new approach for learning processes based on experience, critical thinking and the development of social skills - a progressive educational paradigm that would soon influence the museum environment as well (Kelly 2007b; Muller 2008). In one of his seminal publications, *Experience and Education*, Dewey sustained that both internal and external factors of the learner influence the learning process, namely individual and surrounding realities such as the physical and social environments (Dewey 1938). According to the author, in the overall context of education participants take a collaborative role led by common goals and motivations which help construct a community of learners. This community makes use of these goals and motivations to facilitate shared experiences in a social manner.

In a similar stance, Lynn Dierking and John Falk have studied the ways the sociocultural context of individuals affect their behaviours and, in particular, their learning modes (Falk & Dierking 1992, 2000). The authors argued that it is in the sociocultural environment that people get to find personal meaning and construct a sense of the self as embedded within a social context yet learning as a process is, in essence, an individual internal process (Falk & Dierking 2000). Society, as a context in which learning takes place, is a mediator of the process and a co-creator of the experience. As argued by Kelly based on Etienne Wegner's approach to the individual role in the learning process, the person's cognitive and behavioural natures must be understood in a context of sociocultural dynamics in which learning and meaning-making are informed by the social context and the tools available (Wenger 1998, cited in Kelly 2007b). The influence of the social community on the learning process is also explored by Hooper-Greenhill in her work *Museums and the Interpretation of Visual Culture* in which she argues that individual meaning-making is mediated through the use of a common language within a community and the integration of past personal experiences (Hooper-Greenhill 2000).

The social experience of learning is not a merely contemplative, symbiotic experience. The interrelations that take place between participants are based on active involvement of contribution within a social assembly during the learning process and, therefore, a co-creation of learning outcomes (Kelly 2007b, p. 46). This social aggrupation, also known as 'community of practice' in the museums' educational literature (Falk & Dierking 2000; Kelly 2004), are groups of people that organise themselves according to shared interests, expertise and motivations, in order to expand their knowledge and learning experiences. Regardless of their size and composition, communities of practice are always embedded within a sociocultural context (Falk

& Dierking 2000). In the museum context, these communities of practice develop in the process of accessing and grasping the cultural content through their interaction with both the spatial environment (e.g. museum artefacts, architecture, interpretive tools) and the social environment (e.g. personal group of visitors, museum staff, other visitors). As Kelly states, it is in this ongoing social interaction that “meaning is made and learning happens” (Kelly 2007b, p. 57).

3.5. Summary

Museums are conceived as more than physical spaces for the storage, conservation and presentation of objects. Museums are rich environments of informal learning and social recreation in which the audiences freely access information and create new meanings out of it. This chapter has discussed how the museum role as a public educational institution has evolved with its audience, weaving together new forms of cultural delivery and engagement. In this respect, it has been argued that this evolution has had a significant role on the physical configuration of the museum environment, leading to new ways of presenting collections and narratives. Finally, the learning process as a social experience facilitated by the physical attributes of the museum has been discussed. Altogether, the research discussed in this chapter highlights the museum audience's general perception of the visit as an informal learning and leisure experience of which the core benefit is the potential of encountering rich social interactions. The many implications of interaction at the museum are discussed in the following chapter.

Chapter 4. Interacting with Technologies at the Museum

In the previous chapter I argued that museums are institutions that evolve according to the needs and demands of a society in constant change. Today's audiences are more demanding than ever and expect from the museum not just their traditional delivery of cultural information but also novel experiences. This chapter discusses the meaning of experience within the museum context and how this is shaped by personal, social and technological factors. In this respect, the specific topic of interactive exhibitions is introduced and the impact interactive technologies have on the visiting experiences is discussed. Lastly, I provide a review of the literature on audience research, particularly on the evaluation of exhibitions, as a core element in the design of optimal visiting experiences.

4.1. Interaction in the Museum

4.1.1. Experience Context of the Museum

As it was contended throughout the previous chapter, the museum is a place which visitors attend motivated by individual interests to freely acquire new knowledge and construct meaning in a social dynamic of participation and collaboration. In *Museums and Memory*, Susan Crane refers to museums as "sites for interaction between personal and collective identities, between memory and history, between information and knowledge production" (Crane 2000, p. 10). In 1992, John Falk and Lynn Dierking suggested that museum visitors' experiences, particularly their learning experiences, are influenced by three specific contexts, namely the personal, the social and the physical, at which intersection lays the interactive experience (Falk & Dierking 1992). Later on they would refine their work and add to the interrelation of these contexts an underlying concept, the long-term nature of the learning process (Falk & Dierking 2000).

The personal context of the museum visitor is comprised of several individual factors that influence or motivate the visit in a unique way. Some of these factors include prior knowledge and experiences, cultural background, interests, motivations and expectations, and general life attitudes. In addition, visitors as individuals have a unique perception of these personal factors, which influence the way they learn at the museum. Naturally, this uniqueness means that exhibitions can never fulfil the totality of an audience; however, the more expectations of the personal context are met, the more effective the learning experience is (Falk & Dierking 1992). The sociocultural context, as identified by Falk & Dierking, takes into consideration the social nature of humans and the likelihood of visitors to undertake their visits accompanied by others. The sociocultural context refers mainly to cultural mediations within a social configuration through which knowledge is constructed individually and in collaboration. The three aspects that influence the sociocultural context are the socio-cultural mediation within a group, the mediation by others, and culture. These mediations or shared experiences inevitably influence what and how visitors learn in the museum. Falk and Dierking suggest that the social context influences the physical context of the museum since the spatial design and organisation of the museum primarily focuses on visitors' interactions with the space and with each other. The physical context is represented by the physical attributes of the museum's context, which include its architecture, design, tools and artefacts. Visitors' experiences can be affected by a diversity of spatial factors both immediately, in advance (i.e. preparation for the visit) and even in the future (i.e. subsequent reinforcing events and experiences). An understanding of how these three contexts unfold and how they influence the museum experience of the visitor is essential to ensure a meaningful and enjoyable learning outcome.

4.1.2. Being Immersed in the Museum

The concept of immersion as a sensorial exploration of the museum environment has been covered by various practices from different perspectives. The first incursions on the subject were driven by the introduction and fast development of virtual reality (VR) technologies (Heim 1998; Steuer 1995; Thomas & Mintz 1998; Wickens 1992). In this context, for instance, Michael Heim (1998) in *Virtual Realism*, associates immersion with the notions of sensory experience, interactivity, presence, and a certain level of autonomy. Beyond the realm of virtual reality, immersion is a state of internal sensory stimulation which aligns directly with externally delivered information to create an experience where a sense of time is momentarily lost (Heim 1998; Steuer 1995). In this respect, Jonathan Steuer (1995) claims that one of the most important characteristics of immersion is the total absorption of the individual in the activity in such a way that time seems to be suspended. The peak of the immersive experience, he argues, happens at this point in which sensory stimulation is at its maximum. Examples of immersive experiences could include reading a captivating book, watching a moving film, attending a realistic theatre play, or visiting a well-designed museum exhibition. According to Steuer, the different levels of immersion reached by any given individual throughout an experience are determined by the individual's intrinsically internal interests and predispositions towards the activity as much as external factors or distractions.

The processing of information in the museum visit implies learning dynamics driven not by information itself but by experience. Stephen Bitgood thoroughly develops the concept of immersion in the experience of the museum visit in his book *Social Design in Museums. The Psychology of Visitor Studies Volume One* (Bitgood 2011a). He explains that experience-driven learning takes place when a pervasive and engaged understanding of the displayed topics is sought beyond the primary function of the acquisition of facts and concepts. According to the author, visitor's immersion in an exhibition takes place when the visitor feels absorbed and excited by it, when the exhibit provides a sense of time and/or place, when the exhibit feels natural and realistic, when the visitor's attention is focused on the exhibit, and when this leaves a memorable feeling in the visitor.

Most of Bitgood's initial research back in the 1990s developed around dioramas and natural history displays, both in museums and zoo parks. In this context, he defined the concept of 'simulated immersive experiences' resulting from those exhibitions that reproduce real environments to create the illusion of time and place. In the essay *The Role of Simulated Immersion in Exhibitions*, Bitgood (2011b) identified from these experiences a range of types of immersions: interactive immersions, which occurs when the visitor is involved in feedback-based process (often comprising computer technologies); media immersion, which takes place when the visitor is involved with the audio-visual content included in the exhibit; aesthetic immersion, which refers to the visitor's involvement with artworks or art-based exhibits; dramatic immersion, which takes place when the visitor is involved in a theatrical-like experience. The author's work throughout a period of accelerated development and introduction of new exhibition modalities in the museum allowed him to develop a consistent framework for the identification of the main characteristics of immersive experiences at the museum. These characteristics include the different uses of the physical environment (i.e. architectural space, interiors, ambient effects and objects), interactivity based on input and feedback, comprehensive multisensory and cognitive stimulation, authenticity and aesthetics provided by realistic objects representations, social involvement. Bitgood claims that the experience of simulated immersion in exhibitions is important for visitors as he has found that they are more likely to engage with the material and messages displayed and become immersed if the experience is enjoyable or pleasurable (Bitgood 2011a, 2011b). Interestingly enough, though, emotions are not addressed in his work as extensively as the other mentioned characteristics.

The immersive experience is a highly subjective one and its ultimate success in the museum context is dependent on the way in which the individual visitors respond to the experiences before them. Furthermore, experiences may present degrees of engagement according to the proportional presentation of individual aspects of the experience such as the level of participation it permits, the educational nature of its content or the sensory opportunities offered. Without a doubt, reality is the primary immersive experience which people are familiar with. Accordingly, it can be argued that such reality is an effective scenario for understanding the effectiveness and effects of an immersive environment or experience in a museum context.

4.1.3. Sensing the Museum

We humans interact with and within a multisensory environment, continually assessing the information we encounter in our daily lives. Essentially, we are constantly physically participating in a dynamic and rich world of opportunities. In *Museum Exhibition: Theory and Practice*, David Dean (2002a) argues that museum visitors prefer an active participation over a passive observation yet they tend to access the museum artefact through orthographic imagination, identifying dynamic structures and using visualisation as part of their process. The author goes on to explain that this is due mainly because we humans are widely considered to be vision-driven; however the many other senses reinforce the information of what is obtained by sight. In fact, the author suggests that sensory stimuli should be used to reinforce the predominant visual museum environment and adds that "whenever possible, use all senses, but always try to involve at least two or three" (Dean 2002a, p. 31).

Dean has identified three elements museum visitors typically address in order to gather information during their visits: words, sensations and images (Dean 2002a, p. 26). Words tend to be presented in varied forms in information provided through formats such as printed graphics, text panels and multimedia. The author affirms that language-based information demands most of visitors' cognitive processing. In contrast, he argues, museum information processed through other senses, namely touch, smell, hearing and even taste, takes a considerable shorter time, becoming mostly immediately associated with their meaning. Visual sources, such as images, are given a separate category by Dean as he argues these are the most memorable elements of the museum environment. He explains that even when text alone can be easily processed by a visitor and its core message retained, it is an accompanying image that will guarantee a last-longing remembrance and impact on the visitor' overall experience (Dean 2002a, p. 131).

Although Dean develops his work based on the primary senses, he acknowledges that the senses of kinesthesis (related to movement) and the vestibular system (related to orientation) help the visitors complete their experience with a sense of bodily immersion within the space. This is seconded by Piera Scuri in her book *Design of Enclosed Spaces* (1995). The author claims that in enclosed spaces where information is abundant, such as museums and galleries exhibition spaces, people's perceptions are particularly conditioned by all senses. She goes on to explain that the human body presents a highly complex sensorial structure in which each sense performs in interconnection with each other as well as with the psyche. Returning to Eilean Hooper-Greenhill (2000), the author affirms that the senses are an essential element in the interaction between museum artefact and visitors, and are one of the main aspects to consider when aiming to a successful exhibition design. Hooper-Greenhill also agrees with Scuri in that the bodily behaviour cannot be dissociated from mind and emotions as cognitive activity takes place in close relationship with the bodily responses (Hooper-Greenhill 2000, p. 13).

From a design perspective, Gary Edson and David Dean (1996) provide more clarification for the discipline to work from. The authors assert that museums try to provide experiences that are memorable and meaningful for their visitors by putting together exhibitions that allow a combination of physical, emotional, intellectual, and sensory responses. While physical responses are typically generated through interaction, physical and conceptual orientation, emotional responses are lured through social interactions, memories and pleasurable experiences. Intellectual responses are fostered through the use of narratives and invitations to thinking, reflecting and learning. Once again, it is emphasised that the number of senses stimulated and the effectiveness of such stimulations depends on the visitors and their unique individual characteristics.

4.1.4. Engagement at the Museum

During the museum experience visitors encounter a variety of artefacts out of which they only engage with selection, according to prior or indirect associations, beginning an iterative process of interpretation and reinterpretation. This process is referred to by Susan Pearce as the 'dynamics of viewing' and reveals the virtual dimension of the artefact, its meaning (Pearce 2003). The viewing of the museum artefact is a dynamic yet reflective process of engagement in which both parties - artefact and visitor - complete each other (Pearce 2003, p. 24). In addition, research evidence has revealed that visitors respond very positively to the opportunity to physically engage with the museum space, touching and handling artefacts and exhibits, whenever this is permitted (Black 2005; Caulton 1998; Chatterjee 2008; Lang, Reeve & Woollard 2006). As affirmed by Hooper-Greenhill, the tangible object in museum is regarded both by museum practitioners and visitors as close evidence of the external world and touch becomes a significant modality for learning directly from it (Hooper-Greenhill 2000, p. 13). This engagement mode is often adopted in museums as the 'learner-centred approach' which harnesses the concept of the embodied experience as the basis of the meaning-making process.

Emotions are another element strongly addressed in research of visitors' engagement with museum and galleries exhibitions (Belting 2006; Crane 2000; Edge & Weiner 2006; Muller 2008). In *Shivers Down your Spine: Cinema, Museums, and the Immersive*, Alison Griffiths sustains that exhibits do not simply deliver content "but shape that content into emotional, sensual and memorable experiences that clearly affect the visitors' expectations" (Griffiths 2008, p. 217). Griffiths argues that the museum exhibit carries a great deal of discursive weight as well, triggering affective responses in a way only the artefact used to do. Affect is similarly addressed by Kit Messham-Muir in his work on technologies and museums, particularly on interactive art installations (Messham-Muir 2005). In this respect, the author contends that this type of work expects its audience to respond and hold a dialogue with it. In order to achieve this, the artwork attempts to elicit an emotional response through varied affective possibilities for diverse individual desires. When exhibitions offer their visitors a wide range of possibilities to affectively engage with, more possibilities for the message to be seized arise, with a consequently higher possibility of engagement.

As it was explained in the previous chapter, museums have recently been showing a marked trend to more actively engage in their educational purposes beyond solely displaying artefacts. The new museum presents a more playful and hands-on approach to communicating its messages (Black 2005; Caulton 1998; Chatterjee 2008; Merriman 1989). As a way of optimising the affectual dimension of the museum experience, as developed in the previous paragraph, some institutions are creating exhibitions of high physical contact. Maree Stenglin (2011) asserts that there is an observed inclination to constructing causal relationships between physical contact and the learning process, in which hands-on and amusing activities facilitate the engagement of visitors with the collections and their messages. Among the many activities and media utilised by museums and mentioned in the literature the most recurrent are craft-making activities, intellectual challenges, didactic material, in-house and 'homework' quests, dress-ups, and computer-based interactive exhibits. According to Hein and Alexander, these type of activities are deemed as enjoyable and welcomed by audiences as they imply an active participation of visitors, as opposed to a passive contemplation of events occurring before their eyes (Hein & Alexander 1998, p. 26). Although this approach saw first light in science centres it quickly developed to most kinds of museums, including history, art, natural history and technology museums (Caulton 1998). Literature suggests that increasingly museums regard hands-on learning as more enjoyable than traditional didactic learning as it involves actual physical exploration of the museum artefact, its nature and contained phenomena (Black 2005; Caulton 1998; Hein & Alexander 1998; Kelly 2003; Weil 2002). Fun, enjoyment and pleasure promote in visitors a positive attitude for and predisposition towards participation and active learning. These attributes, in Hooper-Greenhill's words, are "more likely to produce mental and physical interaction" (Hooper-Greenhill 2000, p. 6), which in turn favours visitors' engagement.

Although the museum is an institution with a well-established educational role in today's society, many are facing a time of change in which the museum is challenged to adapt to new generations of visitors and expectations. In this respect, museum visiting experiences, like commodities, goods and services, are an unrecognised economic offering audiences look forward to attain in a similar way they access experiences in the entertainment area (Pine & Gilmore 1998). Pine and Gilmore claim that commercial ventures (e.g. shopping centres, amusement parks, and restaurants), somehow endeavour in the capitalisation of the idea of customers' engagement and providing them with a unique, directed and memorable experience which has traditionally been the domain of the museums. But the museum has a serious role as an education institution and as a communicator of natural and cultural heritage and this task should not be weakened in an attempt to respond to this challenge. Therefore, it is becoming increasingly imperative that museums make sure they are able to draw a clear line of differentiation between their enjoyable, meaningful learning experiences and those of commercial order, as the museum experiences cannot be replicated anywhere else.

4.2. Technologies in the Exhibition Environment

The 1990s saw the most important technological advancements in the museum exhibition realm as technologies presented a thriving development and started becoming more accessible. As a result, experimental artworks created by artists, particularly since the 1960s and mainly in the form of public interactive installations, were only part of what the museum audience would be able to experience (Griffiths 2008; Marty & Burton Jones 2008; Muller 2008). The decade of the 1990s was marked by the fashionable concept of 'virtual' due to the rapid introduction of Virtual Reality (VR) technologies and the proliferation of the personal computer (PC). These technological expansions gave birth to the concept of the 'virtual museum' characterised by a considerable presence of screens and VR apparatus within the exhibiting space (Griffiths 2008; Heim 1998; Hooper-Greenhill 1995, 2000; Steuer 1995; Thomas & Mintz 1998; Wickens 1992). New technologies were then introduced into the museum mainly as computer-based devices that would enhance the traditional graphic and textual media used to communicate the content and its narratives (e.g. printed and painted information, use of serigraphy and letterset tools, etc.). Soon the fast development of the Internet and its associated tools would coronate the end of the decade and help open the doors of the museum for visitors to access content from virtually anywhere in the world (Jones-Garmil 1997; Marty & Burton Jones 2008; Thomas & Mintz 1998)

Humanist theorist Michael Heim was very critical at the time - yet not an opponent per se - of the initial stage of introduction of computer technologies and new media in the museum environment. Through his work he argued that these technologies were often developed without a real connection to visitors and their human ecology (Heim 1998). In particular, his concerns were placed on the interfaces between visitors and museum content, claiming that they would not necessarily act as an adequate mediator, often interrupting the flow of information transfer. In this sense, the work of visitor studies expert Chandler Screven corresponded with Heim's; Screven contended that the design of the interface is crucial for a successful learning experience (Screven 1999). The author claimed that designers and museum professionals should put special attention to computer-based interfaces in the museum context and, in particular, to the interrelationship between learning means and goal. According to Screven, independently of the technology utilised the exhibit should not only support the content but also seamlessly communicate it to the visitors, without overwhelming the experience and outcome of the visit. In *Museum Exhibition. Theory and Practice,* first published in 1994, David Dean provided a more optimistic view about the introduction of new technologies in the museum exhibition realm (Dean 2002a). The author considered the rise of new technologies as an exciting prospect with plentiful opportunity for development if correctly applied. He asserted that technology-aided exhibitions could expand the museum's educational role by providing additional levels of information to stimulate visitors' interest and participation. Furthermore, Dean alleged that the use of new technologies would not necessarily diminish the core attributes of the artefact; on the contrary, they could reinforce the sense of curiosity in the audience and therefore their access to and engagement with them.

Multimedia and interactive technologies have emerged recently to mediate audiences' experiences in the wide spectrum of cultural heritage institutions. As it will be revealed in this section, the new available technologies provide new attributes for museum exhibitions and spaces, generating visiting experiences which are essentially variable, time-based, interactive, collaborative, dynamic, and customisable. As institutions that address one of the most inherently and unique needs of human beings - the furthering of knowledge - and that, in addition, serve the public of a society in constant change, museums are permanently challenged to maintain the provision of a meaningful sociocultural service (Alexander & Alexander 2008; Bennett 1995; Falk & Sheppard 2006; Hein 2000; Witcomb 2003). In this context, many museums face the need of pursuing and achieving novel ways to engage their audiences in a transcending experience. In an effort to respond effectively and successfully to the challenges its stakeholders present, many museums explore new exhibition styles and ponder the integration of multimedia and interactive technologies as a means for re-shaping the overall visiting experience (Griffiths 2008; Jones-Garmil 1997; Knell 2003; Thomas & Mintz 1998). In this respect, literature shows how a variety of academic fields have been increasingly exploring both benefits and drawbacks of the incorporation of interactive technologies to the exhibition space (Marty & Burton Jones 2008; McLean 1999; Pine & Gilmore 1998; Scott 2000). Irrespective of the varied perspectives, approaches, scopes and results of research in the field, all efforts evidence a broad concern for shaping the nature of the museum visiting experience, its dynamics and interplaying constituents (i.e. artefacts, technologies, visitors, and institution).

4.2.1. Multimedia and Interactive Technologies in the Museum

The advent of interactive and multimedia technologies presents museums with the opportunity to develop new ways to communicate collection-based and associated information to their audiences allowing them "to explore the richness and diversity of collections at their own pace and to their own requirements" (Fahy 1995, p. 82). The concept of multimedia technologies is defined by Anne Fahy as a set of tools frequently used to generate new applications or enhance existing ones through a combination of sound, moving images, graphics, animation and computing (Fahy 1995, p. 89). In addition, the authors of *Human Computer Interaction* contend that multimedia refers to the non-linear storage of and access to all forms of electronic media (Dix et al. 2006). In regards to the concept of interactive technologies, these can be defined as computer-based tools that facilitate the two-way process of action and reaction between two parties (i.e. user and system), the control and feedback of information and the consequent achievement of set goals (Dix et al. 2006; Rogers, Preece & Sharp 2006). For a deeper and more comprehensive development of this technology-related concepts, refer to Chapter 2.

Both the review of existing literature and recent observations in the field have revealed that interactive and multimedia technologies in the museum context are regarded and utilised both as media and as tools. Examples of tools include lighting and soundscapes utilised to digitally enhance environments, virtual reality ensembles to situate visitors in a simulated context, and actual computers to access additional information that cannot be displayed in the museum space. As a medium, these technologies typically take the form of interactive art installations and digital displays. Although on occasions these media are regarded as artefacts with a discourse of their own and generate a vivid debate regarding their role in the museum, theorist Lev Manovich alleges that these media are not to be compared to the traditional museum object as they simply offer a different reality (Manovich 2001). Andrea Witcomb in *Re-imagining the Museum. Beyond the Mausoleum* (2003), affirms that interactive and multimedia technologies are used to facilitate the design of more visitor-centred experiences as they allow more flexibility for the visitor to access, process and modify information at the museum. Nonetheless, the author also acknowledges that some museum practitioners and theorists perceive these technologies with more cautiousness. Among the most recurrent apprehensions regarding technological inclusions in the museum environment she mentions the labelling of them as populist strategies for attracting new audiences and the threat they represent to traditional collection research responsibilities (Witcomb 2003).

The general use of the concepts of 'interactive exhibit' and 'interactive exhibition' is often erroneous and misleading, probably as a consequence of a market-led reaction to new consumers' expectations regarding their technological environment. Albeit not necessarily accurate and comprehensive, Hill and Miles define truly interactive exhibits as those displays that "can vary their presentation according to the designer's perception of the response of the visitor" (Hills & Miles 1987, cited in Belcher 1991). As noted by Belcher, what it is very significant about this definition is its focus on visitors' responses which ultimately is the main factor affecting exhibitions' design. An interactive exhibit engages visitors in a series of interrelated activities that involve intellectual, emotional and/or physical actions resulting from a process of input and feedback (Belcher 1991). In essence, an interactive exhibit is a facilitator of a dialogue between the museum and its audience. To date, most interactive exhibits still work on a one-person-to-one-device basis; however new technologies and curatorial approaches are developing towards a more multi-visitor configuration of the visiting experience with interactive exhibits (Belcher 1991; Geller 2006; Hindmarsh et al. 2005; Hooper-Greenhill 2000; McLean 1999).

4.2.2. The Technological Exhibition Landscape

Multimedia and interactive technologies in the museum environment vary in mode, type and levels of adoption; some present a high technological complexity others have a more simple nature. Irrespective of the generous range of technological choices, and as Anne Fahy affirms, the ultimate utilisation of these technologies will be informed and affected by the particular characteristics of each exhibition, its duration, the expertise of the team in charge of design and curatorial guidelines, and the financial availability for their application (Fahy 1995, p. 89).

Although the purpose of this dissertation is not to review the complete range of multimedia and interactive technologies available for the design of museum exhibitions, it is important to provide a general overview of the forms these have taken in the current museum context as they facilitate the understanding of visitors' engagement with and response to the exhibition environment. The following brief account has been put together from diverse primary and secondary sources (Belcher 1991; Black 2005; Caulton 1998; Geller 2006; McLean 1999; Stenglin 2011; Thomas & Mintz 1998); specific reviews of related literature have been made for each of the case studies' exhibition contexts (See Chapters 6, 7, and 8).

Media guided tours were introduced in the museum environment in as early as the 1980s but were only widely incorporated in the next decade. Audio tours were one of the first exhibition-aid media to be incorporated to the museum environment. They were most commonly used in art galleries to present complementary information about the artefacts and artworks narrated to the visitor as he/she walked throughout the exhibition space. Evolving from cassette tapes to digital audio devices these interpretative tools have presented interesting variations such as the option to select points in the narrative, additional formats of audio (e.g. historical recordings, music, soundscapes) and recording of opinions and experiences for future visitors to access.

The late 1990s were characterised by the miniaturisation of computer-like technologies and made possible the proliferation of the already existing personal digital assistants (PDAs). Some institutions introduced these devices as interpretative multimedia tools early that same decade yet most did in the early 2000s. The existence of a screen permitted the addition of another set of information reproduction media: the text and the image. System architecture and interface design played a significant role in the development of these tools as they became an additional layer in the visiting navigation structure. Graphics, images, videos and texts needed to be carefully designed so as not to distract the attention of visitors from the core purpose of the visit, namely the learning from the museum artefact. Multimedia tour guides have also presented several interesting features throughout their evolution; apart from the previous version's attributes some devices allowed interaction and collaboration between visitors, direct interaction with the physical space via infrared (IR) and radiofrequency identification (RFID), display of augmented reality objects, way-finding and museum services information, onsite participatory activities, networked services, as well as personalisation and creation of content. Multimedia tour guides are still widely used, particularly in art galleries and museum, but have been quickly replaced by visitors' personal digital devices such as media players and smartphones.

The jump from PDAs to smart devices was rather short and quick, as it has become habitual with most new technologies. The use of these devices as museum interpretative tools have meant both a benefit and a challenge for cultural heritage institutions; whilst more and more visitors bring along with them a smartphone, which means less device-related costs for the institution, more and more they expect museum-related services delivered to their devices (e.g. visiting guides, smart applications, games, etc.), which demands additional efforts as well. On the other hand, these tools have facilitated the extension of the museum educational service beyond the institutions' doors; with visitors staying connected virtually at all times, significant learning and visiting communities have developed, supported by institutional initiatives, social network technologies and platforms such as Twitter, Instagram, Foursquare, weblogs, smart applications, etc. Most of the PDA versions of digital guided tours' services and utilities are possible through smart devices to which new ones have been added. In terms of connectivity, these devices allow tracking and identification, which works well for both parties (e.g. institutions can use tracking data for audience research and visitors can engage in city-quest-like activities). In terms of graphic capability, enhanced augmented reality technologies have been developed and new optical pattern recognition and identification tools have emerged, allowing visitors to obtain high quality, close-to-real representations of three-dimensional objects in their hands.

Exhibitions and displays based on moving images have become increasingly abundant in the museum environment from the 1990s onwards. Starting with limited numbers of unidirectional screens and projections (i.e. only display, no system-user reaction or interaction implied), the museum space slowly gave room to videos and animations allocated both on the walls and in standalone exhibits. The evolution of supporting technologies and the expected reduction of production costs led the museum of 2000s to a more consistent and pervasive integration of displaying media. In addition, interactive and touch technologies were added to the displaying palette, inviting visitors to directly retrieve information at their own pace and will. The museum environment was now becoming more and more interactive thanks to new technology. This evolution has facilitated the generation of a myriad of interior atmospheres which, added to audio, lighting and sensing new technologies, has significantly changed the now embodied, affectual and immersive visiting experience. Chapter 6 provides a thorough review of recent developments in the interactive displays area in public spaces.

The research on and development of new sensing technologies in the 1990s derived in an accelerated expansion of interactive surfaces, both vertical and horizontal. Although touch technologies were roughly explored in the early 1970s and their development was limited to the field of research of information technologies, in only a few decades these became widely spread in commercial areas and, subsequently, available to the public. As comprehensively reported in Chapter 7, museums were one of the public realms in which interactive presentation devices and multi-user surfaces developed the most. This type of exhibition format is presented in exhibition environments in varied ways, including holographic and video-tracking projections, large scale augmented reality representations, interactive touch-screens, and multi-touch tabletops. The common technological formula to all these formats is some sort of sensing system to capture visitors' input (e.g. direct, unintended, conscious, etc.), a processing system and a display to present the effects of the input. The common user experience to all these formats is the ability of visitors to not only maintain a dialogue with the content but also affect it in some way (e.g. define the amount and type of content displayed, modify the content, share it with other visitors, etc.). In terms of interaction, some of these displays encompass the use of tangible interface elements while some others use the display surface itself as the main interface. In both cases examples include single-user and multiple-user experiences. Although this type of interactive exhibits are increasingly becoming part of the museum environment, the underpinning technologies are still being explored and developed and their design and production costs are considerably high. Nonetheless, and until new developments arrive, these are so far the best regarded exhibition resources for engaging audiences in meaningful, memorable learning experiences.

The possibilities modern technologies offer for exhibition development are endless and the literature suggests that there still are rich areas to be explored. Wherever there is a goal, there is many a road to take in order to reach it. In the museum field, the decision of which exhibition techniques to adopt to fulfil the displaying and education goals is strongly informed by its audience and their particular needs, demands and expectations. Whilst technology can always be adapted and fixed, audience's responses ought to remain natural. Collection display media in the museum must be built on the physical, affectual and cognitive capabilities of the public.

4.2.3. Some Considerations for the Design of Interactive Exhibitions

To any professional involved in the development of museum exhibitions, the previous sections whisper the inevitable question 'what are the requirements for a successful interactive exhibition design?'. As it has been argued throughout this chapter, there is no absolute response to this kind of interrogation as there is no absolute visitor profile upon which to build the ultimate exhibition experience. Nevertheless, it is always possible to build the best approach when taking into consideration some guidelines provided by experts and their research work.

From the field of Cognitive and Communication Technologies and through their research on visitors' engagement in the museum experience, Petrelli et. al. suggest a number of media requirements for the design of multimedia and interactive exhibitions (Petrelli, Not & Zancanaro 2002). The concept of attention is at the core of their consideration. The authors argue that media should not undermine the exhibit and its content but rather draw visitors' attention towards it, stimulate their interest and maintain it. Information displayed ought to be on the particular artefact or narrative and help visitor identify and understand it clearly. The authors allude to audio prompts triggered by motion-sensing technologies and varying media as successful techniques for capturing and keeping visitors' attention. Information load relates to attention: how much information is a visitor willing and interested to attain? Once again, this is a variable hardly possible to control but the recommendation is to not overwhelm visitors with all available information. Consequently, the authors advise for information volume to be flexible enough for visitors to abandon the exhibit early and yet have a feeling of accomplishment or to continue retrieving information and remain engaged. The final consideration noted by Petrelli, Not and Zancanaro is to take into careful account visitors' individual context in as much as possible. They argue that an optimal interactive exhibition system must be dynamic and envision the amount of knowledge that visitors may already have in respect to the exhibition topic, their visiting interests, needs and goals, their likely overall capabilities and social habits. Although the authors' recommendations may feel rather prescriptive they do acknowledge that these are aspects extensively considered in museum studies, particularly through the practise of audience research.

In the book *The Virtual and The Real: Media in The Museum* several authors early addressed the issue of the introduction of multimedia technologies in the museum exhibition environment (Thomas & Mintz 1998). Even though interactive technologies as we know them today (e.g. pervasive, multi-sensorial, immersive, multi-user, etc.) had not yet been widely introduced as media and tools for the visiting experience many of the insights expressed in the book are still validated today as they concentrate mostly on visitors rather than on the technologies. According to Selma Thomas, interactive media can considerably enhance the learning experience as it adds the value of playfulness and to some extent conceals the sense of learning (Thomas 1998). The concept of entertainment mediated by multimedia technologies was often questioned in the cultural heritage institutions field. In light of the claims of lack of rigour and seriousness in the museum exhibiting practises, the author alleged that entertainment does not have to be restrained to young audiences only and argued that entertainment allows adults to be less aware of the fact that they are learning something. Dierking and Falk contributed to the reflection on the matter by advising the community to avoid by all means that poor applications of media "jeopardize the integrity and quality of what is presented in a museum" (Dierking & Falk 1998, p. 68). The authors went on to explain that the stereotype of museums making superficial use of technologies is contested by fostering and maintaining high aesthetic, intellectual, conceptual and technical standards.

The authors of *The Virtual and The Real: Media in The Museum* largely agree that every exhibition and every institution has its own particular characteristics, goals and needs and therefore the use of multimedia and interactive technologies is not always necessarily the most appropriate resource in the design of the visiting experiences (Thomas & Mintz 1998). On occasions, this might mean that the digital media must be disregarded in order to favour the exhibition's purpose. In this respect, the authors argue that computers as tools, for instance, are often not the best way to approach audiences, particularly considering that these are objects they access for many other purposes on a regular basis. Technologies can facilitate plenty of possible experiences yet that does not imply that all possibilities should be taken. The general call is for common sense and balance, particularly avoiding a plethora of choices and complexities among which visitors might feel confused, intimidated, distracted and frustrated (Mintz 1998).

Another important consideration drawing from the above mentioned compendium is that experience is more important than the technology. Visitors attend museums and their exhibitions in search of distinctive experiences, stories told by artefacts only cultural heritage institutions hold and present, a high quality service and an instance in which they can realise a worthwhile activity in the company of other people. Media technologies are supportive of these experiences, they are not the experiences. In this respect, Anne Mintz emphasises the social possibilities media technologies offer for a shared experience. The author reminds the readers that the vast majority of visitors attend museums in groups and therefore they expect to interact socially (Mintz 1998). If the multimedia tools and exhibits offer experiences for one visitor at a time or for a limited number of them, audience is very likely to feel left out (Dierking & Falk 1998). In addition, as Dierking and Falk assert, visitors present different levels of interest and predisposition to exhibition and, in particular, to computer-based exhibits; consequently, some visitors might not want to engage with this type of exhibitions at all. The clue, say the authors, is to make sure that exhibits are designed to fit all visitors' needs and interests but leave room for them to decide whether they wish to engage.

The museum visit is a social experience built in the relationship and interaction with real people, in real spaces, with real objects that tell real stories. When planning and designing interactive exhibitions for the museum experience this reality should be considered the foundation. On many occasion interactives in museums feel dissociated from the context, add-ons within a space that does not welcome them and before users that cannot seem to engage (Semper 1998). In all cases, as argued by the literature, this is the result of a technology-centred design, rather than visitor-centred. The realities of the context have been overlooked. Audience research and exhibition evaluation are systematically conducted in museums in order to study these realities and build the foundations for engaging, meaningful visiting experiences.

4.3. Understanding Visitors' Response to Interactive Exhibitions

Evaluation of museum exhibitions is an area of Museum Studies that has expanded considerably in the last couple of decades. Research and publications regarding the purposes for conducting such evaluations and the diverse approaches and methodologies available have come from a variety of fields, including Human Computer Interaction, Education, Interaction Design and Museology, to name just a few (Black 2005; Dix et al. 2006; Forlizzi & Battarbee 2004; Hindmarsh et al. 2005; Hood 1995; Jones-Garmil 1997; Kelly 2004; Moggridge 2007; Rogers, Preece & Sharp 2006). In this last section, an overview of the foundations of museum exhibitions evaluation with an emphasis on the introduction of multimedia and interactive technologies to these is provided.

As defined by David Dean in *Museum Exhibition. Theory and Practice*, evaluation of museum exhibitions is conducted in order to assess an exhibition's effectiveness in the delivery and accomplishment of meaningful learning experience (Dean 2002a, p. 91). Through a continuous process of evaluating their exhibitions all museum's parties (e.g. exhibit planners, educational program coordinators, marketing executives, in-house and external designers, curators, etc.) learn from their program's achievements and failures. In doing so, the quality of the visitors' overall experience is improved over time and the possibilities of them returning or even recommending a visit to others potentially escalates (Black 2005, p. 267). The overall purpose of evaluating museum exhibitions is to ultimately improve the execution and performance of these. From a perspective of Interaction Design at the service of Museums, among the many benefits resulting from evaluating interactive exhibitions the ones that stand out the most are the gathering of concrete information about their communicative viability, of knowledge about both content and material design efficiency, and of the levels of satisfaction, appeal and usability. The success of multimedia and interactive products ultimately rests on whether end users have an optimal experience (e.g. effective, useful, pleasurable, etc.) through their interaction with these products and their associated physical and social context. As argued by Suzanne Keene in *Digital Collections: Museums and the Information Age*, the aim of conducting exhibition evaluations is to ensure that new exhibitions "convey the *message* of the system to the *designated audience(s)*, and produce the required *effect* on them" (Keene 1998, p. 67, emphasis in original). In the evaluation process visitors are the primary component as it is through them that real accounts of ongoing experiences are obtained. In this respect, and as it will be argued in this section, audience's input commences long before the planning of a new exhibition and it virtually never ends.

4.3.1. The Matter of Evaluation

In the previous chapter it was discussed that museums face the challenge of a jeopardised attendance due to the competition and expansion of the leisure market, to which the public has associated the museum experience in the last two decades. As museum audience research expert Lynda Kelly claims, this situation, added to several other contemporary challenges, has derived in a "conceptual shift for museums, from being primarily curator-driven to becoming market-responsive, focusing on the needs of audiences and their learning" (Kelly 2004, pp. 48 - 9). At the light of such context, it would seem that focusing research efforts on attendance could facilitate the evaluation of museum's exhibitions success or failure. Yet the literature reviewed shows that this tends to develop into a sort of glamorisation and promotion of public exhibitions to increase audience numbers without truthfully considering educational content or meaning

(Dean 2002a). Numbers are only measurable units that reflect little of what the museum can actually achieve in terms of public service; numbers can say very little about the effectiveness of an educational program' communication. Although through applying common sense it might be possible to affirm that once a visitor steps into an exhibition he or she will experience at least a minimal level of impact, "effectiveness must be judged in relation to how well it provides perceptible learning experiences" (Dean 2002a, p. 92).

Measuring and evaluating whether an exhibition meets the expectations of its audience and whether it has delivered its educational and cultural value properly is highly complex yet unarguably beneficial for both the institution and the public. Establishing a concrete framework, variables, and components of the problem to study, namely the outcomes of the interaction between visitors and exhibit, facilitates dealing with research complexity and achieving meaningful findings (Bitgood 2011b; Dean 2002a; Edson & Dean 1996; Hood 1995; Kelly 2007b; Lord & Lord 1999; Silverman 2010). Several authors provide guidelines, in the form of research questions, for the evaluation of exhibitions and their effect on visitors. Essentially, these questions are formulated in the lines of attraction and holding of visitors' attention, evidence of learning processes and outcomes, levels of audience's satisfaction in terms of expectations and needs met, appreciation of the experience as a personal achievement, and fostering of affiliation with the institution (Dean 2002a; Falk & Dierking 2000; Kelly 2004). As suggested earlier, an understanding of the visitor before the actual experience (i.e. audience research) is a reasonable way of evaluating the success or failure of an exhibition. If information about the experience's outcomes can be compared to information about visitors' reality before they have been affected by the exhibition, concrete and reliable analyses can be made. As argued by Gail Dexter Lord and Barry Lord in *The Manual of Museum Planning* (1999), visitors experiences with multimedia and interactive exhibits and in the museum context in general are based on a cluster of variables that need to be considered in as many stages as possible. All parties involved in the development of such museum products, consequently, ought to be sensitive to "the reality that there are factors unique to each individual and to each group's visit to a museum" (Lord & Lord 1999, p. 57).

Research approaches and methodologies for the evaluation of museum exhibitions are varied and numerous, as will be discussed later in this section. Irrespectively of the modes and stages, the main and first thing to do when planning for an evaluation is to consciously make manifest the exhibition's communication purposes, expressed in goals and objectives, as these will provide the foundations of the evaluation. Dean alleges that regardless of how comprehensive and complex these goals and objectives might be, "to be useful they must be quantifiable and measurable" (Dean 2002a, p. 94). In his article *Some Thoughts on Evaluation*, Chandler Screven argued that the effectiveness of the exhibition as a means for educational, cultural and personal achievement can only be assessed by studying its effect on the audience (Screven 1977, cited in Dean 2002a).

4.3.2. The Approaches and Structures of Evaluation

Audience research, also known in the field as visitor studies, is defined by Kelly as "a discipline of museum practice that provides information about visitors and non-visitors to museums and other cultural institutions" (Kelly 2004, p. 49). With the help of a rich range of methods and the contribution from different disciplines' practitioners involved in the development of museum experiences, audience research allows the collection of significant data for museums to design programs and exhibitions that respond to both the institution's and its audience's needs. Lord and Lord (1999) suggest that a comprehensive audience research plan should comprise visitor statistics and surveys (both general and problem-specific), market research, and the exhibition evaluation stages of front-end, formative, and summative evaluation. Other museum theorists add to this list three more exhibit evaluation stages: remedial, program-based and meta-evaluation (Keene 1998; Lord & Lord 1999). Exhibition evaluation is a form of evaluation within audience research that focuses particularly on exhibitions. Through its different stages it is possible to obtain information about visitors leading to the development of effective exhibitions and optimal impact of "its interpretive components on visitor behaviour, interests, or the exhibit's ability to communicate" (Screven 1990, cited in Kelly 2004, p. 56). Given that the purpose of this research project is to examine and understand the effects of interactive exhibits on visitors' individual and social experiences and considering that exhibition evaluation pays particular attention to visitors' experiences with exhibitions and exhibits, this section will outline the four exhibition evaluation stages most commonly developed in museums according to the literature (Black 2005; Dean 2002a; Kelly 2004; Lord & Lord 1999).

Front-End Evaluation

When undertaking visitor studies, museums hold a direct ongoing 'conversation' with their audiences. The Front-End Evaluation can be considered as the initiator of such 'conversation' which will be continued through subsequent stages. This type of evaluation takes place during the planning and development of exhibitions and is undertaken in order to explore potential interests of visitors in exhibition themes, as well as their prior knowledge about them. As asserted by Kelly (2004), this stage is useful in the identification and finalisation of the project brief as it brings in the voices of the future potential visitors. Among the many techniques available for museum practitioners to gather audience's information the most frequently used are questionnaires and surveys (live, over the phone, online), interviews (unstructured and semi-structured), and focus groups. Front-End evaluations that integrate design perspectives also make use of paper-based mock-ups and projected scenarios.

Formative Evaluation

This type of evaluation takes place during the exhibition's development and production stages while changes to the design are still possible to be made. The purpose of this stage is to test particular design and content aspects of the exhibits (e.g. graphics, texts, multimedia, physical proportions, etc.) which implies developing physical test-models such as mock-ups, early prototypes and scaled exhibits. Testings can be performed as many times as necessary, as long as it is possible and practical. When executed early in the planning stage, formative evaluations can help identify target audiences and their particular learning and social profiles. Through this stage of evaluation exhibition planners and designers can define more accurately what works and what does not. Data collection is typically accomplished via audience surveys, analysis of knowledge and attitudes, marketing research, demographic and psychographic analyses, and feasibility studies (Dean 2002a, pp. 96 - 7).

Remedial Evaluation

Once an exhibition or exhibit has been presented to the public an evaluation aiming to identify real-world performance of the whole presentation and its parts can be conducted. With remedial evaluation, as its name suggests, immediate improvements can be realised. It typically focuses on practical issues related to structural aspects of the exhibit, such as calibration, placement within space, lighting, information overload and visitors' fatigue (Kelly 2004). The remedial evaluation may or may not lead to adjustments of the exhibit; this will depend on whether the evaluation revealed that the exhibit did not work as expected or fulfils all the goals set for that stage. Different types of observation techniques and collection of feedback from visitors by application of surveys and interviews are among the most commonly used research techniques applied in this stage.

Summative Evaluation

The fourth stage of exhibition evaluation aims to assess the exhibit or exhibition once it has been completed or has been presented to the public in optimal performance (e.g. the case of permanent exhibitions). This evaluation appraises how well the exhibit performs, how it is perceived by the audience and how it fits within the museum context. This is a complex and comprehensive type of evaluation as it deals with visitor behaviour and satisfaction levels regarding the visiting experience. Through this evaluation stage the exhibition's goals and objectives are evaluated against research findings and concrete insights on success or failure of the program are achieved (Dean 2002a). Consequently, it can be asserted that this stage of evaluation is one of the stages that provide the richest information for future exhibition developments and potential dissemination of acquired knowledge (e.g. academic papers, conference and seminar presentations, etc.). Data collection techniques available for this stage are varied and their selection is dependent on the research team expertise and affiliation (i.e. in-house or outside experts). The most

> commonly utilised techniques are visitor surveys (e.g. over the phone, online, exit surveys), observational studies (e.g. visitor tracking, unobtrusive observations, contextual enquiry), individual and group testings, and external critical appraisals.

As it can be inferred from these evaluation descriptions, formative, remedial and summative evaluations relate to the effectiveness of the exhibition in terms of communication its purpose and to the relationship between exhibit and visitors during their interaction and visiting experience. Conversely, front-end evaluation is related to the building of the foundations for setting program's goals and objectives. All these four stages of exhibition evaluation are complementary, not exclusionary; when museums choose not to undertake any or some of these they limit their audience understanding and building up of knowledge for both ongoing and future exhibitions. By conducting evaluations on all four stages a richer and more complete picture of the overall exhibition context is drawn: program's goals and objectives, audience needs and expectations, and visiting experience satisfaction.

As with many other fields that study human behaviour, when it comes to studying their audiences museums find before them several different research approaches to work from. According to Kelly (1999), particularly in educational and social research there are two prevalent research approaches: the positivist and the interpretive research approach. The positivist approach is typically associated with formal procedures, also known as scientific or empirical methods, and its interpretation aims at "determining precise levels of learning and retention" (Dean 2002a, p. 98). On the other hand, the interpretive research approach is mostly associated with rather informal procedures, which are more perceptual, reflective and less structured, and aim at determining reactions and usefulness. For the purposes of this research project, and given that a crucial part of it has been built on primary research, a thorough review of the literature regarding visitor studies was developed and presented in the Methodology Chapter. In addition, the respective chapters for the three case studies undertaken throughout this project present case-specific methods and tools developed for each particular research context.

The research of visiting experiences and the quality of visitors' direct engagement with the museum collection through its exhibitions combines the study of external evidence of visitor engagement through quantitative and qualitative methods. As argued by Gail Dexter Lord and Barry Lord, "any given study can include several measurement approaches, varying design approaches, and varying approaches to data analysis" (Lord & Lord 1999, p. 60). The challenge, they go on to explain, is to balance information needs and usefulness with the right research resources (e.g. budget, time, expertise). Literature in the field suggests that a mixed-methods approach of both quantitative and qualitative data collection and analysis techniques is the most appropriate to achieve meaningful research insights (Kelly & Bartlett 2002; Kuniavsky 2003; Mack et al. 2005; Silverman 2010; Soy 1997).

In the development of this doctoral project the research approaches and methodologies here discussed were taken into account for the design of the project's empirical collection of information. The analysis of the existing literature in the fields of Museum Studies and developing Interactive Technologies, which included the review of theory and examples of diverse experiences in both fields, contributed to the building a body of knowledge that would prepare me to appropriately address the problem space of museum visitors' experiences with interactive exhibits.

4.4. Summary

Throughout this chapter I have argued that what makes the museum visiting experiences different to any other learning and recreational experience is the flexibility of emotional, sensorial and cognitive expressions that its space facilitates. People go to museums because in them they not only find new knowledge but also make sense of it in an active social engagement, which adds to their personal growth within society. The museum is a space in which visitors find their bodies and minds lured in unique ways. Visitors expect the museum to surprise them, satisfy their curiosity and make them feel they have achieved something different. Museums, on the other hand, are aware of the needs and expectations of their audiences and are more and more finding new ways to keep their interest and attendance. Among other resources, museums have been increasingly incorporating interactive exhibits to their spaces, in an attempt to facilitate audiences' engagement both with their collections and their messages. In this respect, I have argued that the incorporation of interactive technologies in the museum environment is of great potential if considered as a medium for the delivery of meaningful experiences and not as the resulting experience. I have also argued that, in order to ensure that the experiencing of the collection and its message is not taken over by these technologies, it is necessary to deeply understand visitors both as consumers of technology and as consumers of culture. I have concluded this chapter by emphasising the important role that field research has in the development of interactive exhibits, as it allows a direct collection of experiential data from their potential users, the visitors.

Chapter 5. Methodology

5.1. Introduction

The review of the literature, as presented in Chapters 2, 3 and 4, has revealed how museums have responded to the accelerated development of technologies and its consequent effect on their audience as consumers of technology (Black 2005; Lang, Reeve & Woollard 2006; Marty & Burton Jones 2008; Scott 2000). Similarly to other contexts of public use (e.g. entertainment parks, libraries, shopping centres, to name a few), museums have benefited from and been affected by this deployment. In the last two decades museums have integrated new technologies in mostly every activity they carry out, expanding and enhancing the service they provide to their audiences.

For the professionals in the discipline of Interaction Design, the use and experience of interactive technologies in the exhibition environment is probably one of the richest areas for research as these technologies are significantly changing the way visitors perceive the museum visit. This doctoral research originated with a reflection around the impact the incorporation of interactive technologies in the museum might have on the visiting experience. In particular, it aimed to explore the role these technologies have in the visitors' perception of and engagement with interactive exhibits. Moreover, given that the museum experience is intrinsically a social one, the project aimed to study how this perception and engagement is affected by the social context. Consequently, the research questions established for this project were as follows:

> *How do visitors perceive interactive exhibitions and how does that perception influence their engagement with them? Does social interaction influence this perception in any way? If so, is there a social negotiation and common understanding in order to make sense of the exhibition content?*

As emphasised through the literature review, experience of technology is a shared, situated and ongoing flow of sensations (Dewey 1959; Forlizzi & Battarbee 2004; McCarthy et al. 2006). The museum visiting experience, in particular, is an encounter with knowledge and delight that develops throughout the visit (Falk & Dierking 1992; Hein 1998; Lorentz 2006). In order to understand and evaluate the experience of visitors with museum exhibits, it is necessary to get acquainted with them and their processes of developing interactions within the actual museum environment. As stated by Donald Norman, "cultural constraints and conventions are about what people believe and do, and the only way to find out what people do is to go out and watch them" (1999, p. 41). Accordingly, my research is not only based on theoretical enquiry but in the study, analysis and understanding of users' experiences with technologies in the real world: the museum environment.

5.2. Understanding Experience: A Research Approach

A comprehensive work in the understanding of user experience has been developed by John McCarthy and Peter Wright (McCarthy & Wright 2003, 2004; Wright & McCarthy 2008). Of particular relevance is their human-centred approach to the understanding of user experience with digital technologies in their study of the notions of enchantment and empathy throughout the design process as a whole. Furthermore, the most significant contribution of their work to this research project emerges from *Making Sense of Experience* (McCarthy, Wright & Meekison 2003). Through this work the authors argue that "we cannot design an experience [yet] with a sensitive and skilled way of understanding our users, we can design for experience" (McCarthy, Wright & Meekison 2003, p. 52). This understanding of users, as they go on to explain, implies that designers observe, discuss and associate all comprising components of experience with a main focus on the user. Accordingly, the authors propose a conceptual framework - presented and analysed later in this section - as a set of reflective tools expected to aid the designer in the process of understanding user's experiences with digital technologies. Although McCarthy, Wright and Meekison explain this framework is not a method for analysing experience, I adopted it as the lens through which I would develop my primary research of visiting experiences in real-world exhibition settings.

The influence of pragmatist philosopher John Dewey is evident in their account of experience with technology. Their framework embraces the intrinsic holistic, situated and constructed nature of experience and focuses on the relationship between and juxtaposition of its components as opposed to isolated, independent incidents (McCarthy, Wright & Meekison

2003, p. 46). Also of great influence in the definition of this framework was the work of semiotician and literature philosopher Mikahail Bakhtin, who reflected on the dialogical nature of human activity in which "there are always at least two consciousnesses involved" (McCarthy, Wright & Meekison 2003, p. 45). The authors go on to explain that dialogical relationships between the self and the other, as well as between the self and the object, result in interconnected experiences. McCarthy, Wright and Meekison's experience framework is structured in two parts: the main threads through which experience develops and the ways sense is made during the experience. What follows is a succinct description of the framework and its intertwined, permanently interrelating aspects.

5.2.1. Four Threads of Experience

In the process of experiencing technology users encounter a dual structure of part and whole. Throughout the interaction process users identify narratives, explanations, possibilities of and responses to their actions. In the experience each element unfolds as a part and re-composes a whole for the user. This was called by McCarthy, Wright and Meekison the compositional thread of experience (McCarthy, Wright & Meekison 2003). This unfolding of actions and events occur in a particular time and place, two elements that, in addition, affect each other. This spatio-temporal thread of experience presents such flexibility that for different users the same instance of experiencing technology can be perceived in different extensions (e.g. time length and pace, space enclosure and social value) and levels of connection. Another thread of experience is related to the sense-based exploration of technology and its activities' developing context. This is what the authors called the sensual thread of experience[4]: the feel of a physical artefact and space, as well as the sensory engagement and the sensations it offers (e.g. sense of comfort, belonging, unease, etc.). In both individual and shared experiences an array of emotions are triggered (frustration, joy, satisfaction, anger). The emotional thread of experience,

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[4] The word 'sensual' is commonly associated to the sexual aspect of human experience. In the context of this research the word 'sensorial' is more appropriate. Consequently, from here onwards the word 'sensorial' will be used to refer to this thread of experience.

as McCarthy, Wright and Meekison warn, is commonly confused with the sensorial thread of experience, as manifestations as the result of different stimuli might be similar. Throughout interaction with digital technologies users may engage with their own emotions or, in addition, empathise with others' emotions as these are not simply passive responses to given situations.

5.2.2. Sense-Making in Experience

The process of experiencing technology is an ongoing construction of meaning, a process which is both reflective and recursive. Sense-making is reflective as the experience is recounted by a user, whether in a self-oriented mode or in a collective view. It is recursive as the user or group of users are continuously involved in the ongoing process. Users make sense of their experiences with technology by *anticipating* an event's implications as they bring into it pre-conceived expectations, possibilities and ways of making sense of it. This *anticipation* is also extended to the ulterior continuous shaping of the past experience. By engaging in an interactive experience users make initial *connections* with the context through their senses. The process of making sense implies *connecting* sensorial, cognitive and emotional aspects of the experienced environment. In the encounter with the technological environment users make sense of the unfolding experience by *interpreting* the diverse messages displayed (e.g. physical attributes, written content, spatial flows, possibilities of action, etc.). This process allows each user to give a particular meaning to his/her unique experience. *Interpreting* leads to a judgment of the unfolding experience and, consequently, to a valuation of it. This is achieved through *reflection*, the instance in which the user weights the significance and usefulness of an action and its results. *Reflecting* may take place in an intimate form (i.e. an inner dialogue with the self) or collectively (i.e. in a dialogue with others), and both during and after the event. Users make sense of their experiences by relating them to previous and future experiences and by associating them to their sense of present, past and future self. A process of *appropriation* and belonging occurs when suiting the sense of self within the experience. As developing processes the experiences with technologies accompany users beyond the actual event. In *recounting* an experience, users carry the experience with them and make sense of it when connecting it to others. In this process, experience may remain untouched or change as a result of either an individual or socially-driven recount.

Following the authors' advice I adopted this framework of experience as a primary research approach, through which I could better study the experience of museum visitors in their interactions with digital interactive exhibits. Far from considering the framework's components as ingredients of a formula for the analysis of experience, I evaluated their significance for the research of interactive experiences in the museum context and developed my research methodology from them.

5.3. Primary Research Methodology

User and visitor experiences have been researched in depth in the fields of Human Computer Interaction and Museums Studies, respectively. Being human experience in general a complex scenario to be studied, both fields make use of and adapt a rich set of epistemologies, approaches and techniques, drawing from disciplines as varied as Psychology, Education and Interaction Design, according to the particular purposes and possibilities of their research contexts (Dix et al. 2006; Kelly 1999; Sharp, Rogers & Preece 2006). Upon reviewing the literature on social research it is inferred that the two main paradigms of research, positivism and naturalism, have lately found a balance in the search of understanding of human behaviours, yet the debate of what particular methodologies are more suitable for different fields still remain (Bickman & Rog 1998; Gilbert 2008; Greenfield 2002; Kumar 2005; Silverman 2010).

In the particular context of museum audience research both quantitative and qualitative research approaches contribute to the understanding of visitors' experience and have equally helped in the development of meaningful visiting experiences (Black 2005; Kelly 2002; Lord & Lord 1999). Kelly (2002) provides a complete overview of this two-sided contribution. According to the author, quantitative research facilitates the study of a comprehensive scope of the audience as its methods are applicable to large sample sizes and permit a well-structured collection and analysis of data. Mostly factual information is derived from this form of research providing museums concrete information about their visitors' characteristics, visiting statistics and the like. Questionnaires, focus groups and different types of surveys are among the most common techniques utilised in the quantitative research of museum audiences. On the other hand, undertaking qualitative research gives museums access to direct accounts of visitors experience and the various ways they make sense of it as well as their visiting motivations and expectations. Qualitative research is characterised by a flexible and exploratory nature which enables access to detailed individual and collective visitors' experiences and their meanings. Some of the most commonly used techniques utilised in museum's audience qualitative research are observations and in-depth interviews.

As revealed by the review of literature, cultural heritage institutions are increasingly focusing their efforts on understanding their visitors' learning and recreational experiences (see Chapter 3). Accordingly, qualitative research is becoming more and more prevalent in the process of researching and developing audiences (Kelly 2007b; Muller 2008). As affirmed by Social Sciences scholar David Silverman, in qualitative research "detail is found in the precise particulars of such matters as people's understandings and interactions" (Silverman 2010, p. 104). Art Curator Lizzie Muller suggests that on adopting qualitative research institutions "create engagement with audiences and resources of information" that gets them closer to their visitors and, subsequently, to their real experiences (Muller 2008, p. 58). This more direct approach to researching audience is further developed by Kelly (1999) as she highlights the value of closely relating to whom they actually are developing their programs for.

A Case Study Approach

Museums can be considered small-scale representations of societies, places where people construct, express and preserve their culture, their collective memory (Crane 2000; Hooper-Greenhill 1999b). As concurred by several authors in the Social Sciences research field, asking people about their perception of their social and cultural reality offers only an initial base for study (Gomoll 1990; Sharp, Rogers & Preece 2006; Silverman 2010). A field exploration in this research project was envisioned as the possibility of attaining a more comprehensive understanding of the interactional patterns that encompass the museum visit and the particular effect of interactive technologies on the visitors' experiences. Primary research in the museum context represented an opportunity for both interacting directly with visitors and observing them in the real world, were research data occurs naturally.

Case Studies are referred to as both methodology and method in the literature, depending on whether they are applied as a comprising set of data collection techniques or as a tool itself (Baxter & Jack 2008; Gilbert 2008; Museums Australia 2002; Silverman 2010). Case studies facilitate the exploration of a phenomenon within a specific context in which the potentially multiple facets of such phenomenon is explored and revealed through a variety of data sources (Baxter & Jack 2008; Tellis 1997). According to Yin (2003, cited in Baxter & Jack 2008) a case studies approach is suitable when the study aims to answer research questions in the lines of 'how' and 'why', the behaviours of participants should not be manipulated, contextual conditions need to be covered, and/or no clear boundaries are previously identified between the phenomenon and context of study. I adopted Case Studies as a methodological approach, focusing on the characteristics, circumstances, and complexities of a limited yet diverse number of cases. In particular, I took on an explanatory stance through all case studies as I my research questions sought to explain causal links (i.e. the effect of interactive exhibits on the museum visitor experience).

5.4. Research Methods

5.4.1. A Field of Possibilities

In the development of my primary research I integrated data collection methods derived from research methodologies commonly adopted by both Museum Studies and Interaction Design (Kelly & Bartlett 2002; Kuniavsky 2003; Museums Australia 2002; Saffer 2007; Sharp, Rogers & Preece 2006). Some Social Sciences methodologies also informed the building of my set of research methods (Bickman & Rog 1998; Mack et al. 2005; Silverman 2010). As explained earlier in this chapter, my preparation for the field work was informed by McCarthy, Wright and Meekison's Framework for understanding experience (2003) and a clear definition of research questions. Through secondary research I also embarked on a reflective approach to exhibition environments in the terms philosopher Don Ihde has defined the world: as a field of unpredictable events, full of opportunities and possible experiences to be studied (Ihde 1977, 1993). Yet this approach does not imply conducting research randomly; on the contrary, the need of a rigorous in situ enquiry becomes a priority so the outcomes find a solid research validation.

Together, research questions and approach led to the delineation of the type of data that needed to be collected from the field and the most appropriate methods to achieve this in an effective and efficient way. In a field-based research process participants have an active role as it is them who reveal their experiences, either directly or indirectly. In order to understand how visitors perceive and experience interactive exhibits in museums and how they make sense of them in such social context I firstly determined a set of potential visitors' accounts. Some of this included, for each particular research context and case study:

- their perceptions of what the exhibit/exhibition is about and of how they could interact with it and its content
- their motivations behind their decisions about whether to engage in an interaction or not
- the ways they interact with the exhibit and the mental models developed through their interaction process
- the ways they interact with other visitors, whether familiar or strangers
- their interpretation and understanding of the content being delivered
- the emotions resulting of the interactions with the exhibit and other visitors
- their sensorial experience through the interaction with the exhibit and other visitors

As it can be noted, these envisioned accounts fall - to some extent - into one or more experiential threads, as defined by McCarthy, Wright and Meekison. Some accounts are more comprehensive and some are more thread-specific. For instance, the decision to interact with an exhibit can be equally informed by the influence of other visitors (emotional thread), the identification of already known features (compositional thread), the intimate space available for interaction (spatio-temporal thread), and the soundscape surrounding the exhibit (sensorial thread). Naturally, more than one aspect in each thread can guide a visitor's interaction with an exhibit.

Accounts are comprised of several sets of information. The kind of information that was projected to be obtained from field research and that could inform these accounts included:

- time spent interacting with the exhibition (e.g. average time for interaction from the moment the participant notices the exhibit until he/she leaves it)
- facial and bodily expressions upon approaching, interacting with and leaving the exhibit (e.g. participant looking curious, approaching the exhibit but leaving without interacting)
- modes and modalities of use of interface(s), success in the manipulation and interaction outcome (e.g. participant repeatedly pressing a knob as opposed to turning it)
- visitors observing from a distance (e.g. parents that do not interact with the exhibit but observe their children interacting)
- verbal and bodily communication with other visitors during interaction (e.g. visitor raising other visitor's arms to activate an exhibit's feature)
- social prompts for interaction (e.g. visitor encouraging other to do something)
- narratives and direct accounts of the experience (e.g. visitor reporting about his/her recent experience)
- bodily and verbal cues of levels of interest, enjoyment and acceptance (e.g. visitor standing in front of exhibit and raising shoulders in indication of confusion, visitor smiling while saying "this is fantastic!", visitor saying "I wish my home theatre worked this well")

5.4.2. Gathering Data

Although case studies are conducted primarily using qualitative research methods, these do not exclude methods that seek to gather more quantitative data. Quantitative data not only helps collect and organise information based on numbers (e.g. time spent on interaction, participants simultaneously interacting, age range of visitors, etc.) but also provides measurable evidence for the identification of trends (e.g. a phenomenon observed repeatedly, patterns of responses across age groups, etc.).

Most frequently, data need to be cross referenced with others in order to achieve accurate and meaningful results and find relationships between them. For instance, a long period of time spent interacting with an exhibit could be either a sign of high enjoyment or difficulty in the interpretation of the interaction map; likewise, it could also indicate the participant is immersed in a non-exhibit-related reflection (e.g. what to do after the visit, where the car was parked). In this case, an observation of bodily expression or a direct verbal account could help determine the actual motivations for the participant to spend that amount of time at the exhibit. Similarly, a direct account from group members about their collaborative interaction through an interview conducted after the experience could reveal whether a verbal and physical engagement with each other during the interaction was a conflictive or a collaborative action.

As suggested in the literature (Kelly 1999; Mack et al. 2005; Silverman 2010; Soy 1997) the use of mixed methods in field research projects facilitates a much richer and significant understanding of the museum visiting experience as combined techniques can address altogether individual and social perceptions, objective measures and expressive accounts. In having a cumulative view of data drawn from different contexts it is possible to "triangulate the 'true' state of affairs by examining where the different data intersects" (Silverman 2010, p. 133) which may, in addition, improve the reliability of a single technique's results. Triangulation of data, as Kelly argues, "uncovers the rich and complex outcomes" (Kelly 1999, p. 4) at the time it permits researcher to focus on interpreting visitors' meanings of actions, behaviours and interaction outcomes in their own terms.

Through surveying the literature of research methodologies I carried out a thorough analysis of methods available and defined the most suitable ones for researching visitors' experience with interactive exhibits. While I am a professional Designer, this study did not include research methods typically utilised in the design stages of product requirements settings or usability testing (Dix et al. 2006; Laurel 1990; Saffer 2007; Sharp, Rogers & Preece 2006). Instead, I focused on those methods that are most frequently used in the understanding of user experience in their interactions with digital technologies (Gray & Malins 2004; Kuniavsky 2003; Millen 2000; Muller 2008) as well as those used in museum studies, particularly during the processes of Audience Research and Exhibition Evaluation (Black 2005; Dean 2002a; Kelly 2002, 2004). What follows is a general overview of the methods selected for this research projects' primary data collection, as informed by the review of literature, and the rationale behind their selection. A detailed description of the particular structures and techniques of the methods utilised in each case study is given in their respective chapters.

Observing Visitors

I identified observational studies as the most suitable set of methods for this research project. Observational studies are characterised by the uncontrolled and natural context in which they take place. During the conduction of my field studies in museum-related contexts I would have no control over the environment, the activities occurring in it or the participants. In addition, these research contexts present a high level of naturally occurring behaviours to study from. These were my main motivations for conducting research at real-world situations.

Observation of visitors' experience with interactive exhibits typically takes place in the immediate space surrounding the exhibit. Ideally observation time includes not only the actual interaction time but also the preceding and subsequent moments to the interaction. Throughout my field studies visitors were mostly observed during their visiting experience yet additional observations were carried out through the analysis of images and video recordings. Observations were particularly relevant to the study of visitors' experience with interactive exhibits as they allowed for the gathering of accurate information about how the interactions developed throughout time. Consequently, the main advantage of conducting observations was the possibility of capturing the experience as it actually occurred, in their natural environment.

Direct observations were carried out in each of the case studies. Some of the main difficulties of field observations were the time invested in carrying out the studies and the risk of gathering excessive and unnecessary data; this could eventually impact on the analysis stage. In order to tackle these potential complications, a narrowed and well-structured instrumental framework was developed, clearly specifying subjects and units of study for each case. Particular challenges were identified from the researcher perspective, as expertise for developing this type of research was not fully developed yet; the progress of each case study and the evolution from one to the next case helped reinforce skills, confidence and objectivity.

Previous to the commencement of the studies I reflected on how, as an active observer, my performance might affect visitors' behaviour. Although an active standpoint would facilitate a closer relationship with participants and, consequently, a higher possibility for capturing details, this would also mean alter or even stop visitors' experiences. As a passive observer, on the other hand, I would have limited or no contact with the visitors, yet this would guarantee the normal flow of the audience's visiting experience. Problems with passive observation would also include limited visual and auditory access to reliable data, with the risk of missing valuable information (particularly on occasions when visitors' numbers around the exhibit are high). In addition, observing from a distance implied ethical issues as participants might be studied without their consent; ethical issues are comprehensively discussed later in this chapter. During observations I adopted a flexible observing behaviour, switching from an active to a passive role according to particular field and participants conditions. When balancing techniques and approaches, richer sets of data are obtained, with the researcher undertaking her tasks without affecting visitors' and yet integrating them into the process in as much as they are willing to be.

Listening to Visitors

Another method I identified as consistent for the study of visitors' experience with interactive exhibits was the direct account of their actions, decision- and sense-making processes, opinions and emotions triggered. Similarly to the way it was planned to be when observing visitors, the invitation to participants to contribute with direct descriptions and explanations of their experiences would be based on common sense: the overall context would provide cues as per who to address, as well as when and how. The literature presents a wide array of methods for the collection of data directly from participants. These typically take the form of interviews (with different structures and tones), brief enquiries, and focus groups, among others. After analysing the potentials of each and pondering them in the light of time and budget, I decided to conduct mainly interviews and enquiries. On reflection, the main advantage of applying an interview method to the research was the possibility of obtaining a full range and depth of information. Problems and challenges were also taken into account; these included the time to be invested in the interviewing process and the potentially large set of data to be analysed later. The preparation of a concise set of questions consistent with the research questions helped minimise these complications.

In general terms, interviews span from formal to unstructured, depending on the particular field conditions. They may take place directly in the exhibition environment or outside of it. In the development of my case studies interviews were conducted in a conversational style so as to gain expressive accounts on participants' knowledge, impressions and experiences. All interviews were conducted as a complementary method to observations, which means all interviewees had already been observed while interacting at the exhibitions.

Completely unstructured interviews were impractical for a group of participants that was early anticipated to be large. In addition, data was going to need a structure for analysis and, more importantly, pattern recognition. Therefore, semi-structured interviews were defined as the most optimum technique for listening to the audience. Nonetheless, the exploratory and informal nature of unstructured interviews was embraced and integrated into the interviews' questions and structure design, anticipating unforeseen expressions that could enrich the study's findings. As recommended by the literature, a particular attention was to be put on the interviewees' comfort at all times. Enough time for participants to freely express, the option to exclude information, or even withdraw from the interview was provided at all times; reading bodily expressions to interpret their level of comfort was also taken into account to ensure a proper response to their participation. In addition, no audio recordings were made, so as to avoid intimidating the interviewees; only quick notes were taken while interviewing visitors, which were immediately complemented after the interviews.

With the help of both closed and open questions, the semi-structured interviews conducted throughout the field research facilitated a flexible exploration of topics at the time as many research topics as possible were covered. Prompting was a clue action in this process; participants were usually asked specific questions on a topic and then encouraged to develop further with conducting, more open questions.

A technique derived from interviewing methods but with several variances was applied to the research. On occasions I would approach visitors while they were interacting with the different exhibits around which the studies took place. These approaches aimed to ask participants about their experience, gaining fresh, spontaneous impressions of what they were doing and why, what they would feel and how the interactions were informed by both the physical and social space. These contextual enquiries presented at time some difficulties as participants were not necessarily willing to participate, in which case I would never insist. Conversely, participants would sometimes ask for help or invite me to join their interactions, which would alter the purpose of the enquiry (i.e. the interactive experiences would no longer be completely natural).

Later Feedback

Questionnaires or surveys are another method widely used in research in the Social Sciences, in Interaction Design research and development and in particularly in Museum Studies. According to the literature, the types most regularly applied are face-to-face, online and over the telephone. In general terms, these tools allow obtaining similar data to those obtained through interviews but with a few differences: time and place of application. In terms of content, visitors' profiles and a range of opinions can be obtained by making specific questions. As with interviews, questions can be open as well as closed and even provide a range of options for participants to choose from. In addition, complementary information can be provided to the participant in order to help them formulate their answers (e.g. referential images and sample texts).

In the application of questionnaires the researcher takes a different role to that in the interviewing process, as no additional input from her/him should be made (the researcher is present only to deliver the questions). For this reason, questions need to be completely clear, otherwise they can lead to loose and useless responses. Face-to-face questionnaires can take place at the research context or wherever the research subjects wish to be contacted at (e.g. their office or home, a café). Online and telephone surveys do not require the researcher to be at the same place as the participants are; online surveys can be answered from any compatible device while telephone surveys are typically made to the participants' preferred contact number.

There are many advantages and disadvantages between the different surveying tools, yet I considered the online survey as the most suitable one for obtaining data from my participants. The survey technique allowed me to contact a considerable number of participants, reaching a wider scope of visiting experiences. Also, on letting participants determine when they wished to answer - and if they did - not only their interactions were not interrupted but also the possible sense of intimidation often resulting of interviews was reduced. The invitation to answer the survey was made directly via email; this contact information was retrieved from records publicly available or directly from participants when leaving the exhibition. The technique also allowed participants to remain anonymous, as their names were not required in order to answer the survey, which potentially added to their frank answering of questions and sharing of opinions.

Asking the Experts

Interviewing experts gives researchers the possibility to explore topics that are not addressable through the participants. This method mostly adds benefits to the research and there are very few challenges. Some of the challenges I encountered in the use of this method were my lack of experience in interviewing professionals and my limited confidence in communicating with the appropriate professional terminologies and fluid language (my native language is Spanish). Researching the experts' professional backgrounds, preparing a meaningful set of questions and practicing with other peers helped me conduct good interviews, which provided significant input to my research project.

I decided to interview experts after conducting the field research for two reasons. Firstly, I wanted to make sure I brought no further information about the exhibition context into the field, as a way to ensure the data collected during the study corresponded uniquely to the interacting visitors and their experiences. Secondly, I expected to share my findings with the experts as a way to corroborate perceptions and - to some extent - validate my findings. In addition, I consider it to be good professional practice to share information regarding project outcomes with those involved.

The interviews, which were conducted with Designers and a museum Program Manager, were conducted at their respective workplaces in order to take as little of their time as possible. With their consent, all interviews were audio-recorded and some notes were taken. The set of questions was semi-structured yet the interviews would usually develop following different branches of conversation as the topics arose.

5.5. A Correct Pathway

5.5.1. Ethical Considerations

As it has been outlined through the present chapter and as it will be evidenced through Chapters 6, 7 and 8, the nature of my research project comprised a considerable proportion of field work. The collection of data mainly through observational techniques and direct enquiry implied short-term and close personal involvement with participants. With a project based on three case studies as primary research, special care was taken in terms of ensuring wellbeing, privacy and overall comfort of the participants during and after the field research period. A well prepared research strategy and a clear presentation of it to the participating visitors facilitated gaining their trust and collaboration.

In the process of collecting data from all three case study subjects ethical considerations were taken into account. During the design stages of the cases several meetings with UTS Research Ethics Officers (REO) were held in order to obtain guidance as per how to proceed in particular situations (e.g. addressing minors, making audio-visual records, identifying participants by their names, etc.). With their assistance and the review of Social Sciences research literature appropriate procedures were devised. These procedures were not only the regulatory paperwork UTS Human Research Ethics Committee (HREC) requires for conducting research that involves humans as subjects but also included some other materials that would make participants more comfortable during the field study process (e.g. special consent forms for children, visible signage informing of the studies being conducted, researcher's nametag, etc.).

Ethics clearance applications were presented to UTS Human Research Ethics Committee (HREC) for each case study developed. The applications included research methods samples (e.g. interview questions, treatment of images), consent forms for different types of participants (i.e. for adults, children, teenagers accompanied by adults and experts) as well as a research information sheet for them to take away. Both consent forms and research information sheets included my contact details as well as my chief supervisors' details for participants to contact us if needed. It is important to point out that these documents were edited in such way that all legal content was included yet using a language that was straightforward and simple so participants would not be intimidated by complexity. All consent forms were signed by participants when corresponding and none of them withdrew from the study.

Anonymity of participants has been maintained all through this research project, from the collection of data in the field to the final presentation of research outcomes. With the exception of the experts interviewed, who were comfortable with their names being disclosed in research publication(s), whenever reference has been made to participants this have been referred to as Visitor #1, Visitor #2, and so on. The information collected during the case studies, as expressed through different types of tools (i.e. annotations, drawings, photographs, audio and video records) are stored in locked storages and password-secured devices to which only I have access. In addition, any digitalisation made during the analysis and interpretation stages (i.e. interviews transcriptions, written descriptions, tabulations, cross-references, analyses and interpretations) has been secured in the same way. Finally, as it will be noticed in the Case Study chapters, all images taken during the field work in which visitors' faces are recognisable, have been graphically treated in order to protect their identities.

The three case studies presented in this doctoral dissertation were conducted with full ethics approval from UTS Human Research Ethics Committee. For the first case study, *I See What You Mean*, an ethics clearance application was submitted in May 2009 and approved in July 2009. The clearance number for this request was UTS HREC REF NO. 2009-127A. For the second case study, *Facets Kids*, an ethics clearance application was submitted in September 2009 and approved in November 2009. The procedure was carried out under the project number 09/09 HREC 2006-304P through UTS Creativity and Cognition Studios program (CCS), entity with which the exhibition housing institution holds a research partnership. CCS is the final repository of the corresponding clearance letter. For the third and final case study, *Dangerous Australians*, an ethics clearance application was submitted in February 2011 and approved in March 2011. The clearance number for this request was UTS HREC REF NO. 2011-049A. Approval letters have been included in the Appendices for the reader's reference.

5.5.2. Reliability and Validity

Much has been discussed in the research arena about the apparent lack of reliability and validity that qualitative research presents or how its researchers tend to struggle in order to defend their research outcomes (Bickman & Rog 1998; Gilbert 2008; Silverman 2010; Soy 1997). The purpose of this study is in no way to argue whether one research approach is more appropriate for the understanding of visitors' experiences with interactive exhibits than other. Nonetheless, it is in my interest to present a set of approach, methods and procedures consistent with my overall doctoral research aim and professional stance. Consequently, I considered discussing reliability and validity within my field study necessary.

As it will be observed in the three case studies' accounts (Chapters 6, 7 and 8) a thorough design and execution of each unit of study, as well as a rigorous data interpretation and analysis processes were performed throughout this research project. This is reflected by the aim-specific nature of each unit of study, the structured and systematic data collection procedures, the detailed narrative in the interpretations and the comprehensive triangulation of data across different units of study.

In addition, and when possible, methods and protocols were tested prior to their application in the field. For instance, the online survey was scrutinised by colleagues, rephrased several times and restructured until becoming a tool that would fit both participants' interests and the researcher's. Likewise, some of the tools and methods utilised in the case studies were presented to peers from different backgrounds and in different contexts (e.g. Human Computer Interaction-related conferences, academic seminars, student-supervisor meetings), obtaining from them valuable feedback and advice.

Lastly, and as it will be developed in the next section, the case studies were developed informing each other consecutively. Each finished case study became a lesson learned in many aspects. Each lesson was translated into improvements, narrowing down of scopes and refinement of the methods.

5.6. Developing the Case Studies

5.6.1. The Chronology

The decision of complementing my doctoral research with information from the field arose early in my second year of candidature. When invited by a colleague to design, produce and present an exhibition together I realised I was not only having the opportunity to create my first exhibition but also to test some of the research statements I had so far developed through the initial review of literature. By then, my research questions were still not ensuring significant theoretical findings. With the completion of the first case study, the *I See What You Mean* exhibition (see Chapter 6) and a critical reflection upon research findings, new research questions were defined.

By the end of that same year I was invited to conduct the audience research for an interactive installation, *Facets Kids* (see Chapter 7). By then, not only my research questions were definite but also the scope of secondary research had been narrowed down, positioning my project within specific streams of the fields of Human Computer Interaction and Museum Studies. This second case study provided a much richer approximation to these two fields as the concrete, practical information motivated a more solid sense-making of theory. By the end of my third year of candidature I felt something was missing; my progress in understanding the literature, in positioning my research within a specific theoretical framework, and in internalising with visitors lived experience needed a final field test.

On several occasions in the past three years I had visited the Australian Museum and wondered - from the perspective of an audience member, of a professional designer and of a researcher - how the *Dangerous Australians* exhibit was experienced by its audience. After contacting the institution's Head of Web and Audience Research, Dr Lynda Kelly, a proposal for my third and final case study was accepted (see Chapter 8). All through my fourth year of candidature, I dedicated myself to making sense of the comprehensive data collected, contrast and merge it with data from previous case studies and with the secondary research outcomes. Looking back at the entire case studies process and the valuable findings from them obtained I have the certainty this research would not have contributed the same had any of them been left out.

5.6.2. The Variety

Each of the three case studies comprised in my research project presented different characteristics, opportunities, challenges, and outcomes, all of which are analysed and presented in detail in the following chapters. Despite of their differences, there are certain aspects that link the case studies together in an evolutionary way. As expressed in the previous section, each case study would result in new interests and new enquiries; thus, each case would be built on the findings of the previous one (with the exception of the first one, certainly). The variety in the multiple-case studies approach steered the concrete positioning of the research within the body of literature at the time it facilitated the refinement of my research questions.

While the *I See What You Mean* exhibition was presented at a small, community-specific gallery (the DAB LAB Research Gallery, in Sydney), its audience was limited in terms of visitor profile and numbers. Conversely, the *Facets Kids* installation was presented at a science and technology museum (the Powerhouse Museum, in Sydney) whose audience is considerably larger and more varied. The *Dangerous Australians* exhibit is part of the *Surviving Australia* exhibition at the Australian Museum (in Sydney) which is one of the most comprehensive natural history and anthropological museum of the country. With audience numbers and a visitor profile similar to that of the Powerhouse Museum, this case study differed from the first two in that the interactions being studied took place around a permanently presented exhibit. Whilst the participants of *I See What You Mean* and *Facets Kids* would unequivocally encounter these exhibition and installation for the first time, some visitors to the *Dangerous Australians* exhibit might already by acquainted with the interaction experience. Different venues, audience size and type, approaches and interests were explored in each exhibition case study; nonetheless, one common aspect remained: the study of their visitors' experiences with the technologies available.

My role as a researcher varied throughout the three case studies as well. In the first case study I was fully involved in the design and research processes, from the conceptual definitions to the audience evaluation. In the second case study I was aware of the design process (as I knew the artist and researcher as well as his work); however I only took part in the installation from the audience research viewpoint. In the final case study my experience with the exhibit was limited to a regular audience member's knowledge; additional research on certain design and technological aspects was conducted before commencing the case study. Still, my role remained as an external researcher. This variation in the research roles influenced the way I approached each case, both in terms of my relationship with each audience and of the tasks undertaken. In particular, with each case study I would develop an improved research performance, improving my tool design skills and on-site routines, and refining my ability to collect significant data from my participants.

Whenever a new research scenario is met a series of presumptions informed by past experiences is brought in. A logical association of previous research findings, the general knowledge developed throughout professional practice, the theoretical research undertaken before the field study stage, among many other factors, contribute to shape a general idea of what the context might bring during research. This way, an early planning of the project is possible, in which timings, resources, methods and tools can be formulated. However, it is not until actually undertaking the everyday field research tasks that the initial plan is tested and confirmed. Naturally, unless the series of field studies is conducted in the exact same context, the methods' techniques will experience necessary variations - sometimes during the field work period - in order to ensure their accuracy, suitability, and effectiveness. Throughout the *I See What You Mean* case study I made use of a set of data collection techniques which were specifically appropriate for the case's particular context and research questions. Some of these techniques were perfected and modified so they could serve in the next two research contexts, which were considerably different. Some of the first case study techniques were also discarded, either for not fulfilling the overall research project's purpose or for being ineffectual for the next two cases. *Facets Kids* was a case study in which many of the techniques were designed during the first days of field work. The particular context and the rich range of information available merited a dedicated design of techniques. Also the application of these was perfected, being adjusted to the type and size of the audience been studied. The *Dangerous Australians* case study benefited from this evolution of methods and techniques in such way that the collection of data was more efficient and the analysis of them more productive.

5.6.3. The Presentation

Given the variety of the case studies, their richness in terms of data and findings and their particular contribution to the overall research project, each case study is presented in separate chapters. The chapters are structured in a consistent way so their similar research approach can be noted at the time their particular characteristics can be identified as well. Following a general introduction to the case, which delineates its context (i.e. venue, exhibition type, and audience profile), characteristics and research aims, a general background is provided. Each case study chapter presents a brief yet specific theoretical framework within which the exhibition, installation or exhibit is contained. This way, the *I See What You Mean* case study chapter presents the exhibition within the philosophical stream through which the creators developed the collaboration that made the work possible. On the other hand, the *Facets Kids* case study chapter introduces the reader into the research-led artistic work that led to the installation under study as well as a review of the particular technological field in which its type of work has been developed. Likewise, the *Dangerous Australians* case study introduces the reader into the history and current state of the comprising technologies of the exhibit under study. Part of the theory behind these three different exhibition environments and their comprising experiencing of technologies are developed in the literature review of this dissertation (Chapters 2, 3 and 4); however, given their particular impact on the overall appraisal of each case I considered these subjects warranted deeper, dedicated research and attention.

A complete description of each exhibition is provided later on in each case study chapter, including details on each particular venue and their influence on the exhibit, the design rationale and characteristics, and the general visiting experience. Once the reader has obtained a complete impression of the case study context, the methods for the study of each exhibition are outlined. The methods sections of each case study chapter provide information about the general research methods used, the particular techniques applied and their general procedures. Following the methods section, a thorough overview of the data collected through the different techniques is provided. This section presents extensive quantitative and qualitative information which reflects the abundant material from which research findings were obtained. The final section of each case study chapter discusses the most significant findings, expressed according to the specific case study aims and the overall project's research questions. Complementary information to some sections of the case studies, such as exhibition fact sheet, survey samples, and consent forms, are available in the Appendices.

Chapter 6. Case Study: *I See What You Mean*

6.1. Introduction to the Exhibition and Case Study

I See What You Mean: Embodying Creative & Project Minds was an interactive exhibition which enabled the members of a specific academic community to engage in an interdisciplinary dialogue with the help of diverse cognitive artefacts and visual representations of their different disciplines. As a cross-disciplinary artistic collaboration within the Faculty of Design Architecture and Building (DAB) of the University of Technology Sydney (UTS) the exhibition was presented at the DAB LAB Research Gallery for a period of three weeks. Visitors would enter the small bright room which presented printed content on the side walls, a video projection on the rear wall and a white table against this wall displaying objects for them to pick up and interact with (Figure 1). The exhibition space was embedded with sensors that would activate and modify the video projection display as users explored the room and interacted with the objects.

Figure 1. General view of the exhibition space featuring the different surfaces with their respective content.

The design aim of the exhibition was to create a representative, meaningful, and engaging experience for a particular audience with the help of diverse media. It was intended to stimulate the participant's physical, intellectual and emotional responses towards an embodied and integrated experience. The exhibition was designed to make sense to both individual and groups visitors. An individual experience was achieved by entering the room and observing the graphic pieces on the walls, entrenched with diverse visuals and texts related to the creative processes of two disciplines: Project Management and Design. The experience would continue when reaching the rear of the room and interacting with graphic objects spread on a table. Interaction could take place by means of both contemplating the pieces and physically engaging with them, in which case the projections on the wall would respond to the visitors' actions. The visiting experience was designed to be more fulfilling when two or more visitors attended the gallery together; the content presented was meant to stimulate conversations when sharing their individual interpretations with each other. This process of meaning making would also be completed by the system when offering new content for them to interpret.

The development of *I See What You Mean* comprised three phases: design, presentation and evaluation. All through the process and following traditional museum research techniques a series of evaluations were conducted to ensure the exhibition's message was effectively interpreted and experienced by the audience (Dean 2002b; Kelly 2004; Museums Australia 2002).

In this Case Study I took the role of both exhibition co-creator and main researcher, being involved in it from the conceptual formulation of the exhibition to the publication of research findings (Mery Keitel 2010b). As researcher I would occasionally be present collecting data from visitors; in such occasions, I would only accompany audience in their visit and invite them to explore by themselves. Only if they insisted would I offer a further clarification of the content and/or functioning of the exhibition's setting. The experience had no set time therefore visitors could stay for as long as they wished while the gallery remained open to the public.

6.2. Exhibition's Creators and their Collaboration

Set in the context of a cross-disciplinary collaboration *I See What You Mean* reflected on the language, tools, and symbols that both pragmatic and creative disciplines embody and enfold when carrying out their respective productive activities. Furthermore, these make sense to each other mostly when working in collaboration. The creators behind the exhibition idea and design come from two different professional backgrounds: Bryce Cassin, Project Management and I, Industrial Design. Sharing a common interest in the concepts of collaboration and technology-aided social interactions, together we embarked on a project in the form of an exhibition that could offer a space for reflection upon these concepts to encourage other Faculty members' discussions.

Fellow researcher and then Senior Lecturer of DAB, Cassin has vast experience in workplace projects and programs at different levels within the public health system. His research interests focuses on the integration of the left/right cognitive functions of the brain in the particular processes of projects' design and implementation (Cassin 2008). Throughout his extensive work of academic researching and teaching he has developed a whole model of Project Management within the context of strategy and operations in business, particularly in the healthcare sector (Cassin 2012; Cassin & Barach 2012). In this context Cassin is interested in the complex dynamic of the clinical work environment, for which he develops thinking and problem-solving tools to help practitioners manage the usual constrains in their workplaces. Cassin is currently concluding his Doctoral Research in Clinical Workplace Studies at the University of Technology Sydney. His research project reflects on the diverse and rich processes of meaning-making within the built environment of the workplace through diverse fields of enquiry[5]. His experience working with public hospitals has given him direct access to the different situations arising from the application of workplace models that fail to optimally integrate people, place and work dynamics - the social space of workplace.

As a research student of the same faculty and with much interest and skills in interaction design, I was approached by Cassin and invited to work together in the creation of what would be the first exhibition of the School of the Built Environment at the DAB LAB Research Gallery. As an Industrial Designer, lecturer, and researcher, cultural heritage institutions such as museums

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[5] See http://uws.academia.edu/BryceCassin and http://www.dab.uts.edu.au/built-environment/for/research-students/bryce-cassin.html for Bryce Cassin's research and academic profile

and galleries are my main area of interest. Through most of my career I have studied how these institutions progressively incorporate interactive technologies into their exhibition environments as a way of attracting and satisfying their audiences. In particular, I explore the different ways visitors perceive interactive exhibitions and how those perceptions affect their individual and social engagement with them. Similarly to Cassin's work, mine focuses on the social space as well; however, its focuses specifically on the leisure/learning space.

Cassin and I envisioned *I See What You Mean: Embodying Creative & Project Minds* as a dedicated space for colleagues, students and other parties interested in the faculty to discover and understand each other's mindsets. The collaboration gave me the opportunity to engage in both the design process of the exhibition and in the study of its audience's response. This way, the *I See What You Mean* exhibition would become my first research case study and an important building block to my understanding of the role of interactive technologies in the social experience of exhibition environments.

6.3. Theoretical Background of the Exhibition

In the creative industry disciplines like Project Management and Design converge at several stages of the project development. Facing the need for flexibility and efficiency within the collaboration in order to meet each particular brief but lacking a common conceptual language to communicate, the use of a heuristics approach becomes suitable within the working space (Abbass 2002). Heuristics are a set of problem-solving strategies used by people to formulate problems, explain its representations and communicate related ideas (Murray & Worren 2003). In this respect, heuristics can take the form of both a principle and a medium allowing for a quick and positive innovation within the problem space.

In a heuristics approach problems are faced in a creative way, regardless of the level of creativity the discipline is based on or the project requires. Heuristics (with the help of language, tools, and symbols) allow professionals to move from a conventional, rational and one-solution-only thinking space - the convergent thinking - to a multidirectional and open thinking - the divergent or lateral thinking (Guilford & Hoepfner 1971). The *I See What You Mean* project sought to represent this constant process of mindset shifting, participation and movement that professionals characterise at the heart of the creative industry.

The communication techniques that our particular disciplines embody and enfold help connect materials, meaning and experience within the productive activity. Professionals make sense of their diverse creative spaces through visual images and cognitive artefacts they create for each particular problem and purpose. A common and well anticipated outcome to the multi-channelled communication process of creation is the assertion 'I see what you mean'. It is an expression of successful intellectual negotiation and sense making, a balance of habits and routines that comprise multiple strands of meaning and eventually result in the realisation of a product or service. This process of conveying meaning is explored by Brian Massumi, in his work *Parables for the Virtual: Movement, Affect, Sensation*:

> *You interpret the script, you visualize or form a 'mental picture' of what it means for you to be what you are, parent or child, mother or father, boss or employee, cop or criminal, and embody that visualization for the benefit of others occupying the contrasting but complementary character roles. For each role there is a privileged other in whose recognition of you, you recognize yourself. (Massumi 2002, p. 48)*

6.4. The Design Process of *I See What You Mean*

6.4.1. Conceptual Design

Being consistent with our exhibition's principle, Cassin and I needed to develop a conceptual framework that could help us replicate the same sort of rich collegial dialogue we had achieved through our many collaboration meetings. After months of textual, visual and physical analysis of our respective disciplines' materials and approaches, together we outlined the concepts on which the exhibition content would be developed and constructed. These concepts were consistent with the sense of stages behind the creative processes at each discipline's working space. For the Design disciplines we focused on the main potentials of their creative outcomes which were defined as: the discovery of the new from the assimilation of facts - the 'unfolding', modelling and bringing together the human, natural and built environment - the 'shaping', and moving the underlying realities in the required directions - the 'becoming'. Project Management, on the other hand, creates connections of disciplinary engagement around a particular project - outcome from which we defined the concept of 'relationships'. These connections take place at a particular context and in a way that allows for the making of decisions, concrete actions and realisation of products and/or services - from which we defined the concepts of 'time' and 'movement'. This set of concepts became the guidelines for the content design of the exhibition, which were ultimately presented in three parts: posters, video projections and interaction table (Cassin & Mery Keitel 2009).

One of the challenges of balancing Design activities with Project Management is making the information and knowledge domains of the different disciplines clear to each other. We agreed that photographs are accessible visible forms that can easily and effectively be used for this purpose. Cassin undertook a task of visually exploring natural and human built landscapes that could represent creative and managerial work. The prime focus for the composition and selection of the images was on sensation and perception - not necessarily form - which implied an exploration guided by the search for meaning. This documentary photo-research was central to preparing the exhibition's conceptual design. The resulting collection of images helped us map the semantic structure of both creative and pragmatic minds (Design's and Project Management's respectively) when using these images as metaphors of what we were trying to communicate to each other (Figure 2). In much the same way as we experienced this interpretational process, participants would be invited to relate each photograph to ways of knowing and inquiring about the creative and pragmatic disciplines.

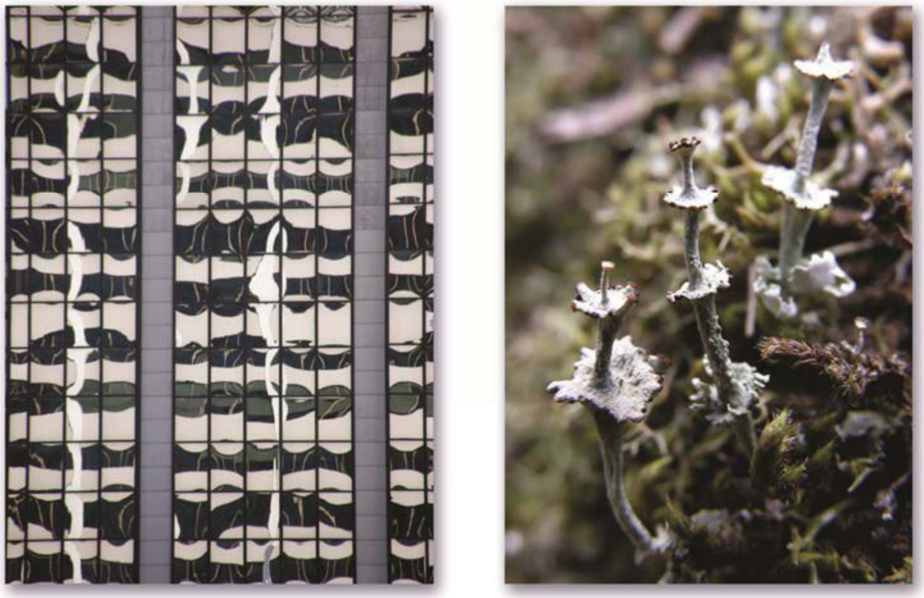

Figure 2. Examples of the type of images collected for the content of the exhibition. Their level of abstraction was intended to offer the audience a wide range of possible interpretations.

In a similar way photographs can help convey meaning, we recognised in textual forms the many possibilities of interpretation. Together we channelled our research into the search for authors and works that address the creative and managerial activities, processes, and outcomes from different perspectives. Drawing from arenas as varied as architecture, poetry, education, politics, and sociology, we put together a selection of quotes that could add to the shared experience of sense-making once participants associated them with their own past or current professional practices. The following are samples of the quotes presented to the exhibition's visitors:

That's why I tend towards iterative processes, stepwise methodologies, because every time the form is changed it absorbs the information differently (Spuybroek 2002, p. 248)

A piece of work is finished in a way that is satisfactory; (…) a situation (…) is so rounded out that its close is a consummation and not a cessation. Such an experience is a whole and carries with it its own individualising quality and self-sufficiency (Dewey 1966, p. 35)

Practically all metaphors for style amount to placing matter on the inside, style on the outside. It would be more to the point to reverse the metaphor (Sontag 1966, p. 17)

The conceptual definition of content informed the overall design of the exhibition's display. Benefitting from the physical opportunities the space provided and guided by the notion of brain function lateralization[6], we created a space that would allow the comparison and contrasting of the respective concepts of the creative and managerial minds and activities, as defined for the exhibition. The managerial concepts of 'relationships', 'time' and 'movement' were mirrored and pondered against the creative ones 'unfolding', 'shaping' and 'becoming' through a set of posters facing each other from opposite walls. A set of three images of seaside daisies were selected from the photo-research collection to depict the dialogue we had as exhibition creators during the collaboration process. We envisioned this would bring up an opportunity for visitors to visualise the flow of activities between creative and managerial minds. The remaining images of the collection were offered to the visitors for them to construct their own visual, textual and verbal conversations. The level of abstraction of the exhibition content was intended to allow participants to bring possible new interpretations as they identified with, or distanced from, commonplace perceptions of creative and managerial work.

6.4.2. The Exhibition Design

The exhibition *I See What You Mean* was created on the Industrial Design side of the collaboration as a design probe, an opportunity to test how technology could support and improve social interactions within the specific context of academic collaboration. Considering the continuous and vast production of visual and tangible artefacts that support communication in our so diverse yet converging practices, the project would allow the study of the use of familiar artefacts for the conveyance and making of meaning mediated by unobtrusive interactive technologies.

[6] The widely accepted albeit not completely exact belief that the right side of the brain is where most of the creative processes take place while the logical ones take place on the left side of the brain.

The generation of knowledge requires continuous interactions between people and objects through which "the meaning of words, actions, situations and material artefacts are negotiated" (Whyte et al. 2008, p. 75). All through interaction, objects hold a meaning uniquely given by their users in particular contexts of space and time. Accordingly, the interactive space would be permanently reconfigured responding to users' needs and becoming a field for both physical and verbal communication, for negotiation and meaning-making.

Previous experiences in the development of interactive products and spaces informed and guided the design of the visiting experience of the exhibition, its physical configuration and mapping, and both its aesthetical and technological components. In the last five years I have been involved in several research projects at the Interactivation Studio[7] developed by its director, Bert Bongers. In particular, working on the Interactivated Reading Table project (Bongers & Mery Keitel 2008), I developed basic skills in some of the technologies behind different interactive systems. The openness of the Interactivated Reading Table, since then semi-permanently exposed to the use and exploration of the Studio's visitors, allows for design iterations and continuous findings. The Interactivated Reading Table used physical artefacts (printed material such as books, magazines, catalogues, etc.) in combination with new media content related to them so as to enhance the reading experience. Media such as videos, sounds and websites would be displayed as complements to the written information presented on the table. Each object on the Interactivated Reading Table was linked to a specific piece of media. Users would interact with the content by placing the physical objects on a particular spot on the table triggering the display of the complementary media piece associated to it. The study of the diverse interaction modes and user experiences that projects of this nature had facilitated so far was essential for the creative process of the *I See What You Mean* exhibition, informing the definition of core components of our project such as the interaction maps and the technological specifications.

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[7] The Interactivation Studio is an interdisciplinary research space that works as a laboratory, studio, workshop and research centre within the University of Technology Sydney. Its focus is on the interaction between people and technology, developing design possibilities for areas as varied as expression and performance, health care, architecture and sustainability. More information about the Interactivation Studio is provided in Chapter 7, Section 2.

The DAB LAB Research Gallery, where *I See What You Mean* was presented, is a dedicated space for academic staff and postgraduate students of the Faculty of Design Architecture and Building (DAB) to express their interests, share research experiences and outcomes and seek critical feedback from their peers. The great majority of its attendees are part of the DAB community (e.g. undergraduate and postgraduate students, academic staff members and administrative staff); however, some other visitors come from outside the community as well. The DAB LAB is regarded as a space where both exhibitors and visitors interact in confidence and comfort. The gallery is located in the Faculty's building courtyard close to its cafeteria, shaping altogether a public space where active social activity takes place.

The exhibition space is a small rectangular room with three walled surfaces and a glass wall and door as façade (Figure 3). The transparency of its façade allows exhibitors the freedom to either completely show or hide the room's content with the help of different materials. Not only the outside perception of the gallery is modifiable but also its interior: whilst the width and height of the space are fixed (290 cm of width and 220 cm of height) the depth of the space can be adjusted according to the exhibitors' needs. An adjustable rear wall allowed us to set the exhibition room's depth at 420 cm. The whole room was painted white, with the exception of the rear wall which was painted in a very light blue. All components of the exhibition were placed to be peripheral, leaving enough room in the centre of the space so visitors could move freely, exploring, interpreting and interacting with the exhibition content.

Figure 3. View of the exhibition from outside the gallery.

The façade also helped promoting the exhibition: in addition to the title of the exhibition and names of creators set in white letters on the glass, the brightness and whiteness of the room was expected to trigger initial interest and subsequent approaching. From outside the gallery people could notice the presence of most of the exhibition components contrasting against the white walls. Similarly, the series of animated texts projected on the rear wall could be noticed from outside the room.

6.4.3. The Exhibition Components

The *I See What You Mean* exhibition was comprised of three main components: posters, video projections, and an interaction table. The posters section consisted of two sets of three graphic pieces each, facing one another on the left and right walls of the room. As explained before, this parallel confrontation of the posters was a dialogue about similar activities undertaken by different professionals throughout the development of a project. From a distance it would seem each poster displayed the same information as that opposite to it, however each set's content was discipline-specific. Whilst the similarity was given by the use of the same main image and the same graphic style, the differences were expressed through the actual sketches and textual representations of each other's problem-solving processes (Figure 4). In each set of posters visitors could recognize a logical sequence of content.

Figure 4. One poster of each discipline as presented in the exhibition, showing the apparent similarities and differences.

Upon reaching the back of the room visitors would find a white horizontal surface - an interaction table. On the table, a set of objects replicating instant photographs were spread loosely on the interaction table. We called these objects photo-artefacts as they were representations of commonly known artefacts, i.e. Polaroid© photos, which were expected to be identified by the audience as such. Photo-artefacts were intended to be interpreted as grabbing objects; when lifting them, visitors could observe and analyse their visual content and, if wanted, define their own personal meaning for each according to their own professional background and experience. The images displayed on the photo-artefacts were part of the final selection of images from the photo-research mentioned earlier. In addition to these loose objects a few more sets of fixed photographs and sketches were shown on the table (Figure 5). These elements were arranged along a helix drawn on the surface of the interaction table. The helix was a metaphor of the structure of DNA, a representation of the intertwining stages where different disciplines' practitioners meet. Each end of the helix presented a set of two printed sketches (similar to the ones presented in the posters) with a photo-artefact fixed between them. In the centre of the helix two more sketches were presented with a silhouette of a photo-artefact between them – an interaction prompt. The fixed sets at the ends of the table were given as examples of hypothetically previously made conceptual matchings between sketches and photo-artefacts, a subtle suggestion for visitors to match the available loose photo-artefacts with the set of sketches presented in the centre of the table according to their own process of meaning-making.

Figure 5. The interaction table with its components distributed along it.

On the rear wall of the exhibition space video projections of various animated texts were displayed. The texts - literal quotes taken from the intellectual works of ten different authors - were offered to the visitors as complementary material for their interpretation of the exhibition content. Two sets of projections were designed for the display: a main projection and a collection of secondary projections. Both sets of projections were scattered pieces of text looping around the wall's surface and eventually assembling to complete full quotes. The display of the videos was directly affected by the actions of visitors within the space: the main projection would display the pieces of text in continuous random motion until the proximity of visitors to the interaction table triggered the assemblage of a complete paragraph (Figure 6) while the secondary projections would each appear, loop and assembly as visitors purposely interacted with the photo-artefacts on the table. Every time a specific photo-artefact was placed on the central photo-artefact silhouette, as shown on Figure 7, the display of a new projection on the rear wall would show.

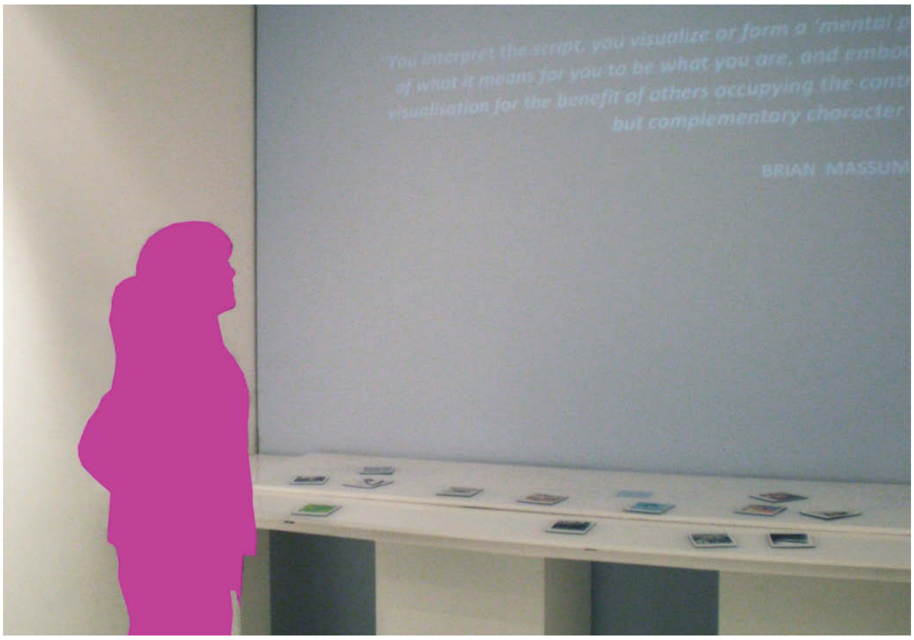


Figure 6. A visitor reading the quote presented in the main projection after approaching the interaction table.

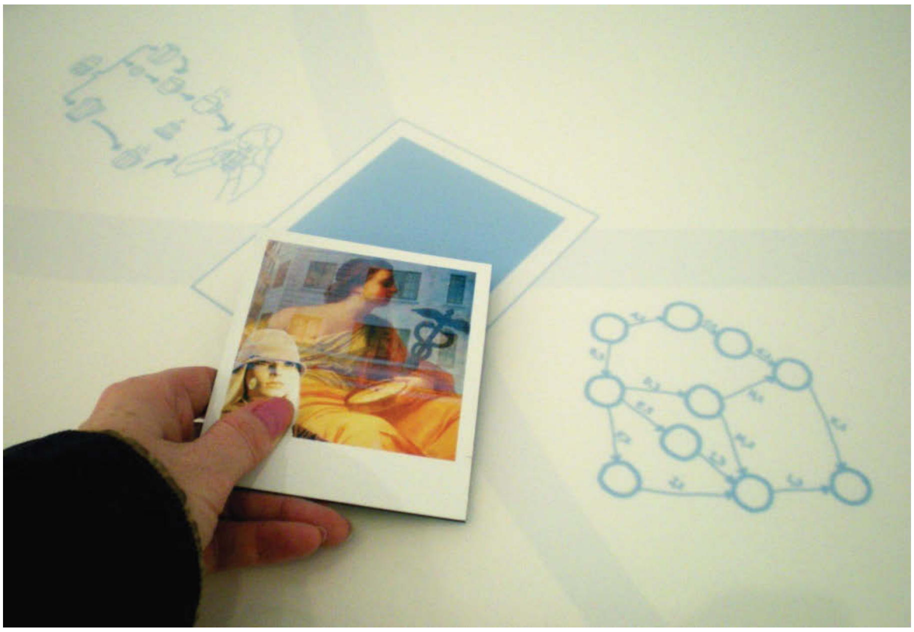


Figure 7. Photo-artefact being placed on the table's interaction prompt, the photo-artefact silhouette.

6.4.4. The Technology Behind the Exhibition

The exhibition was a mixture of contemplation, discussion and action that could generate a dialogue between visitors and content with the help of interactive technologies. However, the actual physical effort in the encounter with the technologies was minimised in order to make this dialogue more fluid. Out of all the displays of the exhibition only the animated texts projections on the rear wall were controlled by interactive technologies. In the same way, the only component that served as controller was the interaction table, which contained the diverse sensors for the control of the displayed content. The definition of a single overall interface for the interaction within the exhibition environment was crucial to keep the visiting experience focused on the content, rather than on the technology. Figure 8 shows the complete scheme of the technological configuration of the exhibition space.

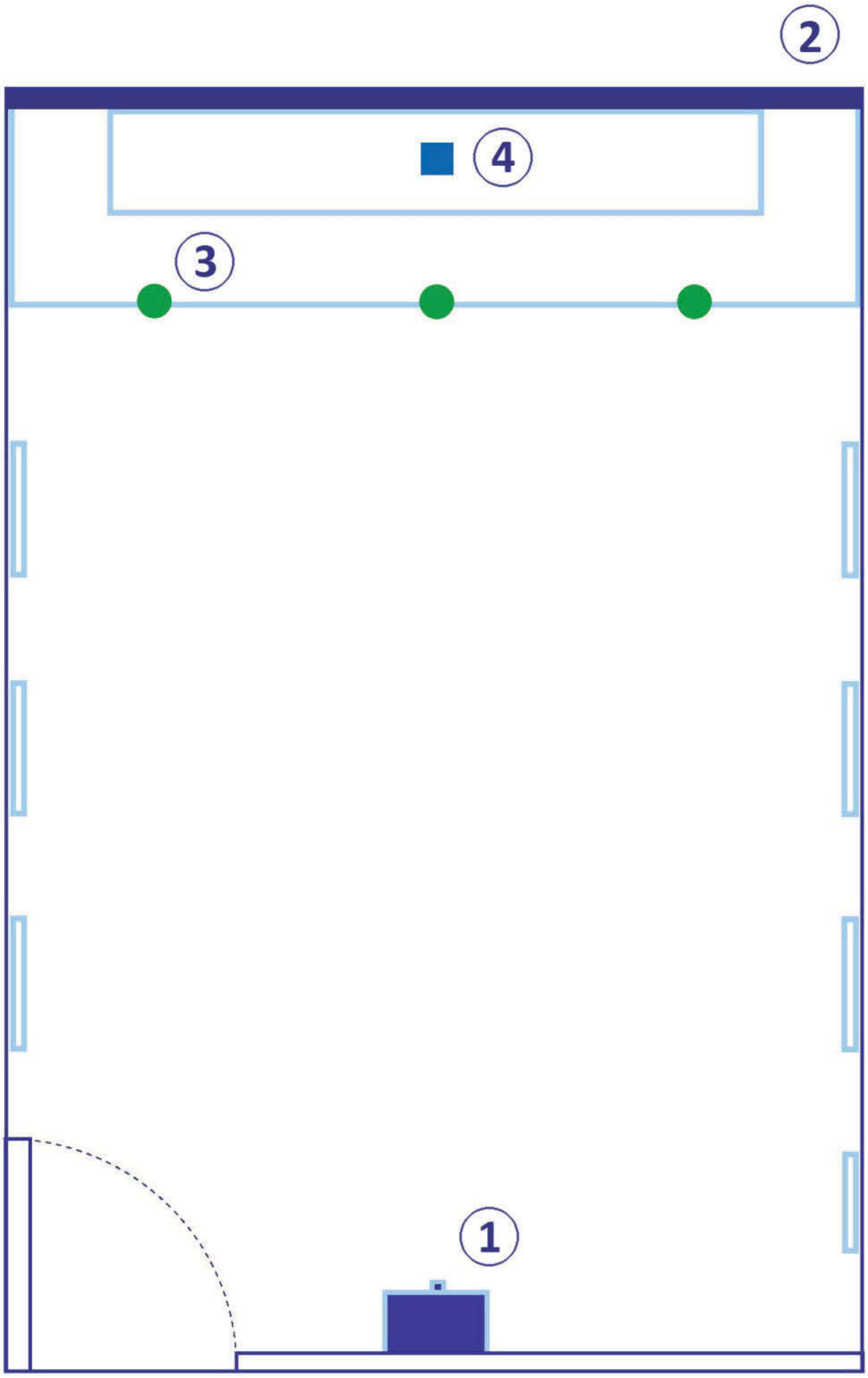


Figure 8. Allocation of technological components of the exhibition: The system is comprised of a projector (1), a projection surface (2), proximity sensors (3), and RFID reader (4).

The text animations of the main and secondary video projections were modified by the visitors upon two different modes of physical interaction with the exhibition: proximal and tactual, respectively. Accordingly, the projections were created as two separate, yet interconnected assemblies. The main text animation was designed to transit from its continuous random motion to assembly (two-action sequence) prompted by the proximity of visitors to the interaction table. The secondary text animations were designed to appear, move and assemble in a continuous three-action sequence as a response to visitors placing photo-artefacts on the interaction prompt on the table. All still and animated texts were designed using Adobe Photoshop SC and Adobe Flash SC. Both main and secondary animations were designed to complete their sequences in 5 seconds and remain projected steadily for additional 30 seconds unless further action was perceived by the system. In such case, a new sequence would start. These timings were defined testing perception and reaction times with eight volunteers during the design stage. 5 seconds was the average time participants informed it took them to notice the projections and 30 seconds the maximum time they informed it took them to read up to 45-word sentences (the longest quote to be projected).

Three infrared proximity sensors were distributed underneath the interaction table's front edge pointing towards the entrance of the gallery (Figure 9). Upon visitors entering the gallery and gradually approaching the interaction table, the sensors would recognise their presence and prompt the first change in the animation: the main animation sentences gathering together and letting the complete first quote to show.

Figure 9. Proximity sensors were placed underneath the front edge of the interaction table, barely perceivable by the audience.

The proximity sensors were connected to a computer through a Phidget InterfaceKit 8/8/8. Their signals were read and processed by a Max/MSP/Jitter patch programmed for this project (Figure 10). When there was nobody close enough to the table the animation would continue its random loop. When crossing the limit of the sensors' reading range (approximately 1.7 m) the quote would show complete. This change was expected to indicate the visitors that their presence in the gallery was already generating an effect on the exhibition content.

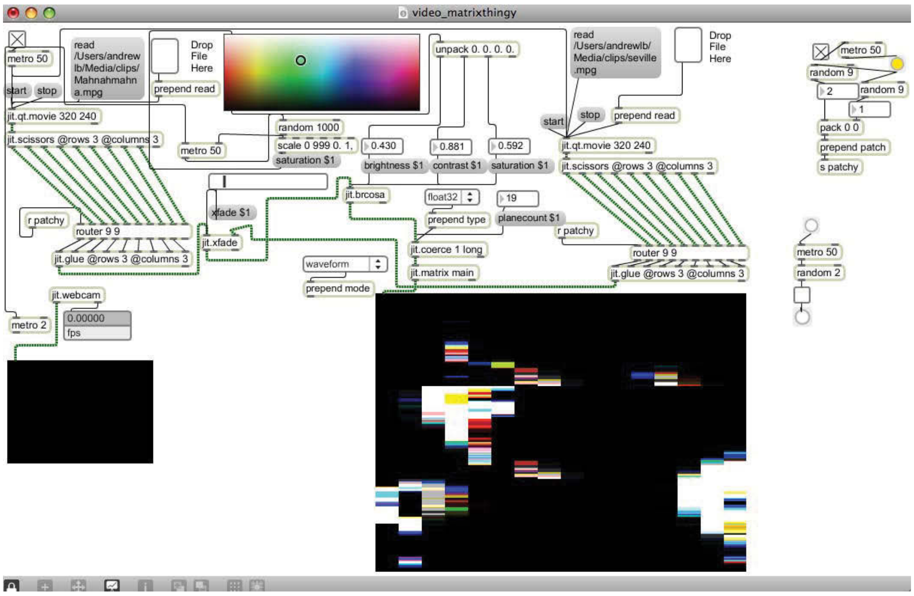


Figure 10. Test screenshot of the MAX/MSP/Jitter patch of the exhibition's video projections.

The secondary text animations would only show in response to visitors' interaction with the photo-artefacts on the interaction table. In the centre of the table, right underneath the central photo-artefact silhouette (interaction prompt), a radio frequency identification (RFID) reader was attached. Each photo-artefact had an embedded RFID Tag whose ID number was associated to a particular text animation; this allowed the system to identify them and generate the changes. When placed on the interaction prompt the RFID Reader would recognize the unique identities of the photo-artefacts sending the signal to the Max/MSP/Jitter patch (same one used for the infrared proximity sensors' reading and processing). The patch controlled the projected animations displaying the one specifically assigned for each photo-artefact.

6.4.5. The Visiting Experience

Visitors were invited to take part of the exhibition as active participants of a communication movement that emerged from proposition to sense-making through a spatiotemporal sequence of proposed interactions. The dynamic projections of fragmented texts drawn from both creative and managerial mindsets would join together to form a meaningful quote only when visitors acted upon the exhibition components; the purpose was only achieved with the actual intervention of the visitors. The assemblage of the sentences of the main video projection into a complete quote as a response to visitors' proximity to the rear of the gallery was an invitation for them to continue their exploration. The process of meaning-making could continue when browsing and discussing the photo-artefacts presented on the interaction table. Furthermore, new textual representations could be called when placing the photo-artefacts on the prompt on the interaction table and activating the display of new projections.

The browsing and exploration of photo-artefacts was envisioned as a sensory experience for the visitors. The physical act of handling the objects and the cognitive act of reflecting on their meaning were further enhanced by the display of the animated text projections, provided as stimulus to thinking through perception and interpretation. The realisation of being participants interacting with images, text and meaning in the exhibition context was anticipated to stimulate in the visitors an increasing interest in sharing professional experiences, perspectives, ideas. The visiting experience was designed under the premise that each person would bring a professional or personal history, preferred methods and tools, identifications with objects and facts and, most importantly, their own passion and purpose for the sharing process.

The exhibition presented no fixed sequence for visitors to follow; however, in order to achieve a full experience of it - from the contemplation of its content to the making of new meaning as a result of a collegiate dialogue - the holding of all the components of the exhibition was essential. Nonetheless, the layout of the exhibition room was designed so the visitor was gradually introduced to the content: the posters presented the collaborative dialogue between the creators, the interaction table invited visitors to have a collaboration of their own, and the video projections provided additional means for reflecting on the exhibition content. An exhibition précis was offered to the visitors for additional information; this was placed at the right-end of the right-hand side wall, so as not to obstruct the flow of the overall visit.

I See What You Mean was designed so that the experience remained with the visitors for a longer period of time, beyond the visit. The overall purpose of the exhibition was that the interaction of visitors within the space, with their peers and with the objects displayed remained in their thoughts and prompted further discussion. Ideally, it could facilitate richer future collaboration dynamics.

6.5. Methods Used in the Case Study

As a researcher on Human-Computer Interaction in public spaces, DAB LAB Research Gallery offered me a highly suitable space for testing visitors' experiences within a technologically-enhanced exhibition environment. Although the *I See What You Mean* exhibition was presented to the community as the final outcome of the collaboration between two colleagues it was a study prototype as part of my doctoral research project. My research questions then focused on museum visitors' understanding of digital technologies and the way these affected their interactions with the exhibition environment; with the years, as a natural outcome of the research process, these questions were refined.

By creating and presenting *I See What You Mean* to the academic community I had the opportunity to explore firsthand how members of the same community would interact for collaboration within a technologically-enhanced space with the help of familiar artefacts and languages. Particularly, the study focused on observing and understanding the diverse behaviours of visitors whilst interacting with peers in the space, with and through the several interactive components offered, as well as their impressions of the overall experience.

The case of study consisted of three kinds of DAB-acquainted people: students (undergraduate, postgraduate, visiting, etc.), academic staff (full time, part time, casual, visiting, etc.) and other DAB interested parties (industry representatives, guest lecturers, administrative staff, casual visitors, students' parents, etc.). Visitors were invited to attend the exhibition via several communication means (emails and printed invitations, posters placed around the Faculty and direct reminders by the creators of the exhibition). Audience's previous knowledge on the topic of the exhibition was important; however, their levels of familiarity and understanding of the disciplines' fundamentals would range from basic to expert. The only condition for participants to be part of the study was that they had actually entered the gallery at least once.

The data collection was conducted by means of unobtrusive observations (distant and shadowing observation techniques) supported by photographs, videos, drawings and annotations, and an anonymous survey (using a web-based encrypted questionnaire tool). The observation method aimed to be informing on behaviours, attitudes, interaction modes and modalities, flows, trends and phenomena, among others, giving a sense of what visitors do and how they interact during the visit. The survey method aimed to give insights on the experience, responses, feelings, opinions, levels of understanding, among others, giving a sense of what visitors say they did and how they interacted during the visit.

A total of 26 visits were registered through the observation process and 24 participants responded the web-based survey after their visit. It is possible that some visitors who answered the survey were the same observed during their visit; however, these two groups of data were considered independently one from the other as a way of keeping anonymity of participants all through the study. Consequently, even though some visitors were indeed identified during the observation process due to my academic relationship with them, they are henceforth referred to as visitor #1, visitor #2, and so on.

During the distant observation process I positioned myself at 10 meters from the gallery's entrance, sitting at one of the DAB Café's tables (see Figure 11). This position gave me visibility not only of the gallery movements but its immediate surroundings. During the shadowing observation I followed visitors inside the gallery, with their consent. Data was collected via means of digital recordings (photography and video), sketches, annotations, a stop watch and a lux meter.

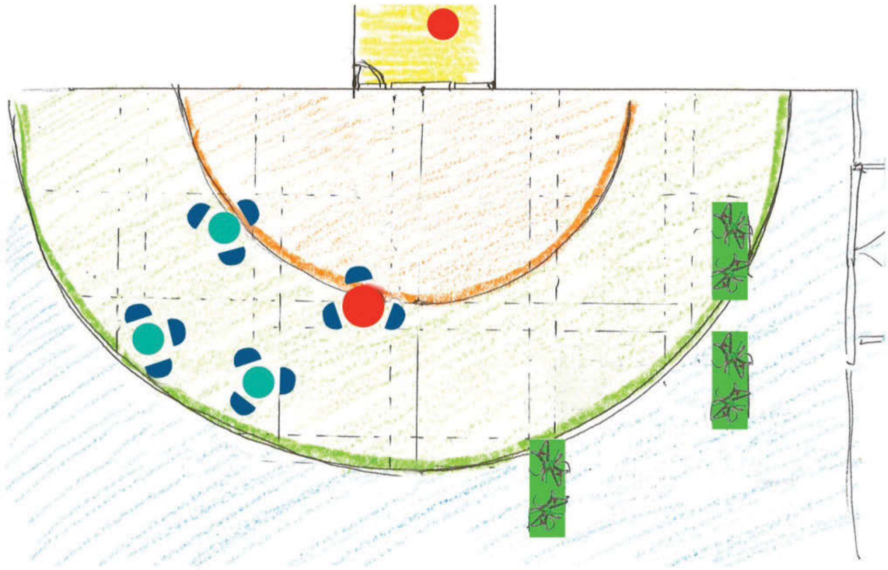


Figure 11. The red dots indicate the researcher's observation main spots.

Several units of analysis were defined to examine behaviours and impressions during the interactive experience. The units defined for the observational stage of the study were:

- social activity in the proximity of the gallery
- visitors' demographics
- trajectory of visitors within the space
- levels of attention given to the different components of the exhibition
- time taken for the attention to and interaction with each component
- time taken for the totality of the visit
- repetition of actions and movements
- bodily and facial expressions
- social interactions within the space

Some of the most important units defined for the survey part of the study were:

- level of appealing of the exhibition
- motivation for the visit
- identification of components and their interactive parts
- comprehension of the content and its purpose

- impact of the exhibition on their idea of collaboration
- overall impression regarding their visiting experience

In order to find answers to the research questions, the analysis of data looked for evidence of the identification of and the interaction with the exhibition components as well as of the extension of the experience beyond the visiting space and time. The validation criteria was therefore determined as a set of conditions that could confirm whether visitors had made effective use of the technology-enhanced components available and whether these had helped them achieve a complete understanding of the exhibition, consequently benefiting from the experience.

6.6. Case Study Data Overview

6.6.1. Observation Data

Observations were conducted during 6 of the 11 days the exhibition was open to the public, at unfixed times between 10:00 and 17:00. As shown in Table 1, a total of 14 hours of observation were conducted, which correspond to 18% of the total exhibition time (77 hours). During the days no observation data was being collected, other research activities - such as Remedial Evaluation and survey design - were being developed. Although 23 different visitors were observed while exploring the exhibition, three of them were repeating their visit. These second visits were studied separately from the first ones, which resulted in 26 unique visits observed.

Exhibition Day	Observation Period	Observation Time	# Visitors Observed	Total Visit Time
2	15:00 – 17:00	2 hrs	3	20’ 06”
3	13:00 – 16:00	3 hrs	4	08’ 29”
6	11:15 – 16:15	5 hrs	14	49’ 52”
7	13:30 – 14:30	1 hr	1	03’ 01”
10	16:00 – 17:00	1 hr	1	06’ 36”
11	15:00 – 17:00	2 hrs	3	19’ 42”
Total values		14 hrs	26 visits	1hr 46’ 46”

Table 1. Observations general records.

One of the units of analysis of this study was a map of social activity in the proximity of the gallery (Figure 12). Four zones of activity were defined based on on-site initial observations according to the measures of physical distance and public flow: Gallery (the space containing the exhibition), Immediate Zone (a half circumference area of radio 480 cm with the centre point in the middle of the gallery's façade), Proximate Zone (a half arch area of external radio 850 cm and internal radio 480 cm following the Immediate Zone), and Distant Zone (all the remaining area of the Faculty's courtyard beyond the Proximate Zone). At the exact moment one or more visitors entered the gallery a count of people present in each of the three central zones was conducted; the Distant Zone was kept as a spatial reference only. This analysis provided a general idea of the levels of activity in the area throughout the day and, most importantly, the percentage of general public becoming visitors.

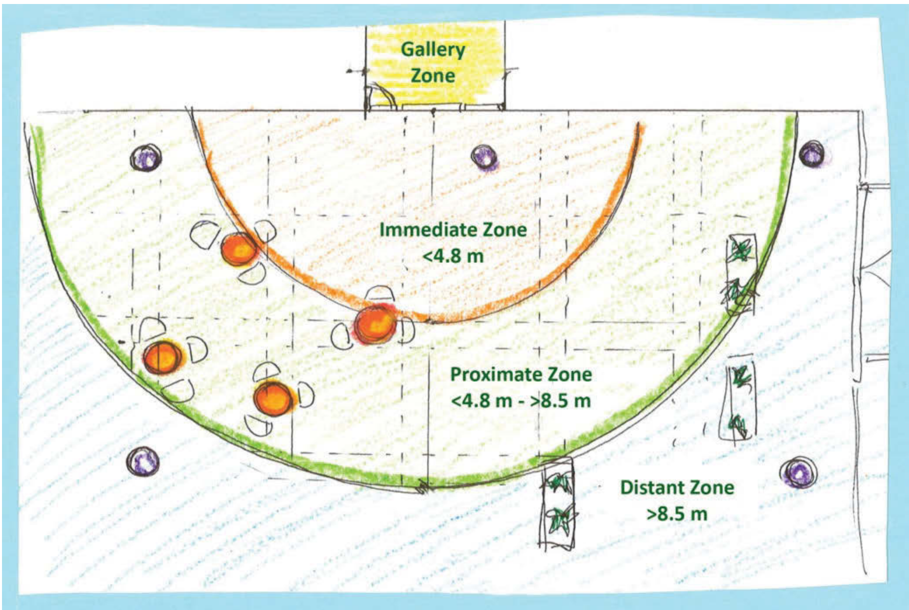


Figure 12. Map of Activity Zones extending concentrically from the gallery to the outmost distant area of the courtyard.

During the 14 hours of observation, and while the 26 visits to the gallery were registered, 139 people were circulating in the Immediate Zone and other 316 people were circulating in the Proximate Zone. The total count of public within the observation area added up to 481 persons (Table 2). These values indicate that only 5.4% of the public became visitors (Figure 13).

Times	Gallery Zone	Immediate Zone	Proximate Zone	Total Public
11:00 - 11:59	1	9	23	33
12:00 - 12:59	3	27	66	96
13:00 - 13:59	8	25	69	102
14:00 - 14:59	6	29	65	100
15:00 - 15:59	2	21	61	84
16:00 - 16:59	6	28	32	66
	26	139	316	481

Table 2. Record of presence of public in the different Activity Zones.

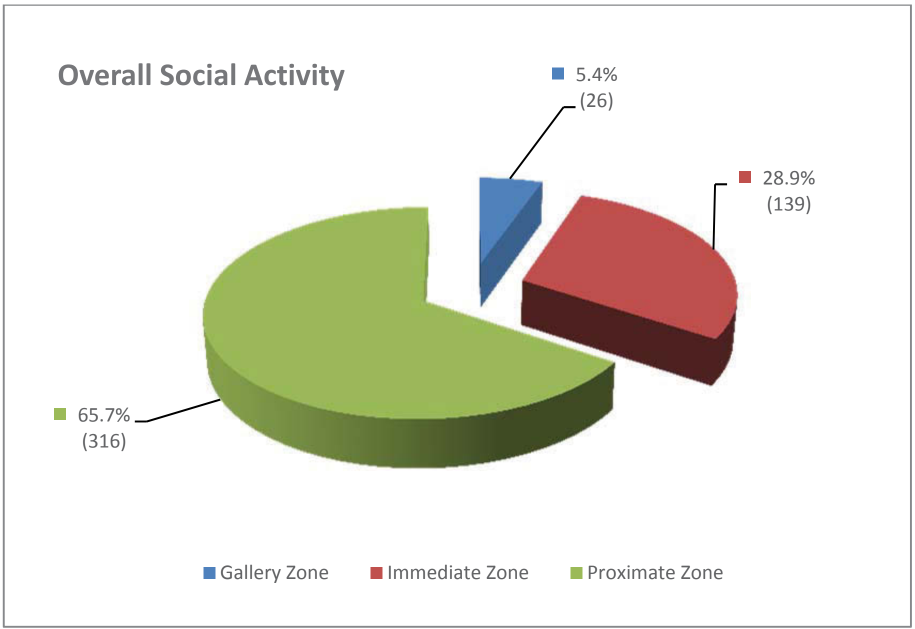


Figure 13. Ratio of public between the different Activity Zones.

Data from all 6 days of observation also show that most visits took place during lunch time and towards the end of the day (See figure 14). The highest number of visits was recorded at the 13:00 - 13:59 period, with 8 visits in total, corresponding to 30.8% of the total visits observed. The lowest number of visits was recorded at the 11:00 - 11:59 period, with only 1 visit, corresponding to 3.8% of the total visits observed. Although it is not possible to define an exact visitor per hour ratio as the observations were conducted at different times of the day, data suggests that approximately 2 visitors entered the gallery every hour. A peak of visits per hour was registered twice in one day (day 6 of the study), when 5 people entered the gallery between

13:00 and 13:59, and other 5 people visited the exhibition in the following hour. Periods of no visits were recorded in two occasions - days 2 and 6 of the study - between 15:00 and 15:59.

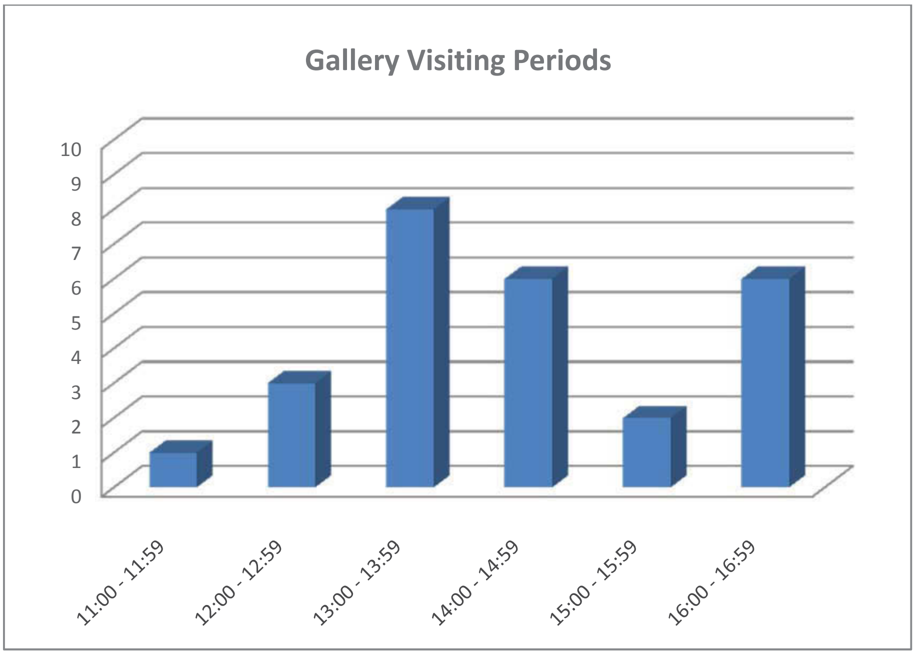


Figure 14. The times visitors entered the gallery the most were lunch time and at the end of the day.

Out of the 26 visitors 14 commenced and finished their visits as part of a group. On the other hand, 12 visitors conducted their visits individually, 3 of which were later on joined by other visitors. These last 3 visitors were thereon considered as group visitors as well, resulting in 9 individual visits and 17 group visits. Whilst gender was represented evenly through the visits (50% male and 50% female visitors) the type of visitors were more accentuated - 53.8% of visitors were students, only a 15.4% of visitors were academic staff members and 30.8% of visitors were external or DAB-interested.

According to data 38.5% of visits took between 46 seconds and 2:15 minutes (See figure 15). An outstanding proportion of 23.1% of visitors dedicated between 6 minutes and 10 minutes to visiting the exhibition - these were all visitors as part of a group. The average visiting time per individual was 3:03 minutes.

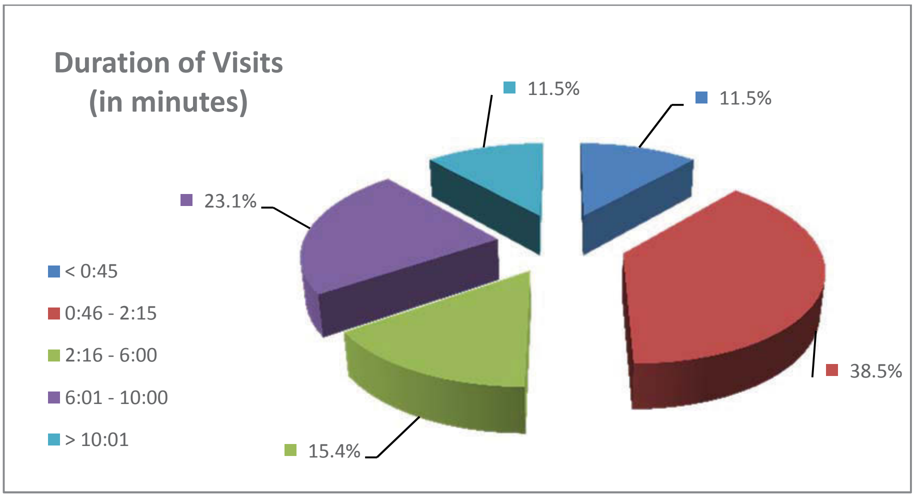


Figure 15. Time spent by visitors in the gallery.

Another unit of analysis defined for the study was the trajectory of visitors within the space. The different trajectory patterns were identified during the observation process itself and thereafter adopted for the study (see Figures 16 and 17). It is important to clarify that group visits' trajectories were recorded as a whole, not individually, and that some visitors showed more than one pattern throughout their visits. The most common trajectory patterns observed were Random (where the visitor entered the gallery and went through the components without any particular order), Wall-Table (where the visitor's path was to some extent defined by the sequences of posters and interactive components), and Perimetric (where the visitor seemed to follow the shape of the room to complete the visit). These patterns were represented in a 42.3%, 34.6% and 15.4% respectively. Other patterns such as Hopping in/out (where the visitor briefly sneaked in and quickly left the gallery) and Mirrored (where the visitor went through the exhibition components facing each other and symmetrically reviewing them) represented only 7.7% of the visitors' trajectories altogether.

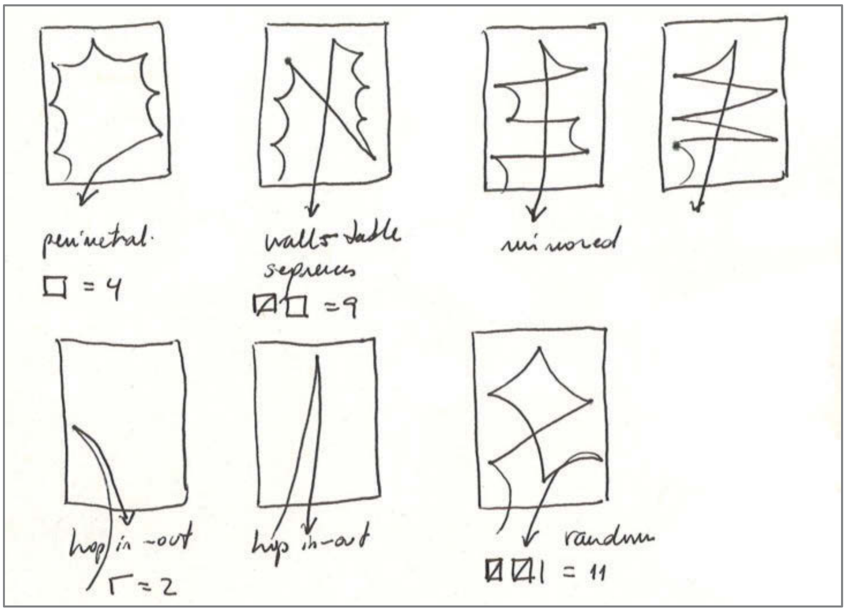


Figure 16. Trajectory Patterns as defined during the observation process.

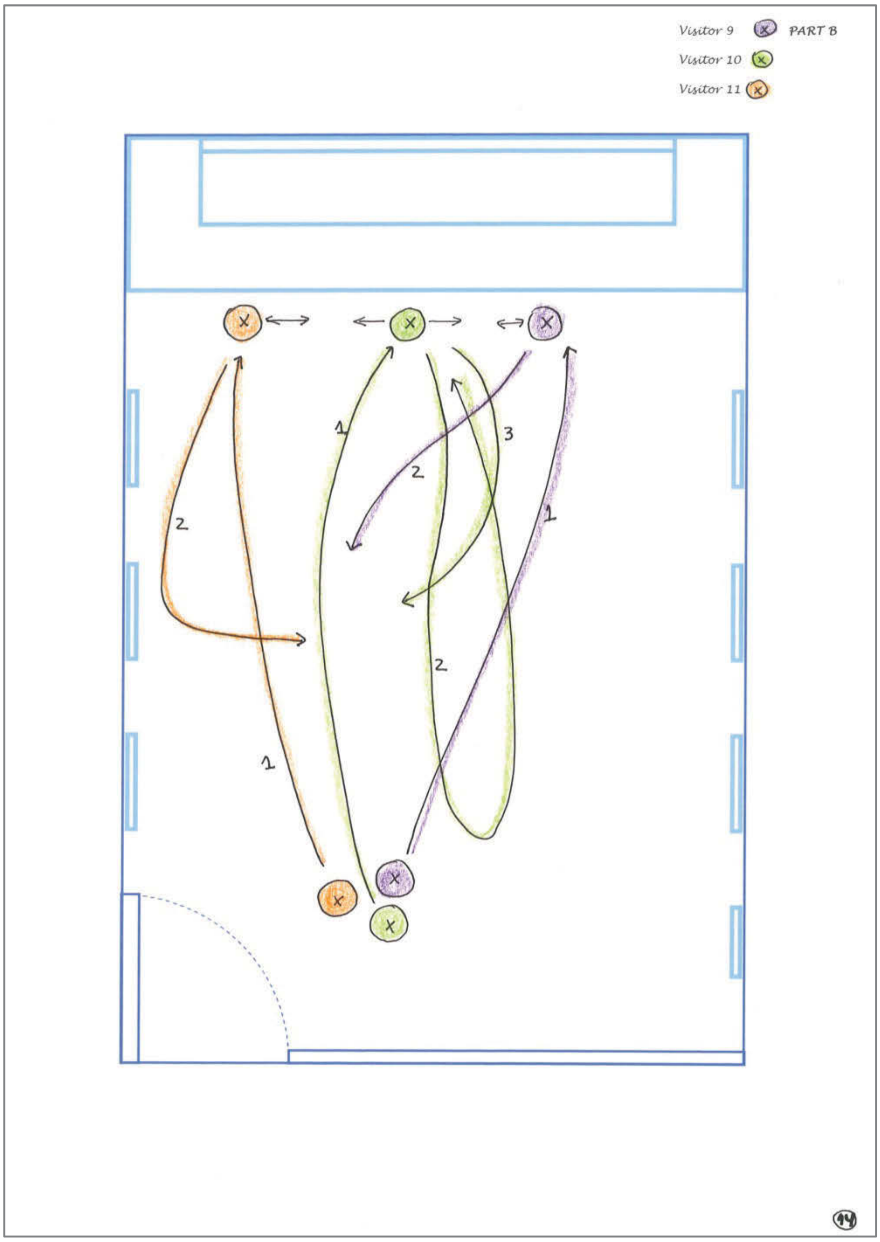


Figure 17. Trajectory Map's sample of three visitors at one particular time in their visit.

Not all visitors gave complete attention to all the components. Some visitors skipped some elements and some others gave more priority to specific elements. This realisation led to another unit of analysis: levels of attention. Based on time, the study expressed the attention given by visitors to particular components and their engagement when observing and/or interacting with them (see Figure 18). The great majority of visitors performed an incomplete visit; only 19.2% of visitors paid attention to all components of the exhibition (posters, video projections, interaction table with its photo-artefacts, and précis). Time dedicated to a single component varied from 2 seconds to 5:33 minutes.

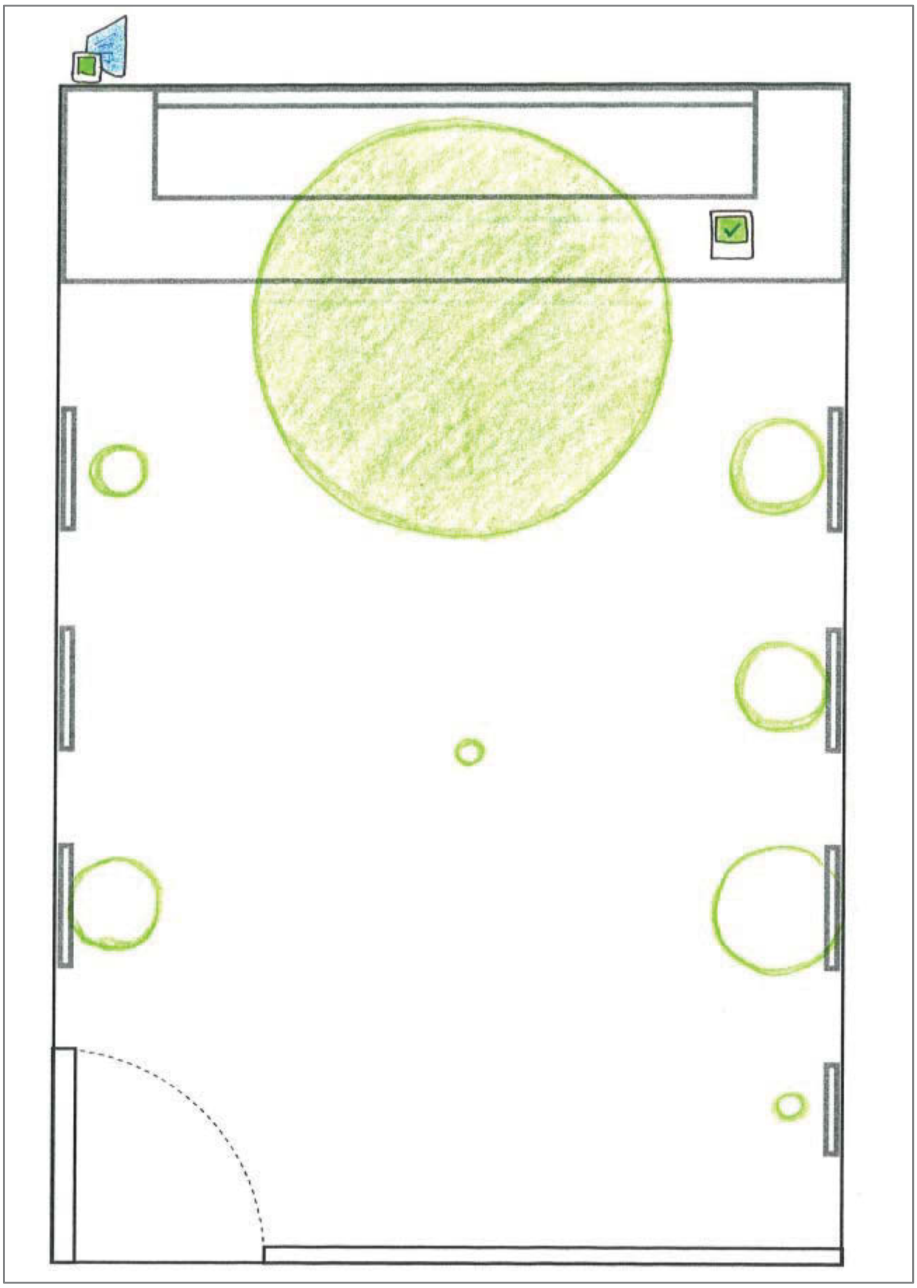


Figure 18. Attention Map sample of one visitor during his whole visit. The circle sizes represent the time spent on each part of the exhibition.

Within each visit, attention patterns were defined according to the amount of time dedicated by visitors to the exhibition components (see Figure 19). This way, six different patterns were identified: Exhibition-even (where components received a uniform attention), Balanced (where some components received more attention than others but in a fair way), Extreme (where only one component received all of the visitor’s attention), Focalised (where one or more components received most of the visitor’s attention), and Minimal (where barely any component received attention from the visitor).

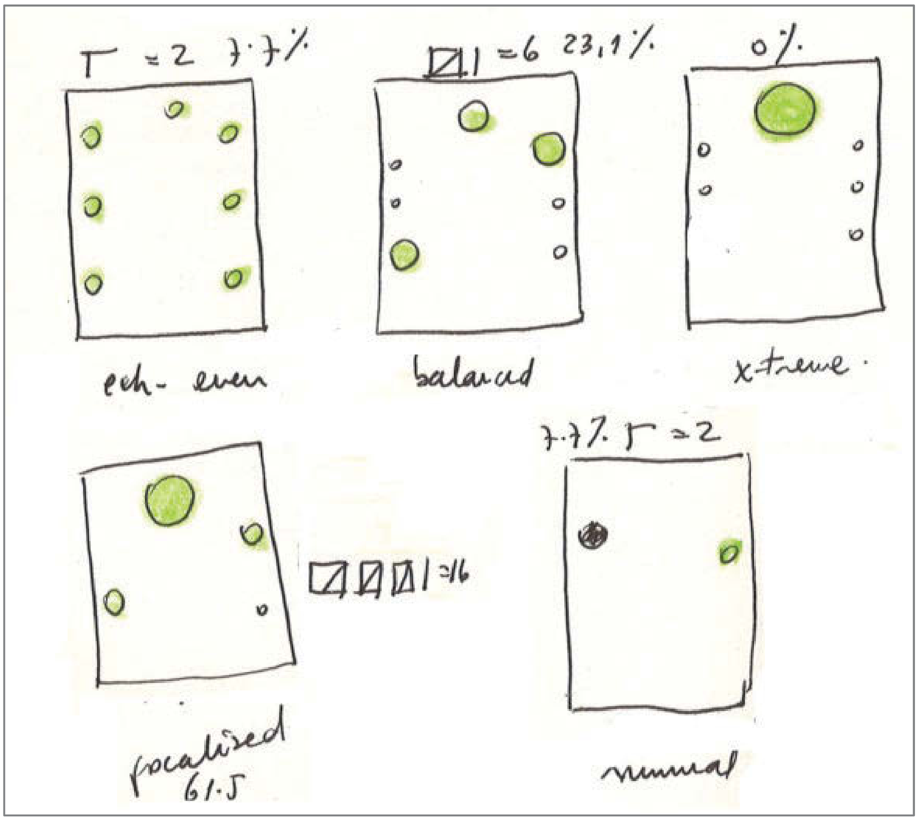


Figure 19. Attention Patterns as identified during the data collection process.

The most common attention pattern observed was the Focalised pattern with 61.5% of visitors spending most of their time either at the interactive components (interaction table, photo-artefacts and video projections) or at the centre of the room. The Balanced pattern was observed in 23.1% of visitors, the Exhibition-even and Minimal patterns were observed in 15.4% of the visits (7.7% each), while the Extreme pattern was not observed at all. The attention patterns served as guidance for the identification of the longest visited components. Each visitor’s attention map expressed one to three components becoming focus of attention (37 repetitions identified in total). According to these maps, the components visitors tended to pay the longest attention were the interaction table with the photo-artefacts and the video projections (which represented together a 59.5%), followed by a fairly even attention to both posters sets (with 21.6% altogether), then the précis (with 10.8% of visitors' attention) and the centre of the room as meeting place (with 8.1% of the attention time).

Another study of attention was particularly conducted for the interactive components of photo-artefacts and video projections, separately. A five-point scale was determined for each set according to the depth of attention given to each, spanning from complete obliviousness to full engagement with their features and effects (see Table 3). This study, unlike the previous one, was not based on time but on intensity. The following table shows the scales and their definitions:

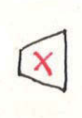
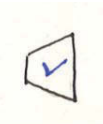
Component	Level 1	Level 2	Level 3	Level 4	Level 5
Photo-artefacts	Ignored or unnoticed.	Noticed. Visitor looks without touching.	Visitor slides elements on table, browses and observes.	Visitor browses elements, observes, lifts, passes and shares with others.	Visitor uses elements to retrieve projections, shares with others.
					
Component	Level 1	Level 2	Level 3	Level 4	Level 5
Video Projections	Ignored or unnoticed.	Noticed. Visitor looks and reads.	Visitor reads with attention.	Visitor reads with attention, discusses with others and looks for associated content.	Visitor retrieves projections and generates changes with photo-artefacts, shares with others.
					

Table 3. A 5-point scale that categorises the different levels of attention to Interactive Sets.

Visitors gave photo-artefacts and video projections different levels of attention. Whilst 15.4% of visitors completely ignored or did not notice the photo-artefacts on the interaction table (attention level 1), more than twice the number, 34.7% of visitors, ignored or did not notice the video projections on the wall. Interestingly, in both cases 11.5% of visitors fully interacted with the components (attention level 5) and 15.4% got to some extent involved (attention level 4). Most of the attention to the photo-artefacts happened at levels 2 and 3 (26.9% and 30.8% respectively) while attention to the video projections happened in an 11.5% at level 2 and a 26.9% at level 3.

Data from this unit of analysis can be further analysed in the combination of both interactive components. By converting the scale's points into values and adding the results from each component, a new scale from low to complete engagement results (Table 4). Data under this interpretation shows that 11.5% of visitors achieved a complete engagement, 42.3% reached a medium to high level of engagement, 38.5% engaged in only a low level, and a 7.7% did not engage at all. Data was further broken down into individual and group visits levels of engagement. Within group visits 66.6% of visitors reached High to Complete levels; in a more comprehensive span - from Medium to Complete levels - this number reaches 78%. Low and Null engagement levels were reached by 50% of individual visitors and a 50% of group visits.

Photo-artefact Attention Levels	Interactive video Attention Levels	Combined Values	Engagement Level
1	1	2	Null
1	2	3	Low
2	1	3	Low
2	2	4	Low
2	3	5	Medium
3	2	5	Medium
3	3	6	Medium
3	4	7	High
4	3	7	High
4	4	8	High
4	5	9	High
5	4	9	High
5	5	10	Complete

Table 4. Creation of Engagement Levels scale from Attention Levels scale.

The duration of visits was also an interesting factor to study. In this respect, two units were studied: the overall time dedicated to each component and the overall time dedicated to the totality of the visit. The interactive components of the table with its photo-artefacts and the video projections took most of visitors' overall time with a 43.8% of the visiting time, equivalent to 44:26 minutes for the 26 visits. The centre of the room became a surprising point of interest as visitors met and talked there for a total time of 24:57 minutes, equivalent to 24.6% of the total visiting time. The posters took altogether a 27% of visitors' time and the précis only a 4.6%.

Bodily and facial expressions were also studied. These were hard to quantify but some repetitions gave interesting results. Table 5 shows a list of the most recurrent expressions and the number of visitors that were observed in them:

Expression	Visitors
Holding an object on one hand as they enter the gallery (coffee, bag, books, etc.)	8
Holding objects on both hands as they enter the gallery	2
One hand in pocket during the visit	5
Both hands in pocket during the visit	2
One or both hands on hips	2
Arms crossed in front	3
Hands held behind back	3
Elbow on one hand, other hand on mouth/face	6
Leaning head to a side	17
Touching objects on the interaction table	15
Picking up objects on the interaction table	7
Talking/discussing with other visitors	16
Balancing body sideways or front and back	4
Turning around on her/his feet redirecting focus on something new	11
Waving arms/hands up and/or sideways	3
Wandering around the room with no apparent aim	4
Being distracted by other people/something else	5

Table 5. Bodily and facial expressions observed during the study.

Facial expressions spanned from concentration to surprise, including eyebrows frowning and lifting, eyes opening wide or adjusting to details, mouth sneering and grimaces, head tilting as if recalling memories or thinking, etc. No full certainty of what visitors were actually thinking or feeling could be achieved through observation only.

A final study was developed during observations to seize an understanding of the social interactions taking place within the exhibition space. Once again, data was mostly qualitative and subject to interpretation but it provides an approximation to how visitors experienced the exhibition in a social way. No group visit was conducted as a cohesive group visiting each component together. Group visitors would mostly start an individual trajectory that would come across other individual's trajectory, spending some time together, occasionally. Once meeting at a same point they would explore and experience the particular component together. The areas where group interactions were observed to happen the most were the interaction table (15 out of 17 group visitors), the centre of the room (6 visitors) and the posters areas (4 visitors). Individual experiences within group visits would often be interrupted by other visitors calling each other's attention briefly; this happened in 12 out of 17 group visits. All visitors who started their experience in groups or became group members throughout the visit left as a group. No individual visit observed coincided with another individual visit. Only one group of 3 visitors was observed to visit the exhibition while another group of 3 was present; in such case they all moved around in the space allowing enough room for each to explore at ease.

6.6.2. Survey Data

In addition to observations, an online anonymous survey was conducted. The questionnaire was answered by 24 people, which represents 60% of the 40 people directly invited to participate in it via email. Invitations were sent to visitors contacted during the observation process and randomly selected academic and administrative staff members of the Faculty of Design, Architecture and Building, UTS. Although all 9 questions of the survey offered multiple-choice answers so as to ensure a high response ratio not all participants submitted a complete survey. All questions but one encouraged participants to complement their responses with further comments or details. Below is a list of the types of questions presented to the participants in the survey; the web survey with its complete questions can be found in Appendix 5.

1. What made visitors attend the exhibition?
2. How appealing was the exhibition for participants from outside the gallery?
3. Which components of the exhibition did visitors notice?
4. Did visitors notice some components were interactive? Did they interact with them?
5. How did visitors physically explore the exhibition space?

6. To what extend did visitors understand the exhibition's message?
7. Did the exhibition encourage further thought and discussions in the visitors after the experience?
8. How did visitors describe their visiting experiences?
9. Was there anything else visitors wanted to say about the exhibition?

The survey questions aimed to reflect more qualitative aspects of the visitors' experiences: levels of interest and engagement, interpretation of the content of the exhibition and the form this was delivered, and the physical and social use of the space, as expressed directly by the visitors.

In respect to the initial motivation for visiting the exhibit 50% of the survey participants informed of having received an invitation (email or printed flyer) to attend the exhibition (Figure 20). An interesting 31.8% of visitors said to having visited the exhibition after hearing about it from somebody else and only an 18.2% of the participants visited the exhibit after noticing it in the gallery, feeling curious about it and walking in. Although the *I See What You Mean* exhibit was publicised in several art-related media, no visitor reported to having visited the exhibition after finding out about it this way.

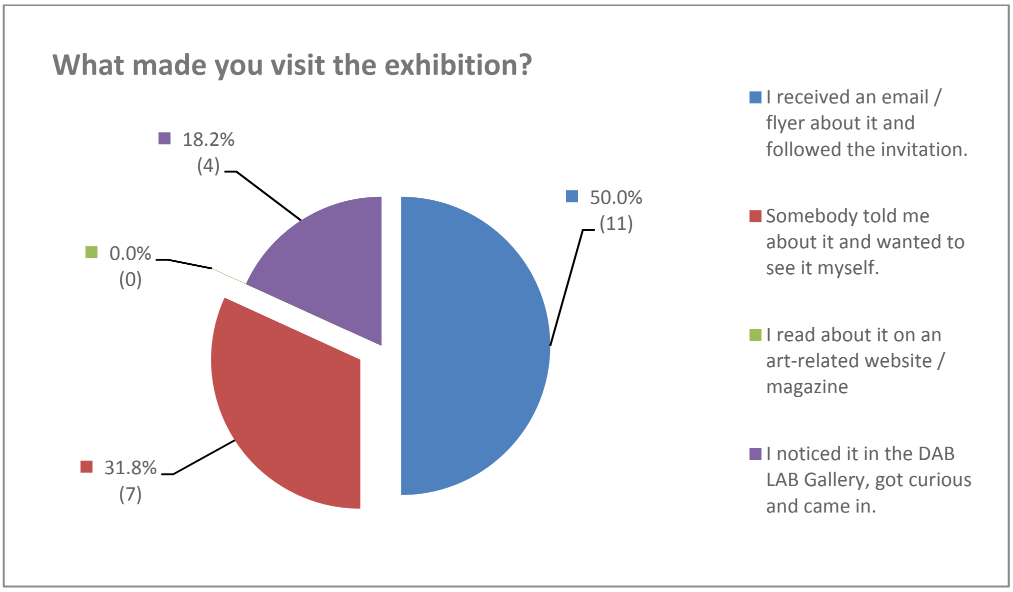


Figure 20. Reasons for visitors to attend the exhibition as reported through the surveys.

The level of appeal of the exhibition within the courtyard space was one of the units of analysis explored by the survey. A moderate appeal was evidenced by the survey results, with 30% of participants stating they noticed there was an exhibition open but were not particularly drawn into it and another 30% stating they considered it somewhat appealing from outside, reinforcing their previous interest in visiting the exhibition. Only a 15% of the survey participants reported to having been strongly drawn into the gallery, while another contrasting 25% thought it was barely appealing or not even interesting enough to be drawn in.

Visitors' appraisal of the gallery's spatial configuration, overall presence of the exhibition's components, and evidence of their operation and purpose (affordances) was also explored through the survey. In most cases all components were indicated as fully identifiable. Wall posters (both right and left hand walls') were noticed in an average of 85.7% and the exhibition précis (which was located immediately to the right of the right-hand wall's posters) was noticed by 81% of visitors. The video projections were perceived by only 71.4% of the visitors, which contrasts with the 90.5% of visitors who informed having noticed the interaction table with its photo-artefacts on it.

In respect to the interactive sets, the clearest component as defined by the visitors was the interaction table and its photo-artefacts, although this represented only 42.9% of all 21 effective responses (Figure 21). The effect of visitors' proximity to the interaction table was only noticed and explored by 2 out of 21 participants who answered this question (9.5% of overall responses). Whilst 4 participants (19%) indicated they had noticed some action could be done by interacting with the photo-artefacts and 8 (38.1%) believed the video projections were presented independently from their actions, 23.8% of all survey responses revealed no interactive components were identified at all.

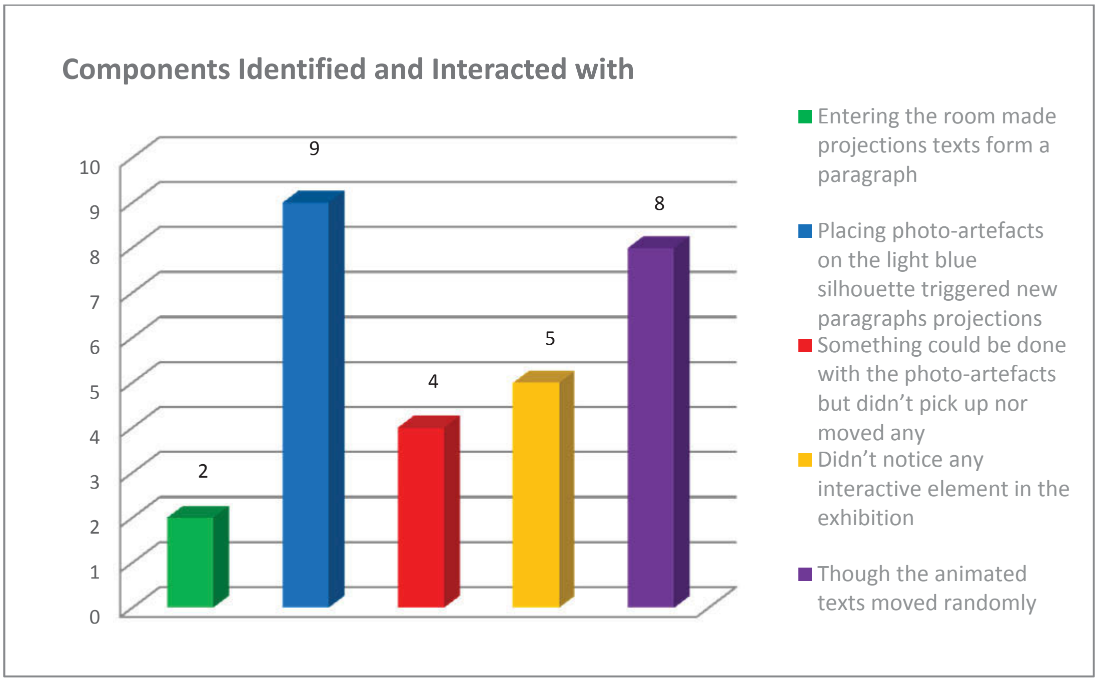


Figure 21. The exhibition was designed in a way visitors could interact with some of its components. Did they notice any? Visitors indicated which ones they identified and interacted with.

Although the trajectory of the visitors within the exhibition space was explored through the observation process, visitors were asked to recall their paths and in doing so inform about the sequence they followed when exploring the components. As Figure 22 shows, the majority of visitors (68.4%) conducted a peripheral exploration of the room, starting with the left-hand wall content (first set of posters), continuing with the rear wall (with the interactive sets of video projections and photo-artefacts) and finishing with the right-hand wall and its set of posters and précis. Out of the 19 participants who answered this question 3 informed of having explored the space without following a particular structure.

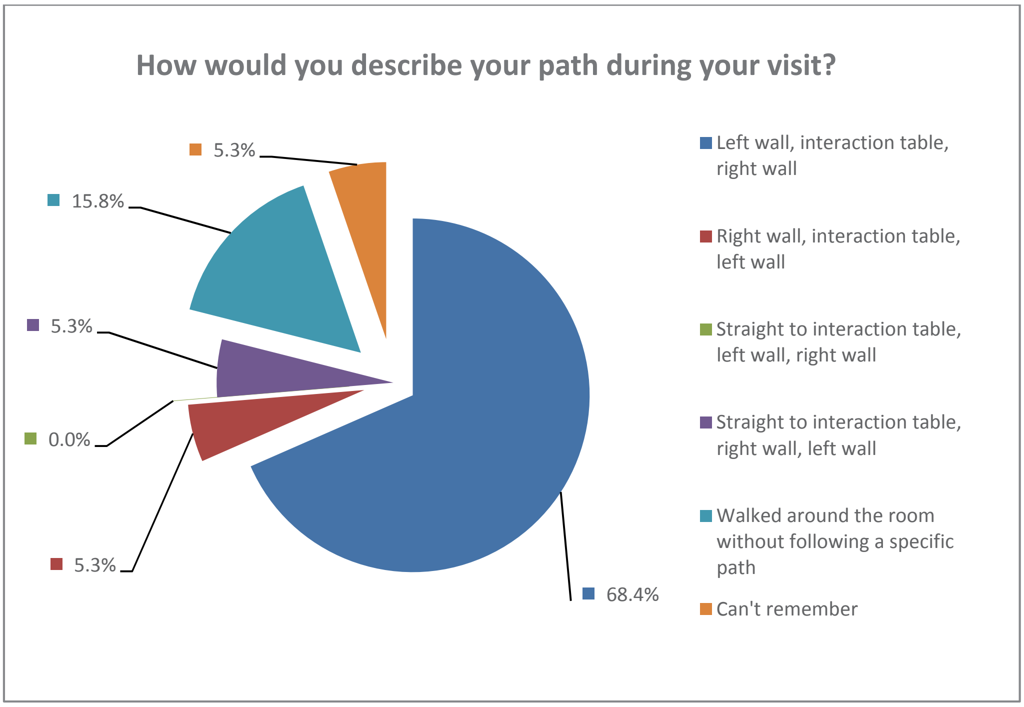


Figure 22. The configuration of the space was meant to lead visitors through an experience of exploration, discovery and appropriation of the message. How did they explore the space?

One of the units of analysis that helped evaluate whether the purpose of the exhibition was achieved was the study of visitors' direct perception of its content and meaning. 42.9% of participants stated to having understood most or all of *I See What You Mean*'s message and a 38.1% stated it was quite clear, leaving room for a few doubts. Out of 21 participants, 4 revealed they could not understand what the exhibition was about at all (17.4% of responses) and 1 participant informed of barely understand its content. Notwithstanding, the message and ideas presented at the exhibition remained in the visitors memory for an important period of time (Figure 23). 71.4% of participants kept thinking of the exhibition's content well after leaving the gallery; not only 38.1% of visitors affirmed to have thought of the exhibition a few more times but another 33.3% actually discussed the content with colleagues and friends outside of the exhibition context. More interestingly, considering the survey was answered up to two months after the exhibition was finished, no participant claimed to have completely forgotten about the exhibition and its content.

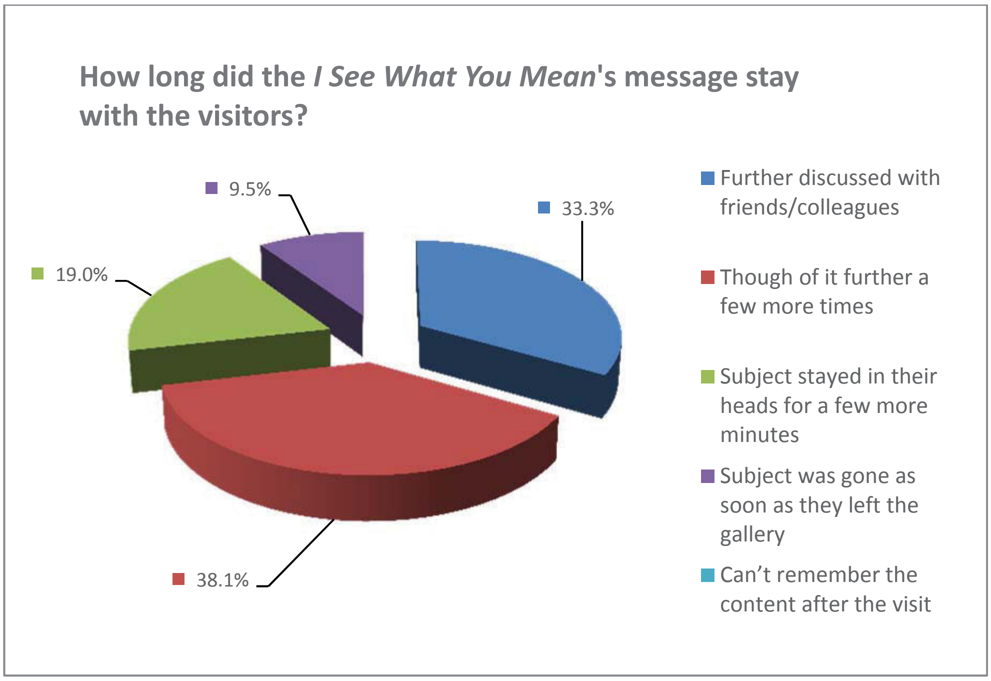


Figure 23. The graphic expresses whether the exhibition encouraged further thought and discussions in the visitors after leaving the gallery.

Finally, a series of adjectives was presented to the survey participants for them to express how they experienced their visit, their perception about the content and how they fell during their visit. Participants could choose to either answer by selecting the adjectives they felt represented their experience the most or by adding new ones. Although participants' perceptions of their visiting experience were slightly balanced towards positive adjectives (i.e. delighted, satisfied, amused, impressed, and proud, with 57.9% of mentions), an important percentage of the appreciations indicated negative feelings as well (i.e. confused, lost, uncomfortable, and excluded, with of 42.1% of mentions). The adjectives most mentioned were *delighted* (9 out of 20 mentions), *confused* (9 mentions), and *amused* (5 mentions).

Many complementary comments were collected from the survey, which built up for a better understanding of the visitors experience with *I See What You Mean*. These are some of their literal expressions:

- "(…) all the other exhibitions had lights or blinking elements! That makes your exhibition a little different to the others!"

- “The interaction felt random and I wanted a little bit more control. Importantly, I wanted to be able to read all of the text on the projections and sometimes the text would move in a way that didn't allow me to read all of it.”
- “I had assumed the project screen was automated (…)”
- “I didn’t realize that something happened when you move the pictures on the table. I think, that was because my eyes were too close to the wall! I couldn’t see the reaction! If the room had immediately changed in a colour that would be more visible!”
- “(…)The viewer had to connect the dots between the collaborates which is not a bad thing (I liked the fact that the exhibition did not try to make any clear definitive statements about the collaborative process) but you needed to be prepared to spend the time to achieve your own meaning from the show.”
- “I believe the intended message was lost on the participant/viewer because the room was too bright and you couldn't properly register the projected images.”
- “Although I did get most of the message, I didn't notice the interactive part with the table. That's too bad, it would have enriched the experience of the exhibition”
- “The exhibition worked a delicate and subtle fine line between installation and user computer interaction. Further fine tuning should not matter that much especially when the style of presentation may fall into the realm of experimental art/performance and communication.”
- “It was good experience and reflection of how I felt in my career path - The centre of the room was more like a limbo between design career and project management career.”
- “I thought about in own projects, how to have several views on an approach or even objects”
- “I think the realistic photographs of flowers etc. had strong metaphoric pretexts that were difficult to ignore and therefore difficult to consider in this / new context.... Sorry I didn't see what you mean :-(but it was bright day and difficult to see the screen content.”

6.7. What *I See What You Mean* Meant: Findings

The *I See What You Mean* exhibition had two purposes: whilst within the context of an academic environment it was a space for collegiate reflection about cross-disciplinary collaboration, within the context of my doctoral research it was a design probe for the study of a set of variables that could inform my research questions. In this respect, the design probe aimed to facilitate the study of the role of interactive technologies in the visiting experience when embedded in familiar artefacts designed for academic conveyance and making of meaning. An evaluation of the collaboration experience and the exhibition as a work of art was conducted together with co-creator Bryce Cassin after the exhibition concluded. The findings presented in this section are the results of the audience research conducted on *I See What You Mean* as a research case study, with a core focus on its visitors and their visiting experience.

Although the exhibition was open to the public for three consecutive weeks, the period coincided with Easter and academic midterm break, reducing the social activity in the gallery's surroundings and the hours of effective exhibition. This implies that a lower number of people than planned had the chance to visit the exhibition. As inferred from the data presented earlier, approximately 154 people were likely to having visited the exhibition (at an estimated ratio of 2 visitors per hour, in the 77 hours the exhibition was open to public). The study was conducted on 26 individuals through observation and 24 individuals through a research survey, which suggests that at least 15% of the exhibition's visitors informed this study.

The overall socio-spatial context in which the DAB LAB Research Gallery is allocated was a very important factor in the way people responded to *I See What You Mean*. Being the faculty's courtyard a lively corridor between work and leisure, the exhibition benefited from the rich social activity of its surroundings. It can be inferred from data that, particularly during lunchtime, visitors made use of their spare time to attend the exhibition (65.4% of the visits during the observation period took place between 12:00 and 14:59). In addition, 17 of the 26 visitors observed entering the gallery were passers-by (they had been previously seen wandering in the Immediate or Proximate Zones), whilst the other 9 visitors were observed coming straight from the Distant Zone or beyond. In view of these figures, it is presumable that visitors had a disposition to spending an enjoyable and relaxed time when visiting the exhibition. This is further reinforced not only by the direct feedback provided by survey participants but also by the average visiting time per person of 3:03 minutes and visits extending for as long as 13:19 minutes.

The external appearance of the exhibition seemed to have had little influence on the purpose of visit. According to the survey the main reason why people visited the exhibition was their prior awareness of it (81.8% informed to having received an invitation or been told about it by peers). In addition, 60% of participants expressed they had already decided to visit the exhibition before approaching the gallery. Only 15% of the survey respondents indicated the exhibition appeal was decisive in their choice of visiting. This insight brings up a reflection of the design aspects of the exhibition and its potential to draw visitors into it. Although most of the exhibition's components (i.e. posters on the walls and video projections) were expected to be noticed from the outside, they could have had a stronger role as an initiator of the overall experience.

Insights are also drawn from the analysis of the internal space configuration. Despite of the visitors' generally positive appraisal of *I See What You Mean* - with 75% of survey participants assessing the exhibition as appealing and 57.9% of positive adjectives as experience indicators - interaction was affected by several physical factors. Upon entering the gallery the space presented a rather contemplative environment; clear affordances for interaction were insufficient for visitors to actively engage with and within the space. According to participants' comments, the predominantly peripheral arrangement of the exhibition components and the reduced size and volume of the graspable objects prevented visitors from further exploring the space. Affordances deficiencies were particularly identified on the prompt and photo-artefacts on the interaction table; many impressions were collected regarding their lack of clarity of purpose and operation. A final insight on the spatial attributes of the exhibition concerns the actual space for collaboration; the design of the exhibition neglected the potential interest of visitors to engage in a collegial dialogue during the visit, providing little room for groups to gather and express accordingly.

In the contemplation of and interaction with the diverse components of the exhibition, different affordances and constraints informed visitors of their visiting possibilities and limitations. The responsiveness of the exhibition space to the presence and action of the visitors was not easily perceived (57.1% of survey participants informed to having not identified the overall interactive attributes of the space); however an important percentage of them recognized the purpose of the photo-artefacts on the interactive table, using them to retrieve new video projections. This was confirmed through observation data, where 22 of the 26 visitors observed manipulated these objects to some extent. The interactive set of table and photo-artefacts, as an interface for the display of video projections, seems to have not conveyed its purpose with enough clarity; consistent comments from survey participants make reference to their confusion when trying to make sense of both visual and textual information.

In respect to audience's bodily interaction with the exhibition, all visitors observed approached the area with their hands either held behind their backs, in their pockets, holding objects brought along with them or with their arms crossed in front of their chests. Contemplation before action was the most common approach. This could be the result of several isolated or combined factors, such as cultural constraints (do-not-touch objects in galleries), a lack of clear affordances to grab objects, a sense of neatness not to be disrupted, decreasing interest throughout the visit, among other constraints. After the analysis of visitors' feedback and observation of their behaviour in the gallery it can be inferred there was not a clear invitation to interact with all ease and confidence.

Research data shows that visitors dedicated a great deal of attention to most components, being the interactive table, photo-artefacts and video projections as a whole the part that attracted visitors the most (43.8% of all visits concentrated in these components). As the analysis of observational material reveals, visitors took time to read and contemplate both textual and graphic representations in all components. Posters, in particular, were usually observed from a short distance and many visitors were observed leaning closer to have a better look at details. In contrast, photo-artefacts, which were expected to be picked up and handled for as long as desired, would receive a general short attention: most visitors would randomly pick them up, one after the other, and quickly interact before putting them back on the table. This could be the result of too many choices for audience to interact with, in contrast with the posters (half as many available). Regarding the video projections, since most visitors could not identify their effect on the delivery of content, a direct operation and conscious interaction was not fulfilled.

In respect to the technologies embedded in the exhibition environment, the analysis of data from both observations and surveys suggests that their application was appropriate albeit to some extent conflictive. The system behaved as expected most of the time, although further calibrations and adjustments were conducted during a remedial evaluation. Several participants manifested in the survey that the apparently random action of the system was rather confusing and misleading. Interestingly, this same condition seemed to have triggered curiosity and a sense of play in many visitors as well. Nonetheless, more feedback to ensure visitors knew what to do was needed in order to accomplish a full exploration of the exhibition's content.

Despite of the lack of understanding of the technology behind *I See What You Mean*, research data indicates that the message of the exhibition was clearly conveyed (as expressed by 76.2% of survey participants) and the aim of the exhibition (facilitating a lasting academic dialogue) was mostly accomplished (according to 71.4% of survey participants). In terms of content, interpretation and meaning, findings are mostly positive, yet room for improvements have now been identified. Although the exhibition offered the audience a generous range of creative material, its level of abstraction made associations difficult to attain; more specific verbal and visual references could have been helpful.

Final insights, and the most important ones, relate to visitors' direct reports of their experience with *I See What You Mean*. As inferred from research data the majority of visitors enjoyed the exhibition, perception that is reflected in their comments expressed freely in the surveys and in the observed reactions during their visits. Important qualitative data was collected from these accounts regarding socio-emotional issues such as sense of collaboration, social engagement and enjoyment of the experience. For instance, 68% of survey participants mentioned the concepts of "thought provoking" and "stimulating" when asked about their visiting experience. It can be inferred from the analysis of research material that the overall audience evaluation is positive though considerably affected by technological uncertainties. A concrete example of this was some visitors' interaction with the photo-artefacts at the interaction table, where cause and effect were not perceived; consequently, visitors were hardly certain of their effect on the system or the reason why the projections displayed were changing. This explains why, despite of a general positive evaluation of the experience, confusion was an issue often mentioned.

I See What You Mean invited its audience to explore individual interpretations and social making of meaning with the help of unobtrusive technologies. Visitors experienced these technologies in different levels and in different ways according to their perception and understanding of their functioning and purpose. The integration of technologies within the exhibition space is a tool for experience design that needs to be balanced throughout the visit. The study of this exhibition showed that visitors appreciate being gently guided through their visiting experience as long as they can attain a sense of control of the interfaces for the retrieval of content.

Summary of Key Findings from the I See What You Mean Case Study

- Visitors' responses to exhibits and their contents are tightly related to the socio-spatial context in which these are presented, shaping their levels of disposition towards the visiting experience.
- Designs aspects associated with space, affordances and aesthetics are of essential interest in the projecting of interactive exhibitions as these have a substantial role in the initiation, holding and retention of the visiting experience.
- Meaningful social interactions within the exhibition space are achieved through a consistent design relationship between visiting narratives, system's interaction maps and visitors' expectations, leading to collaboration and collective sense-making.

- Beyond the exploration and discovery purpose an interactive exhibition may present, clear cues of possibilities and limitations of action need to be offered to visitors; affordances play a fundamental role in the interaction of visitors with computer-based exhibits, stating the difference between a successful and an unfulfilled experience.
- From a user perspective, the inclusion of interactive technologies in the exhibition space ought to be a design response to visitors' interests, expectations and abilities. Interactive technologies that provide merely technological solutions to the exhibit's requirement may obstruct the exhibition's purposes or, furthermore, generate in its visitors an adverse reaction.

Chapter 7. Case Study: *Facets Kids*

7.1. Introduction to the Installation and Case Study

Facets Kids is an interactive video-projection artwork created by Bert Bongers. The installation, presented at the Powerhouse Museum (Sydney, Australia) in October 2009, allowed the museum's audience to co-create kaleidoscopic images with the help of various interfaces and a mixed palette of visual content. The background and development of the installation are thoroughly described in a publication by the artist in The International Journal of Arts and Technology (Bongers 2012a). A number of pre-made and live streaming videos were projected to a large wall for the audience to contemplate and modify at will within a social context, generating not only individual multimedia products but also diverse collective outcomes (Figure 24). *Facets Kids* benefited from the NSW Spring School Holidays, a period of two weeks during which a particularly rich variety of public interacted with the artwork and valuable research data was collected. Three months after the study a preliminary research report was produced and presented to the Interactivation Studio and the Powerhouse Museum (Mery Keitel 2010a). The following year concluding findings were presented at Australian Computer-Human Interaction Conference (Bongers & Mery Keitel 2011). Under the leadership of Bongers a multidisciplinary team collaborated in the different stages of the *Facets Kids* iteration; I was commissioned the audience research of the project (see Appendix 6 for more details).

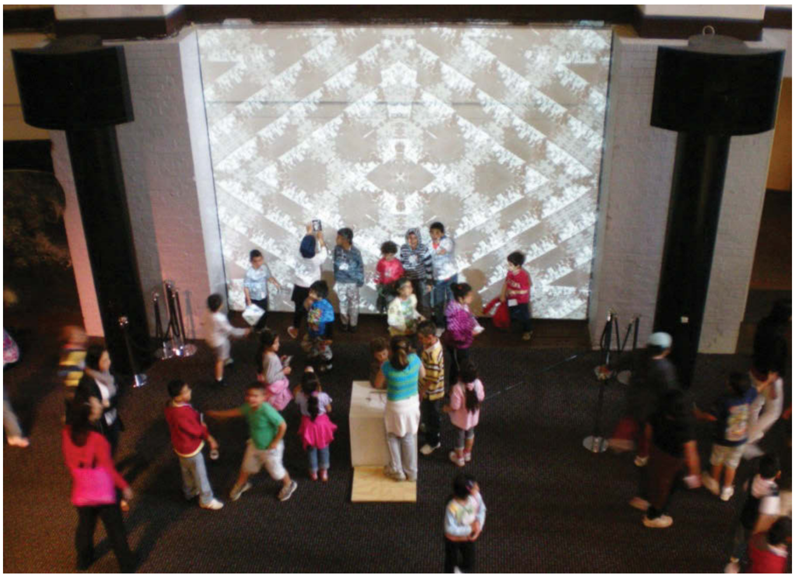


Figure24. General view of the installation space depicting audience activity and part of the interaction components.

The aim of the installation was to further explore physical and social interactions in a mixed environment of electronic and tangible objects where participants' creativity could be expressed through their actions. Interaction with the installation was possible thanks to a series of controllers for the participants to physically provide input into the system and modify the content being projected. *Facets Kids* was designed to allow both individual and shared experiences. The experience of the installation would commence with the visitor entering the Turbine Hall, an open space located on Level 1 of the Powerhouse Museum, in the heart of the museum space. When noticing the large dynamic projection on the wall, visitors could get involved by just observing the projections and other visitors interacting or by engaging directly with the installation at different levels. A much richer experience could be achieved when socially interacting and sharing their explorations and creations with other participants.

Facets Kids was designed in such a way that audience could intuitively interpret its purpose and functions; no guidance was required to either manipulate the interfaces or produce a determined result. However, occasionally, participants would be approached by me, as a researcher, to either obtain feedback from their ongoing experience or to provide some sort of assistance or explanation, if requested. The experience of *Facets Kids* would last for as long as the participants wanted as the products of their interactions were endless both in terms of type and duration.

7.2. Bert Bongers: Interactivating the World

Bert Bongers has built his research and praxis paths through different disciplines and countries. With a balanced blend of electronics, human sciences and art, his work seeks to redefine the way users' minds and bodies interact with technology, exploring the many possibilities that design and technology offer.

Through his doctoral research (Bongers 2006), which reports on the insights resulting from his direct experiences in the development of multimedia and interactive systems, Bongers proposes "an ecological approach to the design for the interaction between people and technology" (Bongers 2012a, p. 17) and establishes several research frameworks. Bongers argues that technology is decreasing in size yet increasing its presence in our everyday activities, generating a complex technological environment for users to interact in. With the field of Human-Computer Interaction (HCI) as a starting point but drawing from explorations in the arts, architecture, design and music he devises the relationship between users and technology as an electronic ecology, or e-cology. Researching and developing numerous interfaces he demonstrates how the adoption of an e-cological approach to the design for interactions and the embracing of the many opportunities multimodality offers, can lead to much richer experiences of what he calls the Interactivated Space (Bongers 2006, p. 82).

As Associate Professor with the School of Design at the University of Technology Sydney (UTS) Bongers[8] created in 2008 the Interactivation Studio (briefly introduced in Chapter 6). The Interactivation Studio is a laboratory set to support the research, design and development of interactivated environments through a flexible practice and infrastructure consistent with his research approach (Bongers & van der Veer 2009; Ford 2008). Part of the Faculty of Design, Architecture and Building (DAB), the Studio provides a space for designers, artists, architects and technologists, among many others, to collaborate and research the interaction between users and their technological environment in both the virtual and the physical world[9]. New interfaces and paradigms are devised, prototyped and tested in order to explore and demonstrate new ways of interacting with technologies. The research projects developed at the Interactivation Studio, under the supervision of Bongers, take various forms and scales that span from intimate wearable interfaces to outdoor interactive spaces; the common denominator of these being the facilitation of users' expression through technology.

Bongers claims that current computer systems are limited entities, technological tools designed with specific restricted applications that tend to derive in a mismatch with their users (Ford 2008). He suggests that a change of paradigms of technology and communication is needed, where these evolve from close to open. Using music as an example, Bongers illustrates the

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[8] See http://datasearch.uts.edu.au/dab/staff/details.cfm?StaffId=2947 for Associate Professor Bert Bongers' profile in the Faculty of Design Architecture and Building website.

[9] For more information about the Interactivation Studio see http://www.educ.dab.uts.edu.au/interactivation/.

contrast between closed and open systems, arguing that musical instruments are “sensitive and allow fluid expression” (Ford 2008, p. 7). Consequently, his research aims to develop integrated technological environments where functionality and expression coexist.

As reflected in most of his academic publications and artistic work, Bongers encourages users to express with technology (Bongers 2007a, 2007b, 2012a). In order to achieve this, his research attention focuses on the interface and social components of the interaction, rather than on the technology itself. Humans and technologies, needs and tasks, expectations and actions, cause and effects, all these relationships depend on the communicational quality of the interface(s) in between. Understanding a good interface as that which facilitates a fluid manipulation (from the user perspective) as well as a solid production (from the system perspective) Bongers pursuits full sensorial, physical experiences in the interaction with technologies. The installation studied and presented in this chapter reflects the philosophical and design principles Bongers puts in practice through his work.

7.3. Background of the Installation

7.3.1. Researching and Designing for Interactivity

Bongers’ works are developed using the Multimodal Interaction Space (MIS) framework for the design, description and analysis of interactions, as described in Chapter 2 (Bongers & van der Veer 2007). This human-centred framework is based on the interaction dimensions of modes, sensory modalities and levels, and focuses particularly on the physical interaction layer. Applying the MIS framework to the development of interactions Bongers demonstrates how an intuitive and flexible linking between human modalities and system functions is possible. The interactive works Bongers has produced particularly in the last 6 years have followed an open research-based design approach in which the artistic practice itself sets the grounds for the research, design and development of new ways of interaction. Understanding exploration, iteration and inclusivity as core components in the design process, the complexity of the final interaction outcome is broken down into design opportunities. In this rather modular approach to designing, each artistic and research creation contributes to the assembling of an ever-increasing set of experiences (insights) and tools (hardware and software elements) to be re-used in other applications (Bongers 2012a).

As widely emphasised by many authors in the fields of Human Computer Interaction (HCI) and Interaction Design (Buxton 2007b; Moggridge 2007; Rogers, Preece & Sharp 2006) gathering constant direct and indirect user feedback steers the design efforts towards the right outcome: that which is ultimately enjoyable for users. In this respect, Bongers aims for the creation of experimental experience prototypes through which various interaction design concepts and underlying technologies can be pre-tested and explored before their deployment in the real world. Bongers recognises this modular method of researching and designing can be rather complicated; however "it allows quicker access to higher levels of the technicality, facilitating greater design freedom" (Bongers 2012a, p. 22). The purpose of designing for interactivation is not managing technologies so they can serve users' needs but achieving mappings that successfully connect the palette of real world parameters (the human, physical environment) with the virtual world ones (its technological counterpart).

Crucial to the mappings between the real and the virtual worlds - and core components within the physicality of interaction - are the interfaces. Tangible user interfaces (TUIs) in particular serve as the physical connection between digital and physical worlds, enhancing the way people access, modify and benefit from their interactivated spaces. Extensive research has been conducted in the last decade seeking a better understanding of the implications of TUIs for the design of accurate electronic-based interactions (Hornecker & Shaer 2010; O'Neill 2008; Shaer & Jacob 2009). Empirical knowledge - information gathered directly from users' experiences - is essential for the design, implementation and evaluation of tangible interfaces. In this respect, when it comes to developing interactive systems (being these as varied as industrial products, communication tools, artworks, etc.) Bongers believes users should be involved in as many stages of the design process as possible (Bongers 2012a). Rigorous user testings combined with spontaneous feedback from casual users have facilitated the evolution of the research work undertaken at the Interactivation Studio.

This inclusive, participatory approach to design is also consistent with the principle of contemporary interactive art for which audience becomes the creator of the final outcome. The artist's actual work is the design of the system, the interfaces, the building content and the experience. Whilst in traditional art (e.g. different forms of literature, visual arts and performing arts, to name a few), interaction is rather passive, with the audience taking a reflexive, spectating role, in interactive arts the audience takes active part through the narrative, purposely modifying and contributing to the artwork, each member achieving a unique interactive experience. As explained by art curator Lizzie Muller (2008), audience's participation, both in the creation and the presentation process, is essential to the success of interactive art. Through the study of audience's participation and engagement and an iterative approach to design, higher levels of engagement are achieved.

7.3.2. Interactive Displays and Public: Related Work

Although interactive displays have been present in different forms in the public realm since the late 60's it has been with the last decade's technological developments that they have become more ubiquitous and embedded in the urban landscape (Edmonds, Muller & Connell 2006). While the array of interactions is varied, depending on their purpose, audience, technology and location, "a common property is occurring on all applications: computational elements are spread out and fill the design space" (Karger et al. 2012, p. 33). Numerous researches and projects on the urban setting as a domain for interaction design have been realised to date with a particular emphasis on their social implications (Dalsgaard & Halskov 2010; Haeusler 2009; Huber et al. 2012; Peltonen et al. 2008). These research and projects include, but are not limited to, mobile projections and augmented gaming systems, various scales of semi-public interactive displays, and urban-scale media. What follows is a brief definition and description of some representative types of interactive displays which places *Facets Kids* within this specific research domain. They all explore different social and spatial uses as well as wide-ranging cultural practices, interaction modalities and technologies.

Pico projectors are handheld mobile devices embedded with projection technologies that provide a very limited light beam projection but can be carried virtually everywhere. Huber et. al. explore ways in which this technology can be “leveraged for tangible interaction with physical, real world objects” (Huber et al. 2012, p. 2513) in the development of LightBeam, a project that transforms the projecting surfaces (usually small objects of everyday use) into tangible interaction devices (Figure 25). Although agreeing with the potentials pico projectors have for an extended interactive user experience Cauchard et. al. (2012) argue that the use of pico projectors may also result in restrained and unfulfilled experiences since these devices are not only meant to be moved about the space but that also provide several other primary functions (e.g. information and communication). Interactive projections are also one of the core display technologies (along with wireless communications and sensing technologies) for the structure of pervasive games. This type of games takes the traditional indoor gaming experience out into the real world - mainly urban and natural outdoor settings - where players physically explore their respective characters’ possibilities free from the constraints of a console. Such is the case of the game *Can You See Me Now?* which projects the city landscape’s real-time situations (spaces, movements, participants) into a parallel virtual city for players to exchange actions (Benford, Ljungstrand & Magerkurth 2005).

Figure 25. Using pico projector for mobile projections in the LightBeam project.

Researchers from the Ubiquitous Interaction group at the Helsinki Institute for Information Technology Lab (HIIT) have also distinguished three other types of semi-pubic and public interactive displays based on their social context and possible interactions (Peltonen et al. 2008). Tabletop displays are configured so participants gather or sit around the device in order to collaborate on particular leisure or work activities (Peltonen et al. 2008, p. 1286). These displays most commonly offer multi-hand manipulations and touching possibilities through touch-based interaction technologies. An example of tabletop displays is *One Road*, a large-scale multi-touch exhibit created by Lightwell, part of the *Yiwarra Kuju: Canning Stock Route* exhibition. The 10-meter table-like interactive display - a combination of several screens arranged assembling a road shape - allows multiple visitors to explore and discuss historical and cultural meanings of a particular Australian indigenous topic[10].

Another category of interactive displays are the ones Peltonen et. al. refer to as ambient displays, which do not always require users to interact directly on the projection surface; they usually are accompanied by tangible interfaces for the manipulation of content and tend to encourage social interaction. Such is the case of *Visual Melodies*, an interactive art installation consisting of various projected interactive animations that can be controlled by users via tangible interfaces arranged on a table in front of a sofa[11]. The installation aims to stimulate feelings of calm and relaxation in visitors and users of health care services (Chen, Bongers & Iedema 2009).

Large multi-users wall displays differ from ambient displays in that they allow a high social interaction within a larger physical scale and with wider possibilities of multiple-entry input from users. These displays tend to facilitate the process of learning from other users during the interaction process; however they present several challenges in terms of turn-taking practices and technological responses. Peltonen et. al. (2008) developed *CityWall*, as portrayed in Figure 26, a large 250 cm widescreen multi-touch display deployed in a central urban location of

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[10] For more information about the Yiwarra Kuju Project see http://www.form.net.au/aboriginal-development/canning-stock-route-project and http://lightwell.com.au/projects/yiwarra-kuju/

[11] For more information about the Visual Melodies Project see www.visualmelodies.org

Helsinki, Finland, for passers-by to engage in city-centred discussions[12]. Through several hand gestures, multiple users collaborate and interact exploring the diverse multimedia content distributed along the display in a never-ending visual strip.

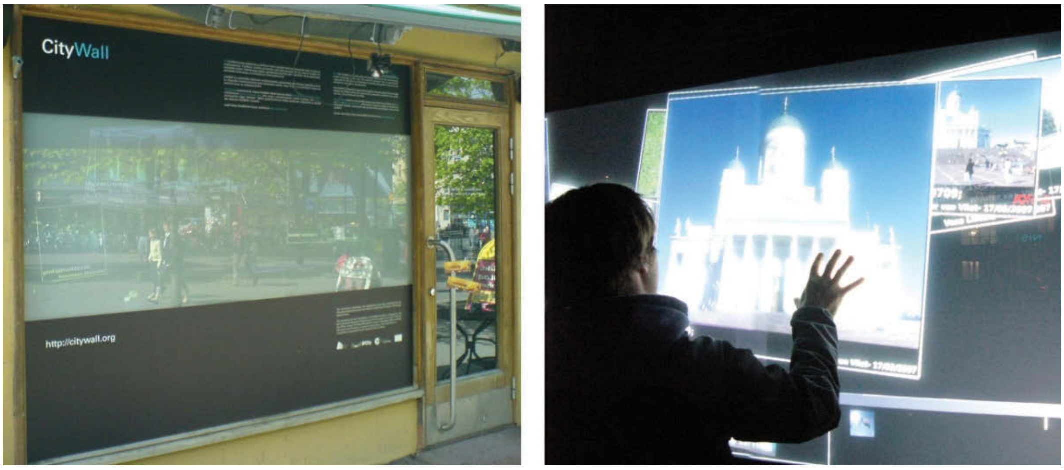

Figure 26. The CityWall display on a shop front at daylight and nigh time.

With the deployment of new technologies and the lowering of costs, the urban space has welcomed a wide array of interactive media façades for citizens to attain entertainment and information at a larger, social scale (Haeusler 2009; Wiethoff & Gehring 2012). Placed in strategic and meaningful public places, these displays - mainly light and/or animated images generated and controlled by computers - allow a new mode of communication between the city's structure (e.g. streets and architecture) and its users. Interaction with this type of displays is possible through the use of remote and mobile devices as well as various sensing technologies. The physical properties of these massive displays differ from other types not only in terms of size and resolution but particularly in terms of visualization and socio-cultural practices. *Aarhus by Light* is one of many examples of interactive media façades developed in the last five years[13] (Dalsgaard & Halskov 2010). Researchers of the Center for Digital Urban Living of the Aarhus University fitted 180 m2 of the Danish Aarhus Concert Hall's front with of animated creatures and city skyline which passers-by could playfully interact with. A sensor-based outdoor

[12] For more information about the CityWall Project see www.citywall.org

[13] For more information about Aarhus by Light Project see www.aarhusbylight.dk (available in Danish only)

distributed system would identify spectators and translate them into silhouettes displayed on the façade together with its content for them to engage and interact with.

Semi-public and public spaces offer the field of Human-Computer Interaction countless opportunities for the development of meaningful physical and social interactions. Whether aimed to acquainted community members or complete stranger passers-by, the increasing focus of interactive displays is to support simultaneous participation of multiple users. Regardless of the differences in technology, content and context all these displays may present, the challenge for designers is to make sure they fit users' characteristics and not the other way round. The success of interactive public and semi-public displays rely on structured design processes that pursue effective and enjoyable interaction experiences.

7.3.3. The Work Leading to *Facets Kids*

The interactive installation *Facets Kids* was one of several iterations of the interactive video artwork *Facets*, which saw altogether almost 4 years of research and growth. In the same way *Facets*' insights now informs the projects being currently developed at the Interactivation Studio, other projects contributed to *Facets* through their own iterations.

Reflecting on how the advancements of technology everyday more allow people to capture audio-visual information from their environments just to keep it stored and seldom displayed in a creative manner, Bongers started exploring a sense of liberation of media and content (Bongers 2012b). Physically detaching the video projector from constrained indoor spaces and with a creative combination of technologies and tools, the *Videowalker* gave its first steps out in the wild in 2003. Carrying a backpack with an instrumental setup consisting of projector, computer, battery, and speaker, in collaboration with other artists, Bongers would perform walks in natural and urban landscapes using their elements as canvas for pre-made video projections. The next few years saw the *Videowalker* further explore audience as part of the performances, large built environments (indoor and outdoor settings) as well as the use of live streaming video. By breaking out the frame in which the projector is usually contextualised, and making the video projections an extended human output modality, the *Videowalker* created a space for expression through technology and balance between the urban and natural environments. In the realisation of the many *Videowalker*'s iterations the interface and audience experiences were at the centre of the design process.

The varied content of *Bongers'* artistic explorations resulted in a rich collection of kaleidoscopic video material which the artist used to create new video-projections. These were composed in patterns of four mirrored pieces using regular features of Apple's presentation application Keynote. In 2007 Bongers re-programmed his work with several other tools, which allowed him to create richer, more complex and interactive kaleidoscopic projections. That year he presented the collaged interactive video installation *Trainflow* at UTS' DAB LAB Research Gallery (Figure 27). With the gallery's door closed but with its glass façade as interface, visitors to the installation could interact with a video matrix of 3 x 3 pieces playing simultaneously. Infrared proximity sensors were embedded in the gallery's façade detecting audience's presence which influenced the speed of the train journeys-themed video and sound streams. Focusing on patterns, rhythms, and textures offered by the landscapes outside the moving trains' windows Bongers made varied footages that combined the concepts of direction, time, and motion. *Trainflow* offered an engaging dynamic environment for visitors to interact, exploring and modifying its content, resulting in unique new patterns.

Figure 27. The sensors embedded in the Trainflow installation's façade allowed visitors to interact with the video content.

7.3.4. The Facets Projects

Since the Interactivation Studio opened in August 2008, kaleidoscopic installations have been constantly displayed as part of the Studio's research and physical structure, benefiting from the rich flow of users and visitors and the subsequent amount of research observations, analysis and findings that emanate from their contributions. In the search of mappings between input space and media parameters numerous sensor systems and input devices are tested and extrapolated into new contexts of use. With *Facets* as an umbrella research project Bongers started a series of video artworks with unique outcomes created completely through their audiences' interactions (Bongers 2012a). Consistent with the Interactivation Studio's research principle, *Facets* enables Bongers to study audience participation and responses, interaction behaviours and systems possibilities, using a flexible yet structured approach and with small gradual changes in each project's iteration.

The *Facets* interactive video-projection installations present a set of pre-made and live camera soundless video streams for audience to engage and interact with. The video pieces are displayed in variations of size, speed and rotation with the projection's X and Y axes as reference. These variations are controlled by the audience through different interfaces with built-in sensors that capture their inputs and transfer them into the system. Each of these inputs is mapped to individual media parameters. When these mappings are recognised by participants they make sense of their effect on the system which facilitates their engagement with the installation.

As introduced earlier in this chapter the notion of palettes of parameters has been applied to the *Facets* projects. The physical parameters (human and environmental input palette) in communication with the virtual parameters (system's media palette) become the core of the project design efforts for it is there where the experiences, interactions and audience's potential to express meet. The *Facets* pieces have been designed with users' experience and expression needs in mind. The design approach applied in *Facets* considers that success in the creation of interactive systems is achieved when these facilitate and create opportunities for use, "proposing rather than imposing, opening up rather than inhibiting, suggesting rather than enforcing, and gently guiding" (Bongers & Mery Keitel 2011, p. 58). The installation offers a semi-immersive environment where participants can control the content, co-creating the artwork from a variety of options available. Since all participants' gestures and movements picked by the sensors are different, endless variations of images are produced - an effect similar to optical kaleidoscopes (Bongers 2012a).

All *Facets* pieces are comprised of a combination of video, physical and electronic components. The pre-made video material is a collection of more than 40 recordings of different scenes (varied contexts, textures and patterns, urban and natural landscapes, still and moving objects, etc.) whilst the live camera streams' content depends on the particular exhibition context. The sound of the videos has not been incorporated to the design palette yet. The video projections have used different canvas according to the particular space and context the installation has been presented in. The interfaces for the manipulation of media have taken varied forms and modes of use throughout the different iterations of *Facets*, including wired handheld controllers, body supporting surfaces, wearable outfits and various types of sensors embedded in the space. All of these have been designed as sensitive interfaces that aim to facilitate rich combinations of virtual and physical parameters and allow multiple levels of physical and social interactions. In general terms, *Facets'* data capture, processing and display is possible through a combination of dedicated hardware and software widely used in the development of multimedia and interactive artwork (Bongers 2012a, 2012b). An object-based program patch is designed so the sensors' data is mapped to the particular media parameters defined for each *Facets'* iteration. The different objects in the program allow the interacting participant's input to be translated into his/her unique video creation.

The *Facets* project is a versatile format of research and development in the design field of interactive audience experiences. Thus far throughout seven iterations *Facets* has seen a wide range of different applications and configurations from deployments on a large architectural scale (with a rather immersive feel) to small furniture scale (a more intimate sense of interaction). In the first iteration of *Facets*, developed for the opening of the Interactivation Studio, three sets of projections were deployed: inside the studio, on a wall of a next-door building and on the floor of the Faculty's courtyard. This provided participants with a varied bodily experience of the installation. The main interfaces available for audience's interaction were a wireless keyboard, live web camera input and distributed sensors. The second iteration of *Facets* took place under the 2009 Sydney Smart Light Festival and was presented at the UTS Tower Building's main foyer. *Facets Tower* was projected on a horizontal 3 x 12 m translucent canvas which allowed the images to be seen not only inside the building but from the outside, connecting both interior and exterior spaces. By interacting with handheld interfaces, a live camera or sensor-embedded furniture, the audience interacted with this *Facets* piece reflecting on the overlaying of natural and built environments. On a contrasting scale, a smaller *Facets* was presented to a community, this time using a screen as opposed to projected on a surface. *Facets Plinth* was a display cabinet containing a screen which content was modified through handheld interfaces and force sensors located outside of the cabinet (Figure 28). *Facets Pool*, the fourth iteration of *Facets*, was presented at the Interactivation Studio as part of the 2009 Sydney Design Festival. Hanging a projector from the ceiling a pool of moving images was built on the floor of the studio. Apart from handheld interfaces, a balance board for visitors to stand or place a seat on was provided. By freely placing and moving their bodies in the projected pool visitors would obtain a higher immersive interactive experience.

Figure 28. A wide variety of interfaces with different functions allowed Facets Plinth's users modify the screen's content.

Also part of the 2009 Sydney Design Festival, *Facets Through the Roof* was commissioned and presented at the Powerhouse Museum for the Play Late event (Figure 29). Five round projections of different sizes and content were displayed on the museum's main foyer's curved ceiling. Each projection's content was controlled by different interfaces: handheld pieces, floor board and a motion sensor-based interactive jacket. The wide availability of projections and interfaces made of *Through the Roof* a highly socially interactive installation. In addition, this was the first time *Facets* was presented in a museum context.

Figure 29. Visitor interacting with Facets Through the Roof through a motion sensor-based interactive jacket.

The sixth iteration of *Facets*, *Facets Kids*, was also presented at the Powerhouse Museum. Aimed to particularly explore a younger audience's response to *Facets* this iteration invited visitors to socially interact with others in the creation of the kaleidoscopic images through the use of handheld interfaces, a floor board and live web camera input. The latest iteration of *Facets* took place at Carriageworks as part of the 2011 Sydney Architecture Festival. *Facets Expanded Architecture* projected a circular collection of videos on the floor of the venue. Attendees would pass by the projection or stay on it; either way, sensors located right above the projection would detect their movements and consequently change the projection mode (Sydney Architecture Festival 2012).

7.4. Facets Kids

Facets Kids was a mid-size iteration of *Facets* presented to a predominantly young audience of the Powerhouse Museum. The format of this installation was a large single projection with new variations of visual content display and a specific selection out of *Facets*' physical interfaces. The main purpose of this iteration was to more structurally investigate visitors' responses to *Facets*, complementing the rather informal studies previously conducted, thus allowing the research project achieve a more systematic set of findings and future work possibilities.

Facets Kids was presented in an interior large open hall of the museum allowing audience to access the installation from four different adjacent areas: the two sides and front in the same level, and the upper level via the mechanic escalators. As it can be seen in Figure 30, the architectural characteristics of the venue guaranteed a high exposure of the installation to passing by visitors. The installation was deployed in an implicitly delimited rectangular area of 8 x 5 m, with walls only at each end. The projection's canvas was the northeast wall of the hall with a horizontal area of 4 x 3 m of display. Approximately 2 m away from the projection wall a 60 x 60 x 60 cm plinth was placed with a front wooden floor platform attached to it; this was one of the installation's four interactive interfaces. In addition, two wooden interaction objects were placed on the surface of the plinth for people to pick up and play with; these objects were attached to the plinth by flexible cables. The fourth interface was a small camera placed on the opposite wall, pointing towards the plinth-projection interaction area.

Figure 30. High audience flow in the area around the *Facets Kids* installation.

The combination of interfaces was distributed throughout the space so as to support a multiple-user interaction and facilitate new social and physical experiences. Given the extensive space the installation was located in, the museum visitors were expected to engage at different levels and at different stages. Whether observing others playing from a distance or directly and purposely manipulating the installation's content, visitors would find themselves immerse in an environment that would invite, suggest and welcome their participation at their own will and pace of action. Similarly, and mainly due to the fact that the outcomes of their interactions with *Facets Kids* were immediate as well as endless, they could finish their interaction whenever they pleased.

The kaleidoscopic video fragments of *Facets Kids* were projected from the opposite wall by a high definition projector, challenging the bright sunlight that would usually inundate the hall from a large southeast window. The web camera placed on this wall acted as a sensor-based input device: a software algorithm was defined so that when it detected movement it started capturing live image input whilst when no movement was detected it would cross-fade allowing the pre-made video projections to keep showing. The camera was embedded in a round-shaped wooden object; this particular interface design (as opposed to an evidently camera-looking case) was expected to minimise a potential feeling of intimidation (the surveillance camera effect, as observed in the study of previous *Facets* pieces) yet elicit a sense of curiosity and invitation to play with once discovered by visitors.

The interfaces that would invite to interact more directly were the two wooden handheld controllers at the plinth. Their somewhat loose presence on a surface, their size, materiality and shape contrasting against the plinth, and the cables through which they were attached to it, all were cues for their interpretation as pick-up objects. The two interfaces presented a slightly different design: whilst both resembled rectangular prisms one of them presenting triangular-shaped indentations on its four sides to denote a different function. In addition, the sensors contained inside the controllers were completely visible to their users through an acrylic plaque. The selection of wood as the primary material responded to the need to add more tangible properties to the typically light weight of the technology inside. By feeling their physical qualities (e.g. weight, texture, shape) the participants were invited to explore the potentials of the technology. Upon diverse modalities of manipulation, the interfaces' embedded 3-axis accelerometers (acting as 2-degree-of-freedom tilt sensors) were mapped to rotation and zooming effects on the video projections, showing participants the results of their explorations.

The plinth in front of the projection area not only provided physical and technological support to some of the installation's interfaces but also acted as the core interaction area. Strategically positioned between the projection wall and one of the museum's most crowded passages between exhibition rooms, the plinth was placed in the hall as a point of attraction. The structure was built out of white painted MDF, with an access lid on its top surface and a plain plywood platform attached to its front's bottom edge. This platform was fitted with 4 force sensors mounted underneath, one on each corner. The sensors would inform the system of the effects of people moving on the platform through the distribution of their weight. This input of participants into the system would result in different rotations of the images depending on the corner of the platform getting most of the weight. The changes occurring in the projection when people stepped on the platform were expected to inform visitors of its step-on nature.

As with all iterations of the *Facets* pieces the processing of the mappings between the visitors' input and the system's output was made through Max/MSP/Jitter patches specifically programmed for the *Facets Kids*' interactions. Interfaces and programming platforms such as Phidgets[14] aided in the reading of the diverse sensors distributed throughout the interactivated space. Given the extensive size of the installation space and the high levels of children traffic around the core interaction area, the removal of as many cables as possible was a priority. With the exception of a power cable to feed the system contained in the plinth, no cables were exposed to the reach - nor accidental or deliberate - of visitors. The *Facets Kids* research team developed a distributed sensing technique to communicate the sensors set up (visitors' input) and the video projections (system processing and output): the sensors' signals were read by a computer inside the plinth and transmitted through Open Sound Control (OSC) to the system's main computer located at the research station. This main computer would process the data and generate the required content.

7.5. Methods Used in the Case Study

The *Facets Kids* installation followed two sets of research purposes: one from the perspective of the interactive artwork (the artists' research purpose) and another one from the perspective of this doctoral project (the researchers' research purpose). For Bongers, this iteration was developed as an opportunity to conduct a more structured research on the artwork's audience responses; for the researcher it was an opportunity to apply new research methods and approaches resulting from the previous case study's methodology reflections (as presented previously in the Methodology chapter). On the whole, the research aimed to inform on visitors' experiences of use during both physical and social interactions with *Facets Kids*. Bongers and I were interested in studying the ways this mixed environment of tangible and electronic objects influenced the audience's interpretation of and engagement with the installation, in individual experiences as well as part of a larger social configuration.

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[14] See www.phidgets.com for more details on these multipurpose microcontrollers.

Facets Kids was presented at the museum during two weeks of school holidays, a period in which audience attendance to museums presents a considerable increase. The installation was part of the specific pedagogical program the museum prepared for that period; several other context-specific activities were taking place at the venue at the same time *Facets Kids* was being presented. As estimated to the Powerhouse Museum' Education Officer, Kath Daniel, nearly 10,000 people visited the museum during those two weeks.

The case of study for *Facets Kids* consisted mainly of families (in configurations as varied as parents/tutors with children or teenagers, one adult with several children, or grandparent(s) with children), organised groups (e.g. school classes, government-aided associations, guided tourist groups), groups of acquaintances (e.g. tertiary students, friends), and individual visitors. The audience was not deliberately led to the installation in any way while visiting the museum (e.g. via printed programs or venue's signage); however, users of the institution's website could be informed about it when accessing the school holiday program published online. The installation presented no user instructions or restrictions; every audience member was invited to interact with *Facets Kids* anyhow and whenever they wanted.

In particular, the study focused on gathering direct and indirect feedback from visitors before, during and after their experience of *Facets Kids*. Research data was collected by different observation and interview techniques, both supported by audio-visual recordings (photographs, videos, sketches). The observations were envisioned to inform on the different ways visitors approached the installation, the ways they interacted with the space, with the installation's components and other visitors, and the ways they made sense of the interaction results (kaleidoscopic projections). The interviews were expected to provide a deeper level of feedback, informing directly on visitors' experiences.

Audience research was conducted in two stages, moving from a completely non-obtrusive enquiry approach in the first 4 days to a much closer researcher-visitor dialogue approach in the following 5 days. As shown in Figure 31, particular spots around the interaction area were defined for observation purposes. An observation deck surrounded by a folding screen was located on the landing of level 2, overlooking the space below on level 1 (the same space that was used to allocate the installation's main computer). From this observation deck on level 2 and from a minimum distance of 3 m on level 1 non-obtrusive observations were made during the first stage of research, without interrupting visitors' interactions and without being identified as a researcher. This observation technique allowed visitors to experience the installation naturally, free from a possible feeling of being scrutinised. In addition, the distance offered a much broader spatial context to obtain information such as other visitors' responses when observing participants interacting with the installation or changes in audience reactions as they approached it. During this first stage qualitative annotations of observations as well as sketches and diagrams were produced; quantitative data was also collected and audio-visual records were made for later analysis. No direct contact was made with the audience during these first few days.

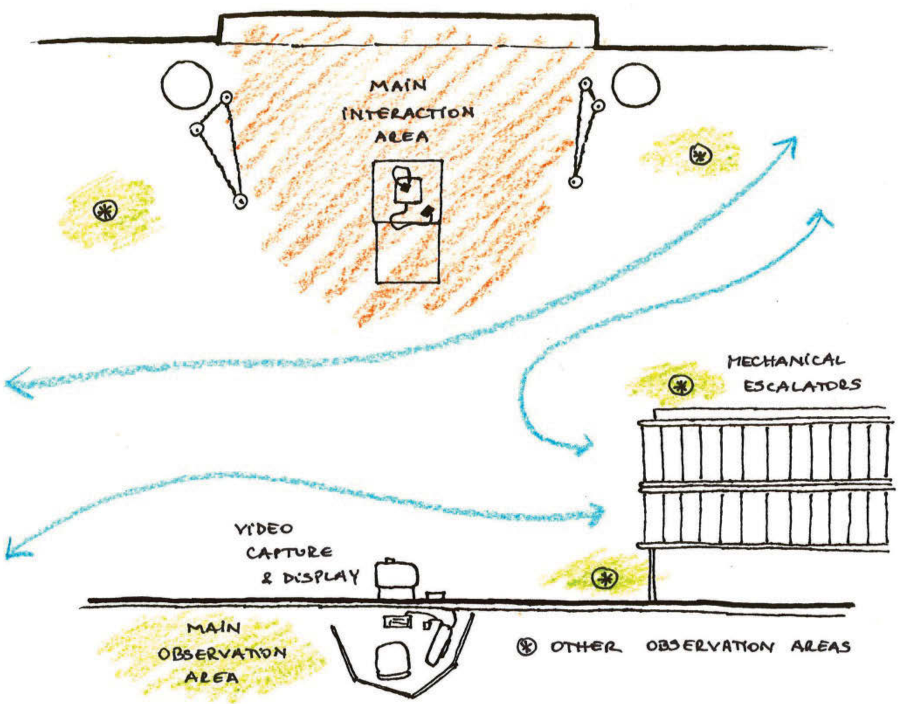

Figure 31. Researcher's observation spots marked in light green and an asterisk.

The second stage of research was characterised by the additional collection of direct accounts from *Facets Kids*' participants. A sign was placed next to the installation informing visitors of the research being conducted and calling for their collaboration. The observation of interactions was made from a much closer position and with more regular verbal contact with the audience. Observation data recording techniques remained the same as the previous week's ones. In occasions, the researcher would intermingle with the audience as part of it, friendly chatting and allowing them to express spontaneously; after each conversation summary notes were made to keep record of the information collected. Interaction between the researcher and the audience members were mainly casual and informal. Semi-structured interviews were conducted during this stage. A pre-designed set of questions and feedback prompts were brought up to *Facets Kids*' users while observing the installation (i.e. its projections, components or other visitors interacting with it) as well as during or after their direct experience. The nature of semi-structured interviews allowed the researcher to quickly gain visitors' confidence and obtain accounts of their experiences as earnest as possible. During this second stage both quantitative and qualitative annotations of the interviews were produced.

Given the high number of audience attending the museum during the presentation of *Facets Kids* and considering the limited human resources to conduct the study, the researcher developed a segmented-data-collection technique. Visitors' interactions with the installation were explored through several units of study applied at set time intervals, allowing a homogeneous and representative collection of data. The definition of these units of study was informed by the research purposes and the opportunities of research procedures identified during the first few hours of observation (adapting research methods according to the context). What follows is a description of each unit of study.

7.5.1. Audience Response to *Facets Kids*

A qualitative study covering general observations of visitors' reactions and behaviours, phenomena and trends, interpretations of mappings, spatial and installation configuration, physical and social interactions. To be weighed against quantitative data later on, these observations aimed to inform about the affordances, appeal and perceived purpose of *Facets Kids*, as well as its participants' levels of physical and social engagement through the interaction with it. The study - 22.5 hrs of enquiry in total - consisted of observations and semi-structured interviews, and would take place whenever no other studies were being conducted.

7.5.2. Demographic Study

A quantitative survey aimed to report on the distribution of age in the installation's audience in the particular context of the museum and, more specifically, in a school holidays framework. Being the venue a cultural-educational institution, the categories were defined according to the NSW Department of Education and Communities' parameters with the assistance of the Education Officer of the Powerhouse Museum's Public Programs. The study was conducted in daily intervals of 30 mins at random times over 6 days.

7.5.3. Audience Participation

This unit of study was comprised of three types of survey: Attitude Towards Installation, Interacting Audience, and Interaction Time. The Attitude Towards Installation study aimed to reflect the way people approached the installation from the different access zones. For this study, the approaching modes were defined in four categories: unaware (passing by the installation without looking at it), aware (looking at the installation but without attempting engagement), approach (observing the installation and/or its participants), and interact (physically engaging with the installation). This study was conducted in intervals of 30 minutes over 8 days. The Interacting Audience study aimed to identify the number of visitors that effectively interacted with the installation. For this study interaction was defined as the physical use of either the plinth (and/or its platform) and the interfaces on it. No interaction was defined as the lack of physical involvement which included behaviours that spanned from observing the projections on the wall to walking by without noticing the installation's presence. The study was conducted four times a day in intervals of 15 mins each for 7 days consecutively. The Interaction Time study measured the amount of time dedicated by participants to interact with *Facets Kids*; the criteria for defining actual interaction was the same as the previous study. Interaction Time was recorded once a day for 6 days in intervals of 30 mins.

7.5.4. Movement Patterns

The different components of the installation, their design and deployment, invited a number of wide-ranging physical behaviours and interactions. During the first 4 days of research the most recurring movements presented by *Facets Kids* visitors were identified. A categorisation of these movements and a study template were designed based on the focus of interaction (interface-centred, plinth-centred, and body-centred). The study was conducted daily in intervals of 30 mins from day 5 onwards.

7.5.5. Social Interactions

Facets Kids was envisioned as a means for visitors to express and interact beyond their individual potentials. This unit of analysis aimed to inform on the social interactions occurring between participants. In the first day of research behaviours of both conflict and collaboration were observed; these were later on broken down into specific descriptions setting a final classification of 11 behaviours. The study was conducted in daily intervals of 30 mins at random times over 6 days.

7.6. Case Study Data Overview

The *Facets Kids*' case study took place daily from 10:00 to 15:00, during the 9 weekdays the installation was available to the Powerhouse Museum's audience. Half of the 45 hrs of field study time was dedicated to general observations; this process was essentially a qualitative one so as to obtain information closer to the meaning of experiences rather than numbers. Consequently, an account of visitors' and system's behaviours during interactions, informal conversations and semi-structured interviews with audience members, as well as fine-tuning of data collection techniques were performed. In addition, 14 interviews were conducted. During the remaining time 1,507 interactions were studied. It is estimated these interactions account for at least 23.4% of the museum's daily audience, proportion that increases significantly when considering that many of these interactions were observed on participants as part of a social group. Table 6 shows a summary of the studies conducted and the number of interactions each contemplated[15].

Day	Audience Response	Dem. Study	Audience Participation			Movement Patterns	Social Interactions
			Interaction	Time	Attitude		
	interviews	visitors	visitors	visitors	visitors	recurrences	interactions
1	-	25	-	-	-	-	-
2	-	-	-	-	127	-	45
3	-	-	56	-	106	-	-
4	-	-	42	16	26	-	25
5	-	35	35	15	61	30	46
6	-	83	83	17	39	35	32
7	14	102	102	20	28	37	52
8	-	78	78	17	87	36	39
9	-	29	29	15	91	40	-
Total values	14	352	425	100	565	178	239

Table 6. Case study's general records.

7.6.1. Audience Response: Phenomena, Trends and other Remarks

General observations covering as many interactions as possible, from the overall spatial context to delicate bodily expressions, were conducted all through the case study. In addition to the specific units of analysis previously mentioned, these observations were aimed to capturing a sense of extended experience over the interaction with *Facets Kids*, the audience's reactions to particular situations, the effect of visitors' actions on other visitors' interactions, variations in emotional and cognitive engagement, and particular physical movements. Instead of a set of specific variables, the researcher took an open approach of discovery of phenomena and trends.

In general terms, museums visitors' profiles vary in gender, cultural background, age and social configuration, among many other features that do not depend on the institution or its displayed

[15] Note that the numbers expressed in the demographic unit of analysis were not considered in the final count of surveyed visitors as the demographic study was usually made while observing participants in the context of another different study.

content. A characteristic that does depend on the exhibit or installation is the role each audience member takes when interacting within it and with other visitors. In the study of *Facets Kids*, three audience roles were identified and consistently used in the analysis and reporting of collected data: participant, group member and general visitor. The term participant refers to the main user(s) of the installation at a particular time. Participants could be individuals alone, a couple or even a group as long as each participated interacting directly with one or more installation's components (i.e. interfaces, plinth, or projection). The term group member was used to refer to the people accompanying the installation's participant(s). Group members were observed interacting with participant(s) in a rather direct way (looking after, calling, cheering them, etc.) yet not with the installation itself. If collaboration was triggered, group member(s) could become participant(s), directly interacting with the installation. The term general visitor related to any other person not related with the participant(s) or group member(s), either observing or passing by the installation. General visitors could also be people briefly addressing participant(s) or group member(s) but without interacting with the installation. Figure 32 shows different examples of roles taken by *Facets Kids*' audience during their interactions.

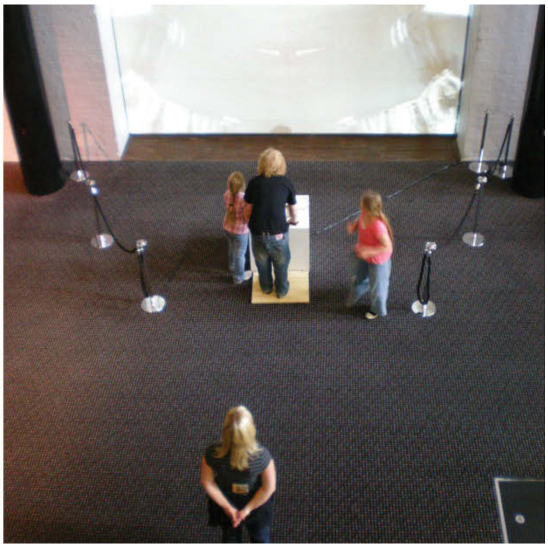

Figure 32. Different audience roles in the interaction with *Facets Kids*. Left: a participant as a general visitor passes by. Right: two participants as two group members observe from different distances.

On the first three days *Facets Kids* was presented to the public, a set of museum barriers and cords surrounded the interaction main zone (i.e. the area comprising the projection wall and the plinth). Although this was mainly a safety measure to protect audience from eventually tripping over the power cable, it was decided the cable was taped to the floor safely enough and audience would benefit from having more space to move around. Consequently, the barriers were removed. The impact this new configuration of the space had on the experiencing of *Facets Kids* was outstanding. Not only more visitors were drawn into the area and a higher social activity was triggered but also a richer exploration of the space took place. Most remarkable was the new ways group members would explore the projection area while participants modified the videos being displayed: standing between the plinth and the wall young children would play as human canvases, letting the projection show on their skins and clothes. In addition, group members would now get closer to the participants, and so would other visitors – complete strangers. Gathering around the plinth or standing behind participants, the audience would actively take part of the experience by cheering, suggesting actions, or simply expressing their wonder.

The space in which *Facets Kids* was presented was a very bright part of the museum. The natural springtime light coming in mostly from the southwest side of the venue, but particularly from the Turbine Hall's large southeast window, would often compromise the visibility of the projection. Aware of this and having access to the main computer, the researcher would often change the video being projected for one with stronger colours and more manifest movements. So as to not confuse the audience, this adjustment would be done only when no participants were interacting with the installation; once visitors approached the installation the sequence of videos was let to continue under their influence only.

The range of video content displayed showed to be an important variable in the interactive experiences of *Facets Kids*' audience. The pre-made video pieces differed in terms of colour, motion and levels of detail; from a uniform almost still footage of small ochre pebbles to multi-coloured fishes vivaciously swimming in a fish tank, participants had an unlimited palette of moving images to paint the wall with. Visitors were more often drawn into the installation when vivid colours and dynamic images were displayed; in general terms, this was also a factor for participants and group member to take part of the interaction for a longer period. In contrast, rather still and monochromatic projections would do little for audience attraction towards the installation and engagement during interaction. Lively videos displayed (be these live video stream or pre-made footage) would also attract more people from afar than those with less vivid content. In addition, the different effects resulting from the manipulation of the interfaces (i.e. size, speed and rotation) also showed to have a significant effect on audience's reaction: axis-based rotation and in/out zooming were more easily perceived as kaleidoscopic expression tools than speed. As motion was an attribute already present in videos, speed changes were rarely observed to be made deliberately by participants; in contrast, the use of interfaces to modify the size or tilt the kaleidoscopic fragments of video was widely observed, particularly in a conscious way (i.e. participants being aware of the effects and how to produce them).

Another noteworthy observation was the response of audience to their presence in the live video streaming projections. From the observations, it has been inferred that, in general, audience enjoy watching themselves in the projections. The realisation of being part of the videos and, moreover, being deconstructed and presented in many kaleidoscopic fragments, was observed as a highly relevant element for engagement: the surprise would turn into an invitation to further explore. The crowd size would sometimes make the difference between recognising and not recognising themselves in the video projection; the more people there were present at the installation the more bodies and faces that were displayed, hence the more visual information to discern from. With the camera filming the audience from their backs made it even harder for them to identify who was who; however, this showed to add an extra sense of play when several participants and group members were observed looking at the camera and then quickly turning around to watch themselves on the screen. A high level of social interaction and collaboration was observed in the manipulation of live streaming video; group members would actively engage in the interactive experience of participants when helping and orienting them in their movements from a distance where both projection and camera were at sight. On a final note on the interaction with the camera, a considerable number of participants were observed inspecting the wooden handheld interfaces as if looking for the camera in them; most of the times they would quickly come to the realisation that the camera had to be farther than that and thus started looking for it elsewhere. There was always an expression of satisfaction upon the discovery of the camera on the wall behind them.

Distraction was an important issue to consider during the presentation of *Facets Kids*. As mentioned before, several holiday-specific events were taking place in the museum at that time; one in particular tended to affect the interaction of visitors with the installation: a theatrical-musical presentation next to *Facets Kids*. Showing daily at 11:00, 13:00 and 15:00 for 30 mins the presentation resulted in unforeseen, yet noteworthy visitors' behaviours. For instance, some tired parents would then take the plinth as a resting object, seating or leaning on it while watching their children attending the show; this would sometimes become an opportunity for them to explore the installation, but it would also often stop other visitors from exploring it as well. Most times, young participants at *Facets Kids* would abruptly drop the interfaces and run towards the adjacent show as soon as it started; long periods of no interaction were then observed. The ending of the show, on the other hand, would usually mean a larger mass of visitors would pass by the installation and somehow take part of it. These periods were also a great opportunity for the researcher to engage in one-on-one conversations with participants and group members or even conduct some interviews.

The combination of sensing technologies and wireless data transfer between the system's computers often resulted in a loss of performance stability. Every once in a while the processing of data would fail making the kaleidoscopic projections freeze. As regular users of technologies nowadays users are somehow accustomed to personal devices stopping working; this was regarded by the researcher as a good opportunity to explore the reaction of technology users to system failures in a public context, furthermore, in an exploratory learning environment such as the museum. A record of 45 system crashes and the diverse responses of participants to these events were recorded for later analysis, further technological adjustments, and remedial design development.

On 17 occasions (37.8% of the incidents) the system crashing occurred when no participants were interacting with *Facets Kids*. In such occasions visitors approaching would either not notice or ignore the installation (12 responses) or briefly try to interact and withdraw in less than 5 seconds (5 responses). On the other 28 occasions (62.2%) when participants experienced a system crash while interacting with *Facets Kids* reactions were almost as many as the number of participants affected; however, a brief quantification of the responses was generated. For 64.3% of the participants the breakdown was immediately evident whilst for the other 35.7% it would take at least 5 seconds to realise nothing was happening as a result of their actions. The most recurrent response observed in the participants was nervousness and uneasiness (71.4%, corresponding to 20 of 28 responses) with participants looking evidently surprised and in some level of discomfort. The second most recurrent response was uncertainty and confusion, with 46.6% of participants showing signs of not knowing what was happening and what they were supposed to do. A sense of frustration or disappointment was perceived in 11 participants and embarrassment or guiltiness was observed in 9. Half of the participants kept trying to play with the kaleidoscopic projections even after realising the system had ceased working; reactions such as looking closer to the interfaces, shaking them, swapping them or simply moving them and their bodies randomly were widely observed. Only 35.7% of participants tried to get help, either calling somebody, looking at group members in the hope of an explanation or by discussing the options with other participant(s). Only 2 of the 28 participants had an aggressive reaction (anger manifested verbally or physically). 57.1% left the installation moderately slowly while the other 42.9% left the space quickly. Out of the 18 participants who noticed the system crash right away, 5 left the installation quickly (17.8% of total affected participants). The range of patience was much lower in the group of participants who took a while before noticing the failure: 7 out of 10 left quickly (25% of all affected participants). Regardless of the cause and complexity of the failure, the researcher would always make sure the system was fixed and back to working as soon as possible.

Mature visitors were observed to be considerably more interested in the physical and technological configuration of *Facets Kids* than their younger counterpart. Although the great majority of the installation's participants and group members were minors (76.1% under 18 years old and, more specifically, 54.5% under 11) an important number of adults would approach the installation with a rather inspecting attitude. Rarely while directly interacting but more often while others were engaged in the process, many adults were observed analysing the installation's components. They would be frequently seen thoroughly analysing the wooden interfaces and closely looking at the sensors inside, lifting the floor platform to check what was underneath it, gently pulling the interfaces cord off the plinth or trying to open the plinth upper lid. The video set was less often studied by this audience group; some were observed tracking the source of the live streaming videos until finding the camera back on the wall opposite to the projection and once there finding the projector as well (but giving little to no attention to it). This exploratory behaviour would generally be complemented with direct enquiries to the researcher regarding the technology behind the installation's components. The younger audience, in contrast, showed to be more interested in the actual interaction and its endless outcomes on the projection wall. Children, particularly the youngest ones, tended to satisfy their curiosity in a more immediate and brief way: they would give a quick look at the components and start moving them and their bodies in accordance. Barely ever an explicit question regarding the technology involved in *Facets Kids* or the way the system worked was raised. Whenever children got involved in a technology-related conversation it was always as a result of an adult (e.g. parent or group guide) encouraging them to reflect on the topic.

7.6.2. Audience Response: Semi-structured Interviews

Information collected directed through interviews complemented and reinforced the audience observations process. Semi-structured interviews were conducted with participants and group members at random times during the observation process. These rather casual conversations were only initiated when the social conditions were estimated as appropriate for one-on-one encounters (e.g. participants showed to be mostly strolling around, parents seemed to be in no rush, more than one adult was minding a group of young participants, etc.). This participant selection criterion was envisioned to facilitate more open responses and ensure the coverage of as many relevant topics as possible in each interview.

Through 14 interviews, the interacting experiences of 44 participants and group members were registered either by their direct account (interviewees) or when referenced to by their companions. 7 pre-school children, 9 infants and 10 primary school children were surveyed (a young group of visitors aged between 2 and 11 years old, representing 59.1% of interviews participants); 2 lower and 1 upper high school students were consulted (a slightly older group aged between 12 and 22 years old, representing 6.8% of participants); the mature group (aged between 23 years old and up, representing 34.1% of participants) was comprised of 8 young adults, 5 adults, 1 senior and 1 elderly. 52.3% of interview participants were female (n=23) and 47.7% of them were male (n=21).

The most relevant questions and conversation starters presented to participants and group members, with slight variations in tone, wording, order and complexity - depending on the interviewee's age range -, were:

- What drew you to play (participant) / not to play (group member) with the installation?
- Have you seen this type of installations before – particularly in a museum context? What do you think of this installation being shown in a museum of science and technology?
- To what extent would you say it was clear for you what this installation was about?
- Did you notice you were modifying the kaleidoscopic projections? Do you know how this happened?
- Could you tell me what each of these elements are for (pointing at the different components)?
- What can you tell me about your experience? Can you describe what you thought and felt when interacting with the installation?
- What did you like the most about the installation – why?
- If you could change (modify, add or remove) anything in *Facets Kids*, what would that be?

Interviews would typically take place with group members while participants were engaged in their interaction with *Facets Kids*; this would facilitate the interviewee's task of describing, referring to and enquiring about specific aspects of the installation. Interviews were mostly conducted directly with adults (i.e. adult visitors, parents or tutors, and other older relatives) and with their assistance and consent when presented the opportunity to talk to children. Younger audience members would usually show to be more interested in continuing exploring the installation rather than talking about it; when asked questions or invited to express their opinions they would mostly reply with short statements (e.g. "it's cool to watch", "I move this thing here", "seen this before, but different") or body gestures (e.g. raising shoulders in lack of understanding, repeating an action to explain its effect, hiding behind a parent so as not to answer). Rarely would children engage in complete, developed explanations or more fluid dialogues unless an adult encouraged them.

In respect to levels of attraction 71.47% of interviewee groups (participants and/or group members) mentioned to having seen either part of the installation's components (i.e. projection and/or plinth) or other visitors interacting with it from a distance and this being the main reason for them to try it. The other 28.6% said they decided to try the installation only once it was in front of them but were not particularly drawn into it. When asked about the type of installation and whether it felt in any way familiar only two interviewees claimed to having seen something similar before: one group member referred to an outdoors art festival in Europe and another one, a child participant, claimed to having seen it at home (together with the mother it was concluded she referred to their game console and large TV screen).

The suitability of *Facets Kids* for the particular context of the Powerhouse Museum was largely agreed: all of 7 interviewees the topic was discussed with expressed the installation was the kind of exhibit they expected to see more in science and technology museums, it would get audience closer to new technologies by making them enjoyable, or was regarded as an interesting and amusing educational tool.

Conversations with interview participants and group members would mainly revolve around the purpose of the installation and the ways of use of the interfaces. When dialoguing with group members as they watched participants engage with *Facets Kids*, these topics would frequently be raised directly by them without any prompt (64.3% of interviewees), in a mix of curiosity and confusion. As none of them was actually interacting with the installation, they would not know with certainty what the interfaces would do; although for all of them it was evident they acted as some sort of control. The platform was hardly ever regarded as an interface (only 3 out of 14 interviewees interpreted them as some useful component) and the camera was identified as part of the system only by one interviewees. These perceptions would change in the case of the interacting participants (all of them children): when enquired about their actions, use of interfaces and effects on the projections, they would mostly refer to how the movements they performed with the handheld interfaces would somehow change the projections (71.4% of participants), they would explain - albeit not necessarily correct - how the interfaces worked (42.9%) and/or they would physically show their actions as a proof of their understanding (50%). All of the participating interviewees were sure it was the handheld interfaces that made the changes possible. In two different interviews the camera was regarded as part of the system and in 6 of the 14 interviews the participants incorporated the platform as an interface (either discovered on their own or aided by other group members).

On a general appraisal of their interactive encounter, most interviews reflected a positive effect of the installation on the visiting experience of both participants and group members. All interviewees were part of family groups visiting the museum in the context of the school holidays; parents, tutors and grandparents would all describe their families' experiences as pleasant, stimulating, educational and original. Some of the most recurrent adjectives to define *Facets Kids* were amazing, cool, wonderful, intriguing, different, interesting, and beautiful. A few of their literal expressions reflect their immediate perceptions:

- "I like this (…) because it makes the kids think" (father with 2 children)

- "I've seen this before. But different. No, wait [chuckles] this is way better!" (pre-school girl with her mother)
- "The controllers take you inside, see? Look! It's like you're not here, you're in a cool world!" (7-year-old girl with her mother)
- "quite fascinating thing [contemplating pause] seeing how they won't give up until they figure it out" (grandfather with 3 children)
- "You guys are amazing! (…) the best school holidays ever!" (mother with 4 children)
- "I prefer to let the kids do it. I tried, but it made me a bit dizzy. But it felt good, though. Funny, uh?" (mother with three sons)
- "I can move the things… I think. Yes, yes! I can move the things! Woah! How cool is that, dad!" (10-year-old boy with his father)

The majority of the interviews (57.1%) concluded with an explicit enquire by the interviewees about the technology behind *Facets Kids;* the sense of these enquires spanned from highly complex technological interest (e.g. range of sensors, market availability, power consumption) to general technology-user curiosity (e.g. similarity with game consoles, possibility of printing images or adding more "controllers").

No suggestions as to what could be modified in the design of *Facets Kids* were made, however two interviewees indicated it would have been convenient to have some sort of fact sheet or information panel explaining how the system works; "it is a science and technology museum, after all", said a father-of-3, adding that it did not need to be something complex but rather introductory.

7.6.3. Demographic Study

Only participants (audience directly interacting with the installation) and group members (audience accompanying participants, some eventually engaging directly with the installation) were considered in this count of age groups; babies and young toddlers were not taken into account. As expressed in Figure 33, the great majority of *Facets Kids* audience was a young one (76.1%), explained by the particular visiting context of school holidays museum attendance.

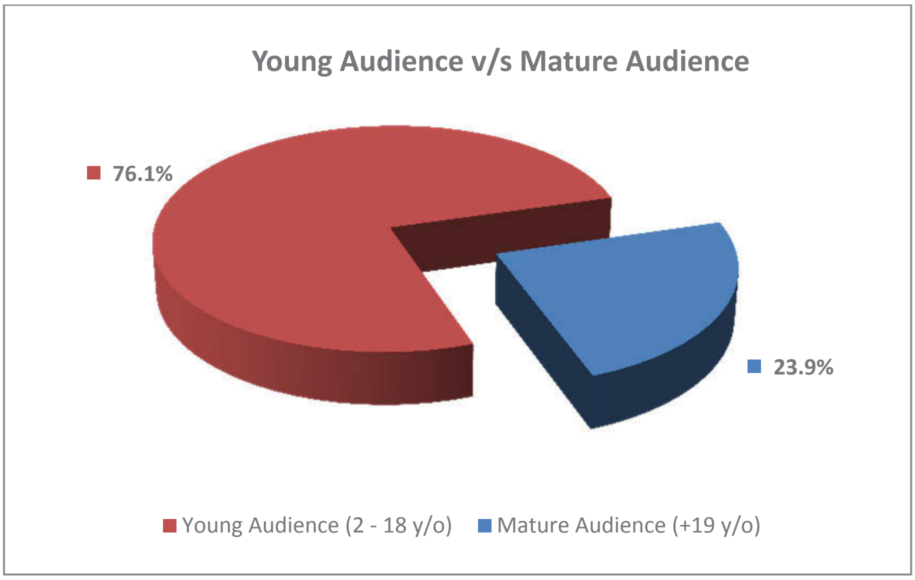

Figure 33. Proportion of young and mature *Facets Kids'* audience.

Table 7 shows a breakdown of specific age groups adapted from the NSW Department of Education and Communities' categorisation. Out of the 268 participants and group members that constituted *Facets Kids'* young audience, the vast majority were children between 5 and 7 years old (38.4%); a similar proportion is observed in the group comprising ages between 8 and 16 years old (39.9%). Out of the 84 participants and group members comprising the older audience group, most of them were presumably parents and tutors (63.1% aged between 23 and 45 years) and an important number appeared to be grandparents minding the children (16.7%, seniors and elderly). A very low general attendance of juvenile audience was observed: only 10.5% of *Facets Kids'* total audience was aged between 17 and 22 years. This demographic study served as a parameter for interpreting and explaining *Facets Kids* audience's behaviours and interactions as observed through other studies.

	Day 1	Day 5	Day 6	Day 7	Day 8	Day 9	Total	Percentage
Pre-School Children (2 - 5 y/o)	0	5	11	13	9	0	38	10.8%
Infants (5 - 7 y/o)	5	7	24	32	26	9	103	29.3%
Primary School Students (8 - 11 y/o)	4	5	6	19	11	6	51	14.5%
Lower High School Students (12 - 16 y/o)	5	5	15	15	12	4	56	15.9%
Upper High School Students (17 - 18 y/o)	0	2	4	7	5	2	20	5.7%
Tertiary Students (18 - 22 y/o)	4	2	6	2	2	1	17	4.8%
Young Adults (23 - 34 y/o)	3	5	11	10	4	5	38	10.8%
Adults (35 - 45 y/o)	3	2	6	0	2	2	15	4.3%
Seniors (46 - 60 y/o)	0	1	0	2	5	0	8	2.3%
Elderly (+61 y/o)	1	1	0	2	2	0	6	1.7%
	25	35	83	102	78	29	352	100%

Table 7. Demographic records.

7.6.4. Audience Participation

As explained before, audience participation was analysed in three different studies in order to cover different yet relating issues: the awareness of and engagement with the installation, the proportion of visitors participating through interaction and time participants invested in their interactions.

As an informing set of data to help determine how appealing the installation was to the museum audience, 4 modes of addressing the installation were defined; visitors attitude towards it were categorised accordingly. Through 4 hours of observation and from a total 1,010 visitors passing by *Facets Kids*, 20.9% (211 visitors) became participants, interacting and physically engaging with the installation. 152 visitors (15%) approached the installation and observed participants in their experiences (whether members of their own social group or unknown visitors). Upon grouping together these two categories of attitude towards the installation (interacting and approaching), and as represented in Figure 34, out of the 363 visitors that manifested interest in *Facets Kids* 58.1% actively engaged with it. In contrast, 20% of passers-by acknowledge its presence but did not attempt to engage in any way and another 44.1% of passers-by did not acknowledge the presence of *Facets Kids* at all. Although these numbers are not consistent with the data obtained from general observations, given the location of *Facets Kids* within the museum space (a high traffic area, close to the museum's backyard cafeteria and a passage to other rooms and exhibitions) it is possible to think many of these visitors had either noticed the installation or even interacted with it earlier. Moreover, the large number of unaware passers-by is consistent with the context of a crowded museum with a variety of distractions (e.g. other events in the venue, other visitors around, countless activities taking place elsewhere in the city).

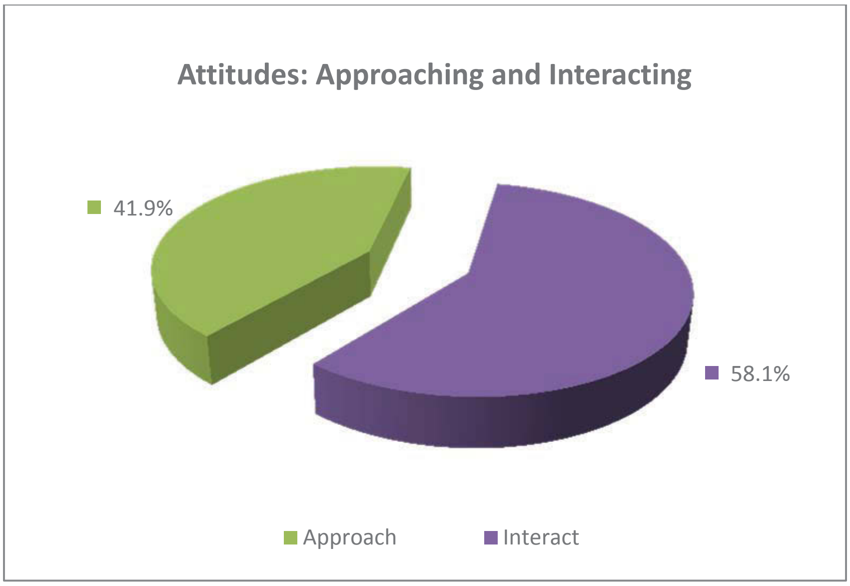

Figure 34. Interest in *Facets Kids*: active and passive engagement.

In respect to the study of effective interactions (visitors physically engaging with the installation), data collected showed that at least 1 of 4 general visitors (25.4%) had a direct experience with *Facets Kids*. During the 7 hours of observation dedicated to this study alone

1,671 visitors were observed passing by the installation, out of which 425 made use of either the plinth (and/or its platform) and the wooden interfaces available. Interaction ratios varied throughout the days, with peaks of 12.5% the lowest and 44.2% the highest however no explanation for this difference was attained. As observed in Figure 35, the numbers from this study are consistent with the previous one, where interaction was observed in 20.9% of the cases.

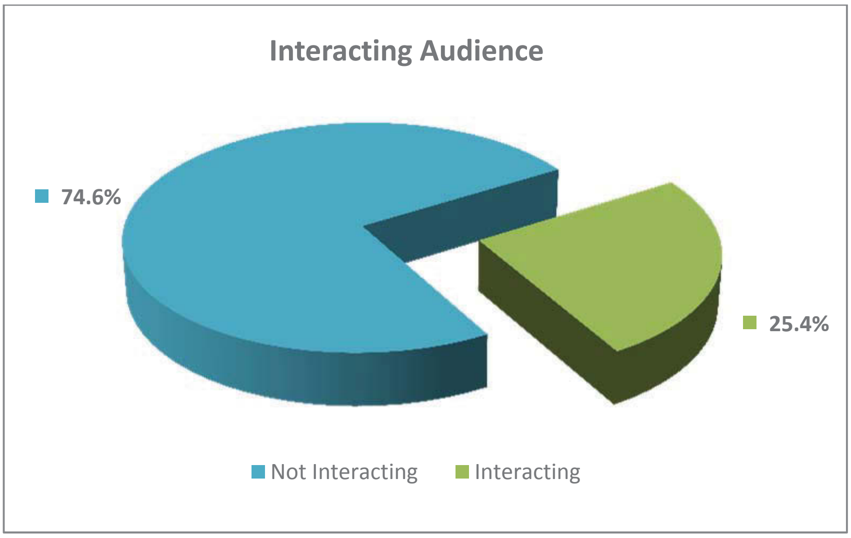

Figure 35.A total of 425 passers-by effectively engaged with *Facets Kids*.

Three hours of observation were dedicated to measuring the amount of time spent by participants in their physical exploration of *Facets Kids*. With 100 users surveyed an average of 52 seconds was attained. The shortest interaction registered was a 3-second one, which was presented by a visitor who quickly picked up one of the interfaces from the plinth and just as quickly dropped it back and left the installation. The longest interaction registered was of 6:57 minutes, which was observed in a young boy who interacted with most of the interfaces as well as with other participants and group members. Given this notorious difference between interaction times the study was further broken down into two sections of interaction times over 10 seconds and over 30 seconds, respectively. After discarding interactions shorter than 10 seconds for not representing a real physical engagement, an average of 1:01 minutes of interaction time for 84 participants was obtained. When considering only interactions that took longer than 30 seconds, an average of 1:24 minutes for 55 participants was obtained.

7.6.5. Movement Patterns

Facets Kids offered visitors a wide array of modes, sensory modalities and levels of interaction by means of physical, cognitive and/or emotional engagement. There was no single possible linear way of experiencing the installation but as many and combined as the participants could discover through their explorations. Participants and group members could take part of *Facets Kids* in a combination of interactions; from a silent visual contemplation to a highly vigorous bodily performance, from the identification of objects presented in the videos to a recollection of personal past memories, from an intuitive random manipulation of a single interface to a purposely body balancing on the floor platform. As interactions were more evidently and immediately physical a study and further analysis of the bodily expressions and responses of visitors was undertaken.

From the first day of the study visitors' physical behaviours were observed, identifying the ways in which participants interpreted the purpose and operation of the objects presented to them. Given that most visitors presented more than one movement during their interaction with *Facets Kids* this study presents the times the movements were observed, rather than the number of visitors performing such movements. A total of 21 different movements were identified - many of them with a few slight variations - with 238 recurrences altogether. During the period of 2.5 hr of observations 12 movement patterns were observed 5 times each in average and 9 movement patterns were observed over 10 times. Table 8 shows a summary of these last 9 most recurrent movements under which the data for final analysis was considered.

Type of Movement	Movement Pattern	Recurrence	Overall Percentage		Type-specific Percentage
Interfaces-related Movements	Interface as game controller	11	6.2%	37.6%	16.4%
	Knocking interfaces against each other	18	10.1%		26.9%
	Paired use of interfaces	17	9.6%		25.4%
	Examining interface(s) with curiosity	21	11.8%		31.3%
Plinth-related Movements	Sliding interface on plinth	21	11.8%	37.6%	31.3%
	Poking or pushing interface without lifting it	10	5.6%		14.9%
	Interacting standing next to plinth	36	20.2%		53.7%
Body-related Movements	Randomly moving body holding interface(s)	21	11.8%	24.7%	47.7%
	Body movements against projection	23	12.9%		52.3%
		178	100%		

Table 8. Participants' physical behaviours in the interaction with *Facets Kids*.

After the collection of data the movement patterns were categorised according to the element they were most related to: the handheld interfaces, the plinth and the participants' bodies. As it can be inferred from the table the recurrence of movements was rather uniform. Most movements were performed in reference to either the wooden interfaces available on the plinth (37.6% of recurrences) or the plinth itself (37.6% as well). 24.7% of the categorised movement patterns were related to the body of the participant. It will be noticed that neither the movements related to the camera nor the ones related to the floor platform are included in the data presented; these movement patterns were observed only 7 times in total, representing a weak 2.94% of the total original account. Many participants did stand on the platform but then their movements focused on either the plinth or the interface(s). Although not included in the final count, the less recurrent movement patterns were still taken into consideration for future design iterations of the *Facets* project pieces.

In respect to the movements related mostly with the use of the interfaces the curiosity of participants regarding these elements is noteworthy. This is clearly reflected in the fact that participants were widely observed examining the interface(s) in different ways; sub-movements observed in these patterns included holding the interface with care, analysing it with attention, flipping it in a hand, shaking it near the ear, and even smelling it. Pressing the wooden piece with the thumbs while holding it with both hands was a significant observation as it may reflect the association of it with other more known interfaces such as game controllers or smartphones (see Figure 36). When holding both interfaces many visitors were observed using them as paired, which could be a natural association of body possibilities with affordances (two interfaces for two hands). It was also frequent to observe participants creating different sounds with the interfaces when knocking them against each other, against the plinth or even part of their bodies; the interfaces would afford more than what they were designed for.

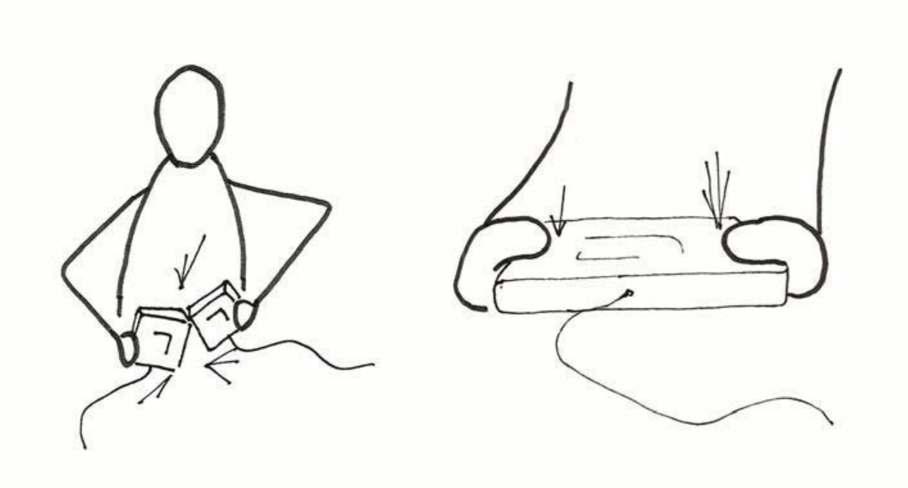

Figure 36. Schematic visual representations of interfaces-related movements.

When observing the physical relationship of participants with the plinth it was noticed that more than half of the movements were performed while standing next to it; the presence of a platform for participants to stand on did not seem to afford an opportunity to interact with both interfaces and plinth as a whole. Also, although the interfaces were designed to be interpreted as objects to be picked up and manipulated off the surface of the plinth many participants were seen sliding the interfaces over it (see Figure 37). It is possible to presume that the interface-plinth relationship was affording similar actions to the mouse-desk ones due to the cord attached to the wooden pieces.

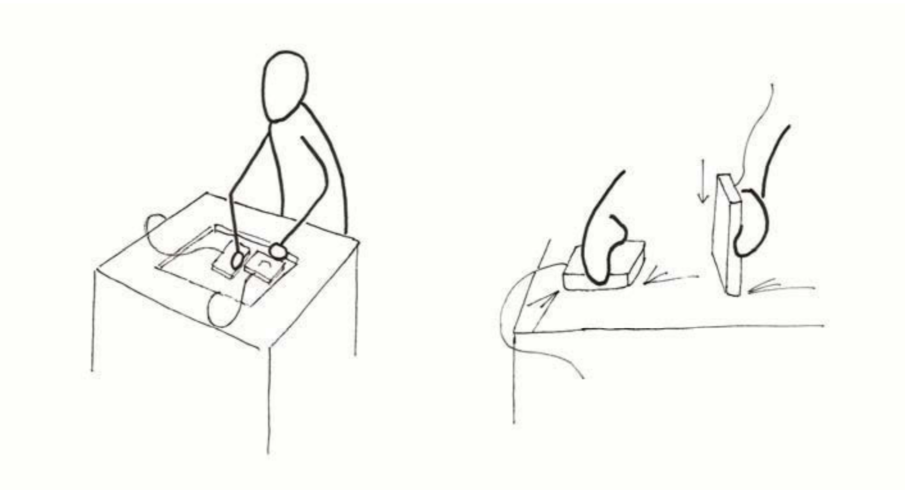

Figure 37. Schematic visual representations of plinth-related movements.

The most interesting expressions were observed in movements that went beyond the use of hands to interact with *Facets Kids*. Albeit the lesser, body-related movement patterns reflected the potential the installation had for the development of complex interaction maps. During observation the integration of the body in the projection area was often noted; almost only children, participants and group members would dance to the movement and colour of the videos projected while standing between the plinth and the projection wall (see Figure 38). Movements would typically include the use of clothes and skin (hands and face, mainly) as additional canvas, jumping or running in order to catch fragments of the kaleidoscopic composition, and imitating with the bodies the movements of the videos (e.g. running backwards and forwards following the zooming in and out of images). This playful behaviour was also noticed in participants that would sway their arms, turn their torsos, jump, crouch, lean, etc. while holding and moving the interface(s) in their hand(s). These movements seemed to be predominantly random, not necessarily aiming to produce an effect on the projection in particular.

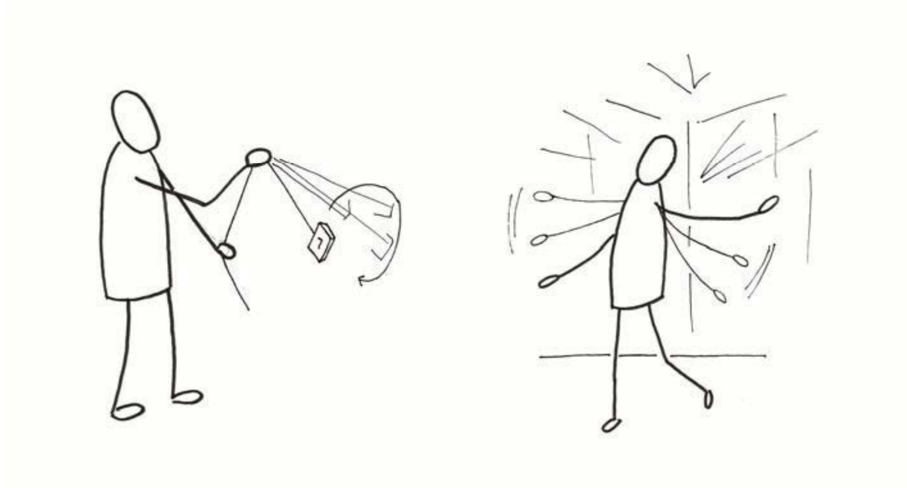

Figure 38. Schematic visual representations of body-related movements.

7.6.6. Social Interactions

Social interactions around *Facets Kids* occurred between and within age groups, as well as between members of a same social group or with strangers (e.g. children with their grandparents, different family groups, tourists and locals). The quality and nature of these interactions were thoroughly observed and reflected on during the first day of the study. As a result, a set of social behaviour categories that spanned from highly collaborative to highly conflictive was defined. From the second day of study onwards, each particular social behaviour observed was placed into a category. Table 9 provides quantitative information of the observed behaviours, with evidence of how high levels of collaboration the social interactions with *Facets Kids* achieved (81.2% collaborative behaviours and 18.8% conflictive ones).

	Influence of Group on Interaction	Day 2	Day 4	Day 5	Day 6	Day 7	Day 8	Total	%
A	Participants explore/play together	9	1	6	6	16	7	45	19%
B	Participant encourages other member(s)	5	5	7	5	9	12	43	18%
C	Participant explains to other member(s)	2	3	6	2	3	3	19	8%
D	Member(s) suggests use to participant(s)	3	5	4	3	3	6	24	10%
E	Participant calls other member(s)	4	2	4	2	2	3	17	7%
F	Member(s) follows participant's action(s)	12	3	9	9	11	2	46	19%
G	Member(s) ignores participant	1	2	4	1	2	1	11	5%
H	Member(s) makes fun of participant	0	0	0	0	1	0	1	0%
I	Member(s) reprimands participant	0	1	0	1	1	0	3	1%
J	Member(s) stop participant's interaction	5	3	4	2	3	1	18	8%
K	Participants argue over use of interface(s)	4	0	2	1	1	4	12	5%
		45	25	46	32	52	39	239	100%

Table 9. Categorisation of participants' and group members' social behaviours.

A visual representation of how these behaviours were distributed in an intensity axis is shown in Figure 39. Each circle represents the number of times the behaviour occurred. A qualitative analysis of the most significant phenomena and trends observed during this 3-hour study was also conducted.

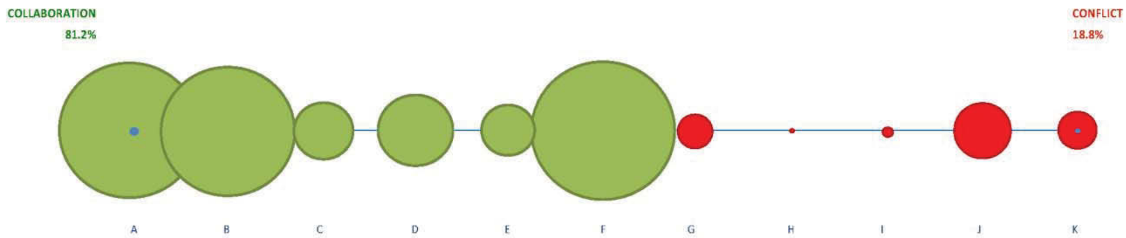

Figure 39. Behaviours axis: from highly collaborative to highly conflictive.

The number of interfaces influenced the way in which participants interpreted their potential use and purpose as well as the number of possible participants. A phenomenon of a somewhat structured organisation was often observed under certain circumstances, affecting the ways visitors behaved around the installation. On one occasion, one of the handheld wooden interfaces stopped working and had to be put away; consequently, only one of the two interfaces was available on the plinth. Visitors intuitively started to line up in order to interact with the installation. There seemed to be a tacit agreement of not taking too long so everybody could have a chance to play. Similarly, from time to time, adult group members were observed organising young participants to avoid conflict and ensure a friendly environment for everybody. Organisation would then be based on periods of time, alternation of participants or even balancing of participants' ages. Turn-taking was observed almost every time there were more visitors than available interfaces for interacting, regardless of the presence of a moderating figure. Participants breaking this implicit code of behaviour by interrupting others to take a turn or even snatching the interfaces of another participant's hands were rarely observed; the only two cases observed were very young children.

Another type of interruption was observed when sharing the interacting experiences with other group members was not possible. Participating children would frequently look around for their parents or other accompanying adult so as to get their attention, approval or support. It became clear that an important part of the experience was making others part of it, indirectly. Not always would these group members pay attention to what the participant was doing; in such cases it was often noticed that the interest of the participant in the interaction would decrease and eventually make him/her abandon the installation. Conversely, had the group members engaged in the experience with the participant, he/she would engage even more intensely. Young participants were regularly observed leaving the installation abruptly when called by other group members to continue their exploration through the museum - their responses not necessarily being in accordance.

Making sense of all the components of the installation as a group would frequently result in a spatially distributed and collective interaction. As an example, a group of 7 participants and members once discovered the presence of the camera producing a live video projection of the group around the plinth. One of the group members ran towards the camera so as to appear in a close-up shot; the other members complained so he quickly moved back to the plinth. Then 3 group members moved towards the projection wall and started moving trying to catch their partners in play being projected on it; soon after other visitors joined the game as well. This kind of social engagement in which unfamiliar visitors collaborated and enjoyed together was widely observed. In addition, the lack of instructions or immediate interpreting of the interaction maps seemed to give visitors the chance to discuss possibilities of use, explain operation ideas, enquire about interaction ways and congratulate each other, to name a few social negotiations observed. On an opposite side of the social behaviour spectrum, some adverse emotions, particularly in young children were revealed as a result of particular situations. The waiting process, for example, would sometimes produce anxiety and impatience which, in consequence, would end up in group members rushing participants or annoying them.

7.7. The Many Facets of *Facets Kids*: Findings

The Powerhouse Museum offered the *Facets* project a highly suitable context for the study of its audience's response to aspects of attraction, affordances, engagement and social interaction. Its spacious and conveniently accessible Turbine Hall welcomed a diverse and larger-than-usual number of visitors keen to take part of new discoveries and pleased to provide feedback about them. The following findings are reflections on their experiences with *Facets Kids* as accounted directly through semi-structured interview and contextual enquiries and indirectly through observations of their interactions.

Upon entering the Powerhouse Museum almost every element of the building calls for its visitors' attention: the old city tram's power station that houses the museum's collection still shows many of its original architectural features. On a further exploration of the venue, different floor levels, room sizes, illumination styles and facilities intermingle to provide the visitor with a very rich physical, emotional and cognitive exploration. This is reflected in the way visitors enter the Turbine Hall from its many access points: the crowds move energetically from one room or exhibit to the other making sure they do not miss anything. *Facets Kids* benefited from this vigorous use of the space, standing out in the hall and inviting passers-by to play with its kaleidoscopic images. As revealed by the Audience Participation study visitors were moderately drawn towards the installation (35.9% of audience approached and/or interacted with it) and it is possible to think that some of the visitors observed passing by after noticing the installation but not approaching it had already experienced *Facets Kids*. The number of casual participants (i.e. visitors that happened to be passing by and decided to interact after noticing it) was rather low in comparison to those who purposely embarked on an interaction (28.6% casual participants vs. 71.4% purposeful participants). The way the installation was deployed within the space and the presence of others at and around it was crucial in drawing these visitors in; the actual visibility of the installation - although proven to be more effective in attracting visitors when showing more vivid images - was not merely a sum of its physical properties. The study showed that visitors seemed to be very attentive to other visitors' behaviours and responses to *Facets Kids*, influencing the way they approached the installation.

The clarity of *Facets Kids'* interaction map was one of the main concerns in this research project. In order to engage audience in the expressive experience of *Facets Kids* the installation needed to provide clear cues for its purpose, operation and outcomes. An evaluation of the installation's affordances and feedback was achieved, informed by both observations and direct accounts from participants. In terms of physical affordances, the most successful components were the handheld interfaces; their design and position made it clear for visitors that they were meant to be picked up and acted with. In contrast, the plinth was rightly interpreted as a supporting surface but also was the wooden floor platform attached to it; the interactive properties of the platform were mostly unnoticed by the participants. The camera, located behind the interaction area, was less noticed as well; however, the design of its case - in the same aesthetical line as that of the handheld interfaces - seemed to have helped visitors to understand it as part of one whole system. In terms of functional affordance less clarity was observed. Once interpreting the immediate purpose of each component (i.e. step on the platform, pick up the interfaces, and get filmed by the camera) most participants found it hard to define what to do next. Although many random exploratory movements were observed, keenly interacting and playing with the installation, only a few actions proved to be in full control. Most participants admitted to be aware of their effect on the projections while manipulating the interfaces but rarely would they know exactly what was happening and how this effect was possible. The installation's interfaces would somehow afford control however feedback was not clear enough for the audience to have a sense of control.

Feedback of participant's actions on the installation was difficult to obtain, mainly due to complexity of the moving images projected in combination with the elaborate effects the interfaces allowed. The nature of the kaleidoscopic presentation of images implied a fragmentation of the content that may have been hard for users to control. Most participants were observed performing random actions with the interfaces noticing indeed that changes were produced; however the identification of specific effects was not always noticed. A more evident feedback of participants' effect was needed in the projections, allowing participants to make sense of their actions and, therefore, have more control over their creations. A reduced palette of videos as creative material, a more manifest difference between them, the involvement of other sensory feedback elements (e.g. sound, vibration, light), or a revision of the interfaces' design are some developments that could be incorporated in future iterations of the *Facets* project for a clearer interaction feedback.

The gaps of interpretation within the interaction map presented several surprising design opportunities as well; after all, having no fixed goal was part of the installation's characteristics. The physical setting of the installation in addition to the continuous on-going design of the interfaces allowed participants and group members to give new uses and meanings to *Facets Kids*. As an example, participants were sometimes observed interpreting the electronics and security cords to which the controllers were attached as part of the interface; rather than picking up the interfaces holding them by the wooden part (the actual interface), some participants - usually children - would grab them by the cord and swing them. This action would usually be accompanied with bodily expressions such as moving hips in circles and coordinated arms movements. The exploration of the interfaces in relation with the body was often observed in children as well; noteworthy were the many ways in which some participants would slide, rub or gently bang the wooden pieces against different parts of their bodies. The interfaces' material and shape would often invite participants to create sound with them; this was even more evident in combination with the plinth. Participants were frequently observed beating the controllers against each other or the plinth, exploring diverse levels of pitch, volume and rhythm. These serendipitous musical expressions were usually accompanied by body movements resembling a dance. More than attempting different effects on the projections these participants were seemingly exploring different forms of use of the interfaces. There clearly is a great potential for future design explorations in which a more comprehensive bodily engagement can be achieved; particular effects could be mapped to corresponding body parts so participants could use their whole bodies to express.

As expressed by field data engagement of participants and group members with *Facets Kids* proved to be reasonably high. With an average interaction time of 1:01 minutes on participations that took longer than 10 seconds, and with a rich array of expressions and social exchange of experiences, the installation not only attracted the attention of visitors but also provided them with an appealing opportunity for exploring their creativity and sharing their processes and outcomes with others. According to observations and interviews the installation was generally perceived as a multi-user assemblage; the presence of several interfaces and the deployment of the installation's components through a generous space invited large groups of visitors to interact without interrupting each other's experiences. A tacit agreement of respect, significant levels of collaboration for discovery, negotiation in the use of the components, and even expressions of admiration for other participants' creations were some of the many positive outcomes observed in terms of social interaction. Engagement of participants seemed to increase when a multiple users were interacting, evidence of a general interest of the audience in sharing both access and use of the installation and a collective sense-making of the experience.

Similarly to other public interaction contexts, the *Facets Kids* installation presented different zones of interaction both in terms of the space and the functions they represent. Generally, public interaction zones can be divided by levels of attraction, involvement, and engagement. Informed by theory in the field of interaction with digital technologies in public spaces, several research projects and the *Facets Kids*' installation research outcomes, a model of five stages of interaction was developed and presented to the research community at the 2011 OZCHI Conference (Bongers & Mery Keitel 2011, pp. 58-9). Attraction was defined in two stages: ignoring (in which the installation is not noticed and consequently no interaction occurs) and noticing (the presence of the installation is perceived, but no attempt to approach the installation is made). Involvement was also defined in two stages: observing (in which participants actively perceive the installation but the relationship with it is rather passive) and involving (participants take part of the installation by physically interacting). The final stage - and the one that allows the installation to reach its full potential - is engaging (a further and immersive participation with the installation takes place). It is in this latter stage where a wider range of explorations are likely to take place, in which audience can effectively develop and co-create according to their newly met possibilities, taking as much time as desired as they find comfort and satisfaction from their interaction with the installation. Although these stages mainly correspond with spatial conditions, interaction modalities of the installation might take a more significant role; the inclusion of sound, for instance, could bring visitors from the stages of attraction to involvement quite faster, hence allowing a potential involvement and later engagement.

A final reflection of the *Facets Kids* studies is related to the research methods applied and their effectiveness. Drawing from the previous case study's experiences a set of units of studies and techniques for data collection consistent with the specific research purposes were defined. Given the rather short time and the limited human resources available for the study, the units of analysis were narrowed down and their application optimised so as to collect as much significant and representative data as possible; this resulted not only in a rich amount of useful data but also in a more manageable package of information to be later analysed. The approach of the field study itself was also very significant. From a distant observation mode, the enquiry and direct collection of feedback from the audience evolved into a friendly, close relationship with participants. Being the museum a social environment by nature, audience tended to have an overall welcoming reaction to the research being conducted. What made a clear difference in the process was the way the enquiries were made and the role the researcher took each time. When approaching participants and group members explicitly as a researcher (taking notes and photographs, showing a nametag and presenting the research in detail) a sense of distance and hesitation was perceived; audience appeared to feel under examination and consequently they would somehow fear saying “the wrong thing”. In contrast, when acting as another audience member or approaching participants and group members providing a more general description of the research being conducted and, most of all, showing a genuinely casual interest in their actions, audience was almost always keen to provide as much feedback as their time would allow. Not only audiences are eager to share their experiences with others but also they want their opinions, needs and expectations to be considered in the development of the institution’s services. The museum is probably one of few public spaces in which users are enthusiastic about being active part of the research process, believing they hold a double role of both receptors and co-creators of the content to be delivered.

Summary of Key Findings from the Facets Kids Case Study

- The way in which exhibits are located and deployed within the exhibition area dictates the way visitors approach and interpret it; spatial cues such as light, sound, and room extension, among others, combined with the surrounding social activity, caters for a dynamic interaction between passers-by, observers and participants.

- Whether in an exhibition comprised of several or unique interactive components it is essential that a fluid communication between these and their users is achieved. Interactive components not only need to afford actions but also effects; the possibilities and limitations of a system and its interaction outcomes will define the fulfilment of a meaningful experience.
- Interactive exhibit's interfaces cater for endless instances of exploration and discovery. Within this scope of possibilities of interaction, a sense of control and purpose ought to be planned and included for users to make sense of their intentions and actions.
- When opening the interactive space beyond the containing box of technology and content that the exhibit represents, namely the surrounding area, a myriad of bodily expressions and manifestations arise. As a consequence, visitors in a role of observers and passers-by more easily interpret the possibilities of the exhibit, facilitating their integration into the interactive experience with the exhibition content.
- Exhibitions that incorporate the surrounding space as part of the experience and that present multi-user interfaces facilitate the creation of co-experiences and collective making of meaning; as a consequence, the social mission of the museum is reinforced and a meaningful informal learning is possible.
- Interactive exhibitions that plan for a social interactive experience through the organised use and access of its components reduce the risk of conflict during the interaction and therefore reinforce the sense of engagement with the exhibition's content.
- A detailed early study of an exhibit's purpose and interaction modalities, together with a thorough analysis of the physical and social space in which this is meant to be integrated is essential for the creation of the potential stages of interaction visitors might take part of. From the completely ignoring of the interactive exhibit to the immersive participation of the visitor in the experience, interactive dialogues and maps can be designed.

- People attend museums not only to acquire knowledge and be amused, but also as a space in which to express and socialise with other visitors, visitors studies can - and should be - carried out with as much participation of them as possible. Museum visitors are willing co-creators of the visiting experience, eager to be heard and to collaborate in the making of their own future museum experiences.

Chapter 8. Case Study: *Dangerous Australians*

8.1. Introduction to the Exhibit

Dangerous Australians is an interactive exhibit part of the *Surviving Australia* exhibition at the Australian Museum in Sydney. It offers its audience an overview of the most relevant characteristics of a selection of Australian fauna specimens with a focus on the risk they imply for human safety. The content is presented via animated graphics and texts which visitors can interact with and retrieve information from. The exhibit is regarded as *Surviving Australia*'s centre piece, strategically located half way through the physical journey of the exhibition. As shown in Figure 40, visitors enter the dark exhibit's space to find a bright long table displaying combined land and water sceneries in which treacherous creatures such as sharks, crocodiles and snakes move waiting to surprise their human guests. The exhibit space is fitted out with sensing technologies that act as the creatures' awareness system, reacting as soon as visitors try to touch them.

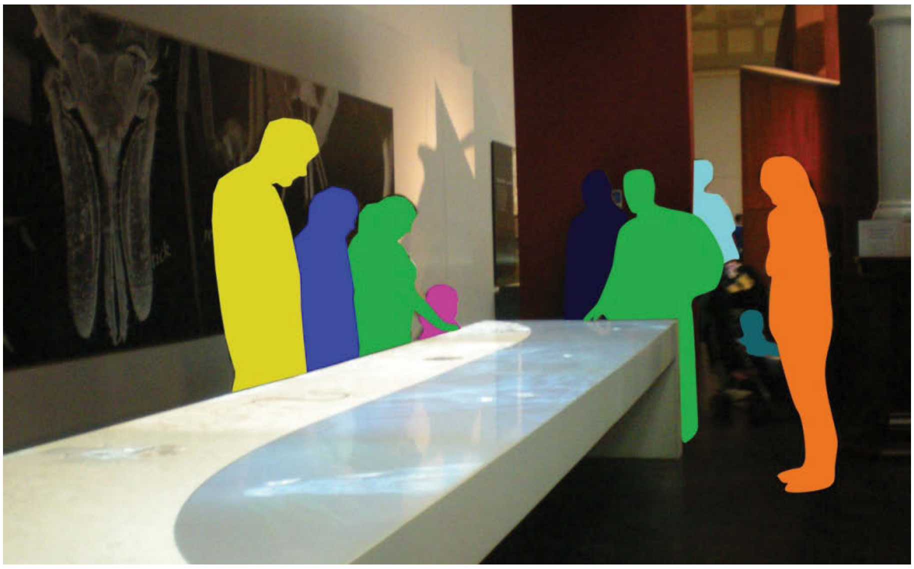

Figure 40. General view of the exhibit's space.

Dangerous Australians was created with the purpose of involving its public in a better understanding of the real risk the species displayed represent for their lives, somehow demystifying their worldwide deadly reputation (Cowell 2012, pers. comm., 27 march). The diverse technologies utilised in its design were envisioned to boost an emotional response in the visitors, supporting their learning encounter and, subsequently, generating a more memorable experience to take home with them (Freeman 2012, pers. comm., 20 july). Although visitors could each examine the content of the exhibit in an individual way, *Dangerous Australians* was designed with a social experience in mind: its content, form and media suggest an active shared exploration in which discussion, mutual guidance and further contribution can take place.

All of the components of the exhibit are reactive to visitors' effect: water and earth move as their hands approach the table, creatures acknowledge their presence by attacking back, panicking or just fleeing away from them, and information boxes display particular facts about each creature. Depending on whether the effect of visitors' action on the creatures is friendly or life-threatening, the information boxes provide general facts (e.g. living environment, life cycle, and general behaviour) or first aid facts (e.g. levels of danger, statistics, and healing process).

The whole *Surviving Australia* exhibition took nearly two years to complete, from the museum's call for proposals to its opening to the public. Freeman Ryan Design Pty Ltd was the leading Design team and brought into the project all the necessary contractors to develop the exhibition: lighting and sound design, interactive experts, multimedia components, etc. One of the most relevant collaborators for the purpose of this Case Study was Lightwell, as they were in charge of the development of the *Dangerous Australians* exhibit's audio-visual and interactive components. In this Case Study I took a role of external researcher, conducting a study similar to what in Museum Audience Research is known as Summative Evaluation: a survey about visitors' use of the exhibit and its impact on their experience. Through interviews with key people involved in the development of the exhibition and a personal professional review, the general design aspects of the *Surviving Australia* exhibition and specific design aspects of the *Dangerous Australians* exhibit were covered. Audience experience of *Dangerous Australians* was studied by means of observations, contextual enquiry and unstructured interviews through 24 days (115 hours) of onsite research.

8.2. Background of the Exhibit

8.2.1. The Development of Interactive Tabletops

All through the history of development of western cultures' human-made environments tables have had a very important role, both for their practical and their social meaning. Broadly speaking, a table is a solid object that presents a flat horizontal surface moderately raised off the floor level. Tables' main purpose, irrespective of their many varied types, is to aid users in the execution of diverse tasks, usually requiring the distribution and movement of other objects along their surfaces. Activities involving the use of tables normally take place with their users sitting or standing around their top surface. Tables' particular form characteristics - shape, material, proportions, content capabilities and activities affordances - enable functional, bodily and social connections through diverse modes of interaction. As an artefact intrinsically associated with human behaviour, a table represents verbal, emotional and physical communication through the embodied expressions its use facilitates.

With the accelerated evolution and availability of digital technologies new opportunities for the design of innovative types of display and interaction surfaces have emerged. Since the early explorations of touch technologies in the 1970s an extensive body of scientific work has been produced both on single and multiple input interactive surfaces, particularly horizontal ones (Hinrichs & Carpendale 2011; Ledo et al. 2012; Pauchet et al. 2007; Wigdor et al. 2006; Xiang et al. 2008). Interactive tabletops are devices that combine multiple technologies for a direct on-screen management of content, making them dual display and interface artefacts. The main differentiator between vertical and horizontal interactive surfaces is that the latter not only presents information but also allows its full elaboration (i.e. display, generation, and manipulation). The horizontal orientation of interactive tabletops makes these suitable as group interfaces allowing multiple simultaneous users to interact with what is most commonly multimedia content (Müller-Tomfelde & Fjeld 2010). Consequently, the position of users around a tabletop determines the design of the system's physical and graphic interfaces as each user will have a different view on the displayed content (Kunz & Fjeld 2010). The capability of tabletops to support multiple users' activities has generated an increasing interest on the shaping effect of these systems on social interactions and group work practices. This is reflected in most of the latest research publications in the field which show a sustained shift of focus from the requirements and constraints of underpinning technologies to human-centred concerns that span from intimate space to social engagement (Hindmarsh et al. 2005; Hornecker 2011; Müller-Tomfelde 2010).

According to Müller-Tomfelde and Fjeld (2010) four particular research domains are regarded as the initiators and promoters of interactive tabletops, each contributing to their development from a particular scientific role. Since the conceptual stage of tabletops in the early 1990's the domain of Human-Computer Interaction (HCI) has addressed mostly single user actions and performance at the interface level, while Computer Supported Cooperative Work (CSCW) has particularly mediated and supported group collaboration and social interactions. Ubiquitous Computing (UbiComp) soon joined the efforts by guiding tabletops' development towards an interactive collaboration space, away from the traditional paradigm of the desktop configuration. Most recently, the research domain of Tangible User Interfaces (TUI) has contributed to tabletops' seamless integration of tangible interactions by exploring the support and combination of human bodily input and various physical objects representing meaning.

Both academic and industrial research groups from the above mentioned domains have produced - at different stages and levels - countless publications and innovations, stimulating a sustained evolution of interactive tabletops. This evolution finds its roots mostly in technological advances (i.e. innovative systems and applications) which have facilitated key transitions in the research and development of these artefacts (Kunz & Fjeld 2010; Müller-Tomfelde & Fjeld 2012). The first transition was the shift from early conceptual notions and prototypes at lab levels to practical, real-world applications, mostly driven by research in CSCW. A second transition is accredited mainly to HCI and their advances in sensing technologies allowing a progress from single touch to multi-touch interaction. Innovations in the consumer electronics market triggered a third transition with the dominance of direct display technologies over projection techniques. Each of these transitions has been characterised by decisive technological advances which are represented by the development of new types or substantial variations of interactive tabletops. What follows is a review of the most relevant indicators of interactive tabletops' technological evolution and the projects that best illustrate this progress in the last twenty years. Given the rich and complex nature of interactive tabletops these indicators are not exclusive one of the other - in fact they are most typically found in successful systems when combined.

Image Display

With data projectors acquiring higher presence in the market in the 1990s the idea of interacting with information displayed beyond the computer screen started to materialise (Saffer 2008). The data projection technology would soon evolve from front-projection to back-projection, providing users of more room to interact and a better visibility of the displayed content. As early as 1991, the DigitalDesk project was the first front-projection interactive tabletop to address the shift of paradigm from the physical desk to the computer-based workstation (Wellner 1991). Balancing the properties of both tangible and virtual objects, DigitalDesk (depicted in Figure 41) allowed the merging of these two realities by projecting visual content on the desk's surface and capturing the desk's physical reality with a camera. With both projector and video camera placed above the desk and pointing down at its surface the main challenge of Wellner's work was the light and image shadowing produced by the user on the surface when interacting with the content.

Figure 41. Early interactive tabletops. From left to right: DigitalDesk, metaDESK and SmartSkin.

Back-projection was envisioned as the first solution to the shadowing problem, placing the user and the image source at opposite sides of the interaction plane (Kunz & Fjeld 2010). In 1997 the MIT Media Lab introduced metaDESK, also depicted in Figure 41, a multi-user interactive tabletop based on back projection (Ullmer & Ishii 1997). Not only did this technology and configuration allow more freedom in the spatial interaction but also facilitated the design of more intuitive interfaces. It was through metaDESK that the authors first introduced the concept of Tangible User Interfaces (TUI) bringing back to objects the properties and metaphors of the physical space that GUI where by then representing. With even more possibilities for form and functionality explorations, the sustained expansion of the home entertainment market in the late 1990s stimulated further research in the field of horizontal interactive surfaces (Müller-Tomfelde & Fjeld 2010; Roberts 2005; Saffer 2008).

Plasma Display Panels (PDPs) represented the first opportunity to produce larger interaction surfaces and contain all core technologies within a robust yet sleek artefact. It took less than a decade for Liquid Crystal Displays (LCDs) to leave PDP technology aside, offering even thinner and larger surfaces. A more recent technology, and as opposed to PDPs and LCDs which work based on backlight emission, Organic Light Emitting Diodes (OLEDs) integrate the light emission into the pixel, providing the best image resolution and viewing angles so far.

User Input and Interaction

Kunz & Fjeld (2010) have described interaction in tabletops according to two modes: body-based interactions - which mainly take place by hand pointing and gesturing - and device-based interactions - which are possible through interfaces such as the mouse, stylus, graspable UI and Phicons (physical icons). Müller-Tomfelde & Fjeld (2010) add to this description a layer of analysis based on the interaction-enabling technologies. Mostly centred on physical contact as the core input mode the authors identify an evolution of technologies that span from a combination of general-purpose technologies (e.g. video cameras and diverse tracking systems) to task-specific and refined systems (e.g. acoustic sensors, optical triangulation, and infrared (IR) image capturing).

Direct input on the display surface dates back to 1963 when Ivan Sutherland developed a system in which a pen (i.e. stylus) was used as the direct interface for the user to access the digital content (Müller-Tomfelde & Fjeld 2010). Later in 1971 Samuel Hurst made the first steps towards touch screens when integrating a human-touch-sensitive layer to a computer screen's outer surface (Saffer 2008). Although multiple objects could be detected by early prototypes (e.g. the previously mentioned metaDESK interactive table) allowing multiple users participation, it was not until 2001 that more than one user's particular action could be identified by the system. The front-projected interactive tabletop DiamondTouch (Dietz & Leigh 2001) was introduced as a system that used the participants' bodies to transmit high-frequency signals from the table's surface to their chairs, in a closed capacitive coupled circuit. Several external objects could be placed on the surface - as with a regular analogue table - without interfering with users' interaction with the system.

With participants' bodies now more actively involved in the interaction process, researchers intensified the exploration of new forms of hand and gesture interaction in close integration with tangible interfaces. SmartSkin (Rekimoto 2002) was an interactive tabletop system very similar to DiamondTouch, provided with capacitive sensing technology for the detection of multiple users' input (refer to Figure 41). Rekimoto's tabletop was one of the first systems to combine several hand gestures (i.e. gripping, position and zooming) and TUIs of different shapes for specific tasks each. In 2006 the Music Technology Group of the Universitat Pompeu Fabralong, under the leadership of Sergi Jordà, published the long developed electronic musical instrument reacTable (Kaltenbrunner et al. 2006). Unlike SmartSkin, the reacTable used a back-projection, allowing users to interact through hand gestures while handling diverse TUIs without shadowing on the displayed content. Since the objects were designed with a strong focus on system tracking purposes, affordances on their functions were not clear enough for users to quickly learn and intuitively interact.

Tracking and Identification

Albeit highly embedded with virtual components, interactive tabletops "still maintain a notion of physicality as they rely in users' mental models of traditional tables" (Müller-Tomfelde & Fjeld 2010, p. 2). Consequently, the presence of objects and the participation of multiple users become the natural setting for a successful interaction and collaboration. The number of objects and users at the tabletop surface, as well as their shape, proportions and location are determinant factors for a fluid and intuitive interaction. Tracking and identification technologies enable the detection of physical presence and position of both participants and interfaces. Whilst identification "is relevant for integrating a device's specialized functionality into a specific application" (Kunz & Fjeld 2010, p. 53) tracking is fundamental for the system to accurately map users' actions with the displaying content. The most common systems for tracking and detection in interactive tabletops are optical (e.g. IR light, visible light and colour, shape recognition, fiducials[16]) and electrical (e.g. resistive, capacitive, inductive, electromagnetic). Depending mainly on their purpose and display technology utilised, most interactive tabletops combine two or more tracking and detection technologies, resulting in a more stable and effective system.

Early prototypes would typically make use of front projection and camera input combined in order to detect and track objects within the interaction space. Such was the case of DigitalDesk (Wellner 1991) which camera would first identify the location of the user's hand and then, through a subsequent higher resolution shot, it would detect characters from printed media on the table. The objects on the surface of metaDESK (Ullmer & Ishii 1997), on the other hand, were detected by means of IR light, with the beam been

[16] Also known as fiduciary marker in the imaging technology field, fiducials are objects used as points of reference or measure in the field of view or scene of an imaging system.

reflected by the objects on the surface and then captured by the camera. The use of fiducials and pattern recognition as an optical tracking system arose in early 2000s and was extensively developed in the reacTable project (Kaltenbrunner et al. 2006). Unique marks for visual reference were incorporated to physical objects (as depicted in Figure 42) and detected by a camera located below the tabletop's surface. With this technique the location and orientation of the TUIs were unmistakably identified. In addition, the system allowed the identification of hands' input through IR light beams reflection.

Figure 42. The reacTable and its varied-patterns objects underneath which fiducials are placed for their tracking along the surface.

DiamondTouch (Dietz & Leigh 2001) is an early example of how electrical tracking system have been applied in interactive tabletops. With the table and chairs working in a transmitter-receiver dynamic, contact signals would travel throughout the system in a closed capacitive circuit enabled by each participant's direct touch. Each participant would represent a unique circuit, therefore a unique identity. SmartSkin (Rekimoto 2002) also utilised capacitive sensing in its tracking system: a mesh of transmitter and receiver electrodes was integrated to the tabletop detecting relative positions and gestures made with TUIs and hands. The introduction of capacitive electrical tracking system to interactive tabletops not only allowed the identification of each participant separately but also the exclusion of external elements not meant for the interaction (e.g. a coffee cup, a notepad, a participant's forearm).

From Prototypes to Products

In their latest publication in the Journal *Computer*, Christian Müller-Tomfelde and Morten Fjeld (2012) envisioned the technological maturity of interactive tabletops' within the next ten years, followed by their pervasive adoption in diverse areas. As inferred from the reviewed literature, the rich development of interactive technologies in the last twenty years has facilitated the deployment of tabletops beyond research labs' walls. Most interactive tabletops were first developed as experimental systems to explore paradigm shifts from physical to virtual environments. Wellner's first tabletop prototype DigitalDesk (1991) and MIT Media Lab's models and prototypes for metaDESK (Ullmer & Ishii 1997), introduced ground-breaking developments combining new and existing display, input and tracking technologies. Although these projects did not evolve to products they are regarded by the research community as the foundation from which new approaches emerged (Müller-Tomfelde & Fjeld 2010, p. 12).

As real-world products, tabletops have been moderately available since the early-1990s, showing a progressive and more prevalent presence by the mid-2000s. This has been possible mostly thanks to joint efforts between academic research centres and industrial partners; in some cases governments have promoted their development through funding or technological injection. The first commercial applications were envisioned in the domain of CSCW with many innovations in the integration of collocated and distributed workgroups and tasks. In 1992, for instance, the Canadian research program Ontario Telepresence Project (OTP) was initiated to research the impact of the introduction of media technologies in the workspace (Information Technology Research Centre 1995). Both the program and its projects became starting points for succeeding academy-industry partnerships with the commercialisation of some of their resulting products, such as the Active Desk tabletop.

The education and entertainment industries have also benefited from research and development of interactive tabletops for semi-public environments' applications. An interesting example of this commercialisation phase is the SMART Table Model 230i (SMART Technologies 2009). This medium-size multi-touch tabletop was the result of the company's research on PDPs and large-size education-aimed interactive whiteboards, in an exploratory development from vertical to horizontal interactive surfaces. On the other hand, the reacTable is considered one of the first and most relevant cases of interactive tabletops for entertainment purposes (Kaltenbrunner et al. 2006). The project was developed by the Music Technology Group of the Universitat Pompeu Fabra, in Spain, as a collaborative electronic music instrument for live performances. The tabletop's TUIs allowed multiple users to control an electronic synthesizer software producing diverse audible content by means of rotation, displacement and proximity.

8.2.2. Public Around the Table: Related Work

In the last few years, the increasing development of new technologies, the lowering of costs and a stronger consumer demand for novel products, have generated a sound design response from both large corporations and small companies. Public domains such as commerce, education and entertainment have been increasingly making use of the new interactive tabletops' underpinning technologies to offer their products or services to their public through a more engaging and memorable experience. Significant examples of the deployment of interactive tabletops in these domains include, but are not limited to, points of promotion (POPs) at commercial exhibitions (Expos), meeting tables at conventions, and museum exhibits. The following cases illustrate - in a representative rather than all-inclusive way - some of these applications, facilitating the framing of the *Dangerous Australians* exhibit within the specific design field of museum exhibitions.

MultiTouch to the Public

The Helsinki Institute for Information Technology's spin-off company MultiTouch Ltd has produced many noteworthy tabletop-based projects since its start-up in 2008. In collaboration with the Swiss design company Bellprast Associates they created a rectangular multi-touch LCD tabletop as part of a stand for the *2009 Geneva Motor Show* (MultiTouch Ltd 2009). The main purpose of the interactive table was to attract attendees' attention and keep their interest and engagement in an exhibition context of high competitiveness. The stand introduced the client's audience to the characteristics of a new electric car both through direct presentations by exhibition staffers and through information displayed in the multi-touch table (Figure 43). The interactive device offered three multimedia windows and other loosely distributed images for attendees to retrieve information by opening, moving, rotating, and rescaling its content. The table's form and technological properties allowed as many attendees to interact simultaneously as could gather around it. The most relevant attribute of this tabletop in terms of public interactive experience was the quality of display and accuracy of response its multi-touch LCD technology offered. This same technology was used by MultiTouch Ltd to co-produce the large-size interactive exhibit *One Road*, as introduced early in Chapter 7.

Figure 43. Attendees to the Geneva Motor Show 2009 interact with a multi-touch interactive tabletop.

The Pod

Interaction Designers Elisa Lee and Adam Hinshaw created *The Pod* in 2009, a multi-user interactive table for the Australian event *Ernst & Young Entrepreneur of the Year Awards* (Lee 2009). The 3.5 m diameter table offered the event attendees a touch-responsive multimedia surface for them to familiarise with the awards' nominees and judges. With the exception of audio output, all of the table's technology was located above the surface. Whilst the content displayed on the surface was front-projected directly from the ceiling, participants' actions were detected via computer vision tracking technology. The size of the tabletop allowed twelve people to interact simultaneously with its content, distributed in twelve sectors (as shown in Figure 44). *The Pod* was designed for both individual and shared experiences as it also invited attendees to engage with others in discussions and networking (approximately twenty people could gather around the table comfortably). The design included a non-interactive perimeter for attendees to place their hands or leave objects (e.g. glasses, evening bags, cameras etc.) without these affecting attendees' interactive experience. Yet another feature made *The Pod*'s physical and social interaction particularly fluid: a single queued video playing mode would ensure that only one piece of video was played at a time, avoiding the overlaying of sounds.

Figure 44. Attendees to the Entrepreneur of the Year Awards interacting with one of The Pod's sectors.

Locations

The *Screen Worlds* exhibition at the Australian Centre for the Moving Image (ACMI) in Melbourne, Australia, illustrates the evolution of the Australian industries of film, television, games and the internet in a highly interactive and immersive multimedia environment. One of its exhibits, *Locations* (Figure 45), particularly depicts a selection of local audio-visual creations linked to their associated filming locations (Lightwell 2009). *Locations* presents its content to the institution's visitors in a 2.5 m diameter circular-table format allowing them to gather around and have visual access to all of the surface's display before them. Similarly to *The Pod*, this exhibit is based on computer vision tracking technology, detecting visitors input on the tabletop and presenting the content for each participant in particular. The content display was designed for six participants to interact with six different video clips at the same time; however twice as many visitors can easily access the audio-visual information while standing around the exhibit. This simultaneous experience, nevertheless, is slightly hindered by the audio of each piece. Even though the exhibit's speakers are located underneath the tabletop's surface, the sounds get jumbled with each other and the overall noise in the exhibition space.

Figure 45. The Locations exhibit within the ACMI's Screen Worlds exhibition context.

Churchill Lifeline

Also a front-projection display, the *Churchill Lifeline* exhibit at the Churchill Museum in London (UK) offers the museum's audience an extensive multimedia experience. Developed by Small Design Firm Inc. in conjunction with other British exhibition and electronics design companies the exhibit displays over four thousand multimedia documents about Churchill's life. The tabletop's 15-meter long rectangular design responds to the concept of a timeline, presenting its content in chronological order. Its lineal content map facilitates visitors' engagement with the digital archive as it offers different levels of depth and detail (Pickford 2008). The length of the tabletop also ensures that audio content is delivered unequivocally above the corresponding visual content (Figure 46). Although visitors' interaction with the content is mainly hand-based, input is realised via touch-strips located on both long sides of the table. From an archival perspective the design of the *Churchill Lifeline* tabletop provides access to major historical artefacts without risking the actual documents' integrity. From an interaction design perspective, however, the mixed use of image projection and touch sensors on separate areas of the surface presents a potential drawback: current interactive surface technologies are based on a touch-slide-grip modality, which puts the exhibit in risk of operational misinterpretation as today's users' mental maps have been updated to this new modality.

Figure 46. Projectors and directional speakers covering the 15-meter-long surface of the Churchill Lifeline tabletop.

Star-Spangled Banner

With 200 years of history the Star-Spangled Banner Flag holds a highly significant value to the citizens of the United States of America. The delicate historical artefact is housed by the National Museum of American History in Washington, D.C. and has been permanently exhibited since 2008. Interactive exhibition design firms Potion and G&P Partners developed an accessible 1:1 scale interactive version of the flag for the museum's visitors to explore, virtually thread by thread (C&G Partners LLC 2008). The *Star-Spangled Banner* exhibit displays an approximately 4 x 1 meters section of the flag at a time; visitors can slide their hands over the surface in order to uncover the rest of it. As shown in Figure 47, circular cues are scattered across the exhibit's surface indicating 150 "hot spots" and giving visitors access to further detailed layers of information. The additional content is presented individually in rectangular pop-up windows, aligned next to each other along the tabletop. Although as many as ten visitors can interact with the exhibit simultaneously the engagement with its content is rather individual. The disposition of the tabletop against a wall limits visitors' access to only one side of it making shared experiences difficult. The trade-off, nevertheless, is that the table is slightly tilted towards the audience, facilitating hand access and reducing the shadowing effect over the projection.

Figure 47. A visitor interacts with the Star-Spangled Banner exhibit by retrieving new information from a circular cue.

As revealed through the review of literature and some distinctive interactive tabletop examples museums are increasingly integrating computer-based displays to their exhibition environments. This has been a quite innate response to the developing demands of an audience that has every day more access to interactive technologies, both in the private and in the public space. Yet these institutions are, above all, cultural heritage depositories and communicators, not amusement parks. Consequently, they understand that the displaying technologies must stand as quietly as possible for it is the exhibit's content which ultimately makes the visiting experience unique. Tabletop format in interactive exhibits encourage a social, collaborative behaviour. Their different shapes and placement within the exhibition space facilitate a face-to-face experience with other visitors, extending the effects of the individual content attainment towards a socially-constructed further meaning.

As recently described by Müller-Tomfelde and Fjeld a "slope of enlightenment and plateau of productivity can be expected" for the near future of interactive tabletops (2012, p. 79). After two decades of research and development new technologies are more consolidated, feeding public expectations and market productivity. In the next decade consumers will not only have the choice to buy fully developed interactive products but they will also expect them to be present in the public and semi spaces they engage in daily. Cultural heritage institutions such as museums have become increasingly aware of this socio-cultural digitally-driven transformation and are working towards it.

8.2.3. *Surviving Australia* Exhibition

The Australian Museum is the country's oldest natural history and anthropological museum and as such it not only undertakes invaluable scientific research but also manages an enormous and comprehensive collection (Australian Museum 2011; Kelly 2004). Part of the museum's collection of natural specimens is showcased to the public through the permanent exhibition *Surviving Australia.* The exhibition provides a wide-ranging, enjoyable and engaging learning experience presenting the reality of different Australian animals and their many stories of survival and adaptation over millions of years. The exhibition is located in the Vernon wing of the museum - a fully refurbished 925 square metre heritage space on the South side of the building - and it was opened to the public in June 2008 after two years of development.

The *Surviving Australia* exhibition was commissioned through a tender to Freeman Ryan Design Pty Ltd[17] who brought along other professional teams for the various design and technology-specific tasks. As explained by the Australian Museum's Exhibition Project Manager, Elizabeth Cowell, the exhibition was foreseen as a complex project: multiple levels of content, a wide array of information and varied physical components were to be combined in an eloquent and evocative exhibition (Cowell 2012, pers. comm., 27 march). Bearing this in mind, both design and museum teams gradually defined and developed the exhibition's form and content in tight collaboration as the exhibition design process evolved.

Visitors can access *Surviving Australia* from two main entrances (located at the East and West ends of the exhibition space) and from the lower level via two separate sets of stairs; Figure 48 depicts the space configuration of the West area of the exhibition where the *Dangerous Australians* exhibit is located[18]. The exhibition is broken up in several thematic sections according to different geographical and human landscapes. A central corridor takes visitors through the different sections in which they have the opportunity to come face-to-face with live specimens, explore taxidermied creatures, join museum staffers for talks and guidance, interact with several multimedia displays, among many other interpretive features.

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[17] For more information about this exhibitions, museums and visitor experiences design firm and its projects see www.frd.com.au

[18] The complete exhibition floorplan can be accessed here: http://australianmuseum.net.au/document/Surviving-Australia-Exhibition-Floorplan

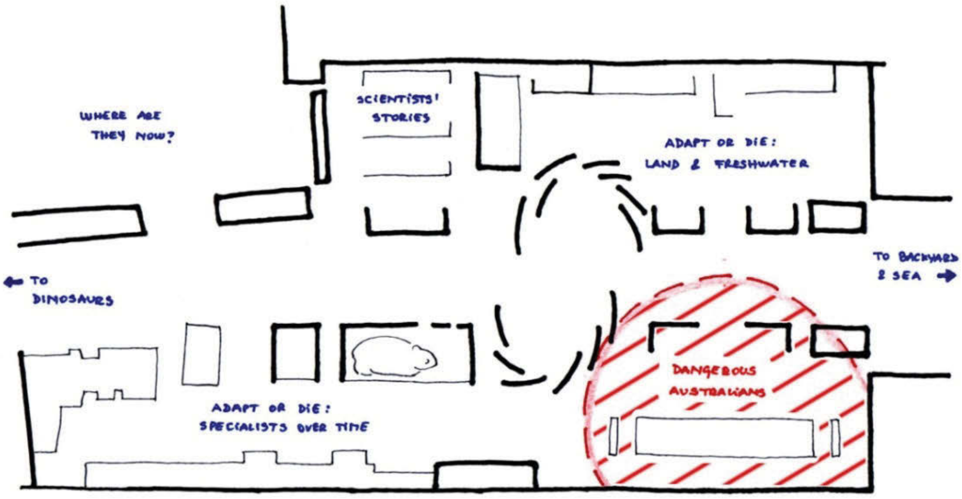

Figure 48. Layout of the West section of the *Surviving Australia* exhibition (adapted from the museum's exhibition floorplan). The *Dangerous Australians* exhibit zone is circled in red.

The design and development of *Surviving Australia* was thoroughly discussed with Freeman Ryan Design's Director Susan Freeman in the context of the *Dangerous Australians* Case Study. As the leading Designer of the project she explained that each of the exhibition's pieces were informed by "the possibilities of the space, the narrative of the stories, the different levels of immersion needed at each topic, the overall experience" of the exhibition (Freeman 2012, pers. comm., 20 july). Accordingly, the exhibition presents a balanced blend of architectural and multimedia resources as well as fluid spatial, content and emotional narratives, distributed in discrete 'pockets of stories'. This way, and as it can be observed in Figure 49, visiting experiences take place in each section independently of the whole exhibition or from other sections.

Figure 49. The 'Island Homes' section of the *Surviving Australia* Exhibition.

Subjects in the *Surviving Australia* exhibition are presented to visitors in subtle ways so that they grab their attention and draw them towards the different exhibits. The experience of the visit includes engagement with direct information (provided by means of text, graphics and multimedia), exploratory enquiry through the appreciation and examination of artefacts (e.g. specimens, objects, visuals), and association of contents distributed strategically throughout the space. The physical design of the space provides its audience with areas for both individual and social engagement, aiming to generate in them emotions as diverse as surprise, reflection and commitment which change along the visiting journey.

8.3. Dangerous Australians

Given the constantly changing flow of emotions, content and social interaction along the *Surviving Australia* exhibition, the *Dangerous Australians* exhibit was envisioned as a space for visitors' re-engagement (Freeman 2012, pers. comm., 20 july). The exhibit is located half way through the exhibition, as the central piece of the visiting experience. It can be accessed from the adjacent section 'Adapt or Die: Specialists Over Time' (as shown in Figure 50) or through a gate-like exhibit on one side of the main corridor. The intricate distribution of other architectural and interior elements (e.g. columns and information panels) provides a playful alternative access which some younger visitors take.

Figure 50. Access to *Dangerous Australians* exhibit from an adjacent section.

8.3.1. Exhibit's Description

The *Dangerous Australians* exhibit is comprised of a central 6-meter long interactive table with an overhead rectangular arch. Several information panels containing graphics, texts and specimens are distributed in the perimeter of the space, virtually closing the exhibit's area. On the tabletop's surface a full-size animated projection is displayed, featuring ten Australian animals in their corresponding water- and land-based habitats. Since regular references to these features are made later in this thesis, a list of the animals' common names and their place on the tabletop is essential. From left to right, the creatures presented in the water-based habitat were the Great White Shark, the Box Jellyfish, the Blue-ringed Octopus and the Saltwater Crocodile. From left to right, the creatures represented on the land-based habitat were the Death-adder Snake, the European Honey Bee, the Funnel-web spider, the Eastern Brown Snake, the Red-back Spider, and Jack-jumper Ants. Figure 51 shows the distribution of the featured animals along the tabletop. The design, production and programming of the interactive components of the tabletop were generated by Lightwell in straight collaboration with both the museum and the leading design teams.

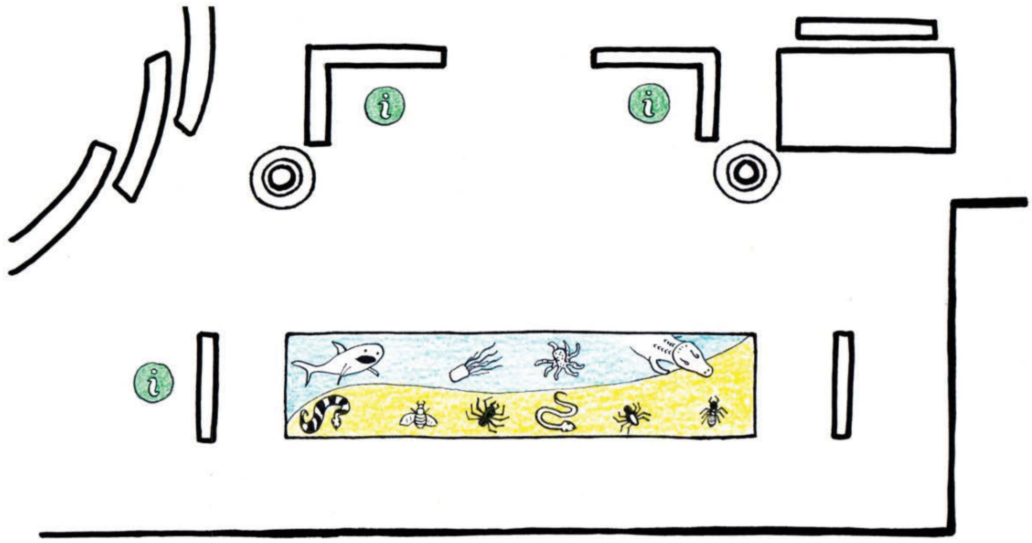

Figure 51. Schematic representation of the *Dangerous Australians* tabletop's content.

The animals are displayed quietly prowling in their allocated sections until visitors' proximity alerts them. Upon direct contact, several blocks of information are displayed in pop-up graphics: the animal's main characteristics (e.g. habitat, life cycle, behaviours, etc.), the risks of encountering it (i.e. first aid information) and a 2-axis rotating 3D model of it (Figure 52). The pop-up graphics present different icons, such as crosses, arrows and a magnifying glass, for visitors to interact with the content. All ten features provide interaction to ten visitors simultaneously; however around 25 visitors can have comfortable visual access to the displayed content at the same time. The landscapes in which the animals move are also reactive to visitors' actions; whilst moderate waves can be created on the water surface, dust can be lifted off the land section. Every fifteen minutes, all interactions are suspended for 40 seconds: the landscape shifts to full water and a close-to-real-size crocodile appears at one end of the tabletop; the creature swims its way all along the surface until disappearing at the other end. This is the only feature that is not interactive and provides no additional information to visitors. Michael Hill, Creative Director of Lightwell and leading Designer of the exhibit's interactive pieces, explained that the varying behaviours and different levels of interaction are meant to add a surprise and theatrical effect, allowing visitors to engage at their own pace (Hill 2012, pers. comm., 17 july).

Figure 52. Three stages in the presentation of pop-up information graphics.

The physical design of *Dangerous Australians* is determined by the space in which it is set up, the particular technological conditions and its role as central piece within the *Surviving Australia* exhibition. The hardware that comprises the exhibit also informs its design in combination with usability and accessibility considerations. The height of the tabletop defines the distance at which the projectors and sensors sit above it and, consequently, the overall framing structure to support them. The tabletop is built of materials robust enough to endure high physical action from a great number of visitors (e.g. pushing and beating, sitting and leaning on) but also soft to its users' touch. The smooth polymeric coat with which the surface is treated allows a neat image projection as well as an effortless maintenance. In terms of audio design, and in order to ensure the exhibit did not interfere with visitors' experience exploring other areas of the *Surviving Australia* exhibition, sound output is located underneath the tabletop's surface. This way, the soundscape of *Dangerous Australians* remains close to the interacting visitors facilitating their focusing on one exhibition at a time.

In respect to its underlying technology, *Dangerous Australians* was the first interactive tabletop of its nature to be presented in a museum in Australia. As explained by Hill, although the technologies had been available for years they had not yet been put together as a system in a public realm (Hill 2012, pers. comm., 17 july). The design and museum teams combined their expertise with new displaying techniques and renovated interpretative approaches, resulting in an accurate, effective and attractive exhibit. *Dangerous Australians* makes use of front-projection camera vision technology (as described in Section 2). Above the tabletop four sets of high definition projectors, angled mirrors and infrared (IR) cameras suit the role of both projecting the visual content and detecting users' action over the tabletop's surface (Figure 53). This combination of technologies means that actual touch on the surface is not necessary for the content to react. An interruption of the visual beam near the projection pane (i.e. a visitor attempting to touch a projected feature) is identified as presence, its exact location processed by the system and the corresponding effect presented. In addition, particular triggers for each graphic feature detect different types of visitors' physical approach, differentiating the interactions between focalised touch (e.g. rotating a 3D representation), playful touch (e.g. chasing an animal on the land) and general hovering (e.g. creating circular waves on the water with the hands).

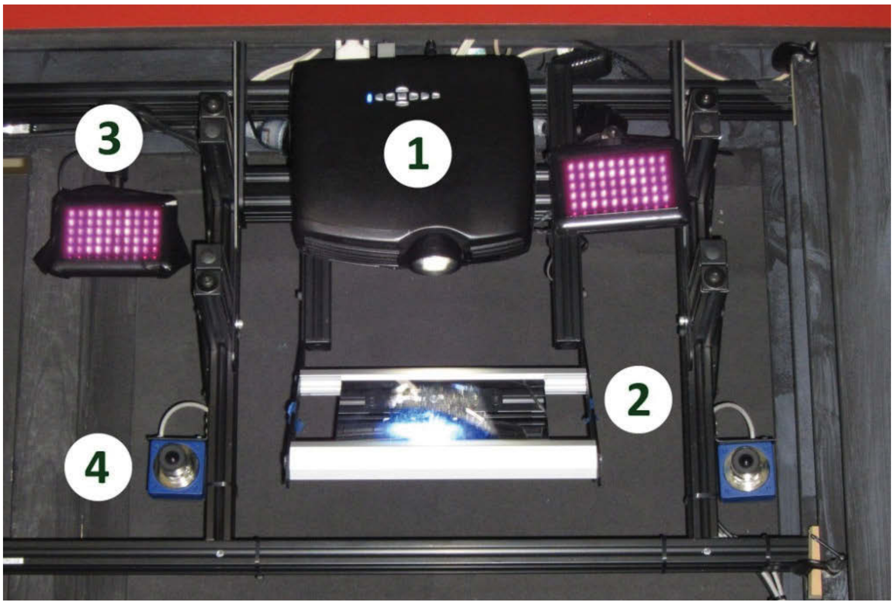

Figure 53. One of the four camera vision sets located above the *Dangerous Australians* tabletop. The system is comprised of a projector (1), a mirror (2), IR lights (3), and video-cameras (4).

8.3.2. The Visiting Experience

A comprehensive design brief was developed in which the emotional response was the central key of all components. According to Freeman (Freeman 2012, pers. comm., 20 july) *Dangerous Australians* was envisioned as a

> *high impact, highly coloured, fast moving set of projections that was fun, engaging and scary … [where] the intention is to both inform and surprise … shifting the visitor's focus, encouraging an emotional response of the visitor.*

This emotional response is present in all stages of the exhibit experience, from the drawing-in of visitors, to the engagement with the content and the taking-away of a memorable encounter. The exhibit aims to offer its visitors not only a selection of curated educational information but also an enjoyable environment for a lively social engagement (Cowell 2012, pers. comm., 27 march).

The first emotional key the exhibit addresses is surprise. Making use of the impressions the creatures of the exhibit may have on the audience, their lurking presence is a call for visitors to move towards the table and have a look. This catching of attention is strengthened when the audience around the table is already numerous, when the soundscape of both the tabletop and the visitors insinuates the exciting activity taking place. Even if other visitors are already interacting with the reacting creatures, participants encounter the content as novelty: they never really know when or how the creature will confront them. The next emotional key is curiosity. Once visitors have recognised the content the different graphic pieces invite them to explore what they actually hold for them. The information is presented and carefully balanced in small packages so as not to overload visitors with library-like, un-curated interpretation material. The scheme of content presentation is based on potential visitors' questions in the line of 'what else could I learn' (content-related) and 'how does this happen' (interaction-related). Curiosity is tightly related to play, another emotional key addressed by *Dangerous Australians*. This emotion is not subject to any stage in particular; in fact, it is expected to take place at all times throughout the visiting experience. A sense of play is offered through the delivery of the rich multimedia content (i.e. all audio, images, videos, text and animations) for visitors of all ages to engage with. As explained by museum's Exhibition Project Manager, a touch of humour is added to the content so as to diminish the effect of the rather daunting content. When losing the potential initial fear, visitors dare exploring further and senses of confidence, achievement and amusement arise. For Cowell, entertainment is a crucial element in the learning experience, for not only it is one of the main expectations audience have on the museum experience but also facilitates the content conveyance and retainment processes.

Physical conditions (e.g. overall exhibition flow, architectural space, interior design aspects) in conjunction with the actual design of the exhibit (e.g. form factors and technologies comprised) make of *Dangerous Australians* a social hub. Visitors coming from the different adjacent exhibits meet around this interactive tabletop with a purpose that quickly evolves from individual to shared exploration. Although the multimedia contents (i.e. information stations with their respective pop-ups) are designed to provide mainly single user interactions (only one user at a time can operate these), their disposition along the table and their visibility from various points facilitate the sharing of information in small groups of up to five visitors in each station. In addition, the many effects presented during the interaction with these components attract the attention and interest of other visitors, encouraging dialogues, joint enquiry and collaboration.

8.4. Methods Used in the Case Study

The *Dangerous Australians* Case Study aimed to provide answers to specific doctoral research questions which had been refined and narrowed down as a result of the project's secondary research and preceding Case Studies' findings. Two main areas or enquiry regarding the museum visitor experience were covered through this Case Study: the individual and the social experiences with interactive technologies. Whilst individual experiences were mainly explored in terms of physical interaction modes and expressions, social experiences were mainly studied through the observation of conducts of collaboration and conflict.

The Case Study was conducted over three weeks, from the 1st to the 24th of April 2011. Research would begin every day at 10:30 am and finish at different hours. A total of 115 hours of research was conducted. Although this Case Study does not focus on the museums' overall visitation scheme, some inference on its audience coverage can be made considering existing data from previous studies. According to the latest institution's Annual Report 2010 - 2011 (Australian Museum 2011), the museum's yearly audience attendance reached 325,554 visitors (an average of 894 visitors per day) which means more than 20,000 people were potential visitors of the *Surviving Australia* exhibition during the period the Case Study was conducted. In addition, although no numbers are provided, the Evaluation Report of the *Surviving Australia* exhibition indicates that it "tends to receive the highest number of visitors out of all permanent galleries in the museum" (Lang 2012, p. 3). Drawing from the results of a tracking study conducted on 60 visitors the report demonstrates that 65% of these interacted with the *Dangerous Australians* exhibit to some extent. In light of these numbers, it can be sustained that the Case Study presented in this doctoral research covered a significant fraction of the audience: an average of 321 visitors per day[19] (36% of the overall museum's daily attendance).

The case of study for *Dangerous Australians* was comprised of the regular museum's audience with an increased number during a period of School Holidays followed by Easter Holidays (April 11th to 25th altogether). The Australian Museum Visitor Profile 2008 - 2011 report (Lang 2011) identifies its audience as consisting mainly of family groups (58% of visitors), followed by couples and individuals (24% of visitors), and groups of friends (11% of visitors). Half of the museums' audience attends in groups with children (50% of visitors) accompanied by up to two adults (90% of these groups). The Visitor Profile report also reveals that the Australian Museum's audience is fairly familiar with its collection already, as 57% of the surveyed participants have visited the museum before; furthermore, 59% of Australian visitors informed to be likely to repeat their visit in the near future. Participants in the Case Study were selected under no particular set of criteria neither were they invited to or directed towards the *Dangerous Australians* exhibit; research subjects and groups of subjects were randomly selected either directly at the exhibit or at its proximities, depending on the particular study being conducted.

Research data was collected by means of observational and interviewing methods, utilising different techniques and tools. While the observational methods were applied in order to obtain information of visitors' individual and social responses to the exhibit (e.g. interaction modes, attitudes, physical behaviours), the interviewing methods were applied so as to gain a qualitative

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[19] A high number of visitors were counted through an age groups study; however these numbers are not included in this estimate as they are considered referential data only.

direct account of visitors' experiences (e.g. opinions, feelings, sense-making). According to the type of information and feedback being surveyed these techniques varied from direct contact with visitors to unobtrusive enquiry. Observations were conducted in two ways: from a short distance (non-obtrusive observations) and while accompanying visitors in their interaction with the exhibit (participant observations). Interviews took place in two ways as well: during interaction (contextual enquiries) and right after the experience (unstructured interviews).

Visitors were informed about the study taking place by a sign posted on a panel at one end of the room. Additionally, the researcher was properly identified wearing a nametag at all times. The space in which the *Dangerous Australians* exhibit is located did not allow for a researcher's fixed observation spot without interfering with the visitors' flow; therefore, data collection was mostly conducted by moving around the space yet always ensuring visitors' experiences were affected as minimally as possible. More importantly, so as to not intimidate visitors, most annotations were made away from the visitors' sight. Graphic and audio-visual recordings were conducted in order to support the reporting and analysis of data: photographs, videos, sketches and diagrams were generated on site.

Drawing from a technique of data collection developed during the *Facets Kids* Case Study (described in detail in Sections 5 and 6 of Chapter 7), observations and interviews were conducted in focalised units of study, segmented in periods of 15 and 30 minutes each. Each unit of study was intended to provide information about particular individual and social aspects of the visitors' experiences. What follows is a description of each of these units of study, the specific methods utilised for each and their scope.

8.4.1. Age Groups Study

Existing research material such as the reports mentioned above has informed this Case Study with valuable data regarding the overall museum's and exhibition's audience composition. Since no exhibit-specific studies had been made on *Dangerous Australians* by the time the Case Study was due to commence, a general visitor count was conducted. Considering one of the most representative characteristics of the Australian Museum's audience is their strong family group constitution, the focus of the study was placed on age groups. A refined age group scale was produced for this study in particular, drawing from the *Facets Kids* Case Study and informed by an Australian governmental categorisation of ages in a context of cultural access (Australian Bureau of Statistics 2010) and some of the Australian Museum's Audience Research reports (Fitzgerald & Kelly 2007; Foot, Sol & Kelly 2005; Kelly 2007a). This new scale of age groups includes all ages from pre-school children (under 5 years old) to the elderly (over 61 years old). This unit of study was conducted in intervals of 15 minutes twice every day at approximately similar times. The count was performed from a distance, without consulting visitors directly, estimating their ages informed by previous research. A total of 5,081 visitors were surveyed through this study.

8.4.2. Stages of Interaction

One of the main outcomes of the *Facets Kids* Case Study was the definition of five stages of interaction with interactive exhibits: ignoring (visitors do not notice the exhibit hence no interaction takes place), noticing (visitors notice the exhibit but no approaching is attempted), observing (visitors engage with the exhibit in a passive way by looking at it and/or its users), involving (visitors interact physically with the exhibit) and engaging (physically active and immersive participation with the exhibit takes place). Participants were randomly targeted while observed from different spots around the exhibit. Both individual and group participants were included in the study. Data was collected almost every day in four separate intervals of 15 minutes. A total of 2,789 visitors were observed through 21.5 hours of observation.

8.4.3. Interaction Time

This unit of study was conducted over 18 days in intervals of different length as the priority was laid on a significant number of participants informing the study rather than a period of observation time. For this study interaction time was considered from the first physical contact with the exhibit to the ceasing of physical contact; observation prior and after the interaction was not timed. A total of 539 interacting visitors were covered in this study, with an average of 30 visitors observed per day.

8.4.4. Trajectories

A tracking study was conducted in order to explore the spatial trajectories most commonly developed by visitors when interacting with the exhibit. Participants were randomly selected and observed from a distance; in occasions, when the exhibit space was too crowded, visitors had to be followed unobtrusively to ensure a complete record was made. Trajectories were registered from the moment the targeted visitor entered the exhibit's space (delimited by walls and information panels) to the moment he/she left the room. Figure 54 shows the blank form that was used to collect visitors' trajectories during the study. The study was conducted on a maximum of two visitors at a time, independently of whether the affiliating group was larger than two members. Records were made once a day during 19 days in intervals of 15 minutes. A total of 229 visitors were surveyed through this study.

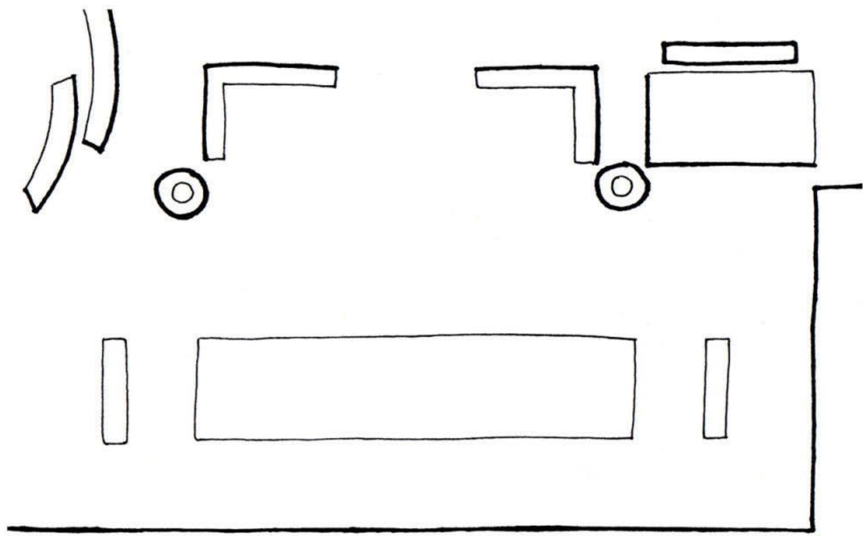

Figure 54. Blank form for the recording of visitors' trajectories in the *Dangerous Australians* space.

8.4.5. Attention Time

Since museums offer their visitors a wide array of content in order to satisfy as varied an audience as possible, it is only naturally expected that some features in an exhibit attract more attention from visitors than others. This unit of study was intended to inform of the areas of the exhibit's interactive display that visitors interacted with the most. The same blank form used in the trajectories study was used to record data for this study. Only individual records were made, disregarding the eventual group affiliation of the visitor being surveyed. During the study participants were discreetly followed throughout their trajectories about the tabletop. A stopwatch was used to record the amount of time a participant dedicated to interact with each section (i.e. each dangerous creature). A total of 120 visitors were surveyed through this unit of study, which was conducted daily during 15 minutes each time.

8.4.6. Bodily Gestures

As described in the section 'Background of the Exhibit' a table-shaped artefact invites different bodily expressions related to the concepts of reunion around it, and support and movement of objects (or parts of the body) on it. A chart of potential bodily gestures was created prior to the commencement of the Case Study and refined during data collection. The aim of this unit of study was to identify the physical ways in which visitors related with the *Dangerous Australians* interactive tabletop. The expressions observed focused on most parts of the body, including those which did not have direct physical contact with the tabletop's surface (i.e. torso and feet). Due to the complexity of the study for a single researcher to carry out facial expressions were not included in this study. For the same reason, bodily expressions taking place in social interaction (e.g. an adult lifting a small child to help him/her reach the surface, a number of hands piling up as if trying to capture a creature, etc.) were also excluded from this unit of study. Gestures were recorded as single events as opposed to repetitions; this means that a repeatedly observed gesture in one visitor was recorded as a single mode of interaction. The study of bodily gestures was conducted on a daily basis, at least once per day, in intervals of 30 minutes. A total of 95 visitors were observed for this study.

8.4.7. Social Interactions

Another contribution from the *Facets Kids* Case Study was a categorisation of visitors interactions associated with social behaviours. Both content and delivery format of the *Dangerous Australians* exhibit invited visitors to share impressions, make sense of the content and engage in a mutual guidance exploration. The aim of this unit of study was to identify social conducts that evidenced either collaboration or conflict. A scale of 14 different behaviours was made with descriptions of social interactions that spanned from highly collaborative behaviours to highly conflictive ones. The scale was created on the first day of study and completed through data collection as behaviours were recorded. The study of social interactions was conducted in daily intervals of 30 minutes, mostly twice per day, at random times. A total of 1,917 interactions were observed through the study of social interactions.

8.4.8. Audience Response to *Dangerous Australians*

Due to the complexity of this Case Study and the limited human resources to execute a comprehensive and, at the same time, accurate study, some variables of the individual and social experiences with *Dangerous Australians* were surveyed in a less structured way. A qualitative study was hence conducted at sections of time during which no other unit of study was being implemented. This study allowed the researcher to approach visitors in a direct way and gain first-hand accounts of their experiences through contextual enquiry and unstructured interviews. Also during these periods, general observations were conducted, paying attention to phenomena and trends that reflected the influence of the exhibit's particular underpinning technologies on both individual and social experiences. Data was collected by means of annotations, photographs and videos. The study comprised approximately 19 hours of observations and one-on-one enquiries. No count of the number of visitors observed through this unit of study was made; however 97 visitors were approached for direct accounts of their experiences.

8.5. Case Study Data Overview

The *Dangerous Australians* Case Study was the most demanding and complex of the three studies that comprised this doctoral research. The characteristics of the venue and exhibit, its audience profile and size, the extended hours of field data collection, among other conditions, provided a sometimes overwhelming research context. Nonetheless, this also meant a field of rich, possible answers to the overall project's research questions. Approximately two months were invested in preparing the case study proposal, designing its stages and methods, and preparing the field work material. After the execution of the case study the extensive raw field data was transferred into charts, graphics, written analyses and interpretations; another five months were invested in this stage of the study. Table 10 shows a summary of the units of study conducted and the total number of visitors contemplated in them.

Unit of Study	Visitors	Study Time
Age Groups	5,081	11 hr 45 min
Stages of Interaction	2,789	21 hr 30 min
Interaction Time	539	9 hr
Trajectories	229	4 hr 45 min
Attention Time	120	6 hr
Bodily Expressions	95	21 hr 30 min
Social Behaviour[20]	3,834	21 hr 30 min
Audience Response	97	19 hr
Total values	7,703[21]	115 hr

Table 10. Case Study's summarised records.

8.5.1. Age Groups Study

Participants (visitors directly interacting with the *Dangerous Australians* interactive tabletop) and group members (visitors part of the participants' visiting group, either observing or interacting) were considered in this study. Babies in prams or adults' arms were not considered however toddlers were. As it can be observed in Figure 55, most of *Dangerous Australians*' audience is young. This is consistent with a mainly family audience context, as expressed by several of the Australian Museum's exit surveys and exhibition's evaluations reports mentioned earlier.

[20] Note that this unit of study surveyed events (1917 in total) rather than numbers of participants; however, an estimated number of twice as many visitors per event was reached given the fact that these events took place with at least two visitors taking part of them.

[21] Age Groups Study data was not included in this final count.-

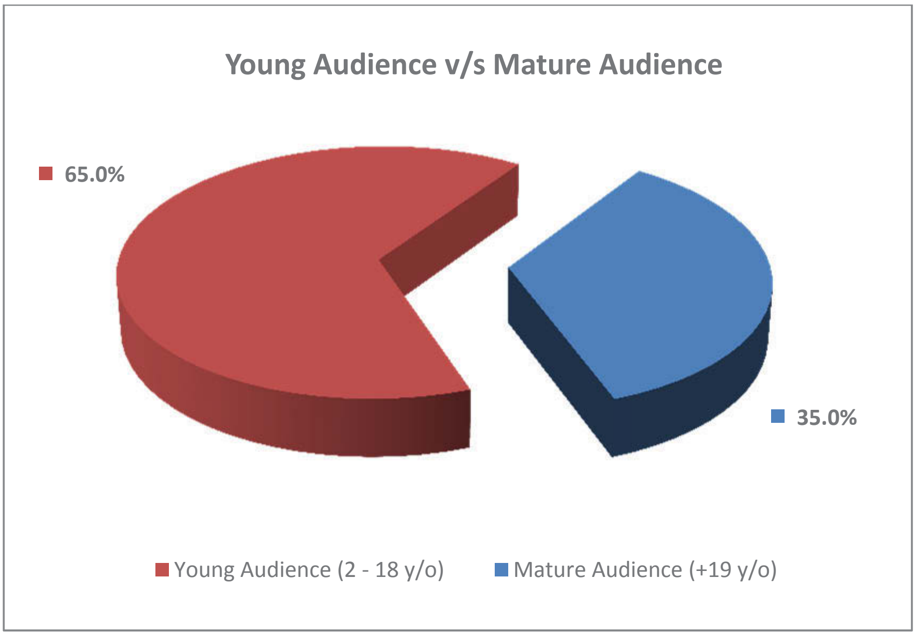

Figure 55. Proportion of young and mature *Dangerous Australians*' audience.

Figure 56 presents a full detailed categorisation of *Dangerous Australians*' visitors by age. Out of the 5,081 visitors surveyed through this unit of study 3,305 were estimated as minors (group comprised of 22% of pre-school children, 29% of infants and 15% of teenagers). Children between 1 and 11 years old represent half of the exhibit's audience (50.1%). Naturally, children were always observed accompanied by adults. It could be inferred from data that most families visiting the exhibit are in their early stages: most adults surveyed were in the category of young adults (19.2%). This was supported by general observations that showed that most visitors in this category were indeed accompanied by children. Older families were also observed, bringing with them their older offspring: teenagers. This last group was represented in a considerable number as well (14.9%), which added to visitors in a tertiary studies age (6%) speaks of an exhibit that is appealing for a wide range of visitors, not only for children. The smallest audience age group observed was the rather mature visitors. Seniors and elderly (3.3% altogether), presumably grandparents, were mostly observed during the earlier mentioned holidays periods.

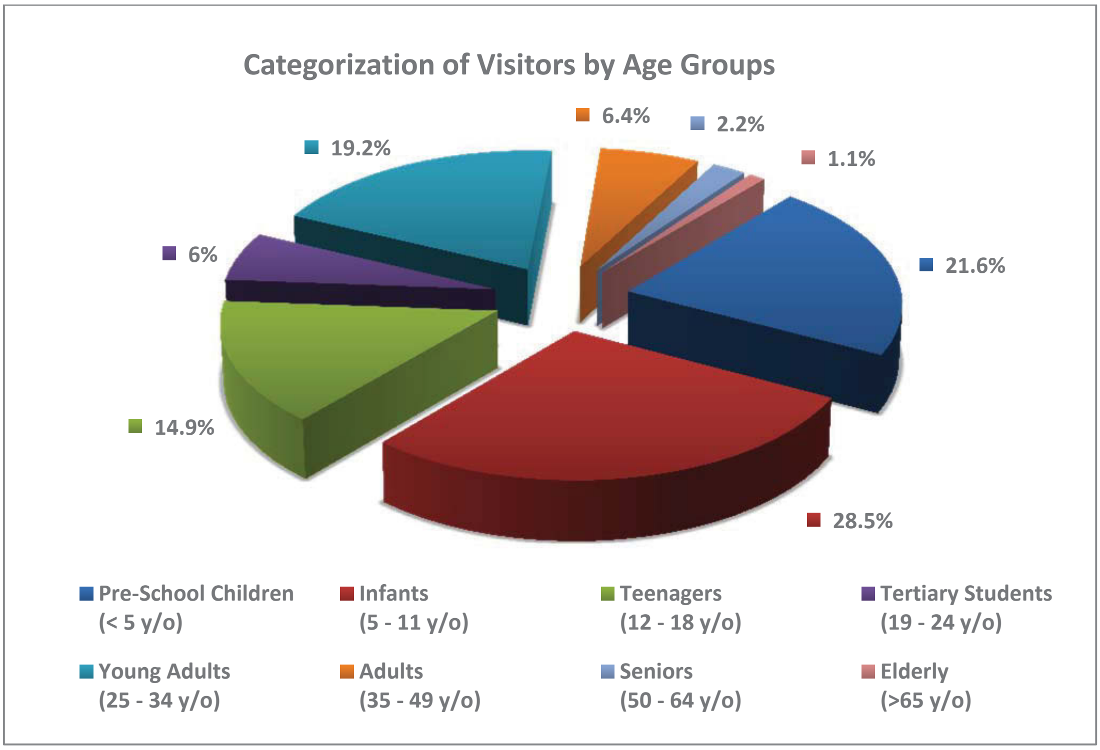

Figure 56. Breakdown of specific age groups attending the *Dangerous Australians* exhibit.

8.5.2. Stages of Interaction

A total number of 2,789 visitors were observed around the exhibit's immediate space (i.e. at the 'Adapt or Die: Specialists Over Time' exhibition in the space next to *Dangerous Australians* and in the central corridor). Out of these visitors 622 (representing a 22.3%) continued their exploration of the *Surviving Australia* exhibition without entering the *Dangerous Australians* exhibit space. It is possible to consider that some of these visitors had already attended the exhibit earlier but with the limited research resources this was not possible to be established. In order to make a difference between those visitors who consciously decided not to visit the exhibit two categories were defined: those who seemed to have not noticed the exhibit and those who seemed to have had visited. As a result, 11.5% visitors were observed missing the exhibit and 10.8% making no attempt to visit it. A reflection of the possible causes and implications of these missed interactions is provided later in the Audience Response to *Dangerous Australians* Section. Figure 57 shows a detailed categorisation of interaction levels reached by the visitors surveyed through this unit of study.

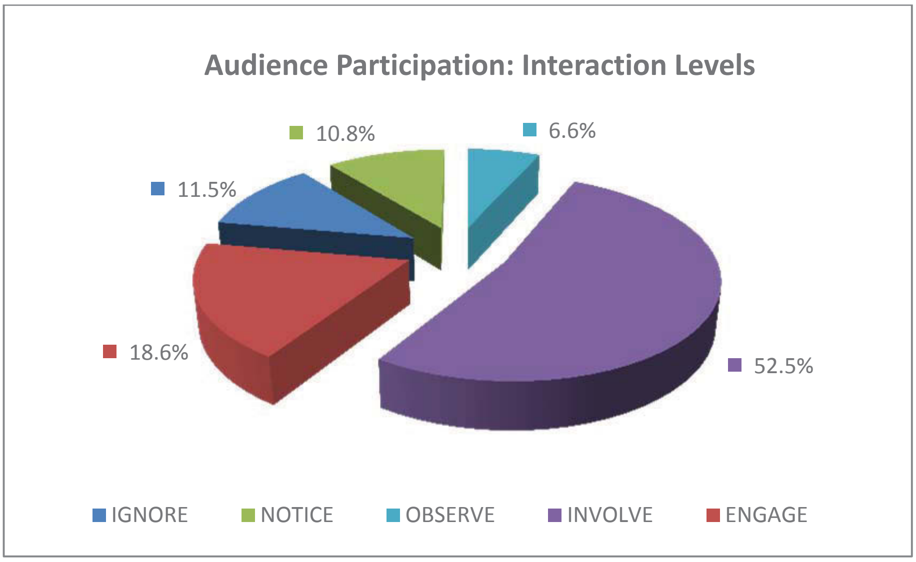

Figure 57. Levels of Interaction observed at the *Dangerous Australians* exhibit.

Out of the 2,789 audience members observed in this unit of study, 2,167 visitors entered the *Dangerous Australians* space and attempted to interact in some way. Only a small amount of these visitors engaged in a rather passive way (6.6% visitors limited themselves to observe the interactive tabletop and its participants). In contrast, a great number of visitors engaged in a direct, physical way (71.1% of the total exhibit's potential audience). Out of these participants, the majority got involved by touching the tabletop's animated content (52.5%), randomly opening and closing pop-up information graphics, quickly reading their texts or browsing through their visual content. Only 18.6% of participants were observed in an immersive exploration of content, interacting consciously with the features (e.g. playfully examining the 3D graphics, attentively observing videos, reading complete sections of text, discussing content with other visitors). In summary, it can be affirmed that some level of interaction was observed in almost 8 of 10 potential visitors to the *Dangerous Australians* exhibit, out of which 7 would have involved with or engaged in an active relationship with the exhibit.

8.5.3. Interaction Time

In the approximately 9 hours of observation dedicated to measure the time participants would dedicate to interact with the *Dangerous Australians* tabletop 539 visitors were surveyed. Although interaction time does not account for meaningful engagement data, the juxtaposition of this type of data with that resulting from other studies help understand visitors' motivations in the interaction process better. Each time a visitor was identified attempting contact with the tabletop a count was performed. The time visitors dedicated to interacting with *Dangerous Australians* varied from quick single pokes that would take only a few seconds to extended periods that would involve a complete examination of practically the complete exhibit's content.

The average time for interaction was observed to be 2 minutes and 59 seconds. The shortest interaction registered by a participant was only 6 seconds, which was presented by an adult who entered the exhibit's space, approached the table, flicked his hand over the water-like surface while walking along the table and headed towards the adjacent exhibition. It is possible to think this particular participant had already interacted with *Dangerous Australians* before as his approaching and interacting mode looked as if certain of what would happen. Most of the short interactions observed took place in a similar manner, with participants being called away by group members or just using the exhibit space as passage between other exhibition areas. In contrast, the longest interaction registered by a participant was an unusual period of 34 minutes and 6 seconds. This record was presented by a young mother and her approximately 8 year-old daughter. They seemed to be very bound together, physically connected at all times (in fact, most of their interacting time was with the girl mounted on her mother's back). The two participants repeated the exploration of several interactive features, engaged with other participants present at the exhibit (whom they did not know), and engaged with the content.

As shown in Figure 58, most interactions took between 1 and 4 minutes (389 participants, representing 72.2% of the visitors surveyed). Whilst only a few visitors presented a quick interaction (23 of them, representing a 4.3% of the total) an interesting number of visitors engaged for longer than 4 minutes (127 participants, representing a 23.6% of the total interacting audience).

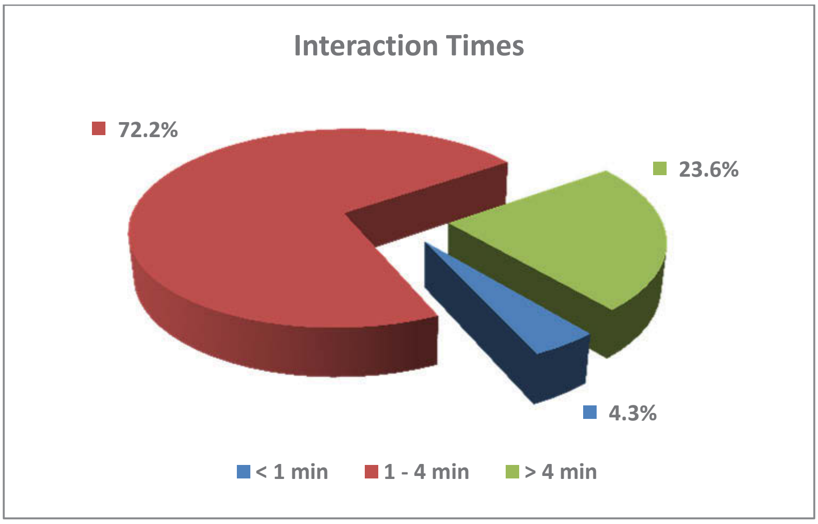

Figure 58. Segmentation of interaction time periods.

Data was filtered in order to perform an analysis over the largest interaction time group (the 72.2% of participants engaging with the exhibit between 1 and 4 minutes). After removing interaction times shorter than 1 minute a new average indicator was reached but no significant changes were exposed. The average interaction time of visits over 1 minute was 3 minutes and 4 seconds. After filtering the data even further and removing all interactions that took longer than 4 minutes a significantly different average time for interaction emerged: 2 minutes and 14 seconds. The reason behind removing considerably short and long interactions is the fact that, as observed, they do not necessarily represent the types of interactions observed in visitors engaging with *Dangerous Australians* closer to the average time of approximately 3 minutes. A further study of how visitors spent their time at the exhibit is presented later in the Attention Time section.

8.5.4. Trajectories

The ways visitors made use of the exhibit space was studied through the tracking of their displacement around the interactive tabletop. A total of 229 visitors' trajectories were observed, some of them performed individually and some of them as part of a group. Upon analysing the trajectories records, several recurrent patterns were identified and categorised. Figure 59 depicts the visual representations of these patterns. The 'Hop in / Hop out' trajectory patterns was defined after noticing some visitors would enter the space, give the exhibit a quick look and leave. The ‘Selected Spots’ trajectory was observed in visitors who would enter the space, interact with a few features and leave. Two perimeter-based trajectories were observed: ‘Perimetric General’ represents trajectories in which visitors moved around the tabletop giving a general attention to some of the features while ‘Perimetric Complete’ represents those trajectories in which visitors not only moved around the tabletop but also dedicated time to each of the features presented. Random trajectories were also observed in two structures: ‘Random General / Complete” were trajectories performed by visitors who did not follow a space-oriented movement around the tabletop but rather skipping features and then returning to an area; no repetitions of interaction were observed in these trajectories. Whenever repetitions were observed in a random-based trajectory, these were categorised as ‘Random with Repetitions’.

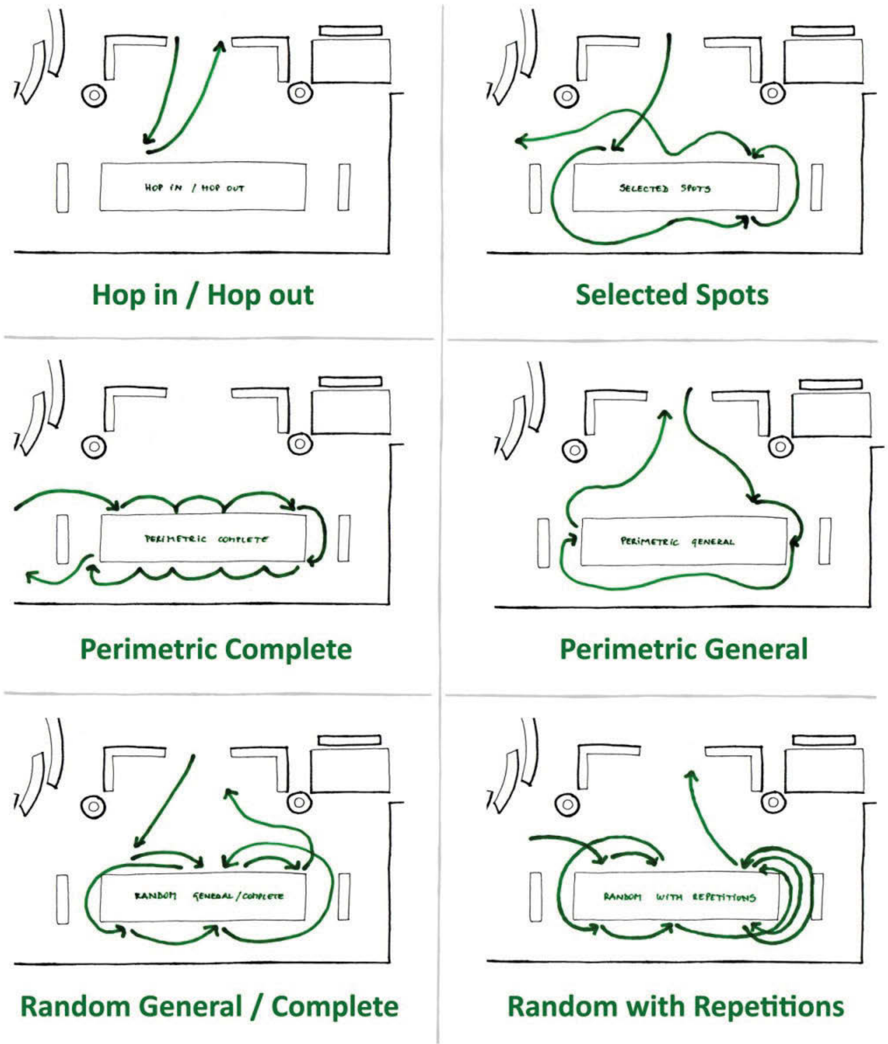

Figure 59. Six of the most recurrent trajectories patterns identified.

During the collation of data graphic representations of both individual and shared trajectories were made so as to have a clear analysis structure from which to gather findings. Figure 60 depicts one of these graphics and the way visitors were identified and represented. The graphic shows how these two visitors entered the room together but one of them, Visitor #47, left earlier. Following a 'Random with Repetition' trajectory, these visitors started their experience by interacting together at the White Shark end and then moving away from each other to different sections, yet still at the same end of the tabletop. After gathering again, they continued their joint exploration towards the other end of the tabletop diverging their ways once again, after sharing experiences with the Blue-ringed Octopus and the Saltwater Crocodile. This trajectory shows how often the trajectory of one individual visitor would be modified by others. Shared trajectories were mostly observed when a participant (or group of participants) was called to join an interaction. Individual trajectories without others joining the interaction were seldom observed.

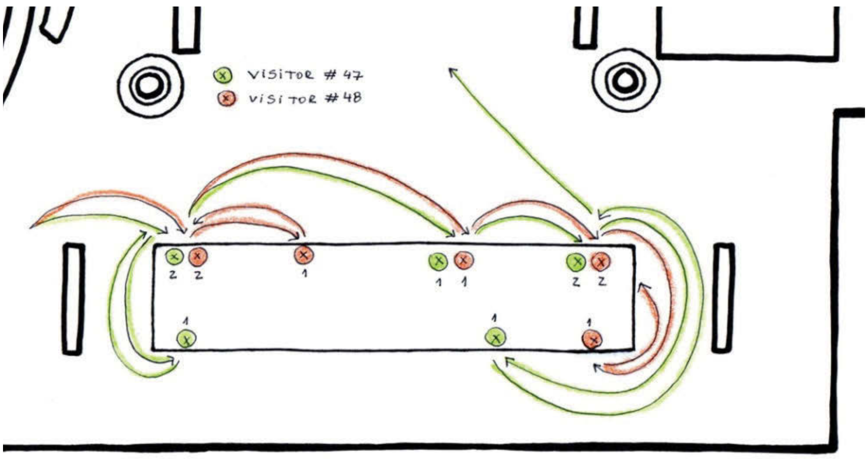

Figure 60. A 'Random with Repetition' trajectory of two participants in individual and shared interaction.

Upon quantifying data from trajectories patterns it is inferred that the movements around the *Dangerous Australians* interactive tabletop based on the spatial configuration were slightly more recurrent than those based on the content. As Figure 61 shows, space-driven trajectories (represented in three different tones of blue) accounted for 54.6% of all visitors' movements around the tabletop, while content-driven trajectories (represented in two different tones of orange) accounted for 42.4% of visitors interactions. A very small number of visitors performed a quick spatial exploration (3.1% of trajectories were identified as 'Hop in / Hop out').

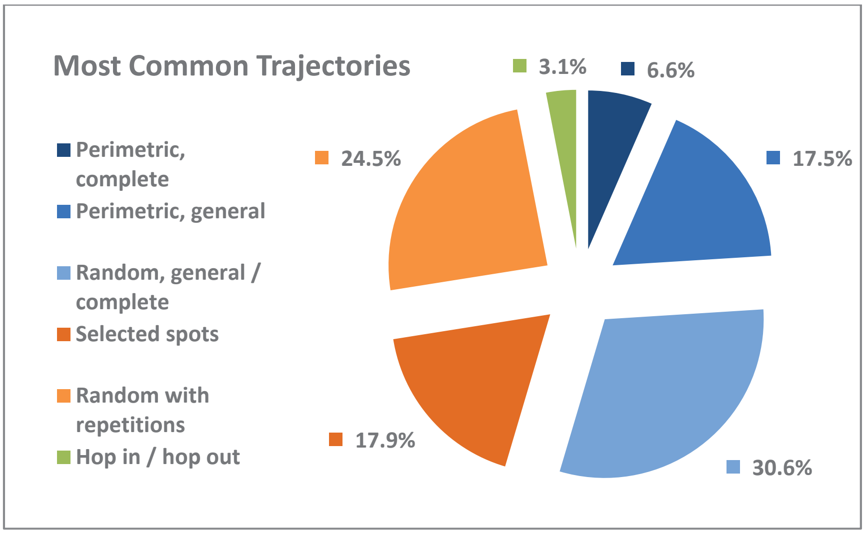

Figure 61. Breakdown of trajectories patterns according to the influence of space and content.

In a breakdown of each main category it was found that the most recurrent trajectory based on a spatial exploration of the exhibit was the 'Random General / Complete' one (56% of this group's visitors) which suggests that the space in which the exhibit is placed allows for an unrestricted and rich exploration of the content. Conversely, the most recurrent trajectory based on the exploration of content was the 'Random with Repetitions' one (57.7% of this group's visitors) which indicates a level of appealing of the tabletop's feature high enough for visitors to engage with the content.

8.5.5. Attention Time

Additional time recordings were made in order to attain an idea of which features presented on the *Dangerous Australians* tabletop were the ones capturing most of the visitors' attention. A total of 120 visitors were surveyed through this unit of study each reflecting unique yet representative patterns. Data was collected from one visitor at a time, registering the amount of seconds (or minutes) spent by them on each feature (or creature). Although reactive to visitors' actions, environmental elements (i.e. the big crocodile appearing all along the tabletop every 15 minutes and the representations of water and land habitats) were not included in this study. As expressed through data from the previous unit of study, random trajectories were the most common ways of visiting this Case Study's interactive tabletop. It is also possible to infer from such study that not all of the features received the same amount of attention. In fact, and as reflected by Figure 62, the most popular interactive features displayed on the tabletop were the Saltwater Crocodile and the Great White Shark (with 19.9% and 26.2% of time invested by visitors, respectively).

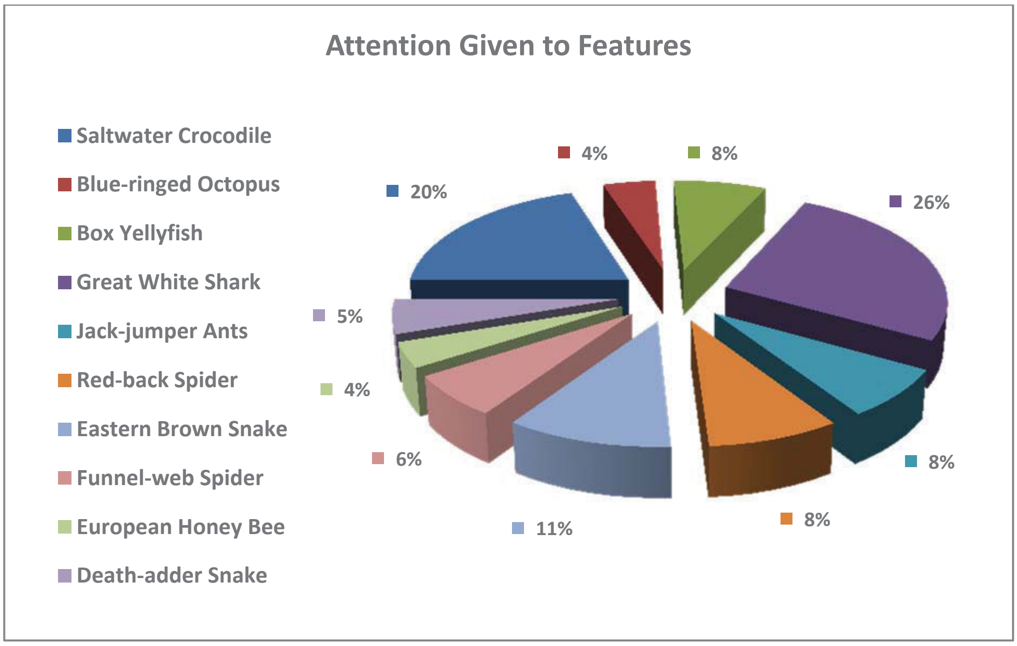

Figure 62. Percentages of time given by all surveyed visitors to each of the tabletop's features.

The 120 data charts resulting from the study were further organized in groups of similar attention patterns, some of which are presented in Figure 63. This additional analysis illustrated that most visitors opted for some features over others. The study, however, did not allow for an understanding of the motives behind this choice-making process. Further observations revealed that not only there is a generalised audience's higher interest in particular features but also factors outside the visitor's control usually affect the interaction selection (e.g. size of audience present at the same time, influence of group members). This is later discussed in the Audience Response study section.

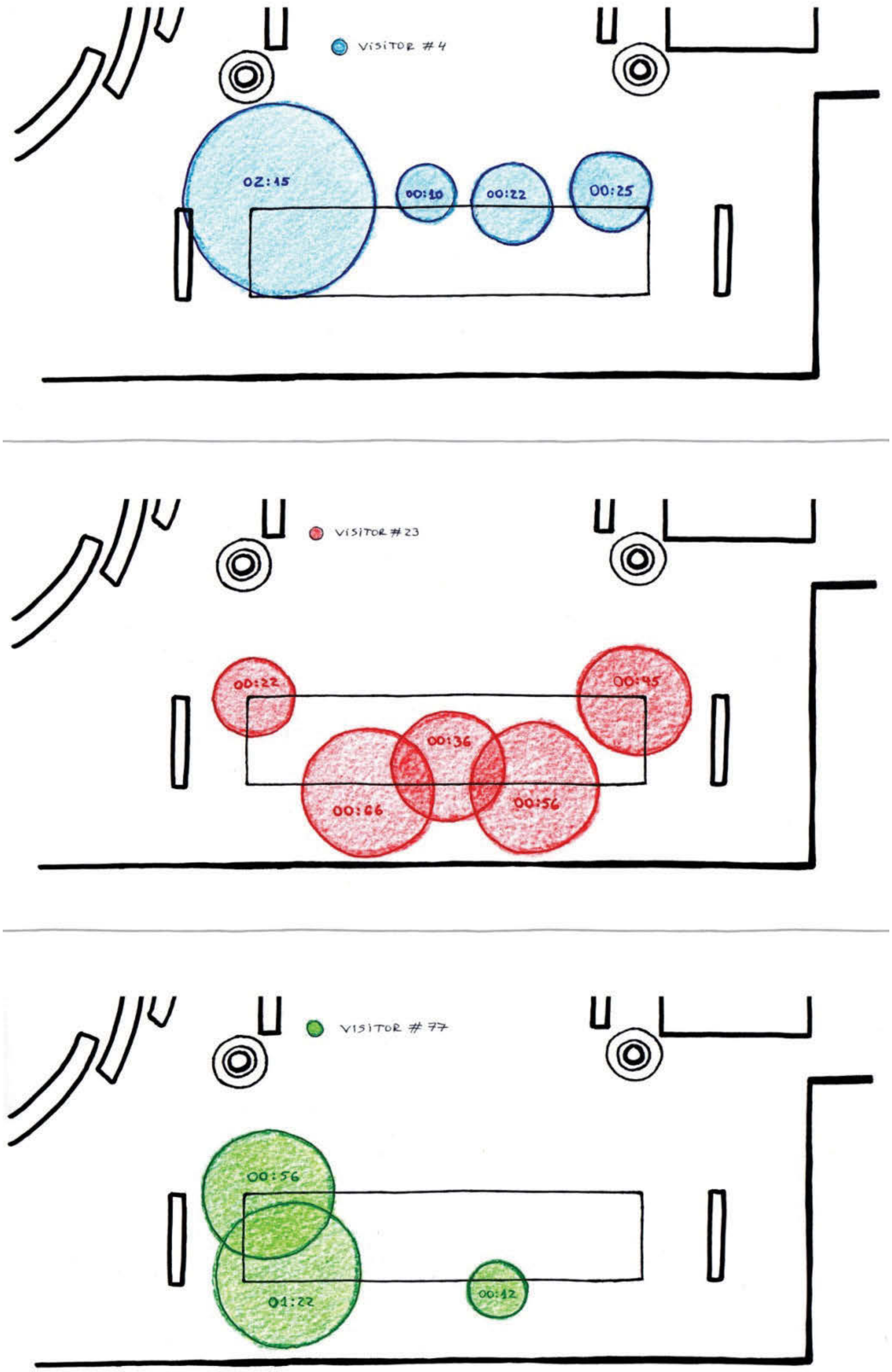

Figure 63. Attention patterns depict with more clarity those features visitors gave more attention to.

8.5.6. Bodily Gestures

The bodily expressions and gestures of 95 participants were observed in order to obtain information as per how visitors interpret the operation of the tabletop's features and the ways these can be affected through their bodies. Although the system's responses of the *Dangerous Australians* exhibit are triggered only through interactions on the tabletop's surface, the human body is a complex system that reacts as a whole to its surrounding space, regardless of the main sensory modality addressed at a given interaction. Accordingly, a count of the most recurrent hand gestures as well as extremities and torso movements was conducted. As a result of this unit of study, 919 gestural events were observed: 164 hand gestures, 281 additional finger gestures, 114 gestures related to arms, 149 gestures related to feet, and 211 gestures made with the torso.

As a way to define to what extent participants would take advantage of the multi-touch nature of the interactive tabletop, both left and right hands and fingers gestures were analysed through this unit of study. Although most hand gestures were observed being made with right hands it is important to clarify that in no way was this study performed to define a ratio of left and right handed visitors[22]. Out of the 445 gestures made with hands and fingers 296 were made with the right hand (67% of the gestures) and 149 were made with the left hand (33% of them). This is an interesting outcome as it suggests that not only the hand with which the participant was more skilful with was used to interact with the tabletop. This ratio remains consistent when narrowing down the values to hands only and fingers only (64% vs. 34% and 67% vs. 33%, respectively).

More than with their hands, *Dangerous Australians* visitors interacted with the content using their fingers the most. Pointing, poking and 'clicking' (as it is done with a mouse or on a touch surface) with one finger was as frequently observed as tapping and touching with all finger tips (see Figure 64). Most gestures were performed with the right hand: 23% of the gestures were

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[22] According to the Australian Bureau of Statistics approximately 10% of the Australian school-age population might be left handed; it is reasonable to assume a similar ratio of the *Dangerous Australians* exhibit' visitors were left handed as well. This information has been taken into consideration when analysing the study's data. Source: http://www.abs.gov.au/AUSSTATS/abs@.nsf/allprimarymainfeatures/9E4764070C78DBF7CA2573AA000F39F9

made with the right hand's fingertips and 24% made with the right hand's index finger. In contrast, left hand's fingertips events were registered in a 14% while left hand's index finger events were registered only 15% of the times. Two-finger interaction was less frequently observed yet they still represent 23% of all finger-based events registered.

Figure 64. A sequence showing different uses of fingers in the interaction with *Dangerous Australians*.

When using the whole hand to interact, most participants tapped on the tabletop's surface with their hands extended and gently moving it up and down; this hand gesture was observed being made with the right hand in 62% of participants and with the left hand in 25% of them. Both hands were use at least once simultaneously by 22% of the participants surveyed. The use of this hand gesture, altogether, accounts for 51% of all hand-based events observed. Another hand gesture commonly observed was the extended hand hovering sideways on or above the tabletop's surface, as depicted in Figure 65. This gesture accounts for 38% of all hand-based gestures. Although not too common, knocking with the knuckles or banging with a fist was another hand-based gesture observed (12% of the events).

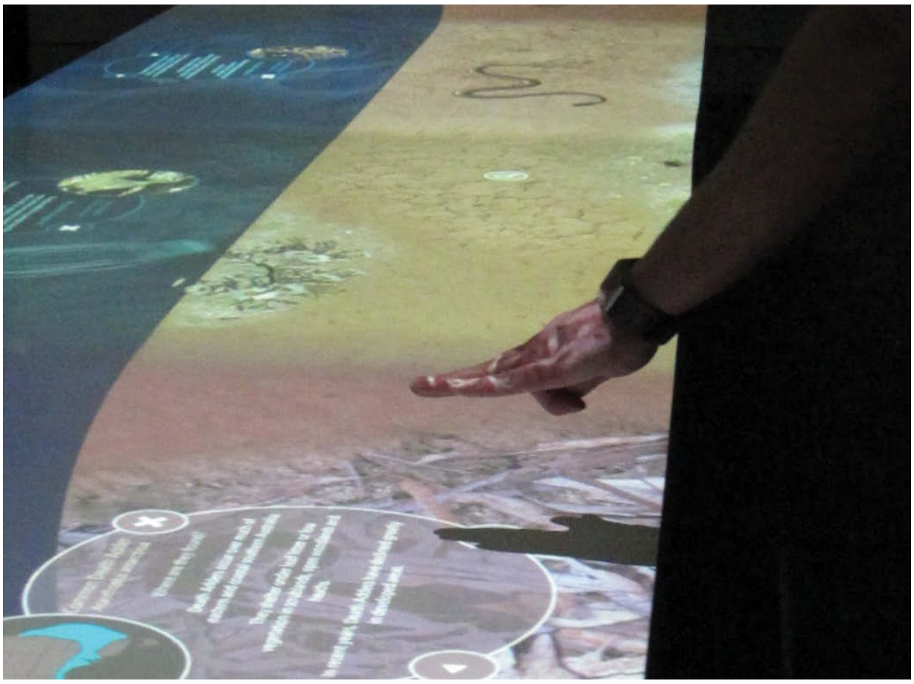

Figure 65. A participant hovering his left hand above the surface over an action button.

Although not using their bodies to interact with or affect the exhibit's content, participants would present different torso postures when approaching the interactive tabletop. Six regular bodily gestures centred on the torso were observed: straight next to the table, leaning towards the surface, bent over the surface, on the surface (e.g. sitting or standing), hanging from the edge of the tabletop, and standing away from it. Figure 66 shows some of these postures.

Figure 66. Participants interacting while standing straight, bending over the surface and leaning on it.

Most participants performed a combination of these bodily expressions (e.g. standing close to the table, then leaning towards a feature, then moving away to have a better look at it, getting closer again, and so forth). All of the observed participants stood straight next to the table at least once which might suggest the tabletop's proportion fits most visitors' bodies evenly. Out of the 95 participants 25% stood away from the table for a while before approaching the edge which could be interpreted as apprehensiveness (as it can be observed in the sequence of Figure 67); however, it has been observed that many parents take this attitude before approaching the tabletop, allowing their children to explore first.

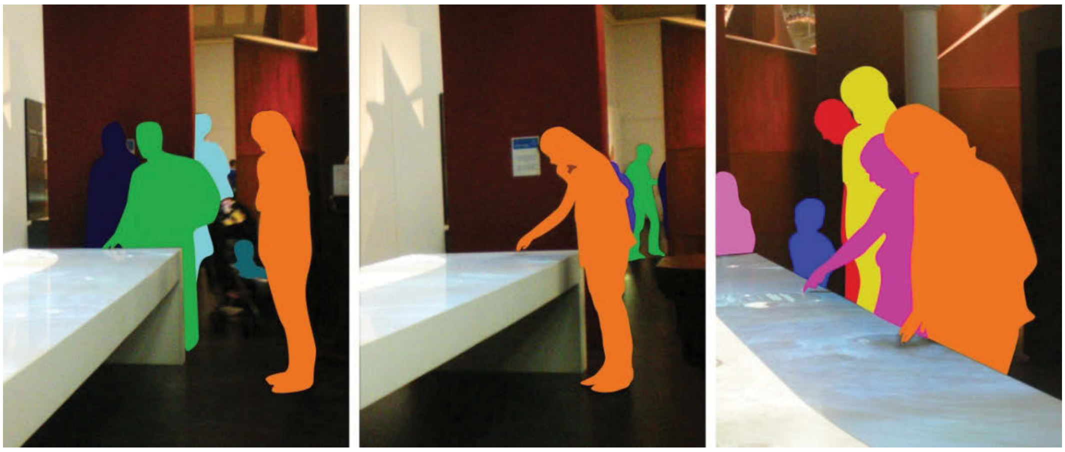

Figure 67. A visitor looks at the tabletop's content from a short distance and approaches gradually to interact.

The most surprising bodily gesture observed during the Case Study was the confidence with which little children - in occasions not very little - hop on the tabletop and either sit there calmly or have a stroll along the landscape (see Figure 68). This was observed in 7 of the 95 participants surveyed in this study. Similarly, 15 of the participants would jump or bend over the edge and hang off it.

Figure 68. Children were frequently observed sitting or standing on the tabletop.

While it would be natural to assume that all participants would stand on both feet when interacting with the *Dangerous Australians* tabletop, it is also true that many visitors would make use of the table for more than simply touching its surface. As expressed in the previous paragraph, a few participants were observed sitting on the table or hanging off its edge, this would mean that their feet were off the floor. Swinging legs were observed in 21% of the surveyed visitors. As it can be observed in Figure 69, the height of the tabletops' surface and the short size of some young visitors did not always result in a comfortable experience. Although throughout the Case Study adults were regularly observed lifting up their children so they could interact with the creatures, most children would usually find their own ways to reach the surface. Jumping off the floor to catch creatures swimming far from the edge or to have a better yet intermittent look at them was observed in 20% of the participants. Likewise, little children reaching the tabletop's surface while rising up on their toes, as shown in Figure 70, were observed in 25 occasions among the 95 participants.

Figure 69. A young and short participant trying to reach the features on the tabletop's surface.

Figure 70. Reaching some of the tabletop's features would require several children to rise up on their toes.

Out of the 95 participants surveyed in this study, 27 visited the exhibit with at least one busy hand. Some visitors would approach the *Dangerous Australians* tabletop while carrying objects such as bags, museum guides, water bottles and prams, among many others. Some others would have a hand resting on a hip or inside a pocket. In 59% of the cases visitors found a way to free their hands in order to more easily interact. Interestingly, 2 visitors were observed interacting with one arm straight down their sides at all times (movements for other purposes were observed yet not attempting interaction with the tabletop). Arms crossed on the front or held together on the back were observed in 16 visitors, accounting for 13% of all events. Out of these visitors, 6 opened up their arms to interact with the tabletop and got them back crossed on front or held on the back right afterwards.

8.5.7. Social Interactions

A rich variety of social interactions was observed during this unit of study. The particular spatial characteristics of *Dangerous Australians* allowed visitors to circulate about the room and access the exhibit's content from different points. This would regularly result in the crossing of paths, physical contact and, eventually, shared interactions and impressions. Anticipating the nature of possible social interactions to take place at the exhibit a set of social behaviour categories was developed and later refined. A total of 14 different behaviours were devised with equal amount of collaborative and conflictive social responses. During data collation the behaviours were organised in a value scale, spanning proportionally from the most collaborative to the most conflictive responses. Behaviours were observed in both small and large groups of visitors. The criterion for selecting participants for this unit of study was the identification of two or more visitors interacting close to each other. In all of the 1,917 situations observed some level of social interaction took place. Table 11 describes in detail the behaviours observed and some of the variations identified during the execution of the unit of study.

Social Behaviour	Description and Variant(s)
Participants play a game together	One or more participants create a game (e.g. tease the snake until reacting, avoid getting bitten by the shark, create circular waves on the water) and play together. Variants: other group members or visitors notice the game and join or are directly invited to play; participants contribute to the game by creating rules or adding new actions.
Participants explore together	One or more participants interact with the same feature together. Variants: other group members or visitors join the exploration or are invited to join; participants discuss content and/or share previously known information.
Visitor(s) helps participant	One or more participants are finding difficulty in the interaction and other group member or visitor approach to provide assistance. Variants: participant asks for help; visitor demonstrates how to interact from a distance.
Participant explains to or encourages other(s)	Participant shares his/her experience with other group members or visitors even when they were in no need of help. Variants: participant insists on others to explore in his/her way; participant shares out loud with no particular addressee.
Participant facilitates content access to other(s)	Participant makes textual and visual content accessible to group members impeded to access it (i.e. they cannot read or they are too short to see). Variant: participant is encouraged by a group member (e.g. parent) to practice reading skills.
Participant invites other(s) to join	Participant calls out for other group members to join either his/her own interaction or the exhibit in general. Variant: participant leaves the exhibit momentarily to find group members.
Participant observes other(s) then follow	Participant is at the exhibit exploring on his/her own but when observing other visitors interacting follows their actions. Variants: Visitor observes participants from a distance and then interacts in a similar way; participant seems to be unsure of how to interact so he/she observes others first; participant changes his/her mode of interaction after observing others.
Member(s) ignores participant(s)	Participant at the tabletop tries to get the attention from other group member(s) but is ignored (either intentionally or unintentionally). Variants: Participant achieves attention but does not last; group member pretends to pay attention only.
Participant blocks other's interaction	Another participant or group member obstructs participant's interaction by walking by or stepping in front of him/her (either intentionally or unintentionally). Variant: participant's body parts obstruct participant's vision.

(table continues on next page)

Participant interrupts other's interaction	Another participant or group member interrupts an ongoing interaction (e.g. a video playing, a text being displayed) by interacting with the feature's action buttons (either intentionally or unintentionally). Variation: participant is waiting for an animated feature to perform an action and another visitor starts interacting with its information graphics; another participant's body parts activate action buttons of the participant's feature.
Participant's interaction is stopped	Participant is called by other group member(s) to continue their museum visit. Variants: group member suggests participant to let others interact; participant is removed from the exhibit by other group member as a result of a conflict.
Participant moves other(s) away	Visitor pushes participant in order to interaction with a feature. Variant: participant clears the surface from other participants' hands and arms so as to allow a feature to appear (e.g. wait for sharks to swim up to the surface).
Member(s) reprimands participant	One or more participants are scolded by other participant(s), group member(s) or visitors for something they have done.
Participants argue over use of section	Participants try to access the same feature at the same time, resulting in either a verbal or physical dispute.

Table 11. Social Behaviours at *Dangerous Australians* explained.

As expressed by Figures 71 and 72 the great majority of behaviours observed were those associated to positive social experiences. Assisting other visitors - whether relatives, friends or complete strangers - was widely observed around *Dangerous Australians*. One of three participants (29.6% of interactions observed) was observed either providing help to or receiving help from other visitors, in forms as varied as explanations, suggestions, assistance and encouragement. A rather quiet social interaction was also observed in which a participant would observe other participants already interacting in order to gain a clear idea of what to do next. This passive social behaviour was observed in 14.5% of the interactions.

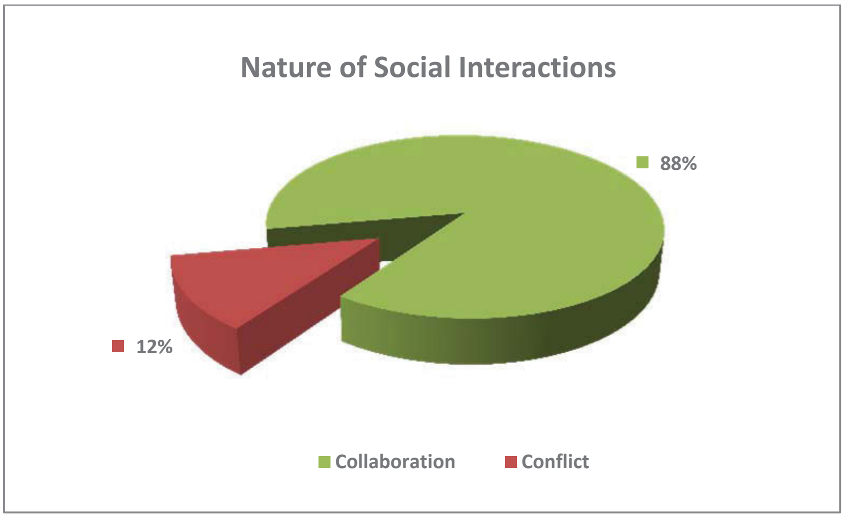

Figure 71. The great majority of the social interactions observed reflected a sense of collaboration.

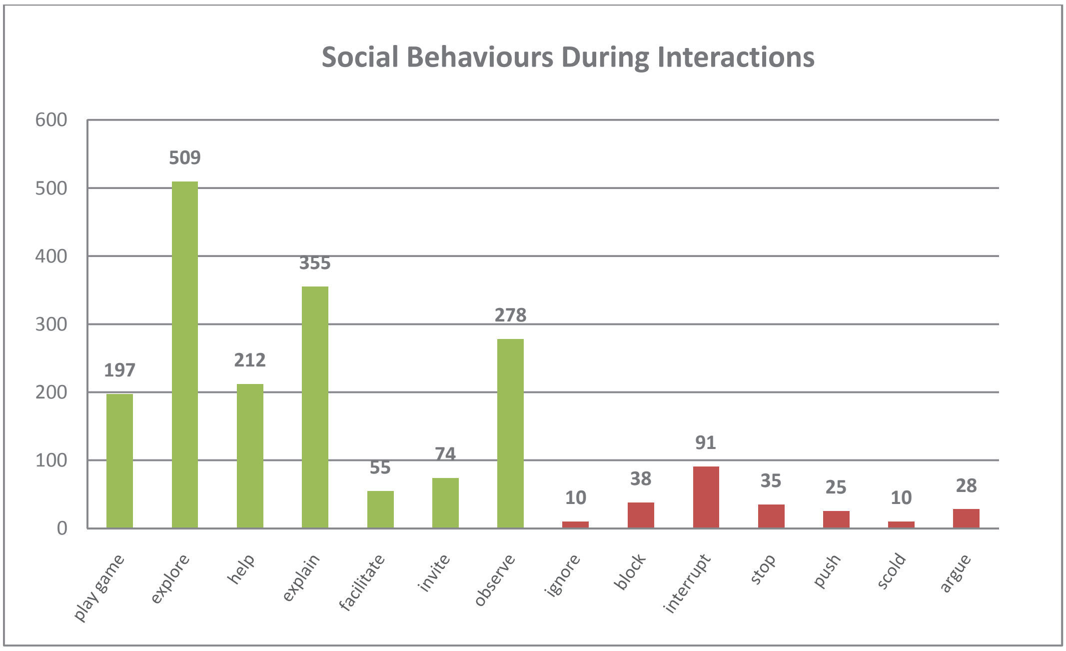

Figure 72. The occurrence of each social behaviour throughout the development of the unit of study.

The social behaviour most frequently observed was the shared exploration of a feature with one or more other visitors; this behaviour was observed in 26.6% of all interactions and would mostly occur among known group members (e.g. relatives and friends). Figure 73 shows a sequence of several shared exploration behaviours within a family group. This sense of shared exploration reached a higher level when a game resulted out of the interaction: a total of 36.8% of the social interactions were based on either a social game or a shared experience (Figure 74).

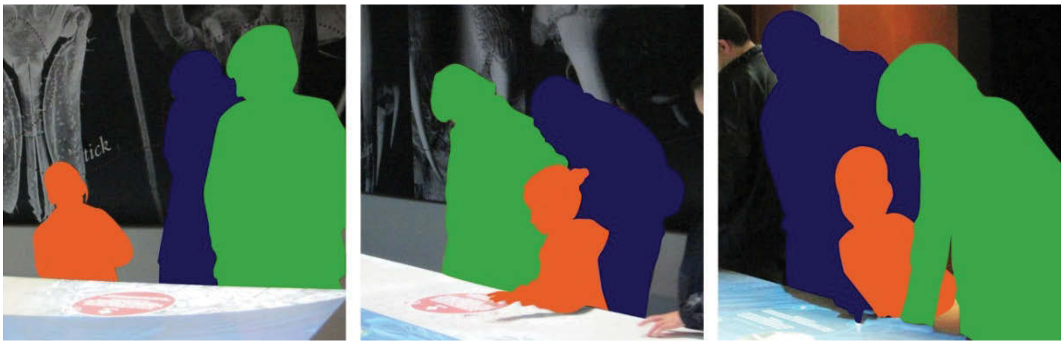

Figure 73. A girl is encouraged by her parents to explore and explain; shortly after they explore together.

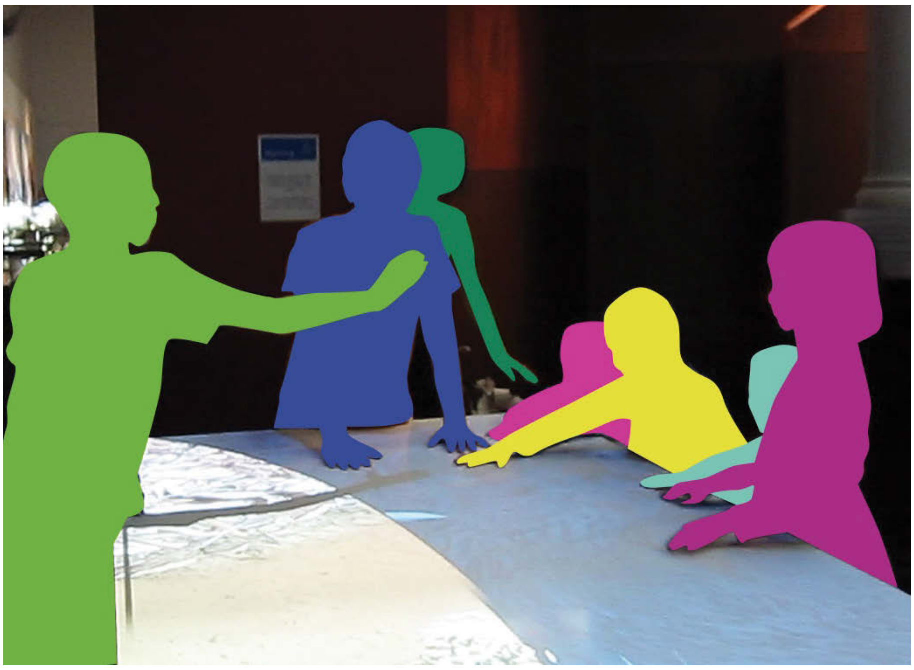

Figure 74. Participants from different visiting groups engage in a game with the sharks.

Behaviours of conflict were rarely observed during this unit of study: only 12% of the interaction responses were associated with negative social experiences. Hardly ever these interactions would result in aggressive situations; it could be said that these were rather unpleasant, instead. For instance, only in 10 occasions a group member was observed reprimanding a participant; in all of these cases this was done so as to avoid a conflict caused by a child (e.g. the participant was disturbing others or fighting over the use of an exhibit's feature). In this respect, fights or arguments were uncommon, observed in only 1.5% of the interactions. The most common conflictive responses observed had to do with interruptions of interactions. On occasions, and mostly as the result of an involuntary action, participants would activate a feature being used by participants, block their views by reaching out over the table with their arms, circulate around the tabletop and suddenly stop between another participant and the feature he/she had been interacting with. This was altogether the most frequent conflictive behaviour, representing a 6.7% of all interactions observed.

8.5.8. Audience Response to *Dangerous Australians*

The seven units of study described above allowed for a systematic collection of data through a mixture of quantitative and qualitative research techniques. During the execution of each of these studies several phenomena and trends were identified. An additional study, structured by the need of gathering detailed information directly from the context and the visitors, was necessary to complement and corroborate findings. The study of visitors' overall interactions with the exhibit and the account of their experiences were conducted by means of interviews and further observations.

Semi structured interviews were conducted with visitors as they left the *Dangerous Australians* exhibit space, making sure their experiences were not interrupted. Participants were selected ensuring a homogenous set of perspectives and opinions. Ranging from all ages, 47 women and 50 men participated of this study. Adults represented the largest group of interviewees (41.2% of them were between 25 and 49 years old), followed by small children (29.2% of interviewees were younger than 11 years old), youngsters (17.5% were between 12 and 24 years old), and seniors (11.3% were aged 50 years and above). The interviews were developed in an informal manner so visitors had an impression of being taking part of a conversation rather than of a survey. On occasions, participants would leave the exhibit already commenting their experiences; in such cases their group conversations would not be interrupted and they would only be invited to be interviewed once they had finished (this would sometimes involve developing the interview in a different exhibition room).

A set of pre-defined questions were presented to the interviewees as part of the conversation yet the tone of the dialogue was expected to invite them to share their experiences at their own pace and will. The following are some of the most significant questions made to the participants; naturally, the wording and tenor of the questions would vary according to the interviewees' profile:

- Have you been to the Australian Museum before? If so, did you remember the *Dangerous Australians* exhibit?
- If this was your first time, did you know it was here? What drew you to enter the exhibit's space?
- What would you say was the most appealing aspect of the exhibit? What drew you to interact with it?
- What would you say were the most interesting features of the interactive table in terms of format and content?
- Have you seen an exhibit like this before? If so, where and when?
- Have you seen something else like this before? If so, please tell me more.
- To what extent would you say it was clear for you how to interact with the exhibit? Did you need any help?
- What could you tell me about your experience? Could you describe what you though and felt when interacting with the exhibit?

Young children were usually more reluctant to answer questions or give full accounts of their experiences; their parents or tutors would often encourage them to participate and help them express. Young participants (teenagers and young adults) would typically provide more complete answers and draw the interview into conversations around diverse exhibit-related topics. Adults would usually express themselves in more detail and associate their experiences with others;

occasionally, they would enquire for more details about the exhibit (e.g. underpinning technology, cost of production, origin of the idea).

Consistent with previous researches by the Australian Museum, most of the visitors interviewed had already been to the museum; 20 of the 32 groups of visitors interviewed informed that all or some of the group members was revisiting the museum. Not all of these interviewees said to remember the exhibit from previous visits, however some of them had not attended the museum in several years (it is important to remind the reader that the *Dangerous Australians* exhibit had been available to the museum's audience since June 2008 only). Of those interviewees who said to remember the exhibit (38 participants), several also mentioned they had been looking forward to interacting with it again. During unstructured observations it was also noticed that some visitors would return to the exhibit - occasionally more than once. Children were typically identified coming back shortly after leaving the exhibit, while still exploring the *Surviving Australia* exhibition. Also, many were observed entering the exhibit's space as if they knew exactly what was in it. This phenomenon speaks of an exhibit that is easily retained by both short and long term memory and that it produces in the audience the retention of a pleasurable experience.

When asked about the space, the exhibit and its level of attraction, one aspect in particular was recurrently mentioned: the lack of light (Figure 75). Opinions were divided and varied; whilst some interviewees suggested it added to the sense of mystery and theatrical effect, some others expressed it made it hard to tell from outside what was happening inside the space. Reflections around how some of the surrounding information panels and graphics were lost in the space due to the lack of light were made by four interviewees from separate groups. Thoughts about the convenience of a round table instead of a rectangular one were made by five interviewees and four suggestions for stools for small children to sit or stand on at the tabletop were made by six of the 32 groups.

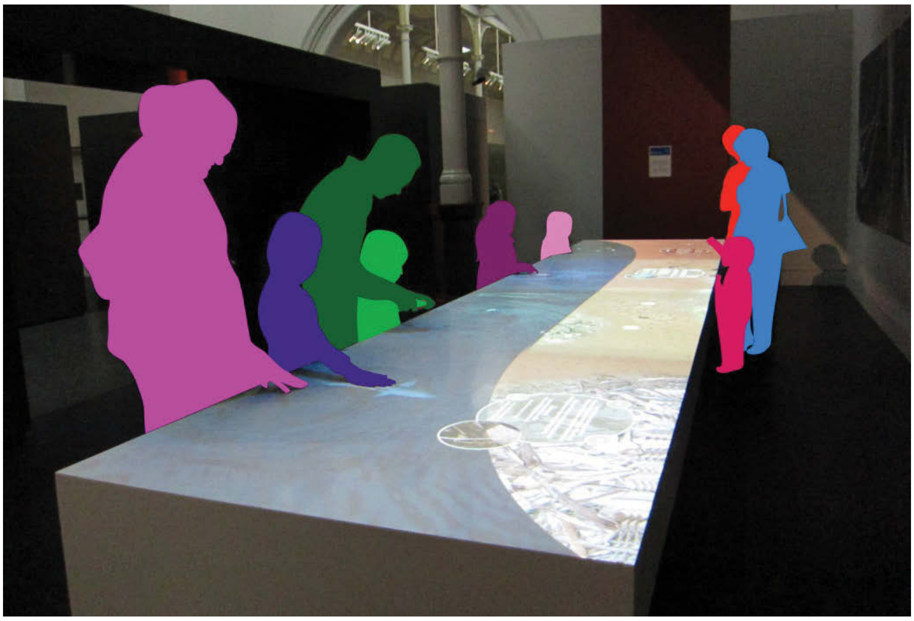

Figure 75. Dark enough for the projection to display properly yet for graphic panels to be overlooked.

From the examination of the design of the space and its content, in combination with observations of audience's response to the spatial experience, it can be asserted that contrast and volume played a crucial factor in the exhibit's level of attraction. Within an overall generous and comprehensive exhibition space, both in terms of architectural and content structure, the *Dangerous Australians* exhibit stands out mainly due to its large components (i.e. complementary snakes exhibit, back wall graphics, information panels and the tabletop itself) and effects of light and colour. However, the ability to draw visitors into the space is somehow weakened by the same spatial conditions: the exhibit tends to get lost behind the big panels and within the dark space (see Figure 76). On the other hand, it was also observed that the crowd attending the exhibit had a considerable effect on drawing more visitors in: the more participants gathered around the tabletop, moving and making noise, the more visitors would get in and join.

Figure 76. The *Dangerous Australians* exhibit as seen by visitors when passing by.

In respect to audience' appraisal of the exhibit, almost all interviewees engaged in a series of comments celebrating the originality of the exhibit (29 groups) and how much fun it had added to their visiting experience (24 groups). Most groups interviewed (27 out of 32) expressed that the most appealing aspect of the interactive tabletop had to do with the realistic effect of the displayed content: quality of graphics, quick response to users' actions and useful information were some of the elements most mentioned. Some of the adjectives that interviewees used to describe the appeal of the exhibit the most were: *vibrant*, *colourful*, *original*, *catchy*, *different*, *scary*, *tempting*, and *fascinating*. Through observations several emotional responses and reactions were identified; all of the visitors observed showed to be pleased and enjoying their experiences. Although on occasions some visitors would seem confused about the operation of the exhibit they would also seem comfortable with the possibility of a free exploration. As Figure 77 shows, curiosity, surprise, playfulness and delight were the most widely expressed responses by the *Dangerous Australians*' audience. two series of expressions, representing typically observed audience responses during their experiences with the exhibit.

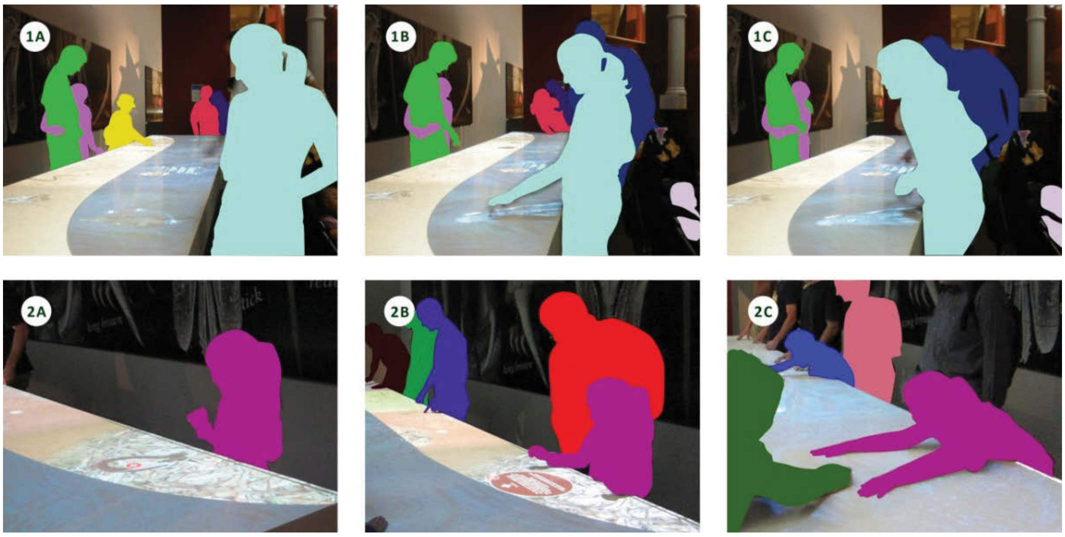

Figure 77. Two series of images depicting audience's responses. Sequence 1 shows curiosity (1A - 1B) and surprise (1C). Sequence 2 shows surprise (2A), curiosity (2B) and playfulness (2C).

Only three interviewees commented to having seen similar exhibits before; the Australian Centre for the Moving Image (ACMI) in Melbourne and The Immigration Museum in Brisbane were mentioned yet no further details were provided. Connections between the experience and interaction with the *Dangerous Australians* exhibit and other similar interactive experiences beyond a museum context were made by 42 participants. Most of the accounts were related to tablet computers and interactive touchscreens in contexts as diverse as shopping centres, car-parks, work and learning environments. Interestingly enough, smart phones were mentioned by only 2 of the 97 interviewees. The participants that could link the current experience with previous ones described those interactions, in general terms, as instances in which information was accessed through a display by touching its surface with the fingers or hand. This association of interaction modes helps make sense of the way almost all observed participants would approach and interact with the tabletop. In most cases visitors would walk straight to the tabletop and start touching its surface randomly. Varied responses were observed after the first contact, which spanned from sliding hands over the surface, touching the creatures' animated representations, tapping on information windows' action buttons, and hovering arms and hands over the features.

The technology behind the *Dangerous Australians* exhibit intrigued, surprised and pleased its audience in general. Several interviewees (from 7 different groups) asked about the specific technologies utilised in the system (e.g. hardware specifications, software and programing language used, sensors). The rather silent presence of the technology was also appreciated by many interviewees, with 12 groups mentioning that the technology was not a distracting factor and that it would only make the experience better.

When invited to explain how their interactive experience took place and how they had interpreted the use of the tabletop, most groups of interviewees (19 out of 32) stated that they thought they needed to touch the action buttons and moving elements to make changes or get more information displayed. In 8 groups this account changed throughout the interview as members engaged in a discussion around the topic; they all ultimately decided the exhibit was not a touch-table but they could not agree on a definite operation. Only 5 groups were absolutely certain as per how the system worked - and they were all correct. According to most accounts (29 of the groups), interaction modes were clear to visitors: action buttons and moving creatures afforded some sort of contact and invited them to interact (see Figure 78). In contrast, the specific effect of some actions over the features and how to achieve certain reactions were said to be mostly unclear (25 groups explained, for instance, how they could not get the sharks to appear again, how the crocodile would not be annoyed at times, or how the snake would not change its course when teased).

Figure 78. Left: a participant touches the correct action button to close the pop-up graphic. Right: two participants bang with their fists on a non-interactive video section.

While interacting with the *Dangerous Australians* tabletop, some participants were asked to share their thoughts and give an account of their interactions. Questions made were different to the interview ones as they were mostly expected to start a conversation or trigger a free expression of emotions and meaning making while interacting. When approached, participants would hear questions such as 'how do you know what to do with that?', 'what did that creature made you feel when jumping towards you?', 'how hard do you need to splash on the water for the shark to show up?', and 'did that information help you understand this creature and the effect of its attack?'. The responses collected through this contextual enquiry supported and clarified the many observations made throughout the Case Study. In general, they helped conclude that most participants start by interacting randomly and allow themselves some "play time" before figuring out exactly what to do and how to do it. As observed through other units of study, information collected from other visitors was crucial: participants tended to learn from others (by observing or verbally enquiring help) and they certainly enjoyed doing so.

Both semi-structured interviews and contextual enquiries led to a small collection of short literal expressions (to guarantee participants' comfort no voice recordings were performed, hence only quick annotations were possible). These expressions reflect their perceptions of the exhibit and its content, as well as their experiences, both from an individual and a social perspective:

- “What an exciting prospect to be able to witness so many of these creepy things!” (senior male, while interacting).
- “Where is it? Where has it gone? Call it back, call it back!” (pre-school girl to girl infant, while interacting)
- “This must have cost a **** lot of money!” (young adult male, when interviewed)
- “Well, you have to touch there and it – see? It shows up”(young female, while interacting)
- “Now I know I will survive Australia!” (young male, tourist, when interviewed)
- “I’m not too sure whether these are endangered species. Are they? *Are we*?” (adult male, standing at a distance while watching his children interact)
- “Oh, Mum, come on… (…) Ok, ok… but, can we come back later?” (infant girl to her mother after she insisted to keep going)
- “We timed our trip here perfectly because the day after tomorrow we are off to Queensland coast where most of these beasties live! We feel safe now [nervous laughter]” (young mother with two infants, when interviewed)
- “Nanna! We’ve gotta come again with Mum [mischievously laughing]. She hates snakes!” (boy infant, while interacting, to his grandmother standing behind him)
- “I think you have to fly with your hand, like this… Weeeeeh… Then, when it comes out, you can touch it… Weeeeeeh, weeeeeeh. (…) It doesn’t always come, though.” (female teenager, while interacting)
- “Stop closing my game! Go get yours!” (pre-school boy to pre-school girl, while interacting)
- “Can you hear the buzzing? Oh, wait! Can you *feel* the buzzing? Here, touch the table… How cool is that?” (male teenager to female teenager, while interacting with the Bees feature and touching the unintentionally vibrating surface)
- “Hey, did you see the long fish? (…) Yeah, yeah, that, the *jellyfish*. I didn’t read it, OK? I just played with it. It’s so cool!” (male infant to his father, while interacting)

- “Now, this is what we do: you, you and you, just hide there. Don’t let it see you! I’ll jump and poke him and then we attack! Wait… wait…” (male infant, to several participants, while interacting with the Sharks feature)
- “Look at them. They love it! Do you think there’s any chance we will get to see any other exhibition? We’re stuck [smiling please].” (mother pointing at her three pre-school children, while standing next to them)

The overall appraisal of *Dangerous Australians* by the 32 groups of interviewees was, without a doubt, a positive one. With the exception of the lack of light, no individual or group of visitors evaluated their experiences as negative or lacking anything in particular. The possibility of learning and having fun at the same time was one of the aspects best valued about *Dangerous Australians*; this mix of cognitive and emotional experiences were mentioned by 26 of the 32 groups. The possibility of accessing information as a group and sharing the experience with other visitors was evaluated as one of the best attributes as well, with 24 groups agreeing. Finally, the sense of modernity this kind of exhibit adds to the museum was mentioned by 17 of the interviewed groups.

8.6. The Voice of the Creatures: Case Study Findings

Dangerous Australians was the first exhibit of its kind to be presented in a museum in Australia. When technologies of personal use based on seemingly touch-sensitive systems were starting to become more pervasive in people’s everyday life, the Australian Museum’s audience found in a public setting a large multi-user device that invited them to experience similar interactions in a social context. Conducting a Case Study in a cultural heritage institution with an audience of the size and variety of the Australian Museum’s audience means having access to a rich array of experiences and, consequently, potentially meaningful research insights. This section presents the most relevant findings from the study of visitors’ experiences with the *Dangerous Australians* interactive tabletop, comprising aspects of design, technology, visiting experience and social interaction.

The space in which the *Surviving Australia* exhibition is set offers the visitor not only a collection of heritage content but also an environment of historical relevance. Many of the gallery's original architectural features were kept as part of the spatial narrative adding to the sense of physical, emotional and cognitive exploration. Exhibitors, information panels, furniture, lighting and sound are combined structuring corridors and pockets of content for visitors to walk about. As reflected by the research conducted this structure facilitates the visiting pace and selection, guiding the experience through different levels of immersion, concentration and engagement. Upon approaching the *Dangerous Australians* exhibit visitors' response to its spatial attributes are varied. Whilst approximately 2 out of 10 visitors to the *Surviving Australia* exhibition were observed passing by this particular exhibit and ignoring it, the remaining audience was not only drawn into it but most of it actively engaged in both an individual and a social way. Field data suggests that *Dangerous Australians* is an exhibit that engages its audience to a great extent. Research data shows how not only architectural and interior design elements contribute to the appealing of the exhibit but also the audience itself, in its various interaction expressions, stimulate more visitors to approach the exhibit. *Dangerous Australians* stimulates considerably expressive reactions in its audience; while walking by the exhibit down the corridor or visiting the adjacent exhibition, visitors can hear and see the excitement of the impressed crowd. All in all, it can be concluded that the *Dangerous Australians* exhibit is a comprehensive spatial experience.

Once at the exhibit, visitors' interactive experiences are also varied. This research showed that young and mature audiences respond to the exhibit in different ways; however it was also observed that they engage in rather similar levels. Adults tend to move away from the tabletop so as to leave enough room for children to interact, yet they are easily persuaded - equally by the children and their own curiosity - to experience the exhibit directly as well. In regards to the content displayed, while children most typically interact in a random, playful way, adults usually dedicate more time to absorbing the factual information provided. It was often observed that both types of visitors would, at some stage, exchange information complementing with each other what they have learned from the experience. Although the graphics displayed communicate quite clearly what actions are possible to be performed and the subsequent steps are clearly mapped, it was observed that many participants ignore the interaction map and drive their exploration by a sense of exploration rather than logic. Even when the information is provided in discrete, easy to attain pockets of content (e.g. short texts and video clips, simple 3D representations, etc.), visitors tend to perform a quick review of information and dedicate more time to activating as many features as possible. This interactive response was more evident in young children, whose attention span is naturally shorter and their interest is more focused on playing than learning. Nevertheless, the overall impression of the *Dangerous Australians*' audience, as informed by their direct accounts, is that it provides enough information for a meaningful learning at the time it makes the experience enjoyable and unique.

In regards to the design of the *Dangerous Australians* exhibit, it is possible to affirm that, within the overall museum and exhibition contexts, it stands out as a visiting experience centre piece. According to its audience's appraisal, the tabletop evokes positive impressions and reactions, and it is regarded as pleasurable and attractive. The exhibit responds to the demands of an audience that expects to find in the museum an embodied experience, where not only their minds are stimulated but also their bodies. Several understandable limitations (museum regulations, universal accessibility, costs and lifespan, to name a few) narrowed down the design possibilities of the exhibit, particularly the physical attributes. Nevertheless, the interactive tabletop offers its audience expressive visual content, varied interaction paths, subtle yet inciting audible feedback and a diversity of features for a memorable visiting experience (and the seeding of desire for a future revisit). In addition, the design of the tabletop successfully invites the audience to engage in a social experience through which actions and learning are possible to be shared. As observed through the study, the features envisioned to become the most popular ones (i.e. the Great White Shark and the Saltwater Crocodile) are distributed at each end of the table and the less impacting are evenly placed along the landscapes, generating a rather uniform distribution of audience along the structure. It was observed that this structure also facilitates the visibility of most of the content from different points of the table's edge, which means visitors can visually reach the ecosystem performing before them.

As demonstrated by both primary and secondary research in the context of this Case Study, some of the greatest challenges in the design of interactive tabletops have to do with their underpinning technologies and the way these mediate the tabletop's displaying purposes. The conjugation of computer vision-based tracking technology, the projection of content on the surface and the audience input have the risk of distracting and, on occasions disappointing, users during their interacting experiences. Unwanted interferences such as the accidental activation of features or failures in the system's calibration result in misleading responses and, consequently, adverse audience's reactions. The *Dangerous Australians* exhibit was designed with existing technologies and in an early stage of interactive museum exhibits' design. Although nowadays several new technologies and their combinations are available in the market, the surveyed exhibit manages to remain up to date and well interpreted by its audience. As a consequence, the overall visiting experience takes place without major obstacles at the time visitors associate its operation with newly developed systems they now have regular access to. In addition, this increasing familiarity with everyday devices that require similar modes of input seems to have generated in users the confidence to misinterpret possible actions yet keep exploring until succeeding. This was widely observed in the case of the *Dangerous Australians* exhibit, where input modes were often mistaken, resulting in unwanted or unsuccessful outcomes; however, the audience would mostly react optimistically and would seem to enjoy the exploration. Furthermore, it was inferred from participants' observations and direct accounts that an implicit general goal of getting something to happen in the anticipation of retrieving useful information motivates visitors to repeatedly perform actions without paying much attention to the input mode and interaction map. As a consequence, even though tasks were not always successful, rarely a reaction of frustration or disappointment was observed. Field data shows that the technology utilised in the *Dangerous Australians* exhibit is properly kept in the background so that visitors can concentrate on their experiences rather than on the system's operation. Naturally, this cannot be taken as a generalisation as visitors bring along different expectations and personalities to the visiting experience; yet the tabletop provides enough levels of interaction for most of them to feel confident and enjoy the experience.

The ultimate purpose of conducting a Case Study on the *Dangerous Australians* exhibit was to examine and understand the ways visitors make sense of a public interactive environment and the effects the comprised technologies potentially have on the overall experience. The data collected throughout the study informed of, among other aspects, the potential of the exhibit to draw visitors in, the different levels of engagement they achieved and the many social relationships built during the interactive with the exhibit. Direct accounts from participants reflect a largely positive appraisal of the experience and high levels of satisfaction. Upon analysis and reflection of the study's outcomes it has been here concluded that the *Dangerous Australians*' audience tends to approach the exhibit without specific practical goals in mind other than the general museum visiting purpose of learning while having fun; however, at the presence of an innovative, attractive exhibit, visitors expectations are narrowed down and a sense of anxiety and fascination for what it is to come arises. In interpreting bodily and verbal expressions it became evident that the exhibit's audience expects to be informed, entertained, and surprised. This explains in great deal why frustration is barely ever present when an interaction mode is wrongly interpreted and outcomes are not as expected. It is now concluded that the technology behind the *Dangerous Australians* exhibit has an indirect influence on how visitors learn from it; field research data evidenced a high effect of the technological setting on their emotional response, which facilitates the learning process. The technology of the interactive tabletop facilitates and invites exploration - and that is mostly what the exhibit's visitors have in mind when interacting with the various creatures and their sceneries.

This sense of exploration is escalated in the possibility of interacting with others. Today's museum experience is not only a sensory-driven one but also a highly social instance. The use of the table metaphor in the museum environment certainly intensifies these two aspects of experience as the table is an artefact that appeals to two aspects of everyday experiences: the horizontal surface as a functional and social space, and the physical relationship it permits, mainly through the use of hand gestures. Both physical and digital attributes of the *Dangerous Australians* interactive tabletop invite large numbers of visitors to gather around and interrelate with each other in a quest for new knowledge and sensations. The multiple users of the exhibit get to decide whether they prefer to engage in a social experience or, instead, participate in a rather intimate way; the exhibit does not impose one way or the other, it is the audience who makes such decision with the help of the diverse design elements presented. Visitors negotiate the access to and use of the different features of the tabletop in a collaborative environment in which turn-taking and mutual assistance occurs naturally, as if per under an inherent set of social rules. In addition, visitors make sense of the information presented mostly in a social manner, collaborating either intentionally or by chance.

The field of museum interactive exhibits is still in a quite early stage of development. Every year new interactive products enter the market and with them new users' demands arrive as well. With the introduction of *Dangerous Australians* the Australian Museum was able to respond quickly and effectively to the forming digitally-driven demands of its audience. Had it been designed today, the exhibit would have probably followed several of the technological trends that are currently observed in users' digital devices, such as motion sensors and social network capabilities. Despite the accelerated development of technologies out there, the *Dangerous Australians* Case Study findings lead to the conclusion that the exhibit is far from becoming obsolete in the near future as the core of the interactive experience is placed not on the technologies but on the possibilities these offer for a clear delivery of the interpretive message in an enjoyable learning visit.

Summary of Key Findings from the Dangerous Australians Case Study

- Whether as the centre piece of an exhibition or as one of several other pieces, an interactive exhibit needs to reinforce the sense of meaningful ensemble each exhibition is planned for. In this respect, content, features, and allocation within the exhibition space need to respond to the visiting map designed by the institution and the particular visiting interests of the audience.

- For large museums with a varied and numerous audiences the challenge of presenting a comprehensive experience is immense. It is virtually impossible to generate a definite and specific visitor profile for an audience that includes participants of all ages, cultural backgrounds, or particular interests. A palette of different types and levels of content to access, several interaction modes and modalities, and a platform on which freely express tend to facilitate a wider acceptance of and relationship with the interactive exhibit.

- Identification with interactive systems is a common issue in public spaces. A sense of belonging, of being understood and integrated, is not always achieved in the design of interactive experiences that are meant to be carried out while exposed to the scrutiny or judgement of others. The reference to familiar aspects of everyday use of technology is, indeed, a design strategy that may facilitate the interaction; nevertheless, the social implications of the use of technologies are crucial in the success of interactives in the public space.
- Public spaces are commonly administrated under governmental regulations and parameters, guarantying universal public availability and safety for both direct and indirect users. This tends to limit design responses but not necessarily possibilities: cognition, emotions and senses offer great potential for designing both individual and collective experiences.
- Interactive exhibitions that plan for a social interactive experience through the organised use and access of its components reduce the risk of conflict during the interaction and therefore reinforce the sense of engagement with the exhibition's content.
- The variety of visitors that form the audience of a large institution signifies a variety of social responses at any given context. Conflict, interrupted experiences, lack of engagement, are some of the adverse reactions caused by interactive designs that overlooks the social implications of interaction in the public space. On the other hand, collaboration, memorable experiences, and deep engagement are some of the positive outcomes of understanding the social effects digital technologies may have when fittingly integrated in the public space.

- When technologies are integrated into exhibits with a purpose consistent with the institutional educational aims and in a way that allows visitors to access and make use of them freely and easily, these become part of the visiting experience, as opposed to being the experience itself.
- Interactive technologies that suggest and facilitate exploration invite visitors to express in many ways: emotionally, bodily and intellectually. Each of these expressions is in itself a trigger for other visitors to take part of the experience. Participants actively engaged in the interactive experience become enablers of further interactions and extended social experiences.
- With the accelerated development of digital technologies great advancements are more often made in the field of public and private interactive experiences. This means that many applications tend to get easily obsolete, with a consequential need of replacement or updating. When an interactive exhibit is designed with experience as the core component rather than the technology itself, it achieves a long-term position in the museum space.

Chapter 9. Research Contribution and Conclusions

9.1. Overview of the Research Problem

For most part of the twentieth century, the main role of cultural heritage institutions such as museums was to collect objects, study and document their nature and cultural meaning, conserve them and present them to society by different means of display. The museum was regarded as a respectable, important public educational institution. This social perception of the museum and its role has remained in the twenty-first century yet many things have changed, and with them, so have society and their demands.

As discussed in Chapter 3, today's museums face many challenges that urge them to continuously adapt in order to keep their audiences satisfied. Museum audiences are no longer passive receivers of a cultural message but rather active participants and modifiers of it. Audiences have started to consider the museum visit as part of their leisure time activity, which places the museum in a competitive arena along with a wide range of other highly appealing leisure alternatives. Furthermore, one of the greatest changes in the last two decades is that people in general are getting increasingly exposed to a variety of new technologies in different contexts and most of them now consider these as an integral component of their everyday activities. In this context of pervasive technologies museums encounter both a challenge and an opportunity. As discussed in Chapter 2, new technologies offer users the possibility of communicating with the world in more varied and expressive ways, of connecting with it and transforming it, of making new meanings out of it, of engaging with others. In this respect, the introduction of new technologies in the exhibition environment represents a great opportunity for the museum to offer new, meaningful and long-lasting experiences to its visitors. The challenge for the museum, however, lies on successfully meeting both the audiences' and the institutional educational needs without risking the technologies to take over the museum's core product: its collection.

This doctoral project has aimed to explore the impact the integration of new technologies may have on the museum visiting experience focusing on interactive exhibitions as distinct types of interfaces between cultural heritage content and the audience. In order to be able to discuss the relationships between museums and technology, the following research questions were formulated:

> *How do visitors perceive interactive exhibitions and how does that perception influence their engagement with them? Does social interaction influence this perception in any way? If so, is there a social negotiation and common understanding in order to make sense of the exhibition content?*

The research was conducted through two forms of enquiry: the review of existing literature in the fields of Museum Studies and Human Computer Interaction, and a field exploration of real exhibition contexts and their visiting experiences. Through the literature review and case studies chapters I argued that the experience of interactive technologies in public spaces occurs through dynamic experiential processes of physical, social, emotional and cognitive engagement and that, depending on their specific context, levels and quality, these experiences facilitate users' meaning-making of the space and its content. In the particular case of the museum visiting experience I also argued that the presence of interactive technologies in the exhibition environment has a particular effect on the ways visitors socially engage to achieve a personal unique experience. Altogether, the literature review and the case studies presented in this doctoral dissertation suggest that the visitor experience is the core building block in the design of interactive exhibitions and that this must be studied and understood as a social dynamic phenomenon, not as an isolated static user problem. The outcomes of both the theoretical and the field-based enquiries have isolated several central points regarding the integration of interactive technologies in the museum exhibition environment and its impact on both individual and social visiting experiences. These will be discussed in the Conclusions section of this chapter. Yet the research process led to another significant contribution to the design problem area of interactive museum exhibitions: a referential model for the future study of social experiences with interactive exhibits. This will be presented and explained in the next section.

9.2. Referential Model for the Study of Visitors' Experiences with Interactive Exhibits

Through the review of the literature I identified two research approaches that influenced the way I made sense of visitors' experiences with computer-based exhibits from an interaction design perspective. These approaches informed my field works' methodology design and procedures. In addition, through field work experience I developed a categorisation of stages of interaction with computer-based exhibits and installations. Together, these theoretical and field survey outcomes helped me build a referential model that I herein put forward for future studies of visitors' experiences with interactive exhibition environments.

The first influential research approach that informed the model was that of John McCarthy, Peter Wright and Lisa Meekison regarding the designing for users' experiences with digital technologies from a human-centred and reflective perspective (McCarthy, Wright & Meekison 2003). As thoroughly discussed in the Methodology chapter, the authors proposed a conceptual framework of reflective tools for designers to approach the problem space and comprehensively understand users' interplays with their technological environment. I adopted these tools as a lens through which I could develop my own understanding in each case study I embarked on. In summary, McCarthy, Wright and Meekison's conceptual framework consisted of two lines of reflection, the first related to the threads through which experiences develop and the second related to processes through which sense-making takes place before, during and after the experience. The threads of experience regard the dynamic part-whole association of elements during the experience (compositional thread), the unfolding of actions in time and place (spatio-temporal thread), the lived exploration of the context through the senses (sensorial thread), and the individual and shared emotional responses (emotional thread). The sense-making process in the visiting experience regards the bringing in of previous experiences (anticipating), the interplay of sensorial, cognitive and emotional aspects (connecting), the particular understandings of the content displayed (interpreting), the judgement and evaluation of the experience (reflecting), the placing of the self within the experience (appropriating), and the taking of the experience beyond the visiting experience (recounting).

The second influential research approach that helped me build the referential model was the comprehensive study of social relationships and behaviours within the exhibition environment as developed by two research groups based in the UK (i.e. Universities of Nottingham and Bristol, and King's College London). As discussed in more depth in Chapter 2, Stuart Reeves, Steve Benford, Claire O'Malley and Mike Fraser undertook a study that aimed to identify the forms of interaction around a particular installation (Reeves, Benford, et al. 2005). Their main research outcome was the identification of the influence each visitor had on the others when interacting with the installation. The authors defined two types of visitor: the *performer* and the *spectator*; for the spectator (a visitor not yet directly involved in the interaction) the performer's manipulations of the installation would be *hidden*, *partially revealed*, *fully revealed* or *amplified*. The effects of a performer's interaction with the installation would affect the spectator and somehow inform his/her decision of interacting as well. The research group constituted by Christian Heath, Paul Luff, Dirk vom Lehn and Jon Hindmarsh also focused their research on the social implications and effects in the experiencing of interactive exhibitions (vom Lehn et al. 2007). Similarly to Reeves et. al., this research group identified the mutual influence of participants' actions and interactions but in addition they observed that these influences and their resulting actions would most typically fluctuate through the experience. The work of vom Lehn et. al. highlights the importance of time and context in the understanding of people's relationship with technology as they unfold dynamically informed by unexpected events and individualities developing around them.

As discussed in the Methodology chapter, the sequence of three case studies allowed for a progressive creation and improvement of research tools and techniques that led to significant research insights. In addition, a particular set of units of study informed the definition of a categorisation of stages of interaction in the process of engagement with interactive exhibits. As presented in Chapter 6, Section 6, this categorisation started as an early definition of zones of activities in the proximity of the installation, that included the gallery zone (the space containing the exhibition), an immediate zone (the closest radial space around the gallery), a proximate zone (further away from the gallery), and a distant zone (considerably away from the gallery). These initial zones were defined according to the measures of physical distance and public flow. Through the next case study and informed by further theoretical research, as presented in the Findings section of Chapter 7, a new categorisation of interaction zones was defined, this time with higher attention to the actual process of interaction and the audiences' levels of attraction, involvement and engagement with the exhibition (Bongers & Mery Keitel 2011). With a reduced focus on the spatial variables, the zones of interaction were consistently renamed as 'stages of interaction'. The new stages of interaction were applied to a field study for the first time through the third case study of this research project, as presented in Chapter 8. The stages of interaction were defined as ignoring (the installation is not noticed), noticing (the installation is perceived but no interaction occurs), observing (the installation is actively perceived but no active participation occurs), involving (participants physically interact with the installation), and engaging (further and immersive participation with the installation takes place).

The referential model for the study of social experiences with interactive museum exhibits I propose here is not a prescriptive framework for the design of exhibitions but a reflective tool for the understanding of interactive experiences in existing museum exhibition environments. As it has been argued all through this research dissertation, we designers cannot design experiences as such for we cannot predict our potential users' complete set of characteristics; however, we can design *for* their experiences. Through a firsthand enquiry of existing experiences of external and own exhibitions, design and museum practitioners can inform the development of their future exhibiting projects and better prepare their design briefs.

The proposed referential model is not a formula either, but rather a mesh of intertwined experiential considerations, as depicted in Figure 79. These considerations are each of the elements and stages identified in the three branches of research outcomes above presented: the conceptual framework of experiences defined by McCarthy, Wright and Meekison, the social influences resulting of visitors' interrelationships in the visiting experience as discussed by Reeves et al. and vom Lehn et al., and the stages of interaction proposed by Bongers and myself and later refined through this doctoral research. Given that experiences with interactive exhibitions are situated and unfold in space and time during the museum visit, the components of the model must be considered as potentially identifiable simultaneously. This implies a dynamic occurrence of experiences rather than a sequential one.

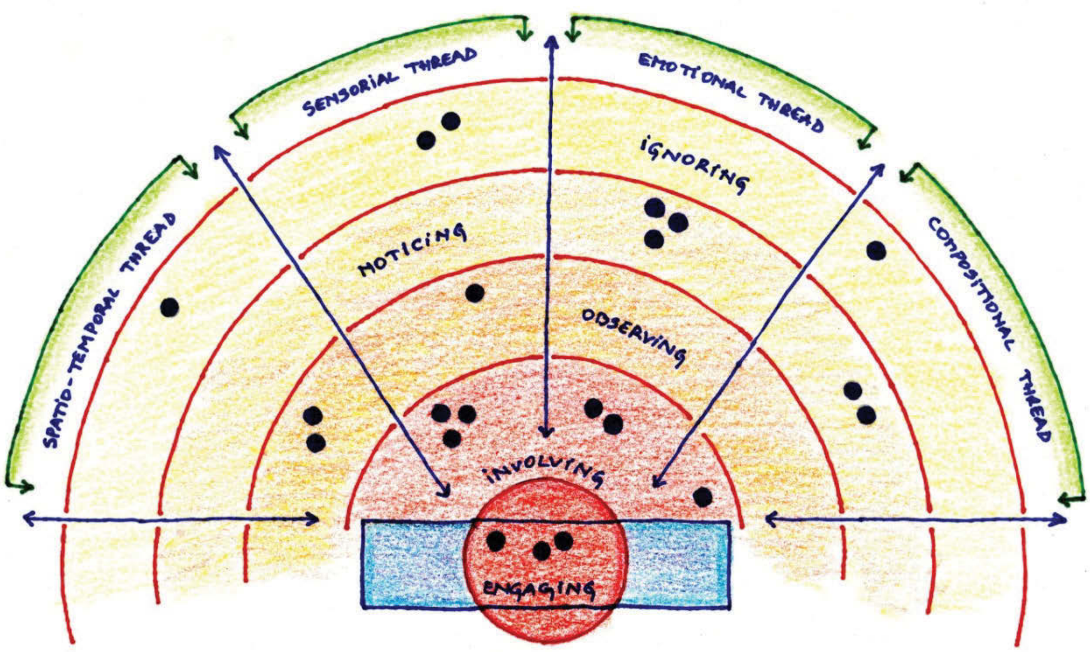

Figure 79. Referential model for the study of social experiences with interactive museum exhibits.

For a better understanding of the referential model for the study of social experiences with interactive museum exhibits I have generated a graphical scheme of the main comprising parts of the interactive process. Distinctive shapes and colours represent these parts in the model. While the exhibit (which could be either a display, a complete exhibition space or and installation) is represented by a blue rectangle, the individual visitors and groups of visitors are represented by small dots scattered around it. The stages of interaction are represented by concentric arches around the exhibit, represented in different shades of orange and red, which are traversed by the threads of experience, represented by forming circumference sections that head towards the exhibit. The diverse social influences and behavioural transitions that occur during interaction are represented by traversing lines that go from the outer interaction stage to the closest interaction stage at the exhibit. Although these elements may seem to visually represent physical components within the exhibition environment, this representation is not to be interpreted as related to space. Instead, the scheme is designed with the intention to help designers to take a comprehensive and dynamic approach to the shifting and interconnected elements that comprise the model, considering its components as the representations of actions and changes along time and space.

9.3. A Retrospective Application of the Referential Model

Since the referential model for the study of social experiences with interactive museum exhibits was the result of this project's theoretical and field-based enquiry, no full application of it on a particular context was possible to conduct in a frame of time that would guarantee a comprehensive approach. Nonetheless, I considered important to provide an example of how this model could be utilised in the study of real interactive exhibitions' cases. What follows is a final reflection on the project's three case studies' findings with specific references to the components of the referential model. For a better appreciation of the inference of each component on the reflections, these will be mentioned in *italics* within the overall text. The reflection is roughly structured according to physical aspects (architectural and interior spaces, displays and artefacts) and human aspects (emotions, cognitive processes, social relationships, and bodily expressions).

Experiences with interactive installations and exhibitions take place in a material context, usually delimited by a human-made physical space (e.g. a museum building, an art gallery, a civic square). As observed throughout the three case studies, the overall spatial context has a great influence in the way audiences experience the visit. Architectural features such as walls, corridors, windows, and even the ceiling, potentially change the emotional and physical behaviour of visitors from the moment they enter the new space. First, there is natural change of the perception of space in the transition from outside to inside the space: the pace, movement, and activities of the 'outside world' are left behind and a new *spatio-temporal* experience begins. Although literature shows that a considerable amount of visitors are regular museum goers, it is also true that regardless of the recurrence of visits, audiences attend museums to encounter new learning and entertaining experiences. In doing so, visitors bring in their previous experiences and expectations (both related and unrelated to the visit) *anticipating* what their new experiences will bring. The architectural features, together with a myriad of interior design elements (e.g. separation and information panels, lighting effects, soundscapes, colour combinations, etc.) are carefully structured in order to lure in visitors varied sensorial, cognitive and emotional responses, helping them *connect* with the space and later on with the museum's message.

Space and its rich and complex configurations within the exhibition context is also a crucial factor in the drawing of visitors towards the exhibits. The use of the right design forms and expressions and their integration within the greater context may make the difference between visitors *ignoring* and *noticing* an installation or exhibit. As a concrete example, the design of the *I See What You Mean* exhibition contemplated the use of brightness and neatness as a factor of appeal to attract the audience into the gallery. Visitors reported of having appreciated this design value; however, the sunny weather outside the gallery created an adverse effect when inundating with too much light the room and reducing the visibility of one of the exhibition's main component (i.e. a video projection). In such case, the drawing of audience into the exhibition was achieved yet a full *engagement* was seldom accomplished. In the case of *Facets Kids*, the installation was located in a wide open area of the museum through which a great flow of visitors would constantly walk. This meant that the *ignoring* of the installation was less recurrent and that the three subsequent stages of interaction - *noticing*, *observing*, and *involving* – were considerably more frequently observed. The *Surviving Australia* exhibition was comprised of several interior design features that aimed to facilitate narratives of space and content. Although the *Dangerous Australians* exhibit was envisioned as a centre-point within the exhibition, the exhibit was physically surrounded by panels and walls and provided with little light, which somehow isolated it from the rest of the exhibition. This could explain why an important number of visitors were observed passing by *ignoring* or only *noticing* the exhibit.

Narratives are some of the most important elements in the interpretation of museum content. The core product of the museum, its collection, tells stories and brings to the visitor a series of messages for him/her to make sense of the overall main message of the exhibition. Artefacts and the exhibits through which they are displayed support these narratives through a process of invitation to discovery and dialogue. Their *compositional* configuration of parts and whole of artefact, content and displaying aims to produce a *sensorial* connection of visitors with the message that may facilitate the process of *interpretation* and *reflection*. Once these processes are completed, it can be asserted that a higher level of *engagement* with the content is achieved by the visitor and a sense of personal *appropriation* of the content may also be reached.

Each display in a museum space, whether interactive or not, is designed in order to support the artefact's message, regardless of the technology utilised to convey this. The museum artefact in itself is a medium and a message which cannot be designed yet it can be presented in ways that reveal to the audience different ways to access its message and make meaning of it. The part and the whole (i.e. the artefact and its surrounding physical context) *compose* a narrative for visitors to *interpret* and *reflect* upon. The ways in which exhibits are designed trigger a variety of *sensorial* and *emotional* responses and, consequently, different levels of *engagement* in the interaction process. The *compositional* structure of museum displays informs visitors of their possibilities of use, operation, purpose and relevance, who can then relate these to their mental maps of the possible interaction before them. It was observed through field research that when visitors are able to interpret the afforded possibilities of action on an exhibit an increasing confidence in the interaction is realised, leading to deeper levels of *involvement* and *engagement* and, subsequently, stronger *appropriation* of meaning. As reported by many case studies' participants when asked about their experiences, the making of memorable experiences was envisioned along with a positive overall evaluation. These generally satisfying outcomes of the visiting experiences were likely to lead to a *recounting* of the experience beyond the *spatio-temporal* thread of the experience as well as a likely *anticipation* for future visits.

Narratives presented through objects via displays and exhibits are carefully structured by the educational, curatorial and design departments of museums (or, on occasions, by external parties). Despite the logical structure, aimed to provide the visitor with a clear story about the object been presented, certain levels of flexibility in the process of interpretation are included so visitors can satisfy their need of self-guided exploration and discovery. The museum is a space for *spatio-temporal connections* of visitors with the past and the present, with material and immaterial knowledge, with other visitors. The museum is a spatial invitation for the public to *engage* in personal ways with intimate *reflections* and *sensations*. Unlike most every-day-use spaces, the museum is regarded by visitors as new spaces to be discovered with every new visit. Visitors use their bodies, minds and feelings to make sense of the messages been offered, exploring with their senses, their previous knowledge and their sense of cultural attachment the many new pieces of information provided. Each visitor *connects* with the museum in a unique personal way and with both other familiar visitors and complete strangers, making sense of the museum content together. The *I See What You Mean* exhibition offered visitors a range of artefacts for them to *connect* with the content and other visitors through a process of *interpretation* and construction of new meanings. In this exhibition visitors were invited to reflect upon their professional practices, *appropriate* the content and take their meaning with them for ulterior *recounting*. As reported by many participants, the dialogues initiated at the exhibition continued beyond the exhibition *space and time*. *Facets Kids* offered no fixed narrative or message; in fact, its purpose was to provide as flexible an experience as possible so visitors could express in unique, individual and social ways. The interfaces of the installation facilitated a comprehensive *sensorial* expression, enhanced by the visual outcomes of their movements. As reflected by the field study, visitors were actively *involved* in the experiences, many of them reaching high levels of *engagement*; due to diverse spatial and social circumstances, *observing* other visitors' participation became an important stage of interaction as well. In the case of *Dangerous Australians* most of the experiences took place by interacting with the exhibit through the senses of touch, vision and audio. As observed during the field study and confirmed by informal interviews and contextual enquiries, visitors would mostly *involve* and *engage* with the exhibit in an *emotional* and *cognitive* way. The exhibit did not invite numerous bodily expressions, yet the affective responses were varied and plentiful.

As argued through both the theoretical and field research conducted in this project, most people report that they visit museums in order to obtain new knowledge while having an enjoyable time. Learning and entertainment coexist in a space of dynamic relationships between objects and people. The learning process in the museum context, as explained in Chapter 3, is an informal, self-guided process in which the *compositional* structure of the objects and their narratives have a core role. Additionally, the social context of the visiting experience is of great influence in the process of meaning making as knowledge is co-constructed in the sharing of the experience with other visitors. In this respect, aspects of appeal, attention and motivation for the interaction are not limited to the properties of the exhibits and contained objects only but also social behaviours will affect the ways in which visitors approach and related with the exhibits.

As it was widely observed in the case studies of *Facets Kids* and *Dangerous Australians*, crowds are a significant factor in the drawing in of audiences towards an exhibit; the more people there are, the more people who feels curious and gets closer to 'have a look'. If, in addition, the interacting crowd seems to be having a positive experience, those visitors or *spectators* that started by only *noticing* the exhibit may soon become participants or *performers* themselves, *observing* or getting *involved* in the interaction. Unfortunately, due to lower levels of attendance than other cases, the *I See What You Mean* case study did not offer sufficient data to affirm that this phenomenon of 'social drawing' took place in the exhibition. Both in *Facets Kids* and *Dangerous Australians* the *observing* stage became a 'hot platform' of potential interactions. *Observing* other visitors interact with an exhibit and/or other visitors allows the shy, reticent or discreet visitor to evaluate the context and take the time to make the decision of whether take direct part of the experience just continue as a passive participant. Upon observing others, these *spectators connect* with other visitors by *interpreting* their bodily cues and examining the results of their actions. It is in the nature of humans to learn by doing; however, people also learn by *observing* others. Visitors who are *involved* and *engaged* in an interaction with the exhibit express in many ways: they move their bodies and manipulate objects in order to retrieve information from the exhibit, they verbalise their actions or learning, they share their experiences with other group members, they express *emotional* responses through their bodies, etc. These expressions are picked up by other visitors, either intentionally or by chance, and *interpreted* as cues for potential interaction.

Field work revealed that hardly ever are these expressions *hidden* to visitors; even when trying to avoid the revealing of a particular emotion, sometimes our bodies simply have a control of their own (e.g. blushing out of embarrassment, jumping away out of surprise). In the case of *Dangerous Australians* some *hidden* responses were observed mostly in adult visitors, particularly when not accompanied by children. *Hidden* responses showed to have little impact on other visitors' interactions. Some other expressions were commonly *revealed*, either *partially* or *fully*, having a considerable effect of visitors' engagement with the exhibits. During the *Facets Kids* case study, for example, it was often observed that visitors and group members would move from *ignoring* the installation to actively *involving* in interaction with it after 'witnessing' (e.g. noticing, observing, attentively scrutinising actions), partially or fully revealed interaction responses. Since *Facets Kids* allowed a higher bodily engagement with the installation and its components, this influence would be often *amplified* by participants calling out for others to join in a physical way, sharing interfaces, interacting with each other or collaborating in the making up of games and other creative activities. In the case of *Dangerous Australians*, most of the influence between audience members happened at a more implicit level of observation-following-action sequence. The size of the exhibit allowed a large number of visitors to gather 'around' and enjoy of a visual landscape of both interacting visitors and interacted features. *Partially revealed* responses and interaction effects were visually and auditory evident and shared along the table. Visitors nearby the exhibit could capture the exhibit's information from a distance and approach to interact themselves. Similarly, *fully revealed* responses and interaction effects were provided by participants at the table and purposely shared with other visitors.

Amplified responses were mostly observed in *Dangerous Australians* in the interactions of younger audiences, as they tended to engage with other visitors in the creation of additional actions such as competitions and games.

Social interactions with interactive exhibits showed to be not only frequent in most of the case studies conducted but also highly dynamic and fluctuating. The transition from *spectator* (observing visitors) to *performer* (actively involved or engaged participants) was often observed to flow backwards and forward depending on the exhibition's social context and particular exhibit's technological reactions. For instance, in the case of *Facets Kids*, due to the existence of a few interfaces for visitors to manipulate, often participants would take turns in the operation of these, shifting from observers to participants and back to observers. This was also observed in the *Dangerous Australians* exhibit where groups of participants would guide each other on the interaction process, taking turns to 'touch' the surface's graphical features and activate the content. In the *I See What You Mean* exhibition a less fluctuating social interaction was observed; in this case visitors that attended the exhibition in groups would mostly interact with the content and explore the space together, engaging in a more reflective and conversational type of social relationship. In such case, the transition from *spectator* to *performer* would be linear and unidirectional, until the experience was over. In the other two cases, *Facets Kids* and *Dangerous Australians*, a more visually evident sense of collaboration was observed, with bodily expressions and co-shared actions representing the rich social experiences taking place around the installation and exhibit, respectively. In all three cases, however, the visiting experiences were interpreted as flexible opportunities for social exchange and negotiation for the construction of meaning.

9.4. Conclusions

Museums are seen by their audiences as places they can attend to experience new ways of learning at the time they have an enjoyable experience. As discussed in this dissertation, today's museum audiences expect to find in museums experiences and information that will allow them to build new knowledge in ways they could not achieve through other experiences. In times when information and communication technologies allow people to increasingly access information in greater amounts and in more varied and faster ways, it is possible to think that the public would opt not to attend museums and instead find the information of their interest through means such as websites or online libraries. However, what this research has revealed is that the physicality of the museum experience, along with the possibility of sharing it with other people, is what makes the museum visiting experience attractive to the public.

Museum exhibitions are complex communicational systems whose messages are conveyed by means of a physical dynamic structure of objects, exhibits and spaces. These messages are uniquely constituted in each visitor according to his/her particular individuality (e.g. prior knowledge, imagination, interests, etc.). In order to facilitate their audiences' expected experiences and provide them with information that will add meaning to their lives, museums' efforts need to be directed towards a presentation of their collections in ways that are accessible, novel and appealing to a wide variety of visitors. The core product of the museum, its collection, needs to remain at the centre of the visiting experience; it is through the collection that audiences access and share information, make sense of it and transform it into new knowledge and, in doing so, engage in a tight relationship with culture and society.

As discussed in the review of the literature, the integration of interactive technologies in the museum environment particularly in the last decade has generated a twofold reaction of scepticism and conviction regarding their contribution to the design of meaningful learning experiences. While the more critical end of the discussion within the museum arena has revolved around the risk of technologies taking over the value of the museum artefact and potentially of the museum message, the more optimistic end of the discussion points out the opportunities these technologies provide for a more flexible and versatile delivery of content. From the perspective of Interaction Design as a discipline, discussions have covered both ends of the spectrum as well. While some have argued that interactive technologies merely digitalise what is intrinsically a physical experience others have highlighted the vast array of new opportunities humans now have to enhance their sensorial opportunities and achieve meaningful physical experiences with an environment which was not long ago considered to be outside of the reach of the hand.

When reflecting from an interaction design point of view on the integration of interactive technologies in the exhibiting space and its impact on the museum visitor's experience it is important to think about the kinds of experiences that museums actually want to provide their visitors with. On the other hand, it is equally important to think about the kinds of experiences visitors - and potential visitors - would expect from a museum visit, particularly regarding interactive encounters with the museum's collection. By reflecting on these two ends of the experience expectation band, and finding a balance between what is possible and what is necessary, we can create seamless optimal experiences that benefit both the institution and its audience. This research project's theoretical and field data has suggested that when this kind of balance is achieved, the interactive experience results in convergent relationships between the museum and its audience.

As it has been argued throughout this thesis, intellectual, emotional and sensorial stimuli through interactivity have a great effect on audiences' experiencing of the museum visit. Information presented in such ways that visitors' curiosity and desire to learn are comprehensively addressed facilitates an optimal experience. Accordingly, it becomes fundamental that design efforts concentrate on offering a spatial arena on which visitors can interact and express with ease and confidence. This design response, naturally, will depend on various factors often away from the control of the designer (e.g. institutional budget, time limitations, or spatial constraints), yet as long as a thorough understanding of what experience means for the interplaying actors, a successful visiting experience should be accomplished. Understanding visitors' experiences, the way they interact with exhibits and other visitors, and the results of their interactions is a critical issue for the development of effective exhibitions. It is by understanding visitors' experiences that we can find and apply the correct technologies that will facilitate the creation of new meaningful experiences.

Social behaviour at the museum, particularly among visitors, facilitates and frequently shapes visitors' individual engagement with the exhibition and its content. Therefore, social interaction might effectively contribute to a wider and deeper learning and recreational experience if considered as part of the design plan. As emphasised throughout this thesis, when visitors encounter an interactive exhibit space the behaviour of other visitors already interacting with it sets their own interactive scenario. In this respect, the response or even the sole presence of others may change the new visitors' attitude towards the interaction experience, as well as the interaction process and its outcomes. The spaces and the technologies that surround and accompany these interactions play a fundamental role in the visiting experiences as they inevitably shape behaviours and actions. Interactions, and particularly social interactions, are situated - they occur in space and time. For visitors interplaying with interactive exhibits, making sense of the context before them, the museum's space and technologies constitute their experience and, at the same time, affect them. This technologically enhanced space, the interactive museum, carries and presents the collection to its visitors, projecting them into their minds, emotions and bodies for them to take and make use of. In addition, and most importantly, the interactive environment offers visitors the opportunity to share this multifaceted and rich experience with other people, learn from them, contribute to each other's meaning-making process, and build a cohesive society together. Finally, in this situated exchange of knowledge, sensations and emotions, visitors may develop a sense of attachment, of bonding with the institution as well. When the visiting experience is successful, a desire for future experiences of similar quality is triggered in visitors, as they realise the diversity of messages delivered by the institution has a meaning for them, is relevant for their lives and their community's life. The interactive museum space is not a mere container of visitors experience, is a facilitator in the making of their own experiences.

Interactivity in the museum environment regards the experience of interacting with information, expressed by means of artefacts and spaces, and with other visitors' realities through social interaction. Meaning of both the information and social realities arise from the rich and complex interactions between artefacts and visitors. Interaction in the museum supposes physical effective and perceivable contact and a disposition to change. In this respect, interactive technologies may play a significant role if applied appropriately: as a means for interaction, not the interaction itself. Interactive technologies are a form of mediation between the museum and its audience. The integration of interactive technologies in the museum environment must take into account all the social implications of bringing them in. Interactive technologies can certainly help achieve a better experiencing of the museum artefact and space; however, they cannot replace them. They cannot replace visitors' direct sensorial, emotional and cognitive encounter with the material culture offered by the museum. They do, nonetheless, have the potential to enhance, compliment, and even extend the cultural experience in novel ways and facilitate the sharing of it with others. The actual challenge in the incorporation of interactive technologies in the museum environment lies in the thorough understanding of the individuals, groups, cultures and institutions that will engage with these technologies. It is fundamental for interaction designers involved in the development of new museum visiting experiences to be aware not only of interaction design 'rules' but also of the nature of the museum as a public institution and its social and material role. This way, rather than just hastily following a current technological wave, museums and designers can master together the potentially powerful interactive technologies and use them when and where really necessary and in ways which truly supports the visiting experience.

The expression "museums are people places" is often heard in the institutional environment. Throughout this research, the most intimate meaning of such expression has been revealed to me, both as a design practitioner and as a researcher in the field of Human Computer Interaction. The initial exploration of theory suggested that visitors make museums' purpose possible through their interactions with spaces and artefacts within the spatial context and through their interactions with other visitors within the social context. It was only after engaging directly with the visiting museum dynamics through the case studies that I truly understood that museums are, indeed, people places. Museums are places in which society builds its future in a collaborative process of learning and making meaning with others. This process cannot be entirely understood through literature. Literature is a highly valuable starting point yet it could never connect the researcher with the lived response of visitors when interacting at the museum. Designers who are interested in being part of the making of solid, cohesive societies by contributing with their work in the museum sector need to engage with audiences beyond what theory reveals. Although through my field enquiry I encountered several difficulties - mainly due to the large scale of the cases being faced by a single researcher - I was able to build a relationship with museum audiences, not as individuals but as a community with whom to work together.

9.5. Future Work

The work presented in this dissertation focuses on the incorporation of interactive technologies into the museum exhibit environment and the effects these have on its audience's visiting experience. The fields of Human Computer Interaction and Museum Studies which supports both the theoretical and pragmatic aspects of the research are of a particular ever-changing nature, which not only demands a constant review of their bodies of knowledge but also of further potential interrelationship. In this respect, and after over four years of active involvement in the public realm, particularly in cultural heritage institutions, I have identified great potential for studying other aspects that emerged from this doctoral research and that I believe deserve closer attention.

The availability of digital technologies for the execution of everyday activities have crossed the limits of private life and quickly extended their potential into areas of activity in which social groups converge. Such is the case of formal education, health services, entertainment, urban deployment, hospitality, and shopping, to name a few. The Referential Model for the Study of Visitors' Experiences with Interactive Exhibits has great potential of extrapolation to these areas provided its approach incorporates aspects that are not exclusive to the museum environment. The Model has been designed with consideration of features of analysis that have drawn specifically from museum visiting experience knowledge. A further study of the Model's components and additional literature review are needed for a more comprehensive application of it for the research and development of interactive technologies for the public space. This new approach would benefit greatly from the appraisal of researchers from both the field of Human Computer Interaction and Museum Studies, therefore the publishing or presentation of its progress in peer-reviewed journals or conferences would be a priority.

Although the Referential Model presented in this doctoral research aimed to contribute to the study of social experiences with interactive museum exhibits rather than to the actual design of interactive exhibits or exhibitions, the Interaction Design community, its practitioners and students, could benefit from the evolution of it into a Design Framework. This does not mean discarding the potential of the Model as an evaluation tool but a reorientation of its components towards a design-centred approach. In this regard, and considering the high social component of the Model, it would be advisable to integrate notions of Participatory Design and User-Centred Design processes and techniques, enhancing the incorporation of users in the diverse stages of design practice.

Previous to embarking in this extensive and intense research project I had become interested in interactive technologies through my academic experience, both researching and teaching Interaction Design. More than often, it would come to my attention that - either purposely or due to lack of experience - many design responses would systematically incorporate digital technologies, not necessarily achieving a good result. Adapting rather than adopting new technologies. Throughout the different research stages of this project I became more aware of theoretical and practical aspects of the use of digital technologies in the public space and got to realise the great significance a firsthand relationship with users had for the practice of Interaction Design. Discussing this issue with my home University's authorities together we decided that upon my reincorporation to academia after finishing my doctoral research, we would commence a program of reinforcement of Design Research in the School of Design with a strong emphasis on users' lived experience and experimental onsite research methods. The project "Human Computer Interaction in Museums as Public Spaces: A research of the Impact of Interactive Technologies on Visitors' Experience" is expected to grow in the hands of future Design generations.

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Appendix 1. Case Study: *I See What You Mean*. Exhibition fact sheet.

Type	Interactive Exhibition, temporary
Creators	Bryce Cassin Alejandra Mery Keitel
Collaborators & Roles	Bert Bongers. Development and programming of the interactive system. Frank Maguire, Interaction Designer. Programming and calibration of the interactive system. Jason McDermott, Architect. Programming and calibration of the interactive system. Lissette Rodríguez, Graphic Designer. Design of exhibition's graphic and animated pieces. Wendy Wang, Graphic Designer. Design of exhibition catalogue. Amy Wahlen, Graphic Designer. Printing of exhibition catalogue. Bryce Cassin, photography and exhibit production. Alejandra Mery Keitel, Doctoral Researcher and Candidate. Design of exhibition's graphic and audience research. Aanya Roennfeldt, exhibition curator.
Venue	DAB LAB Research Gallery
Location	Level 4 Courtyard, Faculty of Design, Architecture and Building 702-730 Harris Street Ultimo, New South Wales 2007, Australia
Exhibition and Case Study Date	1 - 23 April 2009

Appendix 2. Case Study: *I See What You Mean*. UTS HREC Ethics Approval Letter.

7 July 2009

Associate Professor Bert Bongers
School of Design
CB06.05.609
UNIVERSITY OF TECHNOLOGY, SYDNEY

Dear Bert,

UTS HREC 2009-127 – BONGERS, Associate Professor Bert (for KEITAL, Ms Alejandra, PhD student) – "DAB LAB Gallery Visitor's Survey Application: Project Informing Overall PhD Research"

Thank you for your response to my email dated 15/06/09. Your response satisfactorily addresses the concerns and questions raised by the Committee, and I am pleased to inform you that ethics clearance is now granted.

Your clearance number is UTS HREC REF NO. 2009-127A

Please note that the ethical conduct of research is an on-going process. The *National Statement on Ethical Conduct in Research Involving Humans* requires us to obtain a report about the progress of the research, and in particular about any changes to the research which may have ethical implications. This report form must be completed at least annually, and at the end of the project (if it takes more than a year). The Ethics Secretariat will contact you when it is time to complete your first report.

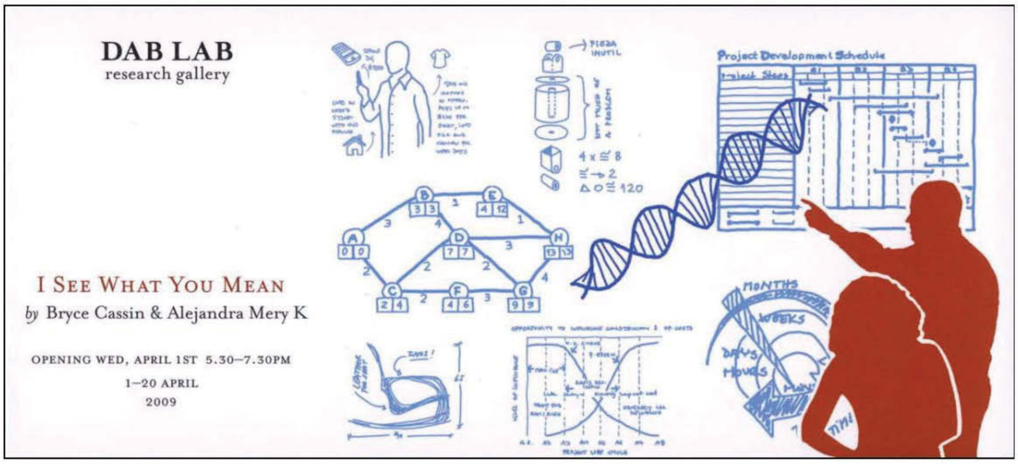
I also refer you to the AVCC guidelines relating to the storage of data, which require that data be kept for a minimum of 5 years after publication of research. However, in NSW, longer retention requirements are required for research on human subjects with potential long-term effects, research with long-term environmental effects, or research considered of national or international significance, importance, or controversy. If the data from this research project falls into one of these categories, contact University Records for advice on long-term retention.

If you have any queries about your ethics clearance, or require any amendments to your research in the future, please do not hesitate to contact the Ethics Secretariat at the Research and Innovation Office, on 02 9514 9772.

Yours sincerely,

Professor Jane Stein-Parbury
Chairperson
UTS Human Research Ethics Committee

Appendix 3. Case Study: *I See What You Mean*. Promotional flyer of the exhibition sent by the Gallery.



I SEE WHAT YOU MEAN: EMBODYING CREATIVE & PROJECT MINDS

"You interpret the script, you visualize or form a 'mental picture' of what it means for you to be what you are, and embody that visualisation for the benefit of others occupying the contrasting but complementary character roles." Brian Massumi

This exhibition reflects on the language, tools, and symbols that the creative disciplines and the pragmatic art of project management embody and enfold when discovering, nurturing and realising productive activity.

Where do you stand in this double helix of disciplinary entanglement? Practitioners in any enterprise make sense of the different thinking spaces they occupy through the visual images and cognitive artefacts they create. When we proclaim 'I see what you mean' it is an expression of sense making: a delicate balance of creative and pragmatic habits and routines that embody multiple strands of meaning and interlink in the realisation of a product or service. Yet we lack a common conceptual language for the journey.

The exhibition space is used to map the DNA of this productive activity. We invite you to explore the genetic code within the heuristics of our disciplinary mindsets. We juxtapose the visual DNA of the creative mind and project mind, and provide an interactive space for you to explore, transform, and translate once separate lines of thought, suggesting new alliances, in a continually moving dynamic of practice and production.

We invite you to see what each other mean.

UNIVERSITY OF TECHNOLOGY SYDNEY

DAB LAB
research gallery

Level 4 Courtyard, UTS
Faculty of Design, Architecture & Building
702–730 Harris Street, Ultimo

www.dab.uts.edu.au/dablab

Gallery open
Mon–Fri, 10–5pm
Contact Gallery Director
Aanya Roennfeldt 9514 8016

Appendix 4. Case Study: *I See What You Mean*. Email sent to random participants inviting them to answer the exhibition's web-based anonymous survey.

Alejandra Mery Keitel

From: Alejandra Mery Keitel {amery@proteinlab.cl]
Sent: Tuesday, 05 of May 2009 16:04
To: Undisclosed Recipients
Subject: Exhibition Survey, I See What You Mean
Attachments: image002.jpg; image009.jpg; image011.jpg;

Dear friend,

A few weeks ago the DAB LAB Research Gallery held the exhibition "I See What You Mean", by Bryce Cassin and me, Alejandra Mery, who created this project in collaboration though considering each individual research interest. As a DAB member you might have visited the exhibition and I would like to have your impression through a short online survey. Please scroll down to see some images of the exhibition for a better remembering of its components.

I'm a PhD student at our Faculty and my research theme is Human-Computer Interaction in Public Spaces, with particular emphasis in Exhibitions Environments. Your feedback will inform my studies on visitors' experiences and help on the creation of better exhibition design guidelines. The survey I'm inviting you to answer is absolutely voluntary and anonymous. The data collected is encrypted and will only be accessed by me.

If you would like to participate in this survey, please click here. A web browser will open displaying the survey. You can also copy the following link into your web browser: http://www.encuestafacil.com/RespWeb/Qn.aspx?EID=460725. It will only take you about 5 minutes to answer the 9 questions that cover the survey.

You could also participate in future studies regarding interaction technologies and exhibitions experiences. If so, please answer this email indicating your preferred means of contact so I can be back to you in a near future.

Have you got any doubt or further enquiry about this research and/or particular study, please do not hesitate in contacting my research chief supervisor, Dr Bert Bongers.

Thank you very much for your collaboration!

Yours,

Alejandra Mery K.
PhD Student in Interaction Design, University of Technology Sydney (Australia)
(614) / (612) 9514 8606

Page 1

Este mensaje (incluyendo cualquier archivo adjunto) contiene información confidencial y concierne únicamente a la persona a la que está dirigido. Si recibe este mail por error, por favor avise al remitente y borre el mensaje. La lectura, copia o derivación del mismo está estrictamente prohibido.
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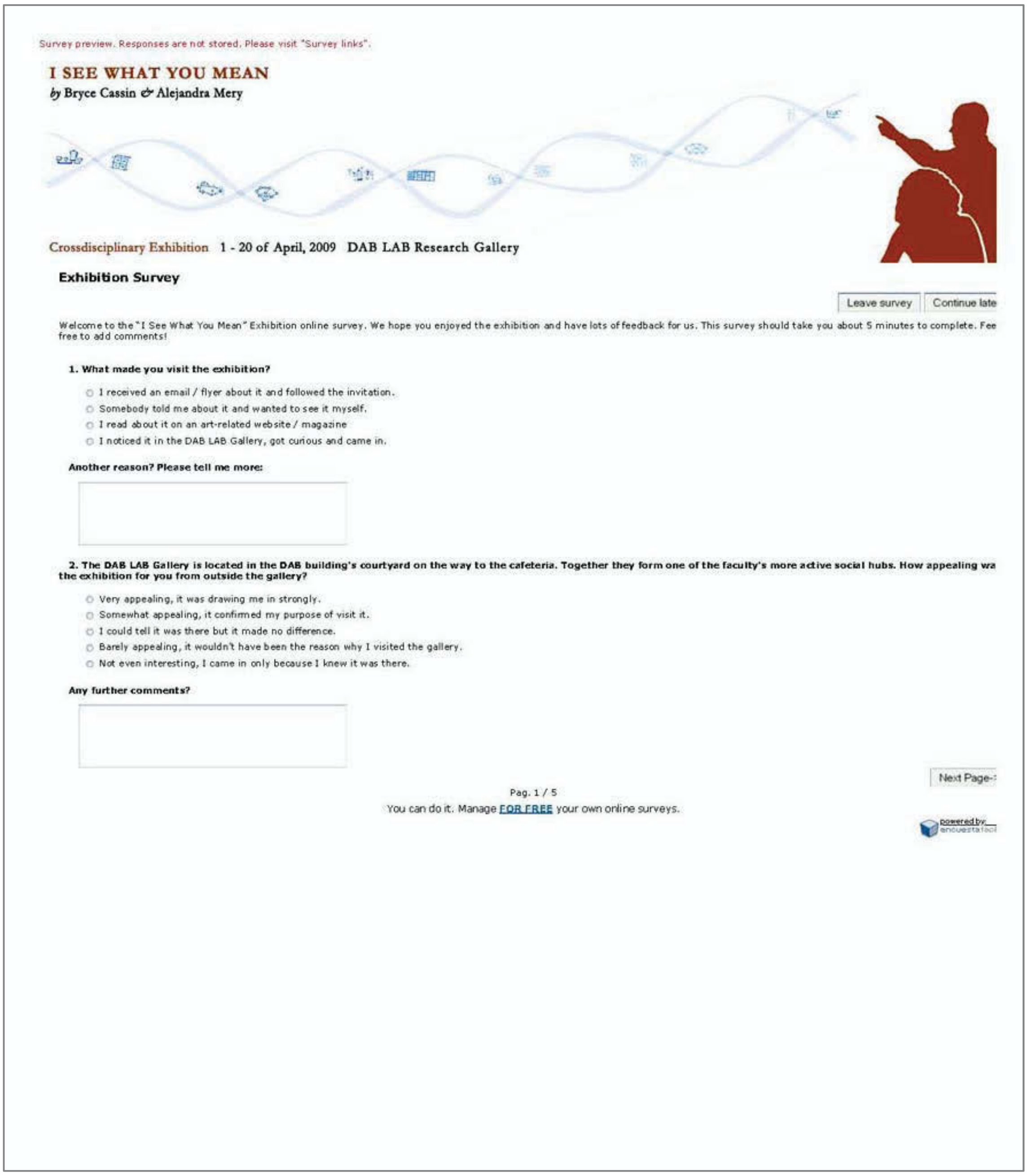
Page 2

Appendix 5. Case Study: *I See What You Mean*. Screenshot of the web-based anonymous survey.



Survey preview. Responses are not stored. Please visit "Survey links".

I SEE WHAT YOU MEAN

by Bryce Cassin & Alejandra Mery

Crossdisciplinary Exhibition 1 - 20 of April, 2009 DAB LAB Research Gallery

Exhibition Survey

Leave survey | Continue late

Welcome to the "I See What You Mean" Exhibition online survey. We hope you enjoyed the exhibition and have lots of feedback for us. This survey should take you about 5 minutes to complete. Fee free to add comments!

1. What made you visit the exhibition?

- I received an email / flyer about it and followed the invitation.
- Somebody told me about it and wanted to see it myself.
- I read about it on an art-related website / magazine
- I noticed it in the DAB LAB Gallery, got curious and came in.

Another reason? Please tell me more:

2. The DAB LAB Gallery is located in the DAB building's courtyard on the way to the cafeteria. Together they form one of the faculty's more active social hubs. How appealing wa the exhibition for you from outside the gallery?

- Very appealing, it was drawing me in strongly.
- Somewhat appealing, it confirmed my purpose of visit it.
- I could tell it was there but it made no difference.
- Barely appealing, it wouldn't have been the reason why I visited the gallery.
- Not even interesting, I came in only because I knew it was there.

Any further comments?

Next Page-

Pag. 1 / 5

You can do it. Manage FOR FREE your own online surveys.

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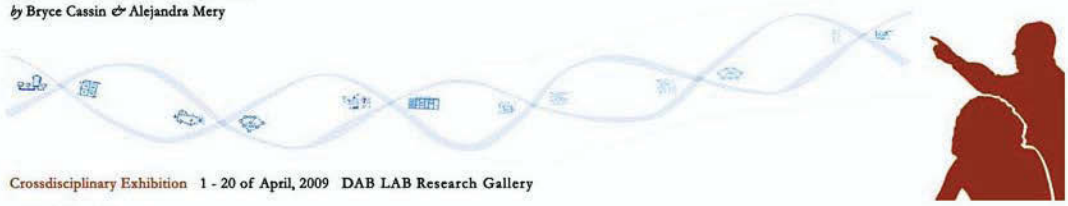
Survey preview. Responses are not stored. Please visit "Survey links".

I SEE WHAT YOU MEAN

by Bryce Cassin & Alejandra Mery



Crossdisciplinary Exhibition 1 - 20 of April, 2009 DAB LAB Research Gallery

Exhibition Survey

Leave survey | Continue late

3. Bellow is a list of all the components of the exhibition. Please tell me which one(s) you did notice. You can mark as many choices as you need.

- ☐ Left wall posters
- ☐ Table with Polaroid-like photos on it
- ☐ Wall projection of animated texts
- ☐ Right wall posters
- ☐ Right wall Précis (written description of the exhibition)

4. The exhibition was designed in a way you could interact with some of its components. Did you notice any? Please mark the one(s) you noticed and interacted with.

- ☐ Entering the room made the wall projection of animated texts stop and form a paragraph.
- ☐ Placing Polaroid-like photos on the light blue square on the table would change the projection showing new paragraphs.
- ☐ I could tell something happened with the photos but didn't pick up nor moved any.
- ☐ Actually, I didn't notice any interactive element in the exhibition.
- ☐ I though the animated texts moved just randomly.

Any further comments on your experience?

<-Previous Page | Next Page->

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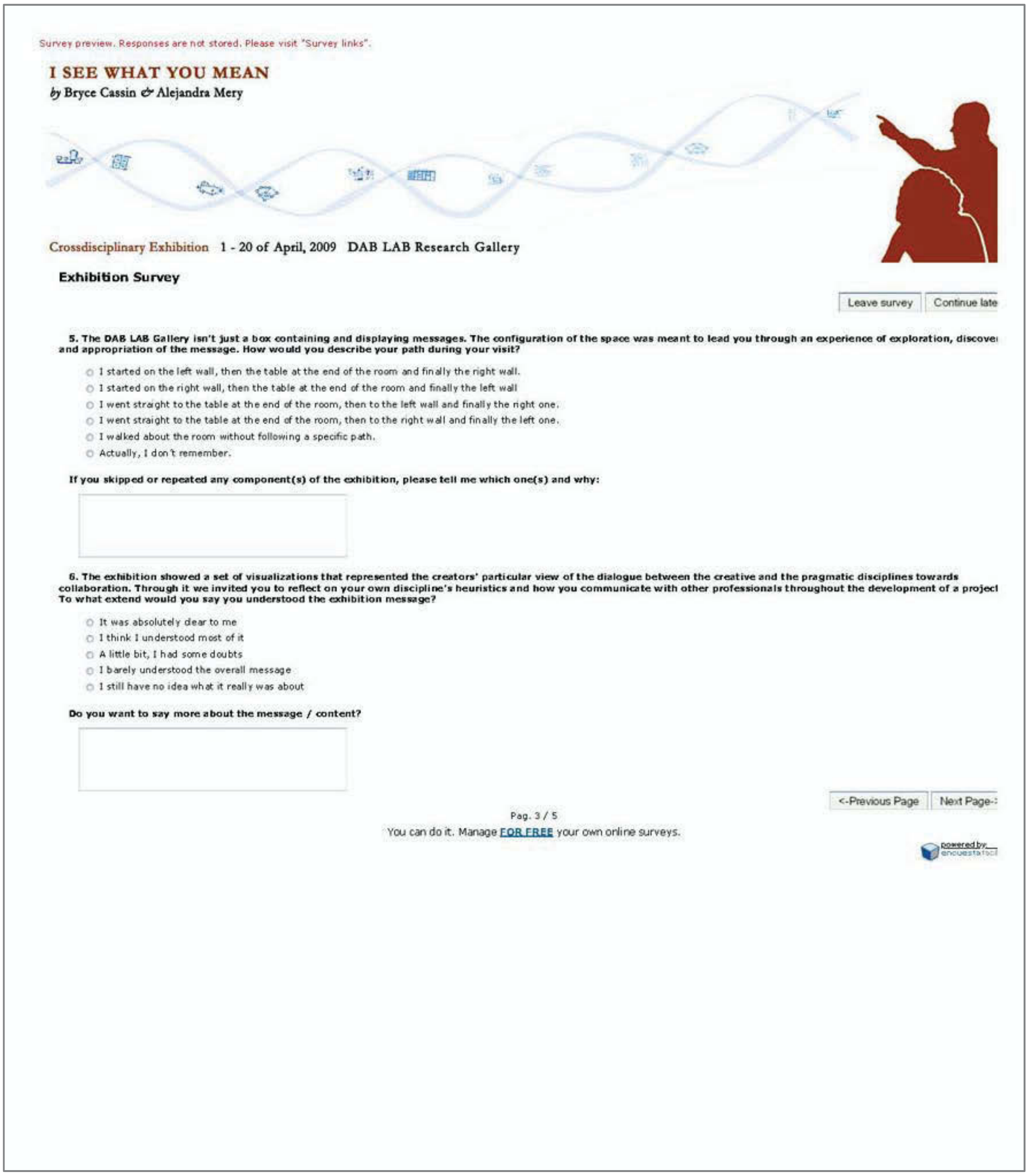
Survey preview. Responses are not stored. Please visit "Survey links".

I SEE WHAT YOU MEAN

by Bryce Cassin & Alejandra Mery

Crossdisciplinary Exhibition 1 - 20 of April, 2009 DAB LAB Research Gallery

Exhibition Survey

Leave survey | Continue late

5. The DAB LAB Gallery isn't just a box containing and displaying messages. The configuration of the space was meant to lead you through an experience of exploration, discove and appropriation of the message. How would you describe your path during your visit?

- I started on the left wall, then the table at the end of the room and finally the right wall.
- I started on the right wall, then the table at the end of the room and finally the left wall
- I went straight to the table at the end of the room, then to the left wall and finally the right one.
- I went straight to the table at the end of the room, then to the right wall and finally the left one.
- I walked about the room without following a specific path.
- Actually, I don't remember.

If you skipped or repeated any component(s) of the exhibition, please tell me which one(s) and why:

6. The exhibition showed a set of visualizations that represented the creators' particular view of the dialogue between the creative and the pragmatic disciplines towards collaboration. Through it we invited you to reflect on your own discipline's heuristics and how you communicate with other professionals throughout the development of a projec To what extend would you say you understood the exhibition message?

- It was absolutely dear to me
- I think I understood most of it
- A little bit, I had some doubts
- I barely understood the overall message
- I still have no idea what it really was about

Do you want to say more about the message / content?

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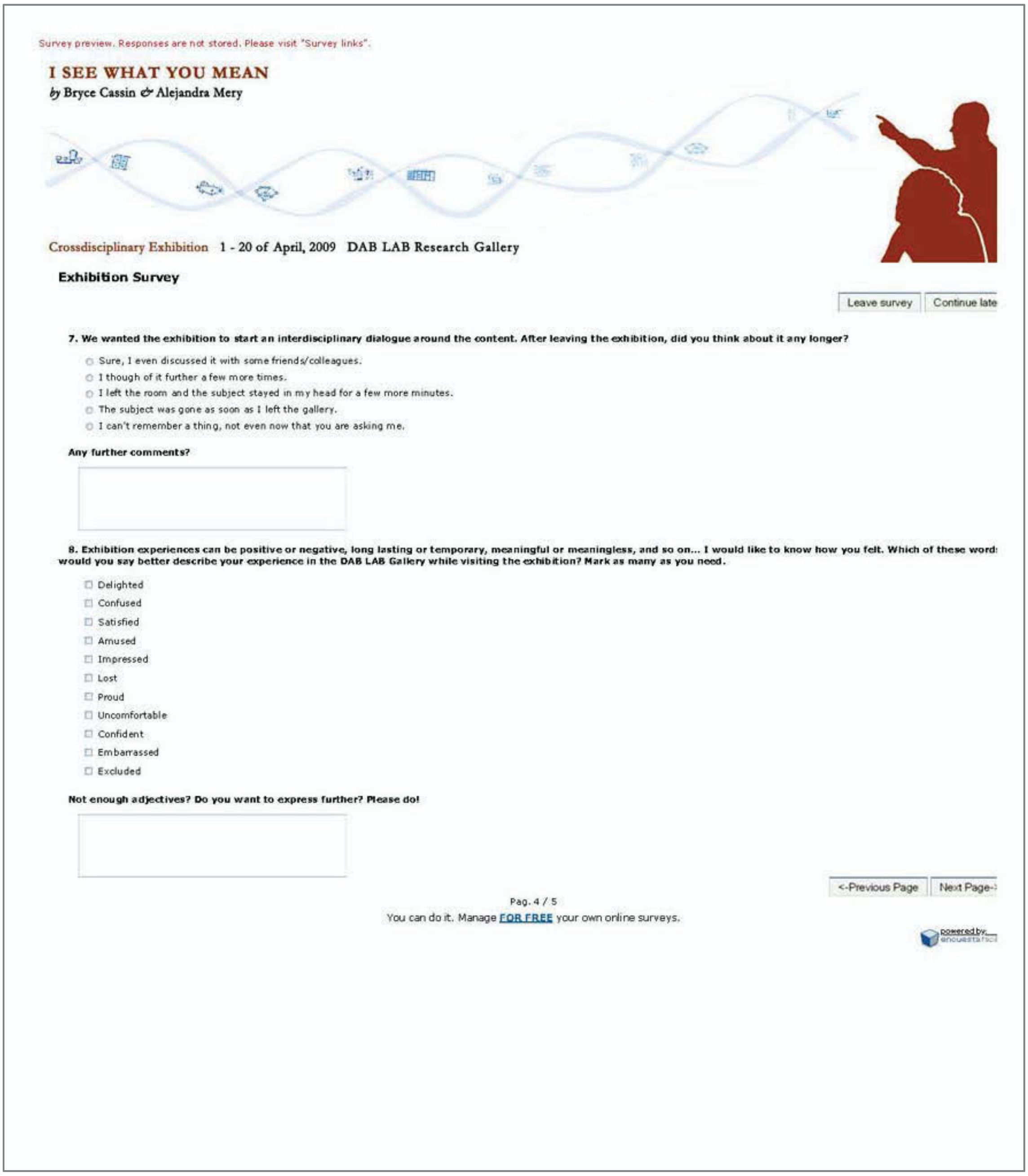

Survey preview. Responses are not stored. Please visit "Survey links".

I SEE WHAT YOU MEAN

by Bryce Cassin & Alejandra Mery

Crossdisciplinary Exhibition 1 - 20 of April, 2009 DAB LAB Research Gallery

Exhibition Survey

Leave survey | Continue late

7. We wanted the exhibition to start an interdisciplinary dialogue around the content. After leaving the exhibition, did you think about it any longer?

- Sure, I even discussed it with some friends/colleagues.
- I though of it further a few more times.
- I left the room and the subject stayed in my head for a few more minutes.
- The subject was gone as soon as I left the gallery.
- I can't remember a thing, not even now that you are asking me.

Any further comments?

8. Exhibition experiences can be positive or negative, long lasting or temporary, meaningful or meaningless, and so on... I would like to know how you felt. Which of these word: would you say better describe your experience in the DAB LAB Gallery while visiting the exhibition? Mark as many as you need.

- Delighted
- Confused
- Satisfied
- Amused
- Impressed
- Lost
- Proud
- Uncomfortable
- Confident
- Embarrassed
- Excluded

Not enough adjectives? Do you want to express further? Please do!

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Survey preview. Responses are not stored. Please visit "Survey links".

I SEE WHAT YOU MEAN

by Bryce Cassin & Alejandra Mery

Crossdisciplinary Exhibition 1 - 20 of April, 2009 DAB LAB Research Gallery

Exhibition Survey

Leave survey | Continue late

9. The "I See What You Mean" exhibition invited you to explore the different mindsets of disciplines with the help of several visualizations that would have particular meanings for each of us. The richness of that difference has been considered the core motive for our project: a new way of communicating, sharing and building together. Would you like to add more to this collaboration?

Thanks for taking the time out of your busy day in sharing your valuable opinion!

<-Previous Page | Done-:

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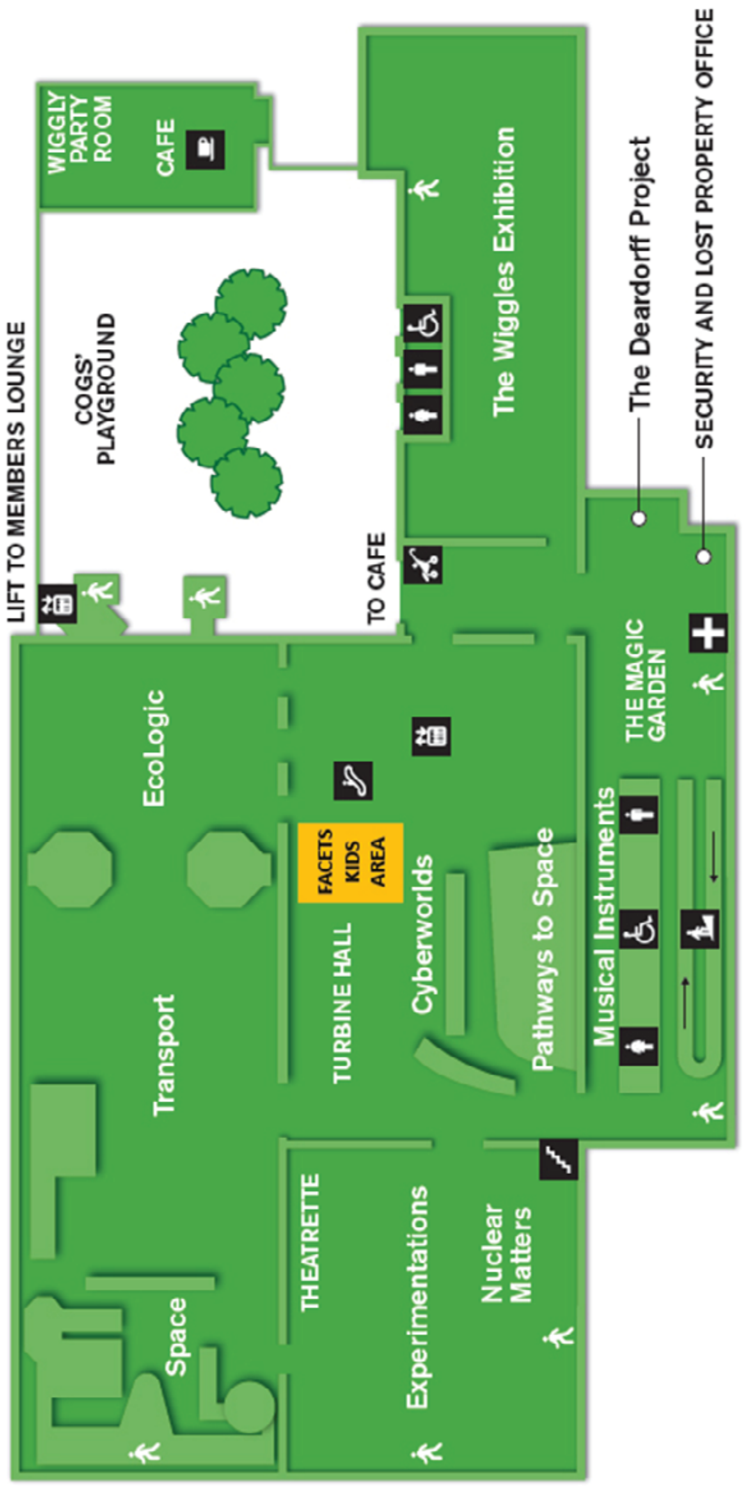
Appendix 6. Case Study: *Facets Kids*. Installation fact sheet.

Type	Interactive Art Installation, temporary
Artist	Bert Bongers
Collaborators & Role	Frank Maguire, Interaction Designer. Development and programming of the interactive tangible interfaces. Kath Daniel, Education Officer of the Powerhouse Museum's Public Programs. Museums' logistics for the installation. Alejandra Mery Keitel, Doctoral Researcher and Candidate. Audience research.
Venue	Powerhouse Museum Science and Technology Museum
Location	500 Harris Street Ultimo , New South Wales 2007, Australia
Exhibition and Case Study Date	6 - 16 October 2009

Appendix 7. Case Study: *Facets Kids*. Powerhouse Museum Floorplan, Level 1, with the orange section indicating the area in which the installation was presented.



Source: Powerhouse Museum website

Appendix 8. Case Study: *Facets Kids*. Draft for the design of units of study made during the first day of fieldwork.

- DATA COLLECTION

1) Phenomena & Trends in periods of 60' pick up special reaction, unexpected, new. Define as trends of phenomena. within each period and in total.

2) % of IX per visitors Registering # of visitors passing by in periods of 15', 4 times a day, and the % of them who actually interact using the platform +/or cues. No toddlers considered (only 3y + up). Area defined acc. to scheme. People taking the escalators not considered.

14) Technical Record. # of system crashes. per day.

) USERS RESPONSE TO CRASHES: observation of users reactions to system crashes. Reactions & Actions (i.e. confused, left immediately,

4) INFLUENCE OF GROUP IN THE IXs social IXs within and through the experience. Considers users as individuals in relation to others and as a group itself. Participants / Groups have been defined. looks for + and − reactions / experiences; levels of collaboration, understanding, engagement & sharing of EX.

5) "Quotes". Literal expressions of visitors & their contexts taken at random times.

6) 10' minutes sample videos. Made at random times. Complete 10' minutes of IX. at ≠ times of the day.

7) Categorization of visitors. According to Australian Visitors parameters (ask Kath) id of ≠ people visiting. 30' at random times of day. Registers only actual IX with platform/cues.

8) Audio recordings, supports (5). random times. 2hs. each.

9) Movements: description of the various ≠ movements of users. Later define the most comm. taken in periods of 30' at random times. // How does the space inform movement?

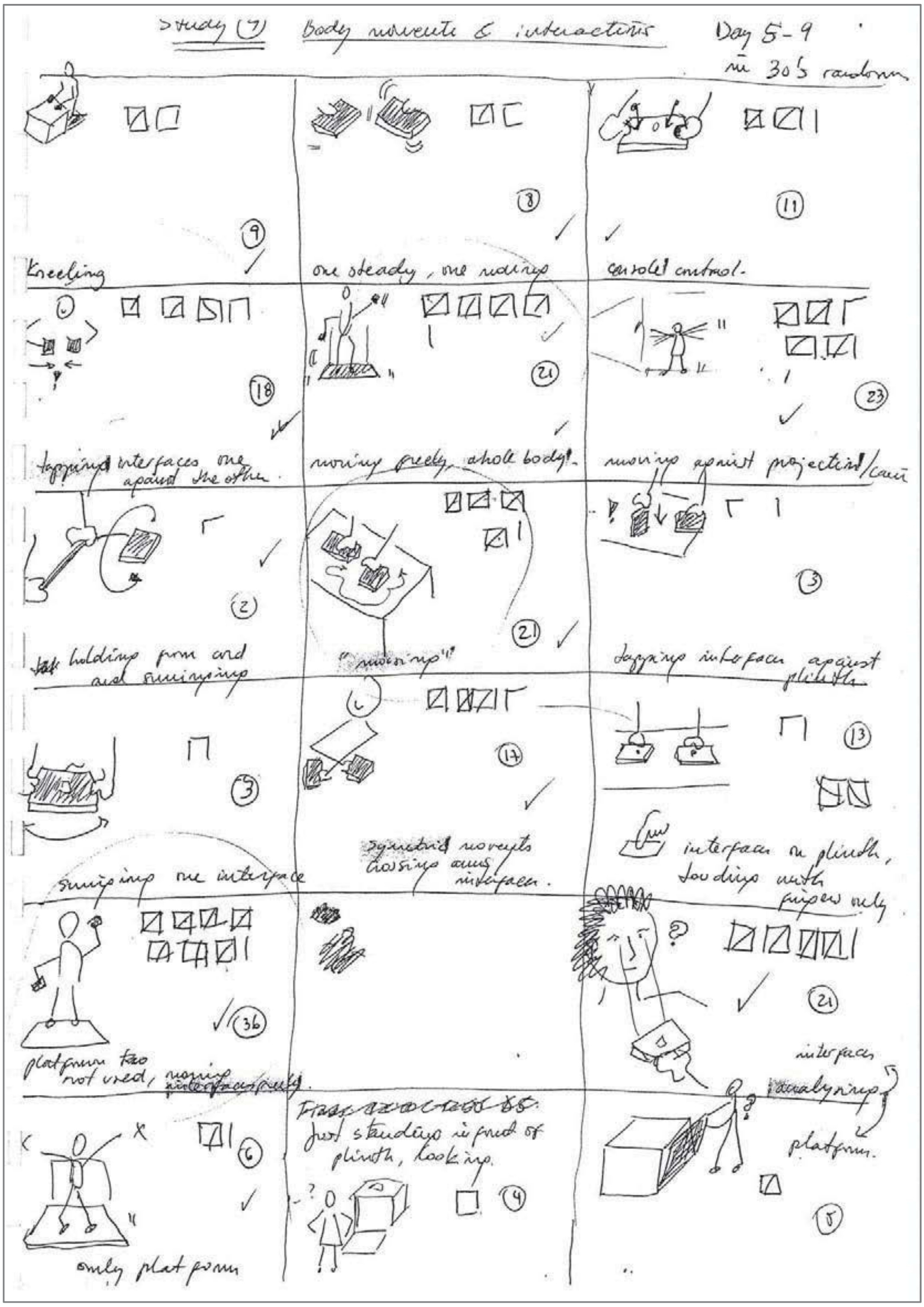
10) Time for IX. from noticing till leaving. $\bar{X}$ of time.

13) Qualitative analysis

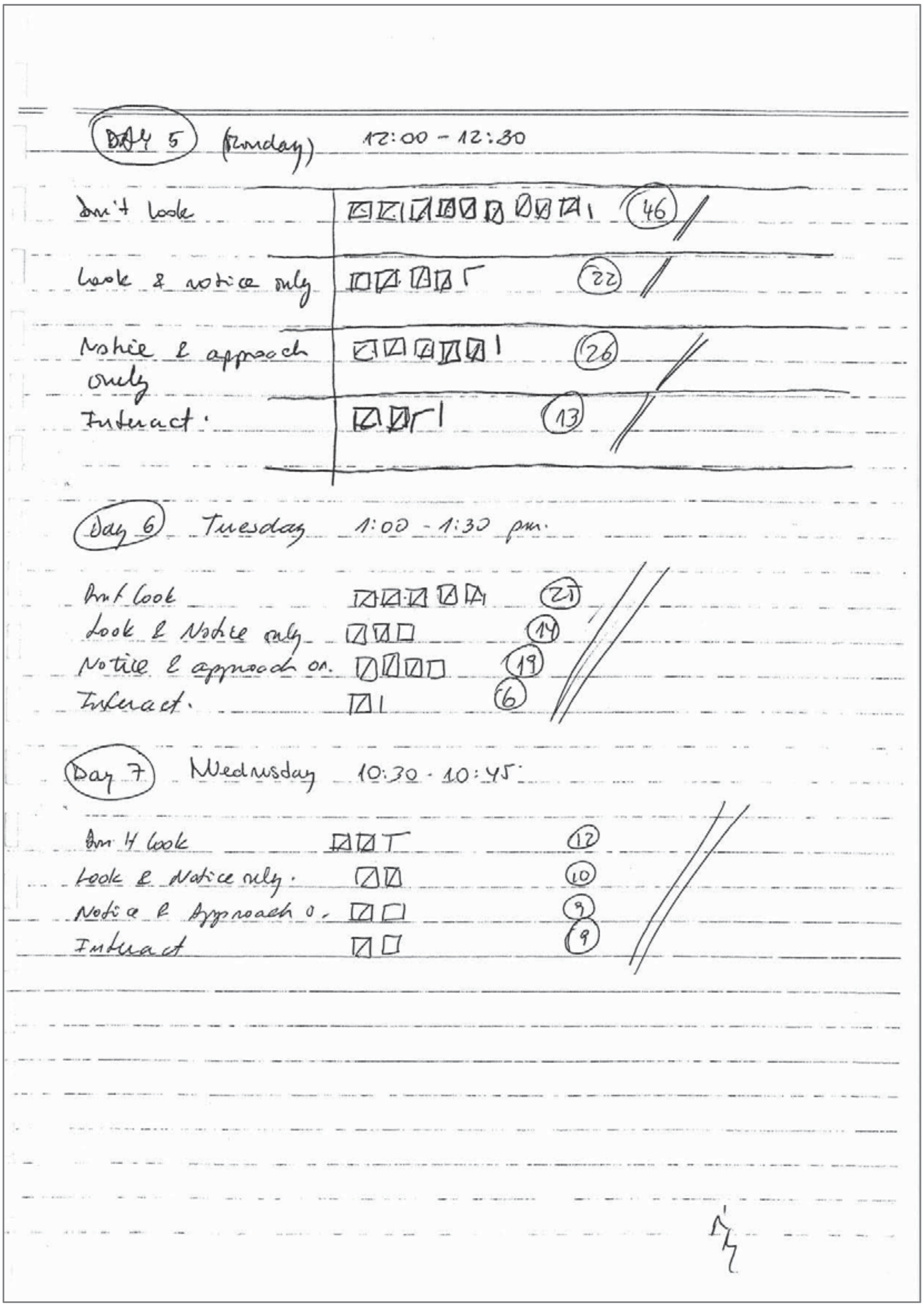
11) Sequences of IX. as (10).

12) 30' of visitors around and their level of X. → cues/plat → video of them

Appendix 9. Case Study: *Facets Kids*. Field notes and sketches for the unit of study Movement Patterns.



Appendix 10. Case Study: *Facets Kids*. Field data collection sample of the unit of study Audience Participation.



DAY 5 (Sunday) 12:00 – 12:30

Don't look	46
Look & notice only	22
Notice & approach only	26
Interact.	13

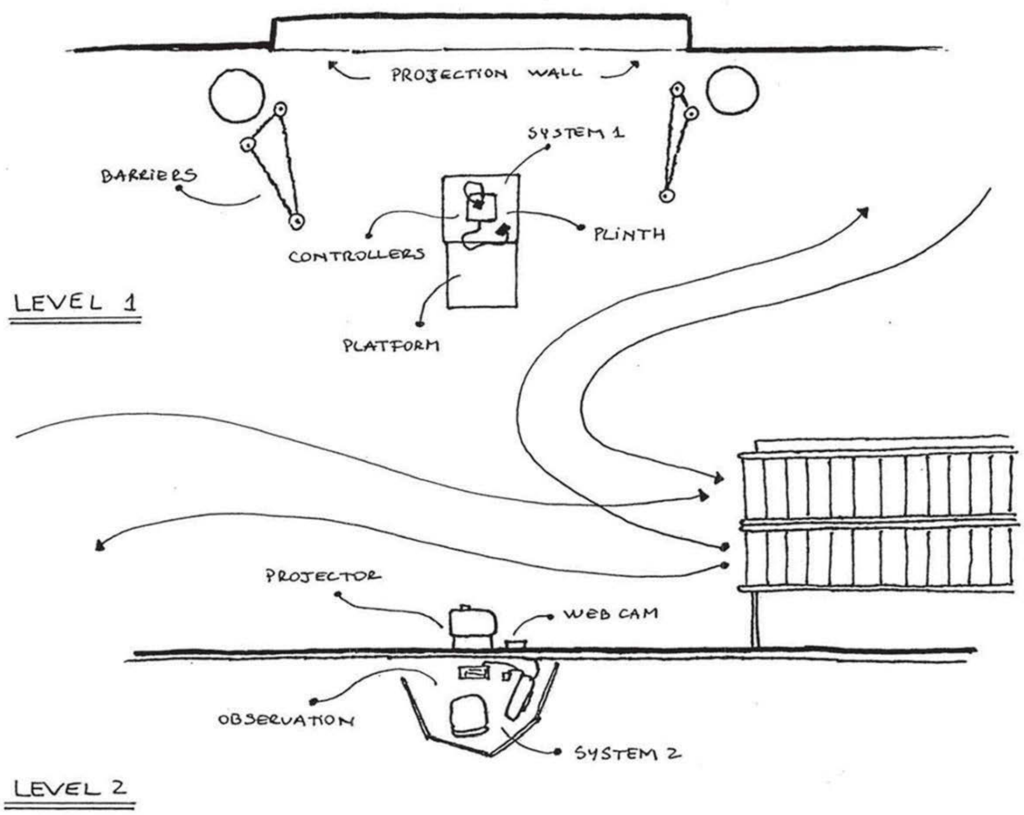
Day 6 Tuesday 1:00 – 1:30 pm.

Don't look	21
Look & Notice only	14
Notice & approach on.	19
Interact.	6

Day 7 Wednesday 10:30 - 10:45

Don't look	12
Look & Notice only.	10
Notice & Approach o.	9
Interact	9

Appendix 11. Case Study: *Facets Kids*. Schematic representation of the distribution of technology in the installation.



Appendix 12. Case Study: *Dangerous Australians*. Exhibit fact sheet.

Type	Interactive Exhibit, permanent
Containing Exhibition	*Surviving Australia*
Venue	Australian Museum Natural History and Anthropological Museum
Key Professionals Involved	Elizabeth Cowell, Exhibition Project Manager, Public Engagement, Australian Museum. Freeman Ryan Design Pty Ltd (Susan Freeman, Director). Chief Exhibition Design. Lightwell (Michael Hill, Creative Director). Interactive System Design. Wizard Projects. Hardware Supply and Installation. Wax Sound Media. Audio Design. Alison Bond. Computer Graphic Imagery (CGI). Idrawfast. Additional CGI.
Location	6 College Street Sydney, New South Wales 2010, Australia
Case Study Date	1 - 24 April 2009

Appendix 13. Case Study: *Dangerous Australians*. UTS HREC Ethics Approval Letter.

31 March 2011

Associate Professor Bert Bongers
School of Design
CB06.05.609
UNIVERSITY OF TECHNOLOGY, SYDNEY

Dear Bert,

UTS HREC 2011-049 – BONGERS, Associate Professor Bert, MULLER, Dr Lizzie (for KEITAL, Ms Alejandra Mery, PhD student) – “"Dangerous Australians" at the museum, a case study part of the PhD Research "Human Computer Interaction in Museums as public spaces: Researching the impact of Interactive Technologies on visitors' Experience"’

Thank you for your response to my email dated 15/03/11. Your response satisfactorily addresses the concerns and questions raised by the Committee, and I am pleased to inform you that ethics clearance is now granted.

Your clearance number is UTS HREC REF NO. 2011-049A

Please note that the ethical conduct of research is an on-going process. The *National Statement on Ethical Conduct in Research Involving Humans* requires us to obtain a report about the progress of the research, and in particular about any changes to the research which may have ethical implications. This report form must be completed at least annually, and at the end of the project (if it takes more than a year). The Ethics Secretariat will contact you when it is time to complete your first report.

I also refer you to the AVCC guidelines relating to the storage of data, which require that data be kept for a minimum of 5 years after publication of research. However, in NSW, longer retention requirements are required for research on human subjects with potential long-term effects, research with long-term environmental effects, or research considered of national or international significance, importance, or controversy. If the data from this research project falls into one of these categories, contact University Records for advice on long-term retention.

If you have any queries about your ethics clearance, or require any amendments to your research in the future, please do not hesitate to contact the Ethics Secretariat at the Research and Innovation Office, on 02 9514 9772.

Yours sincerely,

Professor Marion Haas
Chairperson
UTS Human Research Ethics Committee

Appendix 14. Case Study: *Dangerous Australians*. UTS HREC Working with children regulatory paperwork.

UTS HUMAN RESEARCH ETHICS COMMITTEE

APPENDIX B: CHILDREN

Research involving children and young persons under the age of 18 years raises special issues and considerations. If your research does involve children, you are advised to discuss your application with the Research Ethics Officer beforehand. Adults in any employment that involves direct contact with children are subject to the Child Protection Legislation and the Working With Children Check. Researchers should familiarise themselves with:
- the University's guidelines
- Section 4.2 of the *National Statement on Ethical Conduct Involving Humans*,
- guidelines published by the Commission for Children and Young People and the
- Child Protection Legislation.

(a) How will you obtain consent from **both** children and their parents, and any other stakeholder?

In addition to the regular Information Sheet (Appendix G), a Consent Form (Appendix I) will be handed to parents / guardians in order to obtain their permission to have their children participate in the study. In addition to this, consent from children will be sought by presenting them a Consent Card (Appendix J) with two faces to colour: a sad (☹) and a happy (☺) one. Only if the child colours the happy face (☺) the study will continue. If the unhappy face (☹) is coloured instead, even if the parent/guardian has previously given consent, the study will not continue.

(b) The HREC recommends that, when conducting research with children, a third person is present, or that the researcher and child are in a room that is visible from outside. If for any reason this is not your intention, please explain.

The exhibit around which the study will take place is located in an open public space within the museum (see Appendix E. Surviving Australia Exhibition Floorplan, provided by the Australian Museum) and receives a constant flow of visitors. All parties involved in the study - children, their parents and the researcher - will be together in this space at the same time. In addition, the researcher will be under regular supervision and guidance of the Head of Audience Research of the Australian Museum, Dr Lynda Kelly.

If your research **does** involve children please **sign** the following declaration.

DECLARATION FOR RESEARCH INVOLVING CHILDREN:

We have read and understood the relevant guidelines and legislation referred to above.

We understand and agree that we and any other person engaged to work with children as part of in this research in either a paid or unpaid capacity:

a) must complete and attach a 'Volunteer/Student' declaration, and

b) may be subject to the provisions of the Working With Children Check.

____________________ Date: ____/____/____
Supervisor/Chief Investigator

____________________ Date: ____/____/____
Student/Co-investigator

Note: All researchers involved in the project must sign this declaration.

Ethics Application – Appendix B - Last updated: August 2010 *Page 1 of 1*

NSW WORKING WITH CHILDREN CHECK

VOLUNTEER/STUDENT DECLARATION

Volunteers who mentor disadvantaged children or who provide intimate personal care to disabled children should use the Applicant Declaration and Consent rather than the Volunteer/Student Declaration.

Personal Details:

Name:

Family name: Mery Keitel

First name: Alejandra **Other given name(s):** Soledad

Residential address:

Address Line 1: [redacted]

Address Line 2:

Suburb/Town: [redacted] **State:** [redacted] **Postcode:** [redacted]

Country: Australia

Contact:

Phone: 0295148606 **Mobile:** [redacted]

Email: AlejandraSoledad.MeryKeitel@student.uts.edu.au

Date of birth: [redacted] **Gender:** F

Place of birth:

Suburb/Town: [redacted] **State:**

Country: [redacted]

Identifying document:

If you used one of these documents to verify your identity, please fill in these details

Licence Type:

Issuing Agency:

Licence number:

Passport Type: Government

Issuing Country: [redacted]

Passport number: [redacted]

Position details:

Title of child-related position:	Research student conducting field study
Name of organisation you are volunteering for:	University of Technology Sydney
Address of this organisation (if known):	15 Broadway, Ultimo, NSW 2007
I am a parent or guardian of a participating child (y/n):	No
I am a volunteer or student on placement (y/n):	Yes

It is an offence for a prohibited person to apply for, attempt to obtain, undertake or remain in child-related employment, **or to sign this declaration**. A prohibited person is a person who is convicted of the following (whether in NSW or elsewhere):

- murder of a child
- serious sex offence, including carnal knowledge
- child-related personal violence offence (an offence committed by an adult involving intentionally wounding or causing grievous bodily harm to a child)
- indecency offences punishable by imprisonment of 12 months or more
- kidnapping (unless the offender is or has been the child's parent or carer)
- offences connected with child prostitution
- possession, distribution or publication of child pornography; or
- attempt, conspiracy or incitement to commit the above offences.

A prohibited person includes a Registrable person under the *Child Protection (Offenders Registration) Act 2000.*

Details of these offences can be found online at Working With Children Employer Guidelines Fact sheet 1. A conviction includes a finding that the charge for an offence is proven, or that a person is guilty of an offence, even though the court does not proceed to a conviction.

Declaration:

- [x] I have read and understood the information above about prohibited persons. I am aware that it is an offence to make a false statement on this form.
- [x] I declare that I am not a prohibited person under the *Commission for Children and Young People Act 1998.*
- [x] I consent to the Commission for Children and Young People checking my relevant criminal records, to verify these statements. I understand that this information may be referred to the Commission for Children and Young People and/or to NSW Police for law enforcement purposes and for monitoring and auditing compliance with the procedures and standards for the Working With Children Check in accordance with Section 36 (1)(f) of the *Commission for Children and Young People Act 1998.*

Signature: ____________________

Date: ____________________

Employer to Complete:

- [ ] I have sighted photo identification for this person

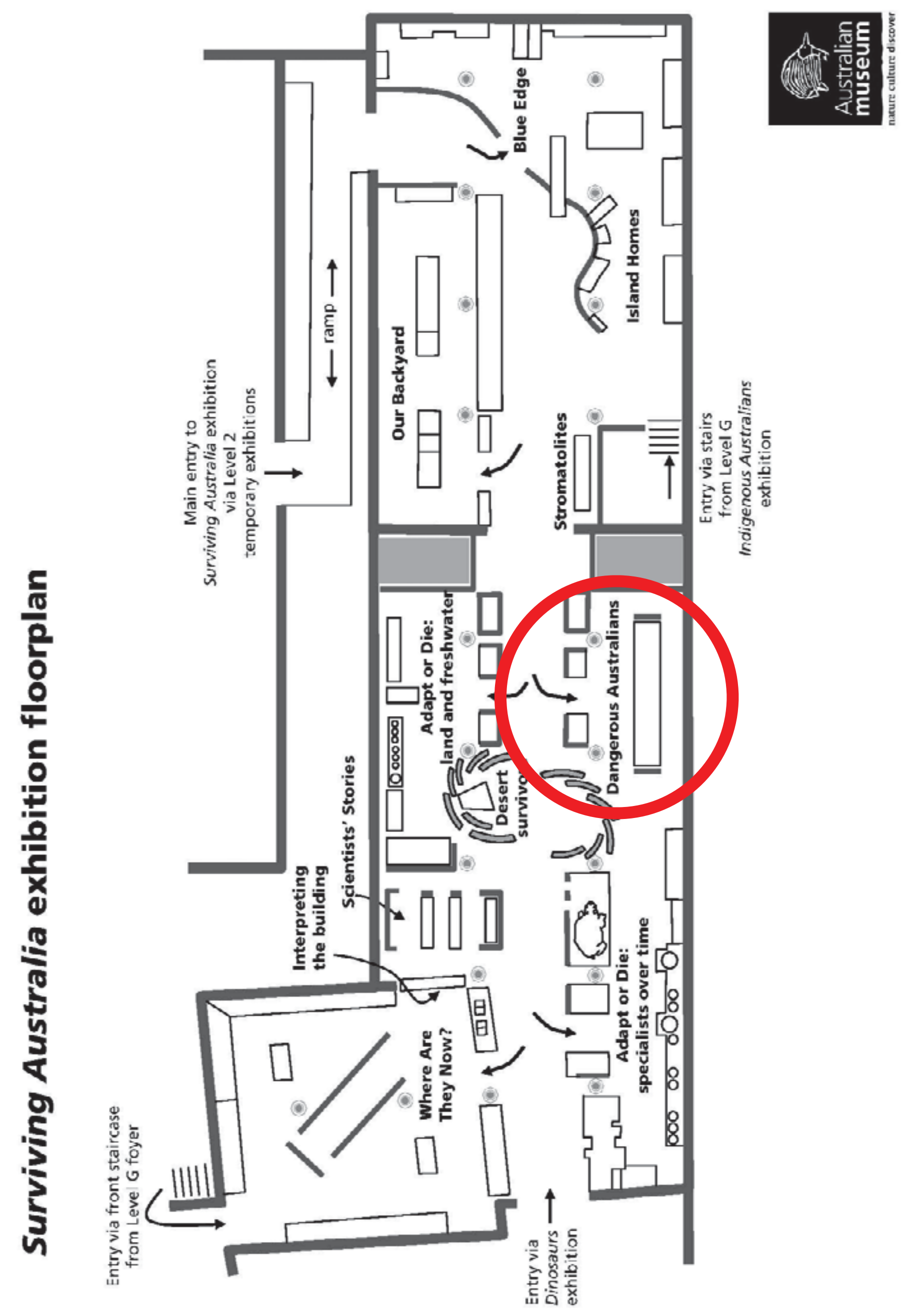
Signature: ____________________

Date: ____________________

Name: ____________________ **Position:** ____________________

What should I do next? Once you have completed your details, you will need to sign the printed form and provide the signed form to your employer/volunteer organisation. You may also wish to retain a copy for your records.

Appendix 15. Case Study: *Dangerous Australians*. *Surviving Australia* Exhibition Floorplan, with the red circle indicating the area in which the exhibit is located.



Source: Australian Museum website

Appendix 16. Case Study: *Dangerous Australians*. Research Information Form presented to participants.

UNIVERSITY OF TECHNOLOGY SYDNEY

Research Information Sheet
(for you to take)

"Dangerous Australians" Exhibit

Audience Research at the Australian Museum

Dear visitor,

My name is Alejandra Mery Keitel and I am a doctoral student at the University of Technology, Sydney.

I am conducting research into the use of digital technologies in public spaces and would welcome your assistance. I have been kindly supported by the **Australian Museum** to study the interaction of the museum's visitors with one of its most popular exhibits, the **"Dangerous Australians"** interactive table.

During your visit, your interaction with the exhibit and other visitors may have been observed, as indicated in the information poster. If you agreed on further participating in this audience research I would ask you to share your experience with Dangerous Australians during a brief interview right after you leave the exhibit, which should take no more than five (5) minutes of your time. If you visited the exhibition with children, I would ask them to participate too, only if you give me your approval and with you being present at all times.

Your participation in this research means no risk for you (or your children), and certainly no obligation on your side. You are free to withdraw from our interview at any time, without consequences, and without giving a reason.

If you have concerns about the research that you think I or my supervisor, Dr Bert Bongers, can help you with, please feel free to contact me (via email amery@proteinlab.cl or phone +61 [redacted]) or Dr Bongers (via email Bert.Bongers@uts.edu.au or phone +61 2 9514 8932). If you would like to talk to someone who is not connected with the research, you may contact the Research Ethics Officer on +61 2 9514 9615, and quote this number *(UTS HREC Reference Number 2011-049A)*

Thank you very much for your help.

Alejandra Mery K.
Doctoral Candidate in Interaction Design

Faculty of Design, Architecture and Building
University of Technology Sydney (Australia)
702-730 Harris Street, Ultimo, NSW 2007
(614) [redacted]/ (612) 9514 8606

Appendix 17. Case Study: *Dangerous Australians*. Consent forms for different audiences: adults, teenagers (accompanied by adults), children (accompanied by adults), and parents accompanying teenagers and/or children.

UNIVERSITY OF TECHNOLOGY SYDNEY

Consent Form
Adult Participant

I ______________________________ *(please give your full name)* agree to participate in the research survey **"Dangerous Australians" at the Australian Museum, a Case Study part of the PhD Research "Human Computer Interaction in Museums as Public Spaces: Researching the Impact of Interactive Technologies on Visitors' Experience" (*UTS HREC Approval Reference Number 2011-049A*)** being conducted by Alejandra Mery Keitel (UTS student number [redacted], ph. +61 4 [redacted], Room 557 730 Harris Street, Ultimo, NSW 2007).

I understand that the purpose of this interview is to explore the way interaction with the Dangerous Australians exhibit was designed, collecting direct testimony from me as part of the exhibit's design team.

Also, I understand and that my participation in this research will involve sharing my experiences with Dangerous Australians and its design process and giving my personal opinion on the exhibit during a brief face-to-face interview. I understand as well that no other people will be present at the same time if I request so and I am free to withdraw my participation from this research project at any time I wish, without consequences, and without giving a reason. In such case, I understand all of the data collected from me will be immediately cleared and not used in any way.

I agree that the research data gathered from this project may be used for publications such as conference papers, journal articles and doctoral thesis, unless I request its kept private. I understand that my identity will be protected by making reference of me as "Expert A, or B, etc." or by my given name only, unless I state otherwise. I understand and agree on the storing of data in personal archives being the researcher the only person to have access to it.

I am aware that I can contact Alejandra Mery Keitel (via email amery@proteinlab.cl or phone +61 4 [redacted]) or her Chief Supervisor Dr Bert Bongers (via email Bert.Bongers@uts.edu.au or phone +61 2 9514 8932) if I have any concern about this particular study and/or the overall research.

I agree that Alejandra Mery Keitel has answered all my questions fully and clearly.

______________________________ ____/____/____

Signature (participant) Date (dd/mm/yy)

______________________________ ____/____/____

Signature (researcher) Date (dd/mm/yy)

NOTE:

This study has been approved by the University of Technology, Sydney Human Research Ethics Committee. If you have any complaints or reservations about any aspect of your participation in this research which you cannot resolve with the researcher, you may contact the Ethics Committee through the Research Ethics Officer (ph: 02 9514 9615, Research.Ethics@uts.edu.au) and quote the UTS HREC reference number. Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.

UNIVERSITY OF TECHNOLOGY SYDNEY

Consent Form
Teenager Participant

I ______________________________ *(please give your full name)*, with the approval of my parent(s)/guardian(s), agree to participate in the research survey **"Dangerous Australians" at the Australian Museum, a Case Study part of the PhD Research "Human Computer Interaction in Museums as Public Spaces: Researching the Impact of Interactive Technologies on Visitors' Experience"** ***(UTS HREC Approval Reference Number 2011-049A)*** being conducted by Alejandra Mery Keitel (UTS student number [redacted], ph. +61 4 [redacted], Room 557 730 Harris Street, Ultimo, NSW 2007).

I understand that the purpose of this survey is to study the way visitors interact with the exhibit by observing and collecting direct testimony from us so better museum experiences can be designed in the future.

I understand that I may have been observed, as indicated in the information poster, as well as my interaction with the exhibit and other visitors.

Also, I understand and that my participation in this research will involve sharing my experiences with Dangerous Australians and giving my personal opinion on the exhibit during a brief face-to-face interview. I understand as well that no other people will be present at the same time if I request so and I am free to withdraw my participation from this research project at any time I wish, without consequences, and without giving a reason. In such case, I understand all of the data collected from me will be immediately cleared and not used in any way.

I agree that the research data gathered from this project may be used for publications such as conference papers, journal articles and doctoral thesis. I understand that my identity will be protected by making reference of me as "Visitor A, or B, etc." or by my given name only. I understand and agree on the storing of data in personal archives being the researcher the only person to have access to it.

I am aware that I can contact Alejandra Mery Keitel (via email amery@proteinlab.cl or phone +61 4 [redacted]) or her Chief Supervisor Dr Bert Bongers (via email Bert.Bongers@uts.edu.au or phone +61 2 9514 8932) if I have any concern about this particular study and/or the overall research.

I agree that Alejandra Mery Keitel has answered all my questions fully and clearly.

______________________________	____ / ____ / ____
Signature (visitor)	Date (dd/mm/yy)
______________________________	____ / ____ / ____
Signature (researcher)	Date (dd/mm/yy)

NOTE:
This study has been approved by the University of Technology, Sydney Human Research Ethics Committee. If you have any complaints or reservations about any aspect of your participation in this research which you cannot resolve with the researcher, you may contact the Ethics Committee through the Research Ethics Officer (ph: 02 9514 9615, Research.Ethics@uts.edu.au) and quote the UTS HREC reference number. Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.

UNIVERSITY OF TECHNOLOGY SYDNEY

Consent Form
Participant under 12 y/o

My name is ______________________________ and I am ______ years old

YES, I want to talk about the exhibition

NO, I don't want to talk about the exhibition

UNIVERSITY OF
TECHNOLOGY SYDNEY

Consent Form
Participant with Children

I ______________________________ *(please give your full name)* agree to participate in the research survey **"Dangerous Australians" at the Australian Museum, a Case Study part of the PhD Research "Human Computer Interaction in Museums as Public Spaces: Researching the Impact of Interactive Technologies on Visitors' Experience"** (***UTS HREC Approval Reference Number 2011-049A)*** being conducted by Alejandra Mery Keitel (UTS student number [redacted], ph. +61 4 [redacted], Room 557 730 Harris Street, Ultimo, NSW 2007). I also agree that the children I'm visiting the exhibit with, ____ child/children in total, take part of the study.

I understand that the purpose of this survey is to study the way visitors interact with the exhibit by observing and collecting direct testimony from us so better museum experiences can be designed in the future.

I understand that the children and I may have been observed, as indicated in the information poster, as well as our interaction with the exhibit and other visitors.

Also, I understand and that our participation in this research will involve sharing our experiences with Dangerous Australians and giving our personal opinions on the exhibit during brief face-to-face interviews. I understand as well that no other people will be present at the same time if I request so and we are free to withdraw our participation from this research project at any time we wish, without consequences, and without giving a reason. In such case, I understand all of the data collected from us will be immediately cleared and not used in any way.

I agree that the research data gathered from this project may be used for publications such as conference papers, journal articles and doctoral thesis. I understand that our identities will be protected by making reference of us as "Visitor A, or B, etc." or by our given names only. I understand and agree on the storing of data in personal archives being the researcher the only person to have access to it.

I am aware that I can contact Alejandra Mery Keitel (via email amery@proteinlab.cl or phone +61 4 [redacted]) or her Chief Supervisor Dr Bert Bongers (via email Bert.Bongers@uts.edu.au or phone +61 2 9514 8932) if I have any concern about this particular study and/or the overall research.

I agree that Alejandra Mery Keitel has answered all my questions fully and clearly.

______________________________ ____ / ____ / ____

Signature (visitor) Date (dd/mm/yy)

______________________________ ____ / ____ / ____

Signature (researcher) Date (dd/mm/yy)

NOTE:
This study has been approved by the University of Technology, Sydney Human Research Ethics Committee. If you have any complaints or reservations about any aspect of your participation in this research which you cannot resolve with the researcher, you may contact the Ethics Committee through the Research Ethics Officer (ph: 02 9514 9615, Research.Ethics@uts.edu.au) and quote the UTS HREC reference number. Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.

Appendix 18. Case Study: *Dangerous Australians*. Semi-structured interviews questions samples for interviews with museum experts and with design experts.

UNIVERSITY OF TECHNOLOGY SYDNEY

Semi Structured Interview
Museum Experts Sample Questions

Thanks for accepting to take this interview and collaborating to the development of my research. According to university regulations this interview has been evaluated and approved by the Human Research Ethics Committee. This committee cares for the protection and anonymity of research subjects. In order to make this interview valid I would like to ask you to read and sign this consent form

Consent form is handed to interviewee. If doubts arise they are clarified. Once the document is accepted and signed, the interview stars by defining the main technical concept of the research: interactive exhibitions.

As I explained before, my research is about the use of interactive technologies in public spaces and I'm taking museums as an example of integration of these technologies in their exhibition environments. By interactive exhibition we understand one that uses computers and other digital technologies as the main means for capturing visitors' action and displaying content.

1. How long have you been working (as an expert) in cultural heritage institutions? What would you say were your main motivations for developing your career in this path?
2. In terms of new technologies, how would you evaluate in general their incorporation in today's exhibition environments?
3. When it comes to defining a new interactive exhibition, what is your role at the museum?
4. And from that role, how do you engage with its future audience before the new exhibit is commissioned? What are your main audience research procedures?
5. What would you say are the first considerations when defining new interactive exhibitions?
6. During the development of such projects, how are the work dynamics with the design firm? Do you take part of any design stage in particular? If so, how does that develop?
7. What do you expect your audience to experience when interacting with this type of exhibitions?
8. In your experience, how would you describe audience's readiness and motivation towards interactive exhibitions?
9. Do you think visitors' experience of interactive exhibitions is different to non-interactive ones? If yes or no, why? What do your think interactive technologies offer to the visiting experience beyond others?
10. How do you evaluate museum visitors' overall experience with this type of exhibitions?
11. When introducing / presenting to the museum audience a new interactive exhibition, do you conduct any kind of evaluation?
12. Is there anything else you would like to add to this interview, suggest or comment?

Thank you very much for your time and interest. If you would like me to, I will be happy to share the results of this study. If there's anything else you would like ask or add after this interview, please do not hesitate to contact me.

Audience Research Information Sheet is handed to interviewee. If doubts arise they are clarified. Once the document is accepted and signed, the interview stars by defining the main technical concept of the research: interactive exhibitions.

UNIVERSITY OF TECHNOLOGY SYDNEY

Semi Structured Interview
Design Experts Sample Questions

Thanks for accepting to take this interview and collaborating to the development of my research. According to university regulations this interview has been evaluated and approved by the Human Research Ethics Committee. This committee cares for the protection and anonymity of research subjects. In order to make this interview valid I would like to ask you to read and sign this consent form

Consent form is handed to interviewee. If doubts arise they are clarified. Once the document is accepted and signed, the interview stars by defining the main technical concept of the research: interactive exhibitions.

As I explained before, my research is about the use of interactive technologies in public spaces and I'm taking museums as an example of integration of these technologies in their exhibition environments. By interactive exhibition we understand one that uses computers and other digital technologies as the main means for capturing visitors' action and displaying content.

1. How long have you been working (as an expert) in interactive exhibitions with digital technologies? What would you say were your main motivations for developing your career on this path?
2. How is team work developed in Lightwell? How much of other colleagues' disciplines do you explore throughout your work?
3. In terms of new technologies, how would you evaluate in general their incorporation in today's exhibition environments?
4. When it comes to commencing a design project for an interactive exhibition, what is your role at Lightwell?
5. And from that role, how do you engage with its future audience before, during and after the design process? What are your main audience research procedures?
6. What would you say are the first considerations when defining new interactive exhibitions?
7. How do you, as a design team, engage with audience prior to the commencement of the design stage? What are your main audience research procedures?
8. In terms of design process, what are the main stages your firm follows? During the design process, does the museum take part of any design stage in particular?
9. In respect to technologies, in what ways and why do you usually incorporate computer-based technologies in your work?
10. What do you expect your audience to experience when interacting with this type of exhibitions?
11. In your experience, how would you describe audience's readiness and motivation towards interactive exhibitions?
12. Do you think visitors' experience of interactive exhibitions is different to non-interactive ones? If yes or no, why? What do your think interactive technologies offer to the visiting experience beyond others?
13. How do you evaluate museum visitors' overall experience with this type of exhibitions?
14. Once the new interactive exhibition is presented, do you conduct any kind of evaluation?
15. Is there anything else you would like to add to this interview, suggest or comment?

Thank you very much for your time and interest. If you would like me to, I will be happy to share the results of this study. If there's anything else you would like ask or add after this interview, please do not hesitate to contact me.

Audience Research Information Sheet is handed to interviewee. If doubts arise they are clarified. Once the document is accepted and signed, the interview stars by defining the main technical concept of the research: interactive exhibitions.