Human Computer Interaction in Museums as Public Spaces:

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

Alejandra Soledad Mery Keitel

Submitted for the Degree of Doctor of Philosophy

Faculty of Design, Architecture and Building

University of Technology, Sydney

2012

Certificate of Authorship/Originality

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Production Note:
Signature removed prior to publication.

Signature of Student

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.

Acknowledgements

This doctoral research project has been made possible thanks to the sponsorship of the Ministry of Education of Chile, through the Metropolitan Technological University (UTEM) and of the institution in which I conducted my post-graduate studies in Australia, the University of Technology Sydney (UTS). The Mecesup Scholarship I was awarded in 2007 allowed me to undertake my studies for three years. In 2011 the UTS Graduate School awarded me the UTS International Research Scholarship to continue and conclude my studies. I am grateful to both institutions for their financial support and their trust in my work. I am also profoundly grateful to my supervisors, Associate Professor Bert Bongers and Dr Lizzie Muller. Their passion, knowledge and guidance made this research adventure enjoyable and rewarding. I also want to thank the Faculty of Design, Architecture and Building (DAB) at UTS, for their support, encouragement and guidance. I am particularly grateful to Ann Hobson, DAB Research Manager, and Professor Peter McNeil, DAB Director of Graduate Programmes and Researcher Education, for their valuable guidance and support during my five years of research.

Many thanks to the staff and executives of the exhibition venues that welcomed my research interests and facilitated the development of my case studies. In particular, I would like to acknowledge the work, support and dedication of Aanya Roennfeldt, curator of the DAB Lab Research Gallery; Kath Daniel, Education Officer of the Powerhouse Museum's Public Programs; and Dr Lynda Kelly, Manager Online, Editing and Audience Research of the Australian Museum.

When coming to Australia I knew my life would change in many ways. I was prepared to make lots of friends, discover new places and take with me long-lasting memories. I did not expect this to start straight at my desk. Most sincere thanks to all my fellow researchers and friends at DAB who made my research voyage a unique experience of personal and professional growth. I cannot name them all, as I have been blessed with too many wonderful people to share my adventure with. However, I want to thank one person in particular, Deborah Szapiro, for being an exceptional friend and colleague, the closest to a sister I could have in Australia. My life these

years would have not been the same without her. I will miss our inspirational and re-invigorating tea sessions dearly.

Above all, my deepest thanks go to those who live in my heart the 24 hours of the day. To my informal co-supervisor Dr Natalia Romero, who would constantly give me her support, time, patience and care. Enormous thanks to Jeff Starling, for believing in me and making sure I sailed safely and happy towards my horizon. Particularly, I thank him for his fabulous stir-fry dinners and for always having 'un café' ready for my tired head. Special thanks to Jen Starling for sharing her passion for museums with me, for keeping me fascinated with museum stories, and for helping me stay healthy. Many thanks to my siblings, who were always next to me, sending me good vibes and courage. Finally, I thank my parents, Cecilia Keitel, Carlos Varas and Claudio Mery, for constantly sowing in me the seeds of knowledge and believing that I could create some on my own. To them I owe my love for culture, my passion for hard work and the conviction that we can all make the world better, one step at a time.

List of Figures

Figure 1. General view of the *I See What You Mean* exhibition space …157

Figure 2. Examples of images collected for the content of the exhibition …163

Figure 3. View of the exhibition from outside the gallery …167

Figure 4. One poster of each discipline as presented in the exhibition …168

Figure 5. The interaction table with its components distributed along it …169

Figure 6. A visitor reading the quote presented in the main projection after approaching the interaction table …170

Figure 7. Photo-artefact being placed on the table's interaction prompt …171

Figure 8. Allocation of technological components of the exhibition …172

Figure 9. Proximity sensors underneath the front edge of the interaction table …174

Figure 10. Test screenshot of the MAX/MSP/Jitter patch of the exhibition's video projections …175

Figure 11. Researcher's observation main spots …179

Figure 12. Map of exhibition's Activity Zones …181

Figure 13. Ratio of public between different Activity Zones …182

Figure 14. Times of the day of highest gallery attendance …183

Figure 15. Time spent by visitors in the gallery …184

Figure 16. Trajectory Patterns as defined during the observation process …185

Figure 17. Trajectory Map sample of three visitors …186

Figure 18. Attention Map sample of one visitor during his whole visit …187

Figure 19. Attention Patterns as identified during data collection …188

Figure 20. Reasons for visitors to attend the exhibition …194

Figure 21. Interactive components identified by visitors …196

Figure 22. Visitors' exploration of the exhibition space …197

Figure 23. Further thought and discussions after the exhibition visit …198

Figure 24. General view of the *Facets Kids'* installation space …209

Figure 25. Pico projector for mobile projections in the LightBeam project …215

Figure 26. The CityWall display on a shop front at daylight and nigh time …217

Figure 27. Trainflow installation's façade embedded with sensors …220

Figure 28. Facets Plinth and its wide variety of interfaces …223

Figure 29. Visitor interacting with *Facets* Through the Roof …224

Figure 30. High audience flow in the *Facets Kids* installation area …226

Figure 31. Researcher's observation spots …230

Figure 32. Different audience roles in the interaction with *Facets Kids* …235

Figure 33. Proportion of young and mature *Facets Kids'* audience …245

Figure 34. Interest in *Facets Kids*: active and passive engagement …247

Figure 35. Number of passers-by effectively engaged with *Facets Kids* …248

Figure 36. Schematic visual representations of interfaces-related movements …251

Figure 37. Schematic visual representations of plinth-related movements …252

Figure 38. Schematic visual representations of body-related movements …253

Figure 39. Behaviours axis: from highly collaborative to highly conflictive …255

Figure 40. General view of the exhibit's space …267

Figure 41. Early interactive tabletops …271

Figure 42. The reacTable and its varied-patterns objects …275

Figure 43. Attendees to the Geneva Motor Show 2009 interact with a multi-touch interactive tabletop …278

Figure 44. Attendees to the Entrepreneur of the Year Awards interacting with one of The Pod's sectors. Image courtesy of Elisa Lee …279

Figure 45. The Locations exhibit at the ACMI's Screen Worlds exhibition …280

Figure 46. Projectors and speakers of the Churchill Lifeline tabletop …281

Figure 47. The Star-Spangled Banner exhibit …282

Figure 48. The *Dangerous Australians* exhibit within the *Surviving Australia* exhibition. Adapted from the Australian Museum' exhibition floorplan …285

Figure 49. The 'Island Homes' section of the *Surviving Australia* Exhibition …286

Figure 50. One of the accesses to the *Dangerous Australians* exhibit …287

Figure 51. Representation of the *Dangerous Australians* tabletop's content …288

Figure 52. Three stages in the presentation of pop-up information graphics …289

Figure 53. Part of the *Dangerous Australians*' camera vision system …290

Figure 54. Blank form for the recording of visitors' trajectories …296

Figure 55. Proportion of young and mature audiences …300

Figure 56. Breakdown of specific age groups attending the exhibit …301

Figure 57. Levels of Interaction observed at the exhibit …302

Figure 58. Segmentation of interaction time periods …304

Figure 59. Six of the most recurrent trajectories patterns identified …305

Figure 60. A 'Random with Repetition' trajectory of two participants …306

Figure 61. Breakdown of trajectories patterns according to the influence of space and content …307

Figure 62. Time given by visitors to each of the tabletop's features …308

Figure 63. Attention patterns depicting visitors' features preferences …309

Figure 64. A sequence showing different uses of fingers in the interaction with *Dangerous Australians* …311

Figure 65. A participant hovering his left hand above the surface …312

Figure 66. Participants interacting while standing straight, bending over the surface and leaning on it …312

Figure 67. A visitor looks at the tabletop's content from a short distance and approaches gradually to interact …313

Figure 68. Children frequently observed sitting or standing on the tabletop …314

Figure 69. A young and short participant trying to reach the surface …315

Figure 70. Children rising up on their toes to reaching some features …315

Figure 71. Most social interactions reflected a sense of collaboration …319

Figure 72. Social behaviour throughout the development of the study …319

Figure 73. A girl is encouraged by her parents to explore and explain; shortly after they explore together …320

Figure 74. Participants from different visiting groups engage in a game …320

Figure 75. Drawbacks of darkness in the exhibit area …324

Figure 76. The *Dangerous Australians* exhibit as seen by visitors when passing by …325

Figure 77. Two series of images depicting audience's responses …326

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. …328

Figure 79. Referential model for the study of social experiences with interactive museum exhibits …346

List of Tables

Table 1. Observations general records …180

Table 2. Record of presence of public in the different Activity Zones …182

Table 3. A 5-point scale that categorises the different levels of attention to Interactive Sets …190

Table 4. Creation of Engagement Levels scale from Attention Levels scale …191

Table 5. Bodily and facial expressions observed during the study …192

Table 6. Case study's general records …234

Table 7. Demographic records …246

Table 8. Participants' physical behaviours in the interaction with *Facets Kids* …250

Table 9. Categorisation of participants' and group members' social behaviours …254

Table 10. Case Study's summarised records …299

Table 11. Social Behaviours at *Dangerous Australians* explained …317

List of Appendices

Appendix 1. Case Study: *I See What You Mean*. Exhibition fact sheet …383

Appendix 2. Case Study: *I See What You Mean*. UTS HREC Ethics Approval Letter …384

Appendix 3. Case Study: *I See What You Mean*. Promotional flyer of the exhibition sent by the Gallery …385

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 …386

Appendix 5. Case Study: *I See What You Mean*. Screenshot of the web-based anonymous survey …388

Appendix 6. Case Study: *Facets Kids*. Installation fact sheet …393

Appendix 7. Case Study: *Facets Kids*. Powerhouse Museum Floorplan, Level 1, with the orange section indicating the area in which the installation was presented …394

Appendix 8. Case Study: *Facets Kids*. Draft for the design of units of study made during the first day of fieldwork …395

Appendix 9. Case Study: *Facets Kids*. Field notes and sketches for the unit of study Movement Patterns …396

Appendix 10. Case Study: *Facets Kids*. Field data collection sample of the unit of study Audience Participation …397

Appendix 11. Case Study: *Facets Kids*. Schematic representation of the distribution of technology in the installation …398

Appendix 12. Case Study: *Dangerous Australians*. Exhibit fact sheet …399

Appendix 13. Case Study: *Dangerous Australians*. UTS HREC Ethics Approval Letter …400

Appendix 14. Case Study: *Dangerous Australians*. UTS HREC Working with children regulatory paperwork …401

Appendix 15. Case Study: *Dangerous Australians*. *Surviving Australia* Exhibition Floorplan, with the red circle indicating the area in which the exhibit is located …404

Appendix 16. Case Study: *Dangerous Australians*. Research Information Form presented to participants …405

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 …406

Appendix 18. Case Study: *Dangerous Australians*. Semi-structured interviews questions samples for interviews with museum experts and with design experts …410

Table of Contents

Foreword 23

Chapter 1. Introduction 25

1.1. Outline of the Research Problem 27

1.2. Research Questions 29

1.3. Research Approach 31

1.4. Research Contributions 32

1.5. Structure of the Thesis 32

Chapter 2. Experiencing Interactive Technologies. 32

Chapter 3. The Shaping World of the Museum 33

Chapter 4. Interacting with Technologies at the Museum 33

Chapter 5. Methodology 33

Chapters 6, 7 and 8. Case Studies 33

Chapter 9. Research Contribution and Conclusions 34

Chapter 2. Experiencing Interactive Technologies 35

2.1. The Relationship between Humans and Computers 37

2.1.1. Designing for Interactions 39

2.1.2. The Lively World of Interactivity 43

2.1.3. Facing Interactions 47

2.2. Experiencing the Interactive World 48

2.2.1. Academic Discussions around Experience 51

2.2.2. A Breaking-Down of Experience 54

2.3. Interactive Experiences in Public Spaces 58

2.3.1. Engaging in Public 61

2.3.2. Social Exchange of Experiences 63

2.4. Summary 65

Chapter 3. The Shaping World of the Museum 67

3.1. A Museum Definition 69

3.1.1. From Cabinets of Curiosity to Engaging Experiences 71

3.1.2. A New Museum, New Challenges 74

3.2. The Museum Audience 76
3.2.1. Overview of Museum Attendance 78
3.2.2. Factors Influencing Visitors' Attendance 80
3.2.3. What Visitors Expect and What They Do 81
3.3. The Museum Space 83
3.3.1. The Material of Stories 83
3.3.2. Communicating Through Displays 86
3.3.3. Displayed and Spatial Narratives 87
3.3.4. Space in Narrative 88
3.4. The Museum Message 91
3.4.1. Construction of Meaning 91
3.4.2. Learning at the Museum 92
3.4.3. Learning is a Social Experience 95
3.5. Summary 97
Chapter 4. Interacting with Technologies at the Museum 99
4.1. Interaction in the Museum 101
4.1.1. Experience Context of the Museum 101
4.1.2. Being Immersed in the Museum 102
4.1.3. Sensing the Museum 104
4.1.4. Engagement at the Museum 106
4.2. Technologies in the Exhibition Environment 108
4.2.1. Multimedia and Interactive Technologies in the Museum 111
4.2.2. The Technological Exhibition Landscape 112
4.2.3. Some Considerations for the Design of Interactive Exhibitions 116
4.3. Understanding Visitors' Response to Interactive Exhibitions 119
4.3.1. The Matter of Evaluation 120
4.3.2. The Approaches and Structures of Evaluation 122
Front-End Evaluation 123
Formative Evaluation 123
Remedial Evaluation 124
Summative Evaluation 124

4.4. Summary 126
Chapter 5. Methodology 129
5.1. Introduction 131
5.2. Understanding Experience: A Research Approach 132
5.2.1. Four Threads of Experience 133
5.2.2. Sense-Making in Experience 134
5.3. Primary Research Methodology 135
A Case Study Approach 136
5.4. Research Methods 137
5.4.1. A Field of Possibilities 137
5.4.2. Gathering Data 139
Observing Visitors 141
Listening to Visitors 143
Later Feedback 145
Asking the Experts 146
5.5. A Correct Pathway 147
5.5.1. Ethical Considerations 147
5.5.2. Reliability and Validity 149
5.6. Developing the Case Studies 150
5.6.1. The Chronology 150
5.6.2. The Variety 151
5.6.3. The Presentation 153
Chapter 6. Case Study: *I See What You Mean* 155
6.1. Introduction to the Exhibition and Case Study 157
6.2. Exhibition's Creators and their Collaboration 158
6.3. Theoretical Background of the Exhibition 160
6.4. The Design Process of *I See What You Mean* 161
6.4.1. Conceptual Design 161
6.4.2. The Exhibition Design 164
6.4.3. The Exhibition Components 167
6.4.4. The Technology Behind the Exhibition 171

6.4.5. The Visiting Experience 175
6.5. Methods Used in the Case Study 177
6.6. Case Study Data Overview 180
6.6.1. Observation Data 180
6.6.2. Survey Data 193
6.7. What *I See What You Mean* Meant: Findings 200
Summary of Key Findings from the I See What You Mean Case Study 204
Chapter 7. Case Study: *Facets Kids* 207
7.1. Introduction to the Installation and Case Study 209
7.2. Bert Bongers: Interactivating the World 210
7.3. Background of the Installation 212
7.3.1. Researching and Designing for Interactivity 212
7.3.2. Interactive Displays and Public: Related Work 214
7.3.3. The Work Leading to *Facets Kids* 218
7.3.4. The Facets Projects 220
7.4. Facets Kids 225
7.5. Methods Used in the Case Study 228
7.5.1. Audience Response to *Facets Kids* 231
7.5.2. Demographic Study 232
7.5.3. Audience Participation 232
7.5.4. Movement Patterns 233
7.5.5. Social Interactions 233
7.6. Case Study Data Overview 233
7.6.1. Audience Response: Phenomena, Trends and other Remarks 234
7.6.2. Audience Response: Semi-structured Interviews 240
7.6.3. Demographic Study 244
7.6.4. Audience Participation 246
7.6.5. Movement Patterns 249
7.6.6. Social Interactions 253
7.7. The Many Facets of *Facets Kids*: Findings 256
Summary of Key Findings from the Facets Kids Case Study 261

Chapter 8. Case Study: *Dangerous Australians* 265
8.1. Introduction to the Exhibit 267
8.2. Background of the Exhibit 269
8.2.1. The Development of Interactive Tabletops 269
Image Display 271
User Input and Interaction 272
Tracking and Identification 274
From Prototypes to Products 276
8.2.2. Public Around the Table: Related Work 277
MultiTouch to the Public 278
The Pod 279
Locations 280
Churchill Lifeline 281
Star-Spangled Banner 282
8.2.3. *Surviving Australia* Exhibition 283
8.3. Dangerous Australians 286
8.3.1. Exhibit's Description 287
8.3.2. The Visiting Experience 290
8.4. Methods Used in the Case Study 292
8.4.1. Age Groups Study 294
8.4.2. Stages of Interaction 295
8.4.3. Interaction Time 295
8.4.4. Trajectories 296
8.4.5. Attention Time 296
8.4.6. Bodily Gestures 297
8.4.7. Social Interactions 297
8.4.8. Audience Response to *Dangerous Australians* 298
8.5. Case Study Data Overview 298
8.5.1. Age Groups Study 299
8.5.2. Stages of Interaction 301
8.5.3. Interaction Time 302

8.5.4. Trajectories 304
8.5.5. Attention Time 307
8.5.6. Bodily Gestures 310
8.5.7. Social Interactions 316
8.5.8. Audience Response to *Dangerous Australians* 321
8.6. The Voice of the Creatures: Case Study Findings 330
Summary of Key Findings from the Dangerous Australians Case Study 335
Chapter 9. Research Contribution and Conclusions 339
9.1. Overview of the Research Problem 341
9.2. Referential Model for the Study of Visitors' Experiences with Interactive Exhibits 343
9.3. A Retrospective Application of the Referential Model 347
9.4. Conclusions 353
9.5. Future Work 358
References 361
Appendices 381

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.