

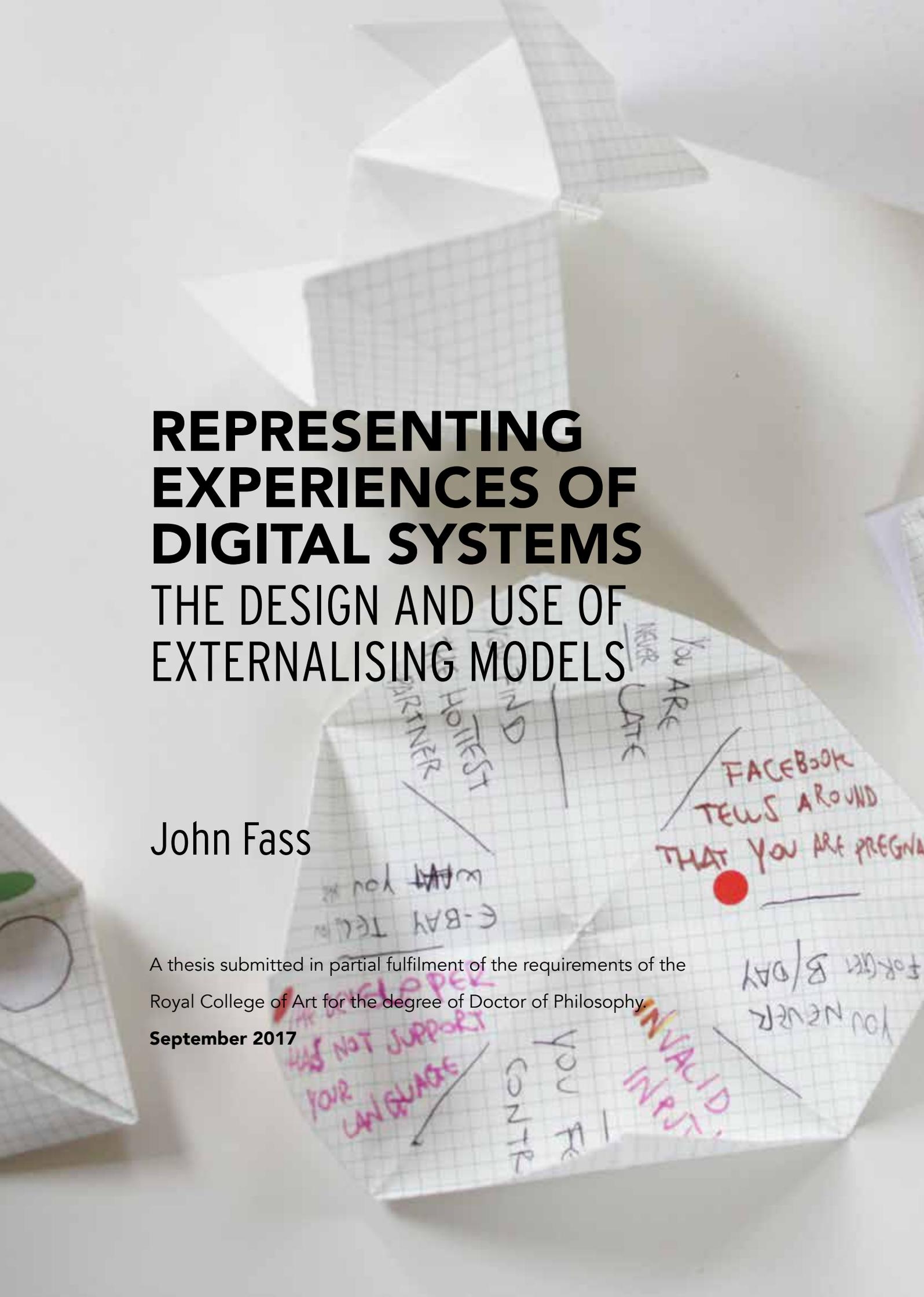
REPRESENTING EXPERIENCES OF DIGITAL SYSTEMS

THE DESIGN AND USE OF EXTERNALISING MODELS

John Fass

A thesis submitted in partial fulfilment of the requirements of the
Royal College of Art for the degree of Doctor of Philosophy.

September 2017



This research is supported by



Copyright statement

This text represents the submission for the degree of Doctor of Philosophy at the Royal College of Art. This copy has been supplied for the purpose of research for private study on the understanding that it is copyright material, and that no quotation from the thesis may be published without proper acknowledgement.

Abstract

This is a PhD by practice that explores how people's experiences of digital systems can be made physically and visually apparent using models and activities I have designed. The theoretical context for this PhD centres on internal and external models of people's experiences with digital systems. This is an AHRC funded PhD written as part of the Creative Exchange, which supports collaborative research projects conducted with industry and academic partners.

The way people experience digital systems can be difficult to observe, and is experienced via complex, fragmented interfaces with hidden effects. We often find that digital systems have a flattening effect, and are frustrating and confusing to use, while our actions and behaviours are invisibly tracked and analysed. There is thus a need for people to gain awareness of the ways they experience digital systems.

My primary research question focuses on the design characteristics of visual and physical models that externalise individual and group experiences of digital systems. Secondary questions include: What effects do the material properties of externalising models have on how digital systems are represented? and What types of activities externalise representations of digital systems? These questions are explored through case studies that focus on a set of digital systems identified through the research including web browsing, digital social networks, and image metadata. The first two case studies are exploratory, the third is applied. I completed these case studies in three collaborative settings, employing qualitative data collection

methods including drawing, physical modelling and semi-structured interviews. I draw on theories of representation and cognition, and Dix and Gongora's theory of externalisation in design, and apply them to new contexts and situations. My units of analysis are the externalising models and participants' spoken accounts of making them. The findings include: externalising experiences of digital systems using diverse materials is a way of countering flattening effects; deploying new non-linguistic metaphors to represent experiences of digital systems is an important way of understanding and communicating them; and designing situations where people can create self-constructed representations of their experiences of digital systems enables narrative sequences, tangible expressions, and shared descriptions.

My research is useful for the insight it provides participants into their own experiences with everyday digital systems, giving them better ways of understanding how digital systems shape their lives. It is also useful for designers working with people to find out about their experiences of digital systems, and design researchers who are developing novel elicitation methods. My original contributions to knowledge include new contexts for externalising models, applying externalisation to experiences of digital systems, and recommendations for how designers can create objects and activities to externalise the experiences of digital systems of non-designers.

List of figures

Figure 1: Delete Delete Delete, 2016.....	92
Figure 2 FootPrints, Maes & Wexelblat, 1999	99
Figure 3: BrowseBack, Smile Software, 2006	99
Figure 4: Google History Timeline, 2014	99
Figure 5: Eyebrowse, Zhang et al, 2016	99
Figure 6: Graphic layout a	104
Figure 7: Graphic layout b	104
Figure 8: Graphic layout c	104
Figure 9: Graphic layout d	104
Figure 10: Isomorphic representation	107
Figure 11: Central panel marriage thoughts	110
Figure 12: Centre left panel, fog	110
Figure 13: Top Panel, blocking out colours	110
Figure 14: Central panel web search results	110
Figure 15: Central panel progress bar	113
Figure 16: Central panel Google searches	113
Figure 17: Arrows and connections	113
Figure 18: Lower panel web searches	113
Figure 19: Top Panel, blocking out colours	118
Figure 20: Four different websites	118
Figure 21: Abstract representations	118
Figure 22: Customised panels	121
Figure 23: Relational map, Bagnoli, 2009	126
Figure 24: Social network map, Roseneil, 2006	126
Figure 25: Network map, Josselson, 1996	128
Figure 26: Social network map, Batada and Chandra, 2006	128
Figure 27: Support networks, Moncur, 2008.....	128

Figure 28: Knowledge distribution model. Photo: Mooney, 2010	128
Figure 29: Aviz wokshop, fête de la science, 2008	131
Figure 30: 3D printed social network, Hemsley, 2013	131
Figure 31: Domestic Data Streamers, 2014	131
Figure 32: Diagram of LinkedIn connections	131
Figure 33: London Workshop	136
Figure 34: London workshop set up with students	136
Figure 35: Hamburg set up	136
Figure 36: Completed tiles	136
Figure 37: Connecting to several groups	140
Figure 38: Connection via business	140
Figure 39: It feels good to link them up	140
Figure 40: Three 'partner' pins	140
Figure 41: One person with three categories	144
Figure 42: Distribution of nodes across a tile	144
Figure 43: Detail showing an acquaintance	144
Figure 44: Connected in life but not on the tile	144
Figure 45: Who makes the cut and who doesn't?	146
Figure 46: Spatial and geometrical metaphors	149
Figure 47: Geographical approach	151
Figure 48: Proximity and friendship levels	151
Figure 49: Clock face layout	151
Figure 50: Sub-groups	151
Figure 51: Telling personal stories	153
Figure 52: Discovering hidden relationships	155
Figure 53: Workshop in TTC office	169
Figure 54: Working with physical materials	173

Figure 55: Self-constructed externalising instruments	175
Figure 56: Key to Figure 55	176
Figure 57: Collaborative working	179
Figure 58: Tangibility has implications for usability	182
Figure 59: Foam, paper, plastic hemispheres	185
Figure 60: Lights, paper straws	185
Figure 61: Paper straws, felt, stickers	185
Figure 62: Reflective card	185
Figure 63: Performing algorithmic processes	188
Figure 64: Model of a personal digital profile	190
Figure 65: A cardboard Zoetrope as a model of image metadata	191
Figure 66: Flip book as a metaphor to explain image metadata	191
Figure 67: A child's game metaphor to represent algorithms	191
Figure 68: Metaphors for a digital personal profile	191
Figure 69: Designing a game to demonstrate algorithms	195
Figure 70: Playing the algorithm game	195
Figure 71: Drawing browser history comics	203
Figure 72: Modelling social networks	210
Figure 73: Self constructed representations	213

List of footnotes

1. Accessing the world wide web
2. Facebook permissions
3. Kosinski et al (2013)
4. Google privacy protection
5. UK internet use
6. Guardian Digital Agency
7. Vanolo (2013)
8. Instragram users
9. Image metadata
10. Image metadata and human rights

Acknowledgements

I would like to acknowledge the support of the UK Arts and Humanities Research Council who funded this research in the context of the Creative Exchange program at the Royal College of Art. I would not have embarked on this journey without their funding. I would also like to thank my principal supervisor Dr Kevin Walker for his advice and guidance. His oceanic calm has pacified my many anxieties, and the sure hand of his intellectual counsel has re-oriented my endless meanderings. Next I would like to thank my second supervisor Professor Neville Brody, his unfailingly provocative responses have consistently made me look at my research with new eyes. I have also drawn on the advice of Professor Teal Triggs, who somehow manages to unerringly identify any weaknesses, and Tom Simmons, who has forged this thesis into any semblance of structure it might have. Dr Brock Craft, whose dependable positivity has lifted me out of many a crisis of confidence, has been another important source of mentorship. I would like to acknowledge the support of my PhD cohort, particularly Ben Koslowski, Susannah Haslam, and Jimmy Tidey who have provided the essential peer network any PhD candidate needs. Finally, my three daughters, Stella, Skye and Leila who are now well versed in the erratic behaviour of PhD students, and my wife Lisa, without whom nothing in life is possible.

Author's declaration

During the period of registered study in which this thesis was prepared the author has not been registered for any other academic award or qualification. The material included in this thesis has not been submitted wholly or in part for any academic award or qualification other than that for which it is now submitted.

Signature:

Date:

Contents

Abstract	4
List of figures	6
List of footnotes	9
Acknowledgements	10
Authors declaration	11
Chapter 1: Introduction	18
1.1 Digital systems	18
1.2 Aims	20
1.3 Structure	20
1.4 Limitations	21
1.5 Research Questions	22
1.6 Methods	24
1.7 Findings	25
1.8 Externalisation	26
1.9 Externalising models	27
Chapter 2: Literature Review	28
Introduction.....	28
2.1 Experience	29
2.1.1 Dewey and Experience	29
2.1.2 Dewey and HCI	30
2.1.3 Technology as Experience	31
2.1.4 HCI and Experience design	33
2.1.5 What are experiences of digital systems?	34
2.1.6 Affect and experiences of digital systems	37
2.1.7 Background relations	38
2.1.8 Summary: Experience	39
2.2 Representation	39
2.2.1 Why representation?	39

2.2.2 Characteristics of representation	41
2.2.3 Internal representation	42
2.2.4 Mental imagery	43
2.2.5 Narrative construction	45
2.2.6 Mental models	47
2.2.7 Summary: Internal representation	49
2.3 Externalisation	50
2.3.1 Models and modelling	53
2.3.2 Externalisation and HCI	55
2.3.3 Externalisation and design	56
2.3.4 Externalisation and multimodality	58
2.3.5 Summary: Externalisation	60
2.4 Knowledge Exchange	62
2.5 Digital public space	65
2.6 Summary: Literature review	67
Chapter 3: Methodology	69
Introduction	69
3.1 Research questions	69
3.2 Methods	69
3.3 Creative Exchange	72
3.4 Qualitative research	73
3.4.1 Design research	74
3.4.2 Case study research	75
3.4.3 Case creation	75
3.5 Observation	77
3.5.1 Stimulated recall interviews	78
3.5.2 Photographic documentation	80
3.5.3 Audio recordings	81

3.6 Participatory design practices	82
3.7 Workshops	83
3.7.1 Sampling strategy	85
3.8 Analysis	87
3.9 Summary: Methodology.	90
Chapter 4: Browser History Comics	93
Introduction	93
4.1 Research questions	94
4.2 Methods	94
4.3 Limitations of this case study.....	95
4.4 Knowledge exchange	97
4.5 Previous work	97
4.6 Workshop: Setting	100
4.6.1 Sample	101
4.6.2 Methods	101
4.6.3 Procedure	102
4.6.4 Results	103
4.7 Analysis	105
4.7.1 Schematic representation	106
4.7.2 Isomorphic representation	106
4.7.3 symbolic representation	108
4.8 Discussion: Design characteristics	109
4.8.1 Visual modelling	114
4.9 Conclusion	119
Chapter 5: Social Network Models	122
Introduction	122
5.1 Research questions	123

5.2 Knowledge exchange	124
5.3 Previous work	127
5.4 Workshop: Setting	132
5.4.1 Sample	133
5.4.2 Methods	135
5.4.3 Procedure	135
5.4.4 Results	137
5.4.5 Analysis	138
5.5 Discussion: Unflattening	138
5.5.1 Re-differentiating identity	141
5.5.2 Distancing	145
5.5.3 Abstracting	148
5.5.4 Scale	150
5.5.5 Discovery	152
5.5.6 Creativity	154
5.5.7 Usability	157
5.5.8 Adaptation	157
5.6 Analysis	157
5.7 Conclusion	160

Chapter 6: Background relations & digital systems 163

Introduction	163
6.1 Research questions	163
6.2 Knowledge exchange	164
6.3 Previous work	166
6.4 Workshop: Setting	168
6.4.1 Sample	168
6.4.2 Methods	170
6.4.3 Procedure	171

6.4.4 Results	174
6.4.5 Analysis	177
6.5 Discussion: Activities	177
6.5.1 Collaboration	180
6.5.2 Materials	181
6.5.3 Material Properties	186
6.5.4 Metaphor	189
6.5.5 Distancing	193
6.5.6 Unflattening	194
6.5.7 Explanation and demonstration	194
6.6 Conclusions	197
Chapter 7: Discussion	199
Introduction	199
7.1 Summary of findings	199
7.1.1 Abstraction	199
7.1.2 Narrativity	200
7.1.3 Adaptability	200
7.2 Effects	201
7.2.1 Distancing and metaphors	202
7.2.2 Accessibility	202
7.3 Design guidelines	205
7.3.1 Materials	205
7.4 Activities	211
7.5 Conclusion	216
Chapter 8: Conclusion	217
Introduction	217

8.1 Context of this research	217
8.2 Contributions to knowledge	221
8.2.1 Experiences of digital systems	221
8.2.2 Externalising models	223
8.2.3 Externalising activities	224
8.2.4 Non-designers	225
8.3 Future work	227
8.3.1 Different experiences of digital systems	227
8.3.2 Designing externalisation	228
8.3.3 Material exploration	228
8.3.5 Applications	229
8.3.6 Design guidelines	229

Appendices

Appendix 1 - Interview transcripts case study one	230
Appendix 2 - Interview transcripts case study two	271
Appendix 3 - Interview transcripts case study three	294
Appendix 4 - Consent forms and information sheets	315
Appendix 5 - Browser history comics	329
Appendix 6 - Social network tiles	331
Appendix 7 - Key to material case study two	331
Appendix 8 - List of publications	334

List of references	335
---------------------------------	-----

Selected bibliography	352
------------------------------------	-----

Chapter 1: Introduction

In this introductory chapter I explain the background and motivation of this research and give a brief outline of the structure and findings. This is a PhD by practice that explores how experiences of digital systems can be physically and visually externalised using visual and physical models. My focus is on how people experience digital systems, and how they work with materials to externally represent those experiences. My primary research question: What characteristics of visual and physical models externalise people's experiences of digital systems? invokes the central place for design in the process of creating externalising models. Other questions include: What effects do the material properties of externalising models have on how digital systems are represented? and: What types of activities externalise representations of digital systems? Three case studies address these questions through participatory workshops involving people completing the externalising models and participating in the activities I have designed.

1.1 Digital systems

I define digital systems in this research to mean software based computer technologies that are accessed using widely available interactive devices. I have not sought to investigate all types of digital systems but instead have identified a subset. In case study one I have chosen to focus on web browsing, with a specific interest in how the browser history list provides a record of web pages visited. In case study two I have chosen to focus on digital social networking, more specifically how people perceive the extent and characteristics of their social networks. The third case study broadens

the inquiry by focusing on the background technologies (Verbeek, 2015) that determine how digital systems are experienced. These include image metadata, algorithms, and cloud computing. These categories of digital systems were selected in collaboration with the research partner for case study three the Tactical Technology Collective as being directly relevant to their work and an extension of case studies one and two. I have not placed any specific attention on the devices used to access the digital systems explored in the three case studies, and acknowledge that there are many other types of digital systems, such as wearable devices or brain computer interfaces, that lie outside the scope of my research.

1. Accessing the world wide web using fixed or mobile technology is now experienced by over 46% of the global population according to the UN (2015). In the UK and Germany, where my research was carried out, the figures are 86% (ONS), and 85% (Destatis) respectively.

2. For example, as a prerequisite for having an account, Facebook asks for explicit permission to; track its users across websites and devices, use profile pictures for both commercial purposes and collect information about its users' whereabouts on a continuous basis.

3. Kosinski et al. (2013) showed how much this information reveals about individuals' beliefs and opinions.

My research seeks to re-materialise specific examples of how participants experience digital systems. Experiences of digital systems reach into many aspects of human life¹, for example, the way people make and maintain relationships (Hitsch et al, 2010), search for and carry out their work (Hart, 2009), and diagnose and treat illness (Ross et al, 2004). Increased awareness of the ways in which providers of digital systems profit from their many users, produces new understandings of how digital technologies often represent an asymmetrical power relationship. Using tracking algorithms², social networking systems build up a detailed representation of their users' social behaviour³, including with whom they communicate, what they say, images they share, and their geographical locations. Access to all the web pages a user visits in the course of their online activity confers knowledge of shopping habits, news preferences, banking details, and political views.

The rationale for my research is seen against the backdrop of a general inequality of knowledge about, and insight into, how people experience digital systems. Users of digital technologies find themselves in the position of having restricted access to their own interpretations of digital systems, while private commercial and state bodies bring complex and largely secret analytical tools to bear on them⁴.

4. In 2012 Google were found to be circumventing privacy protection for users of the web browser Safari and tracking all web page visits.

1.2 **Aims**

The aim of this thesis is to explore how visual and physical models work to externalise representations of personal experiences of digital systems. As an outcome of this research, I suggest a set of design guidelines for the creation of externalising models. The thesis thus demonstrates practical design work in the form of externalising models, and structured activities specifically devised for the purpose of eliciting representations of experiences of digital systems. A further intention is to report on the processes of knowledge exchange that I engage in over the course of my research.

1.3 **Structure**

This thesis first accounts for previous research in a literature and practice review of relevant sources. This includes an exploration of two theoretical ideas: representation and externalisation, and how they relate to the design of externalising models. Next, I describe

the methods used to explore the topic, including participatory workshops and semi-structured stimulated recall interviews. I present the findings of three case studies that feature different externalising models. This is followed by a discussion of the main findings. A set of design guidelines is included in this discussion. I conclude by reflecting on the process of completing this PhD and the possibilities for future work on the topic of externalising models and digital systems.

1.4 Limitations

It is not my intention in this thesis to provide an exhaustive account of all possible experiences of digital systems, nor to account for the many different experiences of digital systems an individual could have. Instead, web browsing is chosen for the first case study because it is a widespread experience. Similarly, social networking is chosen for the second case study because over half of all internet users in the UK⁵ and Germany (where some of my research is conducted) use digital social networks. There are limitations to the research sample in all three case studies and they are not intended to be statistically representative. For the first case study the sample is limited to people visiting a public arts centre who chose to participate in the comic drawing workshop. In the second case study, the sample is initially a selected group of students, which is widened to include people passing by the workshop space. For the final case study, the sample is limited to a group of employees working for a digital rights organisation.

5. According to the UK Office of National Statistics, over 76% of the UK population used the internet every day in 2014.

1.5 **Research questions**

I separate the research questions into three general topics: physical models, materials, and activities. Starting with physical externalisations, I use the term 'model' in place of 'object' or 'artefact' to imply that they are objects that represent a defined subject—a digital system. I describe the models as visual and physical, including the paper sheets from the first case study, since they all have physical properties.

A further intention of this research is to provide guidelines for the design of externalising models. My first research question is thus:

What characteristics of visual and physical models externalise peoples' experiences of digital systems?

I explore this question through case studies in which participants externalise representations of digital systems in the form of models. The design characteristics of the externalising models deployed in each case study are different. I thus address this question by analysing the physical and spoken responses of participants where they refer directly to the material characteristics of various externalising models.

The secondary focus of my research is the material characteristics of externalising models and how they shape participants' responses. My second research question is:

What effects do the material properties of externalising models have on how digital systems are represented?

I address this question by developing models with various material characteristics. To investigate the effects these materials have on the resulting representations I analyse participant responses where they refer directly to materials, such as pens, rubber bands or felt. The qualities associated with these materials are categorised as featuring tangibility, and transformation.

The design of activities shapes what people do by determining how long they have to do it, and what materials they use. It also requires designers to make decisions about individual versus collaborative work, and about staging activities to include questions, feedback, and discussion. My third research question is thus:

What types of activities externalise experiences of digital systems?

I investigate this question through the design and facilitation of various activities in the case studies, including drawing, modelling and making, alongside the contexts in which they are staged, which are public, semi-public and private. In interviews with participants I ask specifically about the attributes of the activities.

The way physical models externalise experiences of background digital systems is explored by modelling the underlying technical phenomena that facilitate digital systems. These include image

metadata which allows digital images to be categorised and searched, personal profiles which are used to target individuals via personalised advertising, and cloud computing, the remote storage of digital data that allows distributed access to files and enables digital systems such as social media platforms. My research positions design as a key intermediary in the externalisation of individual representations of experiences of digital systems, and incorporates the design of activities as a strand of design practice.

1.6 **Methods**

The methods I use include participatory workshops, undertaken in public, semi-public, and private spaces. These are organised in this thesis into three distinct case studies that explore the externalisation of experiences of digital systems using different models. The workshops are carried out over two days and involve designing a situation within which participants make or complete externalising models.

Analysing the drawings and physical models alone is insufficient to reach any significant conclusion about participants' intentions so the physical making and drawing activities are backed up with spoken interviews. The interviews are conducted using the external models as prompts for discussion, encouraging participants to recall what they have done and why. They are thus defined as stimulated recall interviews. I do not use a strict set of questions to ask all interviewees, but rather allow each conversation to develop in its own direction, guiding participants towards a discussion of materials

and models. The interviews are thus semi-structured. Following Goldsteijn and Wright (2013), the interviews encourage narrative accounts of what participants have done in order to expand the possibilities for individual and group expression.

1.7 Findings

This study offers new proposals for how to engage participants in the creation of externalisations. I provide evidence to support the principal research findings as follows.

1. Externalising experiences of digital systems using tangible materials gives depth and nuance to the flattening effects of digital technologies.
2. Using non-digital materials to externalise interpretations of digital systems is helpful because it creates distance and abstraction.
3. Materials should be easily transformed and customised. Adapting materials to be personally expressive is rewarding and enjoyable.
4. Developing metaphors is a critical way of understanding and communicating representations of 'background relations' regarding digital systems.

1.8 Externalisation

Externalisation, as a topic in design research, is explored in the context of professional practice, where it is seen as embodied in the prototypes used by designers (Vyas et al, 2009, Manker and Arvola, 2011, Zhang et al, 2012). Dix and Gongora (2011) propose that externalisation is a linking process between internal or tacit understanding and external or reflective thinking. There are many instruments and artefacts, such as prototypes, models and sketches, that mediate this bridging in design practice, and I use these in my own practical work. Chafi (2014) provides a useful overview of the literature in design research related to externalisation, and suggests a set of concepts for how externalisation happens when designers work with tools and materials, such as sketching, physical modelling, and digital modelling. However, like Dix and Gongora, Chafi's view of externalisation in design is focused solely on professional designers in commercial studio environments. My research involves non-designers working in non-studio settings and so represents new knowledge in the field of externalisation in relation to design.

The value of my research is found in how it positions design as a way of finding out about how people experience digital systems, and the guidelines it proposes for designers on the material properties of externalising models. The other main value of this study is that it proposes ways for people to gain knowledge about their own experiences of digital systems using design methods.

1.9 Externalising Models

The term 'artefact' implies a fixed, static form, easily objectified and made visible. The term 'instrument' implies something made with a specific purpose in mind. An instrument does not have the sense of a conjectural prototype conjured by Dib (2010), nor does it imply design exploration and creativity. Instead, I use the term 'model' to evoke the way people represent specific experiences in various materials.

The following chapter provides a review of the literature relating to experience, representation, modelling, and externalisation as it pertains to the externalisation of experiences of digital systems using visual and physical models.

Chapter 2: Literature review

Introduction

This chapter presents an overview of the relevant literature relating to experiences of digital systems. Starting with a view of how experience has been defined in the field of Human-Computer Interaction (HCI), I turn to inner representation and the ways mental imagery is used to support understanding. Finally, externalisation is explored from the perspective of HCI and design. The literature review includes a view of how experiences of digital systems may be defined and interpreted in response to the following research questions:

What characteristics of visual and physical models externalise people's experiences of digital systems?

What effects do the material properties of externalising models have on how digital systems are represented?

What types of activities externalise representations of digital systems?

How do physical models externalise experiences of background digital systems?

The review consists of three main sections which examine experience, representation, and externalisation, and ends with a contextualising description of the field of knowledge exchange. It thus proceeds from inner experiences to external physical forms, and is intended to

introduce the disciplinary context of the thesis and situate the study in design-oriented HCI. I use HCI as a blanket term to describe the academic field that investigates the relationship between humans and computers. In design, this includes user experience design (UX) and interaction design (IxD). My research involves participants in the making of visual and physical models, and is positioned in the field of design-oriented HCI (Fallman, 2003).

2.1 Experience

In this section I introduce the notion of experience, first as it is articulated in philosophy with reference to pragmatism and Dewey (1934). With reference to McCarthy and Wright (2004) I make the link to experiences of technology, then I connect broader theories of experience to design in the context of user experience (Hassenzahl, 2008).

2.1.1 Dewey and experience

A key concept for Dewey is the idea that experience in general is different to an experience. Experience, Dewey says, is indefinite and un-detailed, a continuous flux of lived events and impressions, both internal and external. In contrast, an experience 'is a whole and carries with it its own individualizing quality and self sufficiency' (Dewey, 1934: 42). An experience is 'demarcated in the general stream of experience from other experiences' (1934: 42). As Roth and Jornet say 'such experiences constitute unities' (2014: 4) and as unities they can be named and denoted, and by implication researched.

2.1.2 Dewey and HCI

Pragmatism as a lens through which to address issues in HCI is used by McCarthy and Wright (2007), who draw on Dewey's notion of aesthetic experience to frame digital technologies as more than just arrangements of interactions. Similarly, Petersen et al (2008) use a pragmatist interpretation of experience to articulate the challenges of new technologies such as digital social media and smartphones. Pragmatism offers a way of framing computer systems and interactions from the perspective of what they enable people to do. Wakkary (2009) bases his view of interaction design on Dewey's pragmatism, finding within it the epistemological roots of interaction design practice in terms of what design is for. Hartman et al (2014) base their research into digital modelling tools on Deweyan pragmatism, as does Steen (2013) in studying co-design methods.

This aesthetic reading of experience is used in design-related HCI by Sokoler et al (2007) who find that the design of doctor-patient interactions are optimised if the technology involved does not interrupt the flow of treatment and conversation. In another study influenced by Dewey's pragmatism, Liang (2012) finds serendipity to be an important quality of aesthetic experience in the design of a music sharing system. The qualities of experience described here are relevant to my research because the visual and physical models I investigate are similarly focused on how digital systems are experienced in the flow of everyday life. The pragmatist position in HCI is reflected in how I see digital systems as framed and influenced

by design constraints. Onarheim and Wiltshnig (2010) find the dual capacity of constraints in design; to simultaneously enable and constrain what designers can do, to reflect pragmatist thinking. Finally, Dalsgaard (2017) draws a connection between Deweyan pragmatism and design, finding that constraints act as 'extensions of our capabilities but also frame and guide our perception and understanding' (2017: 26).

2.1.3 **Technology as experience**

A key text in the foundation of experience-related design is McCarthy and Wright's *Technology as Experience* (2004) which points directly to Dewey's *Art as Experience* (1934). McCarthy and Wright set out to show that 'experience of technology involves something larger than usability or one of its dimensions such as satisfaction or attitude' (2004: 6), and that it is 'as much about what people feel as it is about what people do' (2004: 9).

McCarthy and Wright are in broad agreement with Suchman (1987) and Lave (1988) that a cognitive view of how people interact with computers produces an account of technological experience insufficiently grounded in social and cultural contexts. They argue that, 'people's concerns, enthusiasms, and ambivalence about (technological) participation are abstracted away or averaged out' (2004: 49) by concentrating on the logic of practice, to the exclusion of experience. So an overemphasis on the mechanics of digital systems, such as input devices or eye tracking measurement, may distract from their most significant qualities such as those identified

by Benford et al (2009) in their work on user flow, and by Miller (2016) who finds that good experiences of digital systems feature delight and pleasure as important qualities. The identification of the characteristics that reflect positive and negative experiences of digital systems, and their expression through external models is thus one of the aims of this study, as reflected in the primary research question.

McCarthy and Wright turn to Dewey in order to enrich a view of how people relate to technology, with the pragmatists' attention to 'the everyday events, doings, and sufferings that constitute ordinary experience' (McCarthy and Wright, 2004: 55). They relate Dewey's aesthetic experiences, which are experiences of artworks, to technological ones by categorising online shopping and other examples as featuring a connection with values, emotions, and activities (Ibid.: 66). The experiences of digital systems my research focuses on are thus not distinctly 'aesthetic' in an artistic sense but, following McCarthy and Wright, include prosaic and everyday aesthetic qualities that involve sensory and perceptual effects.

McCarthy and Wright do not focus on experiences of digital systems specifically, but include various kinds of technological experiences, such as watching films. I describe their approach here because they identify a distinction between understanding and interpretation that is useful for my research. The former, they suggest, is immediate and non-linguistic, constituting the 'felt background' to an experience. Interpretation, by contrast, is linguistic for them. Technology

as Experience remains an important work in the way it positions experience as encompassing much of what the cognitive tradition in HCI misses out. However, it does not feature in-depth thinking about design, nor is it explicitly concerned with uncovering how people might model experiences of digital systems for themselves.

2.1.4 HCI and experience design

In the context of how people use digital systems, a parallel in my research is between 'user experience' (UX), a design discipline, and experience as referred to in this chapter so far. UX is a field of design practice involving user research, requirement gathering, interaction design, prototyping, and user interface design, among other skills widely practised by designers active in the development of digital products. Hassenzahl (2008) defines UX as the evaluation of whether people feel good or bad whilst using digital products. Alben (1996) defines the criteria for effective user experience design as incorporating 'the aspects of how people use an interactive product: the way it feels in their hands, how well they understand how it works, how they feel about it while they're using it, how well it serves their purposes, and how well it fits into the entire context in which they are using it' (1996: 14). My research therefore takes these cognitive and perceptual aspects of experiences of digital systems to be defining properties, and looks for ways they might be externalised in visual and physical form.

Forlizzi and Ford (2000) provide an early framework for UX design featuring dimensions of experience including flow and mental

models. This is relevant because it connects to Dewey's ideas about continuity of experience, and the internal states described by Scapin et al (2012), who describe UX as comprising the perceptions and affects of people interacting with digital systems. My research aims to externalise these qualities of personal and social experiences of digital systems.

Hassenzahl (2008) relates experience to physical products and what he calls their hedonic qualities. UX design, from this perspective, involves designing for 'non-task-oriented quality aspects such as innovativeness, originality, fun etc.' (2008: 481). Hassenzahl and Diefenbach (2009) use a questionnaire asking participants to rate their experiences with digital technology. They find participants' responses that indicate positive digital technology experiences are associated with freedom to act independently, unrestricted by system defaults or limitations. My research thus seeks to externalise the hedonic elements of experiences of digital systems and what may obscure them.

2.1.5 What are experiences of digital systems?

Experiences of digital systems can be paradoxical. They are open-ended to the extent that, say, using the web can mean a minute or a day, and include multiple or single site visits. Yet experiences of digital systems are also constrained, as reported by Stone et al (2005) and Galitz (2007) who find that the interactions available when using a digital system are commonly limited to task fulfilment objectives. Following Coyne (1995), I suggest that experiences of

digital systems involve people navigating a constrained interface with limited opportunities for interaction, featuring transitions between states in a structured environment designed to produce a particular outcome.

Experiences of digital systems may be considered a subset of general experiences. Experiences of digital systems are those that have achieved a specific end—a search completed successfully, an item bought online, or an email composed and sent. In a study of internet users who were asked to list criteria that motivate or hinder them in using interactive, technological products, Pohlmeier et al (2009) find task fulfilment to be an important factor. However, experiences of digital systems also feature characteristics quite unrelated to how efficiently tasks are fulfilled through them. Jain (2001) highlights the importance of human senses in how digital systems are experienced, Buckingham (2008) focuses on the shifting contexts of mobile experiences of digital systems, and Mowlabocus (2016) on the increasingly embodied nature of experiences of digital systems. Experiences of digital systems can also be less focused than task fulfilment implies. Much of the structure of how digital systems are experienced is characterised by transition from one state to another, according to certain rules. Rules often govern progress through an experience of a digital system. For example, when building a digital personal profile, certain information, such as name and gender, is required before one can proceed.

When people participate in digital social networking such as posting Facebook updates, or connecting with someone on LinkedIn, they are directly participating in an experience of a digital system with diverse characteristics. Baird and Fisher (2005) find that social media users value their ability to use multiple forms of interactive, social, and self-publishing media tools, implying that experiences of digital systems are distributed across systems and devices. My research thus does not specify experiences based on any particular device or platform but instead examines the nature of experiences of digital systems through modelling activities using visual and physical materials.

McCarthy and Wright (2004) suggest that experiences of digital systems are not reducible to interfaces, devices, systems, or interactions. Yet experiences of digital systems such as web browsing, emailing, or social networking often feature a limited set of sequential interactions delivered in specific ways, e.g. when trying to send an email with no subject line, the user receives an automatic alert. These types of constraints are highlighted by Galitz (2007), who finds that they can limit opportunities for interaction. Constraints are thus at once useful for structuring experiences of digital systems but also restrictive of open ended exploration. My research seeks to suggest ways of externalising the qualities of experiences of digital systems, including how they may be constrained by existing technical features.

2.1.6 **Affect and experiences of digital systems**

Desmet and Hekkert (2007) provide a framework that draws on Dewey, intended to inform the design of digital products. They conflate the terms affect and experience and so frame experience predominantly in terms of emotional response. More recently in HCI, Tuch et al (2013) analyse user-generated narratives for what they reveal about experiences with technology. They find that positive narratives involve social aspects and beneficial affective values, while negative narratives are about anger, and frustration at technical failure. Elsdon et al (2015) explore experiences of personal fitness data from the perspective of lived phenomena in a workshop setting, identifying design opportunity in how data is used by people as they collect information about their own fitness and health using digital wearable devices.

Affect in experiences of digital systems is relevant to my research because I aim to externalise the qualities of those experiences irrespective of technical performance, efficiency, or task fulfilment. The way people feel about their experiences with digital systems, and how they choose to externalise their feelings is what the models in my research are intended to show. There is a gap in the literature relating to experiences of digital systems because the focus in HCI has traditionally been on evaluation and performance metrics, i.e. quantitative measures, rather than how people feel about their experiences of digital systems.

2.1.7 **Background relations**

I identify experiences of specific digital systems in my research but also pay attention to experiences of the technologies that determine how digital products work, such as image metadata and cloud computing

Verbeek (2015) builds on Ihde's (1990) definition of the background relations which govern technologies that are 'the context for human experiences and actions' (2015: 4). I use this idea in my research to address background digital systems. These are technologies that constitute 'a context for human existence, rather than being experienced themselves' (2015: 4). Verbeek updates the concept of background relations to include technologies that do more than form a setting for human activity. He finds 'technologies are... an interactive context: They detect if people are present or not, recognize faces, give feedback on behaviour' (2015: 4). Thus background relations may be present in the form of passive measurement or individual profiling.

Manovich (2013) makes a similar point, positioning software as the background phenomenon that guides and shapes how people experience digital systems. He argues that an understanding of digital systems in the form of software is fundamental to contemporary culture. This is relevant to my research because the reason for externalisation in the three case studies is framed as a form of democratisation, providing knowledge in the form of insight and awareness to participants about their own experiences of digital systems.

2.1.8 Summary: Experience

In this section of the literature review I describe the relationship between Dewey's pragmatist conception of experience and the literature in HCI that seeks to establish an aesthetic basis for experiences of digital systems. I define what experiences of digital systems are, and emphasise the affective qualities of those experiences. Finally, I establish a basis for the externalisation of experiences of background digital systems. The next section develops the literature review in the direction of representation.

2.2 Representation

This section starts by asking why representation is important in the context of experiences of digital systems, and outlines some characteristics of representation relevant to the research questions. The importance of representation is related to mental imagery in the form of mental models, and to narrative constructions of understanding. Finally, multimodality is discussed as an aspect of representation that I acknowledge but do not specifically deploy in this thesis.

2.2.1 Why Representation?

How people build accounts of their own experiences is a key aspect of research in cognitive psychology. This is seen to depend partly on representation. Palmer (1978) states the importance of a broad concept of representation; what he calls a 'general construct'. His most basic definition, 'a representation is, first and foremost, something that stands for something else' (1978: 262), is developed

into two categories, 'the represented world' (an experience) and 'the representing world' (a model or representation of that experience). For my research, the former is the experience of digital systems, and the latter the externalising models and surrounding context in which they are constructed. Palmer emphasises that the two worlds do not need to be comprehensive—the representing world does not need to represent every detail of the represented world, and not all elements of a representing world model the represented world. In other words, models may externalise only some features of the experiences of digital systems—those that participants choose—and similarly, not all parts of the models work to represent digital systems. There is room for specific aspects of digital systems to be modelled by different elements of an externalising model.

Cadoz and Arliaud (2004) position representation as the locus of transformation between internal and external mental worlds 'in the sense that the first... stands for the second' (Cadoz and Arliaud, 2004: 168). For them, external representations (what they call objective media) of internal worlds 'are necessarily material objects' (Ibid.). The materials used in the models created by participants in my research thus enable the inner experiences of digital systems to be externalised. A question here is therefore: What kinds of materials are useful in the realisation of external representations of experiences of digital systems?

My research makes the connection between internal (mental) representations of experiences of digital systems and external forms by concentrating on the participatory design of externalising models and activities. The following section therefore focuses the literature review towards the ways experiences of digital technologies can take external form, with reference to how representation is treated in the relevant literature.

2.2.2 Characteristics of representation

Palmer (1978) states that representations preserve relations between represented worlds and representing worlds. That is not to say that representing worlds cannot be abstract, symbolic, or schematic, but that some element of their relations should maintain a correspondence with some element of the relations observable in the represented world. There is thus a mapping between objects such that relations are preserved. Since digital systems involve various elements (such as browser windows, software controls, page views, and interactions within pages) acting in dynamic relation, representing them involves distinguishing those relations chosen to be represented, and connecting them in a representation, such as a drawing or physical model.

In a questionnaire-based study, Altaboli and Lin (2011) report findings that support this view of experiences of digital systems as comprising screen elements, specifically how they are arranged to achieve unity and sequence. This prompts the question: How might visual and physical materials work to preserve certain aspects of experiences of digital systems in an external representation?

Palmer places representations into three distinct categories: informationally equivalent, non-equivalent, and completely equivalent. Informationally equivalent representations 'preserve the same relations about the same objects' (Palmer, 1978: 270) but need not be themselves the same. Non-equivalent representations are those which preserve different information about the same objects. Finally, completely equivalent representations are representations in which the same information is preserved in exactly the same way. For example, if two representations of the same experience of a digital system were to both focus on the aspect of security, in exactly the same way, using the same materials in an identical configuration, they would be completely equivalent. These three categories suggest a way to assess the characteristics of externalising models since they address the question: What are the characteristics of physical models intended to externalise representations of experiences of digital systems?

2.2.3 Internal representation

My research is concerned with ways in which design can facilitate the externalisation of experiences of digital systems. This means accessing internal representations of those experiences. Internal representations are 'cognitive constructs' internal to peoples' cognitive system (Demetriadis et al, 2004). This section explores the literature related to how people construct mental representations of what they experience.

2.2.4 **Mental imagery**

Much of the research about internal representation uses the term mental imagery, indicating representations of the external world, including experiences, that are in some way held or preserved in the mind in the form of images. There are many ways in which mental imagery is understood by cognitive psychologists. Anderson (1978) proposes that, firstly, images are easier to remember than words, taking advantage of the human brain's 'superior mnemonic capacity' for pictorial representation (Anderson, 1978: 259). The condition on this claim is that it may hold true only when pictorial material can be meaningfully interpreted (Anderson, 1978).

Mental images of experiences rather than objects are shown by Loftus et al (2015) to be important in the context of witness testimony, and by Cocks et al (2014) to be used by surgeons when planning and performing surgical procedures. Mental images of digital systems are shown by Chastenay (2016) to be used by pupils in the context of learning about astronomy. He finds that the mental image of the planets and stars built up in childhood prevent pupils from a realistic understanding of planetary movement. By presenting them with a digital planetarium, in which lunar phases were explained via digital projection, he was able to challenge and thereby adjust their mental models towards a scientific view of planetary motion. I use these examples to support the idea that mental representation in the form of images remains a current idea in terms of how people understand the world around them

and how external representations of that world work to adjust or 'correct' misleading mental models. Thus inner experiences of digital systems may be expressed using external representations that work in turn to adjust existing mental models.

MacInnis and Price (1987) argue for the distinctiveness of imagery processing (pictorial representation) compared to discursive processing (verbal or numerical symbolic representation). They echo Dewey (1934) by proposing that mental imagery is not a structure, but a process that acts on stored knowledge. If mental imagery is described as a process that acts on a knowledge structure, then other processes may act on it in different ways as interpretation demands. Dual-coding theory (Paivio, 1991) demonstrates this notion of parallel modes of understanding, visual and verbal, supporting the view in my research that inner representation can be externalised using various modes and materials.

Mental images 'involve concrete sensory representations of ideas, feelings and memories, and permit recovery of past experiences' (Yuille and Catchpole, 1977: 175). Pylyshyn (2003) concedes that distinguishing discursive from imagistic mental representation may be impossible: 'it might not have a scientific answer because it concerns the relation between brain processes and conscious experience' (Pylyshyn 2003: 117). This focus on the particularly sensory origin of mental imagery finds expression in McCarthy and Wright's (2007) distinction between understanding and interpretation outlined previously in this review.

Tversky (2009) reports on experiments that support the idea that pictorial representation is fundamental to, and constitutive of, human cognition. She finds that spatial arrangement informs the way representation allows for abstract thought, for example that glyphs in diagrams, such as arrows and boxes, are abstracted, spatialised thought instructions. She supports Paivio's dual-coding theory, finding that multiple semiotic modes, i.e. images, text, gestures, and expressions, enable mapping between inner and external representations, and suggests that external representations 'support and augment cognition and action; unlike language, they do so silently and directly' (Tversky, 2009). Tversky's experiments are thus relevant to the way inner experiences of digital systems are considered to be expressible in visual and physical form in my research.

2.2.5 Narrative construction

One important way that people represent aspects of their experiences is through narrative construction (Bruner, 1991). This view suggests distinctive characteristics that distinguish it from mental imagery and recalls Tversky (2009), Paivio (2013), and Loftus et al (2015). Tversky and Bryant (1999) find evidence for the role of narratives in structuring inner representations, showing that 'although narratives present no perceptual information, they invoke extensive knowledge of environmental space. People can draw upon this knowledge to build an inside world' (1999: 154).

A narrative representation is played out in 'human time' (Ricoeur, 1984), i.e. it is a subjective temporal pattern of events experienced over time in the way suggested by Winnicott (1960). The implication for experiences of digital systems is that digital technologies impose a strict computational temporality which may be at odds with how people construct their own internal representations. Narrative construction is grounded in language—written and spoken accounts of experience (de Rivera and Sarbin, 1998, Parry, 1997, Bird and Dardenne, 1997), but is also influential in HCI research related to design (Turner, 2016, López-Arcos et al, 2016).

Narratives have cultural conventions (White, 1978, Turner, 1982). They are legitimised by cultural norms which themselves change over time. Experiences of digital systems are often structured narratively, as for example discussed by McCarthy and Wright (2004) in their account of online shopping. Goldsteijn and Wright (2013) present findings from a study featuring narrative analysis in design that supports the use in my research of narrative accounts of digital experience. They find that narratively oriented interviews lead to a deep understanding of individual makers' practices and how they engage with physical materials and processes. Similarly, Blythe et al (2002) use 'technology biographies' to find out how participants used digital devices in their homes, taking a consciously narrative approach to the analysis of experiences of digital systems that I use in my research.

Narrative accounts are thus used in HCI both as data and as a research method, to find out about experiences of digital systems, and to represent them. These findings are relevant to my research because I investigate the elicitation of narrative accounts of experiences of digital systems.

2.2.6 **Mental models**

Knowledge representation in HCI, and design in particular, can be understood through the concept of mental models, first proposed by Craik (1943), as a way to 'try out various alternatives, conclude which is the best of them, (and) react to future situations before they arise' (1943: 57). Craik sees mental models as a special kind of representation that he calls an analogue representation because he assumes that a mental model shares the structure of the world it represents (Craik, 1943). This connects to Palmer's (1978) notions of informationally equivalent, non-equivalent and completely equivalent representations.

Dix et al (2003) explain, 'in constructing the mental model, a conscious mental simulation may be "run" from which conclusions about the predicted state of affairs can be deduced' (2003: 83). When users browse the web, for example, this view assumes they are using a mental model of how pages work, how links behave, and what URLs do. Mental models allow users to account for what might happen, and are considered to be most useful when people need to make predictions or draw inferences about a digital system.

Mental models are extensively deployed in HCI (e.g., Kiesler and Goetz, 2002, Young and Howes, 2008, Mayr et al, 2016) as a tool for structuring digital systems in a way that matches how users think. Norman defines them as 'the models people have of themselves, the environment, and the things with which they interact' (Norman, 1988: 17). Mental models are described by Payne (2012: 40) as 'what users know and believe about the systems they use'. This distinguishes mental models from mental imagery because they attempt 'to explain people's reasoning about the world not in terms of working memory limits or particular representations, but in terms of their beliefs about the physical world' (Payne, 2007: 40). This reflects the way my research is concerned with the qualities of experiences of digital systems and how they might be represented in the minds of people who use them.

Payne notes that this understanding transfers well to HCI, 'where practical interest may focus on how users conceive the workings of a particular device, how their beliefs shape their behaviour, and what lessons may be drawn for design' (Payne, 2007: 40). This relationship with design evokes the possibility that mental models may have a productive connection to visual and physical external representations of experiences of digital systems.

Norman (1988) points out however that often the mental model people have of a particular system is highly abstract, or even inaccurate. Car users are able to drive while having only a vague idea

of how the engine and gears work. Similarly, users of email services can send and receive messages without knowing anything about SMTP servers or POP3 protocol. Functional mental models thus allow people to act in a system without detailed knowledge of its workings and may map not to the mechanics of a digital system but to a working understanding of how to act.

2.2.7 Summary: Internal representation

This section expands my focus to the ways digital systems are represented. The conceptual characteristics of representations in general, and inner representations in particular, are expressed through notions of mental imagery. Research on mental imagery relates to my own research by providing a basis for the centrality of non-verbal representation of experience, complemented by Bruner (1991) and Loftus' (2015) work on how events are recalled narratively. The way mental imagery is developed in HCI is through mental models (Craik, 1934), particularly according to Norman (1983) and Dix (2003) who find a role for mental models in how people understand what to do with digital systems (Mayr et al, 2016). Mental models thus provide a way of framing inner representations as relating directly to experiences of the external world (Johnson-Laird, 1988), particularly in how they account for peoples' beliefs and opinions (Payne, 2007). For my research this means people's attitudes and feelings towards their own experiences of digital systems. My research is concerned with ways in which design can facilitate the externalisation of internal experiences of

digital systems, and thus the next section expands on the idea of representation to include external forms.

2.3 Externalisation

This section builds on the literature covering internal representation to consider external representation. The relationship between the two and how it may be mediated by visual and physical models is explored through the lens of HCI research. I also consider the important difference between presented and self-constructed representations conceived by Cox (1999), and how externalisation in the form of models is articulated in design-related HCI.

Hegarty (2004) shows that the relationship between internal and external representation is not simply augmentative, i.e. that external representation is not limited to simply enhancing internal representations, but that external representations may sometimes replace internal ones. She suggests, 'a person can have the same insight, (or perhaps a better insight) by viewing or manipulating an external visualization of some phenomenon as he or she would have by internally visualizing the same phenomenon' (Hegarty, 2004: 3). For my research this means external representations can be useful in providing insight into the nature of experiences of digital systems.

This prompts the question of whether internal representations are isomorphic to external ones, or whether they need to be. Scaife and Rogers (1996) call this 'the resemblance fallacy'. They find that

people's internal representations of external phenomena can be quite unlike external representations of them. Cognitive psychologists have held to the notion that internal representations are 'stimulated' (Finke, 1990), 'transformed' (Hegarty, 1992), and 'manipulated' (Bauer and Johnson-Laird, 1993) by external representations. This depends on a purported similarity of resemblance between internal and external representations, again reflecting Palmer's (1978) classification of representation into informationally equivalent, non-equivalent and completely equivalent. Since representations of digital systems may vary widely, in my research the relationship between internal and external representations does not depend on the idea that they are morphologically similar. This is relevant because it supports the design of externalising models that can incorporate schematic, symbolic or metaphorical representations.

In HCI, Cox (1999) finds an important difference between presented external representations, by which he means pre-existing ones presented to people, and self-constructed external representations i.e. those created by people for themselves. This difference is evident in the cognitive benefits of self-constructed representations which are found to refine and disambiguate mental images—participants who construct their own representations, examine their own ideas, re-order information, translate information from one modality into another (re-represent), and keep track of their progress through a task (Cox, 1999: 359). In addition, Cox shows that the effectiveness of an external representation depends on the properties of the

representation, the nature of the task, and prior knowledge or experience. These findings are significant for my research because they propose that activities and tasks are important elements in the process of externalisation. For my research this means external representations of people's internal experiences of digital systems work to elucidate and reveal qualities of experience that are difficult to perceive and interpret using internal representations (in the form of mental imagery or mental models) alone.

Finally, Stenning et al (1995) find that abstraction is a key quality of external representations. The more an external representation is able to capture the abstract qualities of an internal one, the more cognitively beneficial it is, leading to increased understanding. This reflects Norman's (1988) finding that people's mental models of a system, task or experience can be highly abstract. This is relevant to my research since a representation of internal experiences of digital systems necessarily draws on abstract qualities, both in the modality of the external representation, and in the nature of the experience itself, because experiences of digital systems, such as building a digital social network or ordering an email inbox, have many abstract elements. Forsythe (2015) finds that the process of working with physical materials when making models leads to greater understanding of abstract qualities.

2.3.1 **Models and modelling**

Visual representations, spoken accounts, and physical objects are focal points around which externalisation occurs. Visual representations, as shown by Larkin and Simon (1987), Winn (1989), and Scaife and Rogers (1996), help guide people to explanation. Spoken accounts allow participants to structure a narrative account of their experiences with digital systems in line with Blythe et al (2002), and Goldsteijn and Wright (2013). In order to bring about externalisation, models that provide a focus for attention to experiences of digital systems are important (Wojtczuk and Bonnardel, 2010). Physical models, in line with Mäki (2006), Kirsh (2010), and Werner (2011) provide access to a range of affordances, otherwise unavailable.

A model is a particular kind of representation—one that allows people to observe an aspect of a system that would otherwise be difficult to perceive. For example, architectural models allow for a design to be developed collaboratively between architect and client without having to commit to materials, shape, or size. Kirsh (2010) finds that an important quality of physical models is persistence—they do not disappear from mental (or actual) sight but remain accessible to cognitive processing. A key point for my research is his finding that ‘the materiality of external representations provides affordances internal representations lack’ (2010: 448). Kirsh’s affordances include the ability to approach and manipulate physical models from various angles, important in the opportunities it offers

participants to adopt different views of the representation. Physical models enforce consistency since they must exist in the world and be made of stable materials. Physical models also make interactions more explicit than visual ones, a finding echoed in Ferguson and Hegarty (1995).

Brandt and Grunnet (2000) find physical objects offer a way of thinking distinct from visual or screen representations because objects can embody various aspects of shape, interaction, and functionality in workshop scenarios. Brereton and McGarry (2000) show how the material characteristics of physical objects influence the way designers work. They find that physical objects 'give physical tangible presence to conceptual models' (2000: 221). Brandt (2007) explains how tangible models support design collaboration. She finds that very detailed physical prototypes provoke a limited range of ideas and focused communication, whereas unfinished or crude prototypes are open to wider interpretation and use. The way I explore the notion of physical models in this research, involves this sense of physical objects providing a means for the external representation of the various qualities of experiences of digital systems.

Mäki (2006) ascribes a distinctive indexicality to models that contributes to the way they are deployed in my research. 'The epistemic point of making models is that the properties of such substitute or surrogate systems are directly examined in order to indirectly acquire information about the properties of the systems

they represent' (Ibid.: 304). Models of experiences of digital systems can thus be interpreted as providing indirect and abstract information about the experiences they represent, such as ordering images or uploading files to cloud storage. Mäki provides justification for the use of models in terms of how they provide access to otherwise difficult to perceive phenomena. 'It is within, and in terms of, such simple representatives that questions about the complex real system can be recast so as to make them tractable and answerable' (Ibid.: 304). I use the term models to refer to physical representations, in preference to 'artefacts' or 'instruments', in order to reflect their particular function in externalising experiences of digital systems, and in sympathy with Mäki's definition above.

2.3.2 Externalisation and HCI

In HCI external representations are defined as embodiments of experience which materially exist (Zhang, 1997). They are external in relation to the human sensory and cognitive system and can be constructed using some representational format (Duval, 1999). Zhang refines his definition of external representation to include 'relations embedded in physical configurations' (Zhang, 1997: 180) which suggests the possibilities for sculptural forms and physical models.

For Dix and Gongora (2011), externalisation involves 'the embodiment, representation and exploration of our own thoughts, feelings and interior life' (Dix and Gongora, 2011: 1). They identify art and design specifically as a place where inspiration as 'an

internal mind state', and creative work as 'embodied engagement' (Dix and Gongora, 2011: 1) happily co-exist. This has an implication for my research in that experiences of digital systems can be made explicit and therefore accessible to discussion and analysis through externalisation. I build on a view of externalisations as useful in communicating and revealing unspoken experiences of digital systems, but extend Dix and Gongora's perspective to non-designer participants.

Dix and Gongora suggest that representation is important in the process of developing a counterbalance to the formative influence of digital systems, and present three types of representations: schematic representations, which are distanced in style or resolution, or shown in a different medium to the thing they represent; symbolic representations, which deal with more abstract concepts, ideas, criteria or properties; and isomorphic representations, which take the same shape and appearance as the experience, object, or situation they depict. I specifically utilise these categories in analysing the data from my first case study because they offer a way of structuring analysis with a precedent in design-oriented HCI.

2.3.3 Externalisation and design

The whole field of design—vehicles, services, graphics, interfaces, architecture—can be thought of as knowledge embodied in different forms of externalisation. Cross (2006) maintains that objects 'are a form of knowledge about how to satisfy certain requirements'

and 'how to perform certain tasks' (2006: 9). Based on evidence from anthropology (Turner and Bruner, 1986), cultural studies (Bennett, 2010), and design research (Laurel, 2003, Armstrong and Stojmirovic, 2011) I expand this functionalist definition to include the possibility that objects can also be regarded as a form of knowledge with which to inquire about human life, bring about improved conditions, and imagine alternative realities. Dalsgaard (2017) calls these 'instruments of inquiry'. One important effect of the attention designers pay to objects (digital or physical) is that design activity involves being what Cross calls 'immersed in material culture' (Cross, 2006: 9). Objects are made of materials, and designers manipulate materials into various configurations. Designers are profoundly involved with materials—what Ingold (2013) calls 'correspondence', and what Sennett (2012) calls 'engaged material consciousness'—they are adept at reading the meaning of existing objects and encoding those meanings into new forms.

The materials used in the process of externalisation have a profound influence on the resulting forms or models, and through them on how knowledge is constructed and internalised. For example, people using physical materials tend to explore through examples, while those using pen and paper through abstract categorisation (Ramduny-Ellis et al, 2005). The designer of models intended to produce externalisations should therefore give careful attention to the material properties of those models. In the context of design research. Wakkary et al (2016) call this 'material speculation' which

they characterise as 'the intent to critically investigate our world through the design of material artefacts that are specifically crafted for the purpose of inquiry' (2016: 3).

Externalisations 'assist in translating vague mental conceptualisations... into more concrete representations' (Fischer and Giaccardi, 2008: 23). Thus participants' experiences of interacting with digital systems could be given concrete expression through constructing external representations. Externalisations also 'provide a means for users to interact with, react to, and negotiate around and build upon ideas' (Ibid.: 24). Externalisation is at once a process, as a result of which people can formulate an attitude or opinion, and an outcome through which these attitudes are themselves experienced.

Based on his studies of designers at work, Kolko (2010) says that externalisation involves 'taking the data out of the cognitive realm (the head), removing it from the digital realm (the computer), and making it tangible in the physical realm in one cohesive visual structure.' (Ibid.: 19). Kolko refers to this process as abductive reasoning.

2.3.4 Externalisation and multimodality

In a review of literature relating to how people interact with technologies, it is necessary to include recent work in semiotics since this has shaped the discourse around modes of interaction. Semiotics is the formal study of communication and how signifiers

are arranged to denote a particular range of meanings. Social semiotics expands on the traditional landscape of semiotics laid out by De Saussure (1916) and Levi-Strauss (1963). Social semiotics (Hodge and Kress, 1998, Kress and van Leeuwen, 2001) holds that meanings are not fixed in objects or signifiers in the way that De Saussure suggests, but that meaning is made (or constructed) in use. This shifts semiological study to a necessary exploration of context, social and physical. The natural extension of this is multi-modality. Kress and Van Leeuwen (2001) point out that it is no longer possible to talk about text and image relations in a time of synthesised cultural experiences. In this context, an account of representation that does not acknowledge multimodality runs counter to current analyses of the gestalt of communication technologies and what van Leeuwen (2005) calls 'the articulatory aspect of sign production', i.e. interaction.

I mention social semiotics here to acknowledge the importance of shared representations and the context in which they are constructed. I do not specifically employ a multimodal analysis however, since I am not concerned with how digital systems support meaning making through analysis of their constituent elements, nor how the arrangement of modes and signifiers of interactive systems are configured. Adami (2013) presents a social semiotic multimodal framework for the analysis of website interactivity, concerned with the semiotic distinction between sites and signs, sites being loci for actions, signs being bearers of meaning. Multimodal analysis is thus focused on a detailed reading of how websites work to communicate

opportunities for interaction through their arrangement of signs, and the values they project through use of, e.g. colour, shape and size. My research is concerned instead with how digital systems are experienced holistically, and the affective qualities of those experiences as represented by people who use them. In addition, my emphasis is not on how the signifiers of external representations have come to be established through social use.

The limits of the cognitive framing of experience articulated by McCarthy and Wright (2004) and others is seen in their emphasis on feeling, memory, and understanding; qualities of the inner mind. The opposing view articulates a socio-cultural basis for experience, one grounded in how objects and instruments are used to make meaning in specific social contexts. This view has been deployed in design-oriented HCI by Kaptelinin and Nardi (2006) who use activity theory to inform their analysis. Alternatively, Law (2009) and Yaneva (2009) use actor network theory to do similar theoretical work by showing 'the ways in which materials join together to generate themselves and reproduce institutional and organizational patterns in the networks of the social.' (2009: 379).

In my research I have used a psychological reading of experience as described by mental representation (Anderson, 1978; Loftus et al, 2015) to ground the analysis. As the case studies progressed, the reading of experience I use has developed to reflect the more affective and embodied nature of working with physical materials to make new representations of personal experiences of

digital systems. The case studies were also conducted within the various social contexts of the workshops, and revealed through conversations between participants, and in spoken interviews. The cognitive levels of thought, sensory impressions, memory, and understanding were framed by the social environment within which the models were completed. Although participants were often working on individual representations, they rarely did so alone. The completion of these models thus constituted the integration of an individual, cognitive view of experience, to one taking in the workshop setting, objects, other people, and materials. My analysis has focused on the individual models and what participants said about them, through which I have articulated a wider view of the way people experience digital systems.

2.3.5 Summary: externalisation

This section develops the review from internal to external representation, taking in the topics of morphological similarity, abstraction and self-constructed representations. Models are described as a special type of external representation and the ways external representation has been used in HCI and in design is explored. Finally, I account for multimodality and social semiotics.

The relationship between internal and external representation is shown by Hegarty (2004) to consist of more than augmentation, external representations may operate and appear quite differently from internal ones. Scaife and Rogers (1996) explore this from

the perspective of isomorphism, while Stenning et al (1995) find abstraction to be an important quality of external representations. Cox (1999) shows how self-constructed external representations, i.e. those made by participants, are different to those imposed by designers and offer increased cognitive benefits. Models are discussed as a particular type of representation often used in design as a form of knowledge (Dalsgaard, 2016) and as a way of translating internal images and ideas into external forms. The importance of materials in external representation is described (Wakkary, 2016). Similarly, in HCI external representations are used as a way of making interior life externally visible (Dix, 2011). Finally, I explain how the perspective of social semiotics is related to my research but not directly applicable.

The next section accounts for the knowledge exchange processes I engage in during my research, with particular reference to multi-partner research and the generation of new forms of value.

2.4 Knowledge exchange

In this section I give an overview of the relevant literature on knowledge exchange (KE) where it connects to design and creative practice, as my research has roots in a KE focused doctoral programme called Creative Exchange (CX), an AHRC funded partnership between Newcastle University, Lancaster University, and the Royal College of Art. My intention here is to position my research along a spectrum of the knowledge exchange agenda

from national-level imperatives to research fieldwork and the partnerships I engage in. Explorations of how each case study handles knowledge exchange can be found in the respective case study chapters. KE for me involves accessing the expertise and knowledge of individuals in diverse domains and contributing my own in return. My research involves KE at various scales. As I progress through my research, the projects become smaller, with fewer partners and participants as my research interests crystallise around a narrow set of questions. These changing scales of KE activity are a direct result of my research journey—from exploratory to applied, and from general to particular.

KE is traditionally (Martinelli et al, 2007) seen as a shorthand for how research in science, technology, engineering, and mathematics (STEM) subjects has made its way into the national economy via university start ups and other spin-out mechanisms designed to connect academic research to business opportunity. The literature of KE, where it intersects with design research or design practice, is sparse. The four AHRC-funded KE hubs are, however, a rich source of new research, e.g. Prior et al (2014), Briscoe and Lockwood (2013), Moreton and Dovey (2013). All these examples take KE as a subject of research, or reflect on the procedures and processes at play in academic collaborations. Morris and Cruickshank (2013) address the issue of design methods directly with their idea of 'second order' KE design. This refers to instruments people can use to structure KE projects i.e. tools that support good case study writing (Ibid.: 2).

The difference from my research shown by all these examples is that I do not take KE as my subject. Instead I undertake KE and reflect on the process in each case study. My work is thus positioned at the fieldwork, action end of the KE research spectrum. I find that the interests and motivations of PhD researchers are often different to external partners. Industry collaborators may be engaged in a research project for a variety of reasons, including commercial development or capacity building. The institutional demands on doctoral candidates (such as ethical approval, or supervisory schedules) means there are aspects of collaborative research specific to PhD work. Consequently, I find it necessary to reserve time and space for PhD-specific work within larger collaborative enterprises. I find participating in and managing collaborative KE research projects informs my own research in new ways, both practical and conceptual.

For example, I draw on the expertise of a furniture and workplace designer to stage group activities in a public institution, and adopt the strategies used by a community activism group to encourage participation in a physical modelling exercise. This includes making the research visible at street level, providing creative satisfaction in the research activity, and framing research work as part of a wider local initiative.

The whole field of doctoral research that features KE is new; definitions are not yet stable and practices remain unburdened by

orthodoxy. There is therefore an opportunity to be both part of a new cohort of researchers trained in collaborative research practice, and to contribute to an emerging discourse around how arts and humanities researchers interface with industry partners, and for what reasons.

The CX context of this research promotes and suggests the case study method and has therefore shaped this PhD. Participating in multiple collaborative research projects means adapting my research methods to the particular conditions of each collaboration, which I structure as separate case studies. Taking advantage of partners and contexts to explore various methods is a positive attribute of the CX structure as it allows me to develop my research in varied settings. In the next section I describe how I approach the concept of digital public space as articulated by CX.

2.5 Digital public space

The initial context for this PhD was established prior to the recruitment of doctoral candidates to the CX program. The original definition of Digital Public Space (DPS) was laid out by the then BBC head of archive Tony Ageh (2015). He proposed the idea of a common cultural treasury, expressed in multiple forms, encompassing a huge variety of media and content, all delivered digitally. In this vision, the national collections held by the BBC, the British Library, British film Institute, National Gallery and other nationally prominent UK institutions would be made digitally available to people for free. The resulting Digital Public Space would be an exercise in democratic

accessibility and accountability. My own research is aimed at externalising internal representations of experiences of digital systems, and could therefore inform the development of technical standards for the DPS by externalising how people understand data standards and computational interoperability. Taken more holistically, DPS calls for a view of digital systems that encompasses ethics, memory, materiality and methodology, a definition of what public means in the context of digital interfaces and experiences, and an understanding of the norms of virtual spaces as they intersect with physical spaces (Brody and Fass, 2013).

I am motivated by a curiosity about how people interpret their own experiences of digital systems using design, which seemed to be an under-explored area. The CX final report (2015) acknowledges this transformation of DPS, noting that research efforts 'radically broaden the concept of DPS to embrace the value creation opportunities in a range of additional digital public spaces resulting from social, civic, health and co-working flows of data' (2015: 5). This interest leads me towards a human-centred view of DPS. Digital public space for me means the collective experience of using digital systems, such as cloud storage or web browsing, and I explore how people represent these experiences using externalising models. The development of a set of methods for the external representation of experiences of digital systems is the focus of this PhD, rather than the archive based reading of DPS articulated by the CX program.

2.6 Summary: Literature review

Drawing on the literature related to experience, particularly

Dewey's pragmatist view of aesthetic experiences (1934) and McCarthy and Wright's (2007) application of Dewey's ideas to technology experiences, I expand on the importance of affective qualities in relation to digital systems. These are defined in relation to the discipline of user experience design, which is concerned with the holistic impressions users of digital systems form and the role of design in shaping those impressions. I explore the nature of internal experiences of digital systems through the concept of representation, both internal and external, with particular attention to the characteristics of representations of experiences. I examine the notion of internal representation from the perspective of mental imagery because of its widespread use in design-oriented HCI, and further refine my interpretation of the topic to include narrative construction and mental models. In addition, I account for experiences of background digital systems and explain why I do not adopt a multimodal analytical approach. Finally, I position my research in the wider context of knowledge exchange and digital public space. The following research questions emerge from this literature review:

1. What characteristics of visual and physical models externalise people's experiences of digital systems?
2. What effects do the material properties of externalising models have on how digital systems are represented?
3. What types of activities externalise representations of digital systems?

These questions are explored using the methodology detailed in the following chapter.

Chapter 3: Methodology

Introduction

In this chapter I describe the overall methodological approach adopted—a mixed methods qualitative inquiry—and explain why it is suited to addressing the research questions, which are restated below. I position my research in the context of the publicly funded research programme that supported it, then show how I have used the case study method with particular reference to case creation. Finally, I describe the additional methods I have used, including observation and semi-structured interviews, and conclude with a rationale for the research sample and analytical approach.

3.1 Research questions

The following research questions emerge from the overview of literature:

What characteristics of visual and physical models externalise people's experiences of digital systems?

What effects do the material properties of externalising models have on how digital systems are represented?

What types of activities externalise representations of digital systems?

3.2 Methods

I address these research questions using qualitative methods, including observation and semi-structured interviews, across three

case studies, each in a different workshop setting. The specific digital systems investigated in this research are web browsing, digital social networks, image metadata, cloud computing, personal profiles, and computer algorithms. They are investigated in public, semi-public, and private settings. Finally, the institutional background to my research promotes the case study method. Creative Exchange, a nationally funded, inter-university programme focuses on the relationship between industry partners, academics, and PhD candidates. This relationship is specifically structured on a case study basis, encouraging the realisation of a series of collaborative research projects.

The research questions imply that there are characteristics and properties applicable to externalising models, which emerge from the contextual review in the previous chapter. Characteristics may include the material properties of visual representation such as graphic illustrations (Mayer and Gallini, 1990), physical properties such as rigidity and movement (Werner, 2011), or visual properties such as transparency and opacity (Mäki, 2006). The practice element of this thesis is seen in the design of externalising models intended to be completed by research participants, and in the design, organisation, facilitation and documentation of creative, participatory workshops.

Following Palmer (1978), I define representation as consisting of a relationship between a represented experience, i.e. using the web,

and a representing world, i.e. a model or drawing of that experience. The characteristics of a representation, in my research, thus refer to the type of correspondence between the former and the latter, and the influence design can bring to bear on the process of creating representing worlds. Physical models in the research question are defined as those that can be touched, smelled, heard etc. They exist in the phenomenal world of the human senses, as opposed to being limited to the screen-based interfaces of digital systems.

I define activities as actions undertaken by participants in response to a set aim or objective. Activities may involve multiple actions in a specific sequence—the procedure of the research workshops—but may also be open-ended. Martin and Hanington (2012) describe activities in the context of design research methods as ‘goal-directed sets of actions’ (2012: 10). This description incorporates the understanding that activities in design research have a specified purpose, and are multi-layered or sequential. Martin and Hanington provide an eloquent rationale for activities in design workshop settings. ‘Engaging people in creative expression through facilitated participatory exercises can provide them with a tangible artefact, on which to project thoughts, feelings, desires and emotions that might be otherwise hard to articulate using traditional research methods’ (Ibid.: 48).

3.3 Creative Exchange

The context of my research is an AHRC-funded national doctoral programme called Creative Exchange (CX), described in the previous chapter. The purpose of CX is to train a cohort of design researchers skilled in collaborative practice who can make a meaningful intellectual and practical contribution to the UK's creative economy.

The stated aims of CX are in four areas. Firstly, the intention is to foster collaboration between creative sector businesses, such as design agencies, film production companies, or theatre groups, and researchers in the arts and humanities. CX doctoral candidates are seen as the operational element in this arrangement because they are expected to engage in, and manage, a series of collaborative design projects. An element of my research is thus to incorporate collaborative work into the requirements of this thesis. Secondly, CX sets out to cluster interested parties around its themes of personalisation, experience, participation, connectivity, narrative, and identity. In my case there is crossover between participation, collaboration, and experience. Thirdly, CX funds collaborative projects between researchers and industry. For me, this involves working with academics from Swansea University, the Royal College of Art and industry partners from social enterprises such as Design for Social Change, NGOs such as Tactical Technology Collective, and a design consultancy, The Bossons Group. Finally, CX is oriented towards practical design activity. Research outcomes are intended to be prototyped and field-tested. CX thus intends

to generate new forms of collaboration in the context of doctoral research, new methods of knowledge exchange, and new processes of co-creation.

Ideas for CX projects have emerged from large 'sandpit' style events where potential collaborators are introduced around a series of themes. For example the Royal College of Art hosted an event in 2013 titled 'Modelling digital public space', where participants came together over shared interests to define ideas that could be developed and ultimately receive funding from CX. The aim was to identify partners, write a proposal and apply for funding. On receipt of approval, the collaboration started.

3.4 Qualitative research

This research is positioned as qualitative since it is concerned with the qualities of experiences of digital systems, how participants feel about them and how they represent those feelings in visual and physical models. Bloomberg and Volpe (2012) describe how qualitative research is suited to 'promoting a deep understanding of a social setting or activity' (2012: 27). In my research this means the activity of using digital technologies in various settings.

In line with qualitative approaches, my research makes explicit assumptions about the nature of lived experience, how we gain knowledge about it, and what methods are appropriate to find out about it (Flick, 2009). In particular, I use a range of methods available to qualitative researchers, specifically interviews, observation and

visual methods. Miles and Huberman (1994: 1) describe qualitative data as a source of 'well-grounded, rich descriptions and explanations of processes in identifiable local contexts'. This is what I aim for in asking about the relationship between models and experiences of digital systems. The possibility of serendipitous discovery and what Miles and Huberman (1994: 1) call the uncovering of 'new integrations'—novel relationships between people, things, and situations—is also a key strength of qualitative inquiry. In sympathy with this view, I use visual and physical models to uncover how participants experience digital systems.

3.4.1 **Design Research**

Designers often want to find out how people act in the world in order to design new things suited to a specific activity. The sub-fields of usability, user experience, and user-centred design follow this principle (Hartson, 2012). In practice-oriented design research, non-textual and non-verbal data assume extra importance as ways of finding out about the world (Laurel, 2003, Koskinen et al, 2011), because they are seen as affording access to alternative kinds of knowledge such as embodied or tacit understanding.

Design research data may thus include visual, interactive, or sculptural forms. Design research typically draws conclusions about the potential for design from respondents' materials (Martin and Hanington, 2012, Milton and Rogers, 2013) and as such I provide a range of materials for participants to work with—from printed paper templates to physical materials—from which a model could be

created. In sympathy with 'metadesign' as articulated by Giaccardi (2005), my research involves under-designed visual and physical models intended to be completed by participants.

3.4.2 Case study research

My research uses the case study method to explore peoples' internal experiences of digital systems, and is structured as a series of related case studies which build on each other to arrive at a set of findings applicable across all three. According to Yin (2009: 34), case study research involves 'an empirical investigation of a particular contemporary phenomenon, within its real life context, using multiple sources of evidence'. Consequently, my research captures data about the way participants experience digital systems using interviews, observation, and visual and physical modelling.

3.4.3 Case creation

A specific aspect of case study research is case creation, a term which implies that the units of analysis are not encountered in the field fully formed and ready for analytical attention, but instead developed by the researcher. In my research, case creation involves consciously creating the conditions in which participants could make visual representations and physical models of their experiences of digital systems. I follow Jung (2010) and Edelman (2011) in positioning case creation as a way of controlling for the complexity of qualitative research situations, but extend their use of laboratory environments into more naturalistic places. The contexts of my case studies are public, semi-public and private. There, I present people

with the opportunity to creatively explore their own experiences of digital systems. Thus the advantages of case creation stated by Edelman—‘prompts can be supplied, duration of observation can be calibrated, and media and tools... can be filtered’ (Edelman, 2011: 84)—are present alongside the advantages of the case study method.

The disadvantages of case creation are that the methods may involve improvised or atypical settings. Case creation studies nevertheless still involve the in-depth examination and identification of cases specified by Burns (2000) and Yin (2009), and the resulting data can be considered as collected in what Schwandt (2007) refers to as ‘clearly delimited settings’ (2007: 35). The idea of hybrid settings is familiar in design research, where researchers may work with people in professional design studios (Stolterman, 2008), or other workplaces (Vaughan, 2017), often in a specific room set aside for research purposes. Design researchers also gather data from people in their homes (Kidd et al, 1999), or at exhibitions or performances (Newell et al, 2006). Case creation in my research is thus a way of preserving some of the rich, real world characteristics of people experiencing digital systems and modelling their experiences, and of allowing the model-making situation to be partially designed so as to address the research questions. Complexity is not designed out, and thick description (Geertz, 1975) is preserved.

3.5 Observation

Asking what effects the material characteristics of externalising models have on how digital systems are represented means observing how participants use them to construct those representations. Similarly, finding out what types of activities externalise representations of digital systems means staging various activities with a view to identifying what activities work best to externalise those representations. Observation as a method in design-related HCI is used, for example, in a study of how people use their mobile phones while shopping by Newcomb et al (2003), while Nakhimovsky et al (2009) show the use of field observation in a user experience evaluation study. These studies are relevant because they demonstrate the use of observation as a method in studies of how people use digital systems.

Kiefer et al (2008) use observation to investigate how people interact with digital music controllers, and Bruckman et al (2009) show the use of participant-as-observer methods in their study of designing computer systems with young people under semi-controlled conditions. These studies relate directly to my research question: What characteristics of visual and physical models externalise people's experiences of digital systems? because they establish a basis for the use of observation as an effective method of data collection in research that asks how people use digital systems. I thus take observation in qualitative research, as outlined by Gray (2014), as a primary data collection method. Following Bruckman et al (2009), Robson (2011) suggests participant-as-observer is a

good way to incorporate the time constraints that may prevent the full immersion implied by participant observation on the one hand, and the dispassionate distance implied by naturalistic or non-participant observation on the other. This is relevant to my research because of the workshop situations used and because it provides a way to address the question: What types of activities externalise representations of digital systems?

I attend the case study workshops, though not directly as a participant. My participation in the research is as instigator, observer, and interviewer, remaining unobtrusive in terms of modelling activities and not making written observation notes. I am obviously and visibly the instigator and facilitator of the activity in the way described by Sanders and Stappers (2008) and Stringer (2013), distributing materials, explaining the procedure and rationale behind the research, and eliciting informed consent from participants.

3.5.1 Stimulated recall interviews

Stimulated recall (SR) is a research method that involves interviewing participants while they view visual materials such as video footage or photographs (Lyle, 2010). SR has been used in HCI research by Michel and Smith (2017) and Chau and Lee (2017) using digital technologies and interactive systems as stimuli. Stimulus materials in qualitative interviews have traditionally been in the form of two dimensional representations such as video recordings (Lyle, 2010, Dempsey, 2010, Rowe, 2009) but Yliveronen, and Seitamaa-

Hakkarainen (2016) use physical objects such as school bags and craft materials as stimulus materials during research interviews. There is also increasing attention on the use of physical artefacts created by participants. Burden et al (2015: 27) show how 'discussion of artefacts created by participants can promote participant-driven enquiry, thereby reducing researcher bias'. Punch (2002) describes the use of stimulus material during interviews during which participants were asked to complete a set of tasks with materials including boxes, cards, and pens. These materials were used as a stimulus to the conversation between researcher and participants in a situation where personal information was elusive or difficult to uncover.

Stimulated recall in design research is a usability evaluation tool (Hyrskykari et al, 2008) that can elicit emotional recall of experiences (Pätsch et al, 2014), often augmented with other technologies, such as mobile devices or eye tracking systems. I use participants' own models as prompts to elicit their experiences of digital systems, relying on their spoken accounts about what the models show. The use of physical prompts in design research is also a long established practice (Houde and Hill, 1997, Laurel, 2003).

I conduct semi-structured interviews, in line with Weiss (1994) and Drever (2003), because the nature of this research is exploratory. I direct the interviews with a few initial questions but then let the conversation evolve, occasionally bringing the interview back to the

relevant topics in relation to the research questions. The presence of visual and physical models helps to maintain focus during the interviews, since I am able to touch or point to them to frame questions.

3.5.2 Photographic documentation

While participants make their models I document their actions and outcomes visually by taking photographs of what they are doing. This method is used by Hirsh et al (2000) to gather data related to uses of technology by elderly people, and by Macdonald (2015) to document the technology interactions of librarians. Pierce (2014) describes the importance of photographic documentation in HCI research, emphasising how it plays a significant role in the documentation of research artefacts and activities. I use photographic documentation in direct response to the questions: What characteristics of visual and physical models externalise people's experiences of digital systems? and: What effects do the material properties of externalising models have on how digital systems are represented? by capturing aspects of how participants use the models and how materials are configured.

My aim is to capture not just the models themselves (although this is important) but to include the room, furniture, materials, spatial layout, lighting, etc of the spaces. Photographic observation is a way of capturing this type of contextualising data. Addressing the question: What types of activities externalise representations of digital systems? means capturing those activities visually as they

unfold. Finding out how the material characteristics of externalising models affect how experiences of digital systems are represented involves maintaining a visual record of participants using those materials to construct their representations.

As Rose (2014) points out, photographs can be unreliable records taken from a chosen perspective that may exclude or omit important details. I thus use them as supporting evidence in this research and include them as reference material in the process of data analysis. Gray (2014) provides support for this method of using photography in qualitative research, saying photography can be used to recall events or stimulate theory building.

3.5.3 **Audio recordings**

I use audio recordings in my research to gather data relative to the question: What effects do the material properties of externalising models have on how digital systems are represented? asking participants about these effects with the models in front of them, and recording their answers. Audio recordings as a data gathering method in HCI is used by Blandford et al (2016) in their discussion of qualitative approaches to analysis in interaction design, and in user experience research by Law and Sun (2012). Ardito et al (2014) show how audio recordings can be used in a study of UX practice in real world situations.

3.6 Participatory design practices

I use participatory design practice as an umbrella term to cover co-design, co-creation and all other forms of design work that involve research participants. In addressing my research questions I use participatory and group situations as a way of reaching people in public places and structuring group encounters through the use of creative activities, because they offer participants the chance to author representations of their own experiences of digital systems alongside other participants. I use participatory design settings specifically to address the question: What types of activities externalise representations of digital systems? by providing a context for these activities and an opportunity to observe their effects and outcomes.

Sanders says, 'in participatory experiences, the roles of the designer and the researcher blur and the user becomes a critical component of the process' (2002: 1). Sanders goes on to show how participatory creative situations are 'focused on what people make i.e., what they create from the toolkits we provide for them to use in expressing their thoughts, feelings and dreams.' (Sanders and SonicRim, 2002: 4). This view positions design making as a distinctive element of participatory design in HCI, albeit normally oriented towards the production of new software systems and web based tools. Halskov and Hansen (2015) provide a useful review of participatory design in HCI, demonstrating the many ways it has been used to involve participants, not just as subjects but also as active partners in research. The group experience aspect

of the question: What characteristics of visual and physical models externalise people's experiences of digital systems? is addressed through participatory design by allowing people to work together on shared representations. Keil et al (2016) use participatory design specifically to explore the emotional qualities of a design, which is in line with my own aim to explore the affective qualities of digital systems.

In summary, I position my research along the spectrum of participatory practice, and as an example of co-creation but with some important provisos relating to the design of models intended to be completed by participants, and the aims of workshops oriented towards externalisation of experiences rather than product development.

3.7 Workshops

My research uses multi-participant workshops as research settings in which participants create visual and physical models intended to externalise experiences of digital systems. As Binder and Brandt (2008) point out, a design workshop implies a group creative activity, the purpose of which is to explore a specific idea, or set of ideas, by making things. They design a workshop in which industrial plant workers make a mock-up of a proposed new device and document themselves using it in fictional workplace scenarios (in Sears and Jacko (Eds.), 2009). Similarly, Pedell (2004) uses a visual storyboarding workshop in which participants annotate photo stories with speech and thought bubbles. In common with

my research, both these examples use creative methods to involve people in research.

Workshops also imply time-constrained but playful and participatory events (Binder and Brandt, 2008), where participants work towards a common goal. Lee (2007) runs a design workshop in which participants create physical models with the aim of making abstract planning processes tractable to local residents. The models are made of low cost tangible materials such as cardboard and wood. She finds that the workshop activities allow participants to gain an understanding of the relationship of their private space to the communal space and encourages projection of the patterns of their daily existence into the space (Lee, 2007: 42). This approach reflects how I use workshop activities to encourage representations of the abstract nature of experiences of digital systems made of accessible materials.

This method is in line with Muller (2002) who identifies workshops as important sites of participatory design practice. Westerlund (2007) shows how participants working in a conscious and attentive way, making physical things in a workshop setting, make it more likely that the outputs are seen as meaningful to people. Wendorff (in Hanington, 2007) runs a design workshop in which participants are asked to model their emotions using clay and plasticine. She finds the familiarity of the materials and their malleability leads to mappings between emotions and shapes, i.e. negative emotions

are spiky and angular, positive ones rounded and smooth. This has clear implications for my research question: What effects do the material properties of externalising models have on how experiences of digital systems are represented? in the sense that the novel materials and methods used by Wendorff have a distinct effect on the characteristics of representations.

Investigating the characteristics of external models through workshop activities allows my research questions to intersect. Workshops provide a context for the characteristics to emerge and an opportunity to observe how they affect representations of experiences of digital systems. Finally, participatory workshops in my research feature various types of activities across the three case studies, addressing the question of what activities externalise representations of experiences of digital systems.

3.7.1 **Sampling strategy**

I focus on adults, aged between 18 and 87, because their experiences of digital systems span a wide range of systems and situations from healthcare, work, and games to sexual life, travel and banking.

My research features criterion sampling since the research questions imply responses from people who have directly experienced digital systems. When including participants in the study, it is therefore important that they are adults familiar with the digital systems I am interested in. The above criteria notwithstanding, I place no restriction on age (beyond specifying that the participants should

be over 18), gender or ethnic background, also not selecting for these traits. In the public and semi-public settings, the sample is made up of people who enter the space, are willing to participate, and fulfil the two criteria for inclusion. In the case of the private context (the offices of an NGO), the research sample is pre-selected by the project partner as comprising those people most likely to benefit professionally from inclusion.

Following Yin (2016: 93), I use a purposive approach so as to yield the most relevant and plentiful data. The emphasis is on information richness rather than statistical significance, and the sample is not intended to be representative but to provide 'a range of information and perspectives on the subject of study' (Kuzel, 2001: 37). Gray (2014) describes the rationale behind purposive sampling: 'the researcher exercises a degree of judgement on the phenomenon of interest and then invites these participants into the study' (Gray, 2014: 217).

The danger of both purposive and criterion sampling is that there may be built-in biases to the sample that pass unnoticed (Gray, 2014). For example, younger people may be exceptionally heavy users of digital social networks. Art and design students may be more aware of the design implications of network modelling and comic drawing. By including the purposive sample of passers-by, I hope to account for this potential problem.

3.8 Analysis

This section describes the analytical methods I employ across the three case studies. I describe the analytical steps employed in my research, with reference to practices in qualitative data analysis in design research and my research questions which are restated below.

What characteristics of visual and physical models externalise people's experiences of digital systems?

What effects do the material properties of externalising models have on how experiences of digital systems are represented?

What types of activities externalise representations of experiences of digital systems?

Following Dix and Gongora (2011), I adopt the categories of isomorphic, schematic, and symbolic representation as a starting point for analysis in the first case study, because they have a basis in design research concerned with externalisation. Isomorphic representations are those that display a close resemblance to their subject. Schematic representations such as architectural drawings or exploded views of products are diagrammatic or indicative. I use schematic representation as a category of analysis in my research because some aspects of people's experiences of digital systems, such as repetition and confusion, may have no direct analogue in

materials or forms. Symbolic representation is used by Dix and Gongora to describe abstract concepts, ideas or properties such as mind maps or equations. I use symbolic representation in my research to analyse metaphorical and emblematic participant responses. These three categories are discussed further in Chapter 4. The emphasis on categories of representation reflects the emphasis on characteristics in the initial research question.

An overriding analytical lens in all three case studies is a concern with materials. Döring et al (2012) observe that material qualities guide participant's actions and behaviours, for example if they are perceived to be fragile or valuable. Wiberg (2014) states that tangibility is an important aspect of materials and how they are used by participants. He finds that the more people touch and manipulate materials directly, the more they take ownership of them and value what they have done using those materials.

The developing materiality of the externalising models—from paper sheets to fully dimensional sculptural forms—is a principle informing my analysis. Jansen et al (2015) find that physical representations leverage human sensorimotor skills, invoking non-visual qualities such as texture, stiffness, and weight. Roberts and Walker (2010) find physical representations allow people to activate intermodal perception, i.e. sight, sound and touch, which integrates the senses. The increasing dimensionality and opportunities for intermodal perception through the case studies in my research address the research questions of what the characteristics of externalising

models are and how they affect the way the participants externalise their experiences of digital systems.

Since I am looking for ways in which visual and physical models externalise experiences of digital systems, transcripts of participant interviews are the main data type. Analysis of participant interviews in the form of transcribed audio recordings is well described as a reliable and valid technique, for example by McLennan et al (2003) and Knoblauch et al (2008). I transcribe participant interviews and analyse passages in the text that refer directly to activities, and models, particularly material properties and workshop activities. I analyse the visual and physical models in relation to representations of experiences of digital systems as elicited in semi-structured interviews to inform the relationship between objects and interview responses. This helps address the research questions relating to the characteristics of externalising models and how they influence the process of externalisation.

The analytical categories reflect my own interpretation of how participant responses address the research questions. Bazely (2013) demonstrates the way categories are used to 'link or test for associated ideas' (2013: 154). I thus develop categories in dynamic relation to emerging themes in the interview transcript.

As categories develop, I group them, re-label them as new categories, and subsequently incorporate them into existing themes. Themes are a step to building a 'rich and detailed, yet complex,

account of the data' (Clarke and Braun, 2014: 78) which is necessary to account for the range of experiences of digital systems covered, the diversity of participants and settings, and more generally the nuanced nature of participant behaviour.

3.9 Summary: Methodology

My research is positioned as qualitative research since it is concerned with the qualities of personal experiences of digital systems. It emerges from the AHRC-funded Creative Exchange, and is oriented towards the development of multiple collaborative research projects that lend themselves to the case study method. I develop this towards case creation in which researchers create the contexts of their own research.

The use of models in my research is highlighted as being methodologically important. The overall research design and its positioning in the knowledge domain of design research as it relates to HCI and UX design is identified. In addressing the research questions, I describe the design of three participatory workshops with different models, materials and activities. The qualitative methods used include observation, photography for documentation, and audio recordings of interviews. The main source of data is semi-structured interviews conducted with visual and physical models in front of the participants to act as stimuli to discussion. The sampling strategy is purposive and criterion sampling of adults aged between 18 and 87 who have experience of the digital systems I investigate.

I transcribe the interviews and identify common themes across each case study, looking particularly for participants speaking about the design characteristics, material properties, and workshop activities that the research questions feature. These themes are grouped and higher level categories of analysis derived.

The next chapter reports on the procedure, analysis and findings of the first case study, in which participants were asked to create comic book style drawings of their browser history lists.



Patrick Kielty hosts this brand new comedy chat show in which special guests hand over their laptops to see what their internet history can reveal about them.

Figure 1. Delete Delete Delete, BBC 1, 2016)

Chapter 4: Browser History Comics

Introduction

This chapter reports on a workshop in which participants were asked to create comic book-style drawings from their browser history lists. The browser history list is a standard feature of web browser software, an automatic, interactive record of all individual web pages visited. Its purpose is to enable people to revisit or find sites they have previously visited. Using visual representation in the form of comic drawings, I address the question: What design characteristics of visual and physical models externalise people's experiences of digital systems? I also address the question: What types of activities externalise representations of experiences of digital systems? by asking participants about the activity of drawing their browser history lists.

Browser history has recently entered political and cultural consciousness in new ways. For example, the BBC television programme *Delete Delete Delete* (first shown April 2016) 'the show in which special guests hand over their laptops so he (the presenter) can rummage around their internet history' confronts celebrities with their browser history lists. The stated aim is 'to see what their internet history can reveal about them' (www.bbc.co.uk). Now on its second series, *Delete Delete Delete* plays on the fact that people are often unaware of the information their internet history list may contain. My research focus is on the design characteristics of the externalising model from the perspective of how schematic, isomorphic, and symbolic representations work to externalise experiences of using digital systems, including the web.

I first describe the development and structure of the case study, including the methods, sample and procedure used. Then I present data analysis with associated findings from the research workshop. Finally, I discuss the overall findings from the case study and relate them to the research questions.

4.1 Research questions

This first case study addresses the primary research question: What design characteristics of visual and physical models externalise people's experiences of digital systems? by asking participants to draw representations of their browser history using sheets of paper, pens, brushes and ink. Participants were invited to work with simple and commonplace materials, and use a recognisable method of representation, comic drawing. The third research question: What types of activities externalise representations of experiences of digital systems? was addressed by asking participants in semi-structured interviews how the activity of comic drawing shaped their responses—specifically, how their responses might have been different if expressed in an alternative medium, and what barriers to externalisation, if any, they found the activity presented.

4.2 Methods

The advantage of drawing as a research method is explained by Zweifel and Van Wezeemal (2012). They find that it 'allows the simultaneity of processes' to be represented. This recalls Palmer's (1978) suggestion that representations depend on the availability of processes—what he calls 'operational relations' to act upon them.

This idea holds that the meaning of a representation is dependent on whether there are processes, described as operational relations, adequate for acting on it. In other words, a representation is illegible as regards relating one world to another unless it carries certain instructions for interpretation of the representation that can be commonly understood. For example, an arrow indicates direction, a list carries the idea of next item within it. Zweifel and Van Wezeemal (2012) suggest that drawings can be carriers of parallel operational relations and thus are an advantageous way of representing complex experiences.

From the perspective of materials, Zweifel and Van Wezeemal (2012: 15) describe how 'paper enters the interview as a material actor, influencing and changing' the human setting. This provides support for using stimulated recall interviews in this case study as an enhanced way of finding out about participants' models, and through them, about their experiences of digital systems.

4.3 Limitations of this case study

The limitations of using drawing in research include concerns participants have about their artistic abilities, and potential unfamiliarity with the materials and the comic form. In this case study, the materials ranged from pencils and fibre tipped pens, to brushes and inks which may have limited use as they require specialist skills. The comic form may have presented a limitation through its associations with cartoons and childhood.

The ability of visual representations to externalise people's experiences of digital systems is highly subjective and depends on each participant's motivations and choices of what to depict. Asking for visual responses to the browser history list software function presupposes that participants have access to technology in the form of devices and connectivity, or have sufficiently distinctive memories of browsing to create a meaningful representation. Consequently, participants with no experience of web browsers were not included or sought.

Limitations of semi-structured interviewing include researcher bias and how it can lead participants toward an expected answer, and the likelihood that participants are trying to give the 'correct' answer to questions as they perceive it. I asked the interview questions in plain language, and incorporated open questions such as: "Can you tell me about what you have done?" or "How did you find the activity?" to manage possible bias.

The limitations of the sample are that it was constrained firstly by visitors to the workshop venue, and secondly by the people among those visitors who chose to participate specifically in the comic drawing activity. The sample was further limited to those people with knowledge and experience of internet use and those with an existent browser history list. The limitations of the setting include the crowded and distracting environment of the building entrance (described below) and its association with avant garde and experimental art exhibitions. Finally, the study was limited to two

dimensional drawing and therefore did not offer the opportunity for tangible or embodied representation.

4.4 Knowledge exchange

This case study took place within a larger collaborative project, involving the development of an exhibit designed to contribute to a large public exhibition related to contemporary working life. I worked on this collaboration with partners from three organisations; the University of Wales; The Bossons Group, a design company specialising in ergonomics; and Unwork, a workplace design consultancy. The fourth, less active, partner was a public gallery in Liverpool, FACT, and its curatorial staff, who were involved in integrating our project into the larger exhibition. The work was carried out at many different levels; from high-level conceptual dialogue with the director of FACT, to discussions of available facilities and resources with FACT operations personnel. The FACT management board and Royal College of Art project managers also had a stake in how the project was manifested.

4.5 Previous work

This case study focuses on a visual narrative construction of individual browser history in the form of comic drawing. Browser history is an important subject for HCI researchers (see Cothey, 2002, Shrestha, 2007, Cui and Biersack, 2011). Much of the research is focused on tools that allow people to easily re-find web pages they have previously visited (Ayers & Stasko, 1995). The emphasis is on revealing and facilitating hypertext navigation, not on providing

ways for web users to reflect on their own web activity. Weinreich et al (2006: 13) observe how 'the data of clickstream logs have a limited expressiveness, as aims and tasks of the users often stay below the surface'. This case study consequently questions the usefulness of the browser history list as a representation of the experience of using the web, and investigates a way of allowing the impressions and perceptions of web use to come to the surface.

Various graphic and textual strategies have been used to represent web activity and the branching nature of hypertext links. These include thumbnails (BrowseBack 2006, Figure 3), paths and signposts (FootPrints, 1999, Figure 2), and text snippets (Contextual Web History, Won, 2009). Google's History Timeline (Figure 4) shows browser history in a format that automatically creates thumbnail images to represent pages visited; content boxes are arranged chronologically either side of a central spine, URL details and live links are visually integrated with images. The problem that many of these practical examples address is that although web users navigate in a nonlinear manner, jumping between topics and pages, browser history is typically organised in a strictly linear list of URLs.

Studies of what people think of browsing explore users' opinions of web advertising (McDonald and Cranor, 2010, Ur et al, 2012) and online privacy (Anton et al, 2002). More recently, Eyebrowse (Zhang et al, 2016, Figure 5), a web application that allows people to share their browser history list, intends 'to give users themselves... access to the same type of browsing data that big Web companies

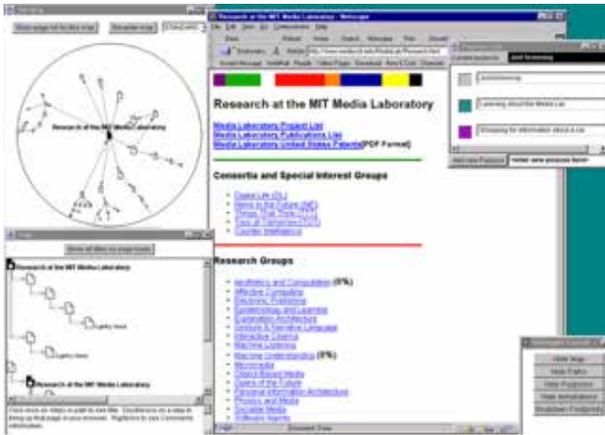


Figure 2. FootPrints, Maes & Wexelblat, 1999



Figure 3. BrowseBack, Smile Software, 2006



Figure 4. Google History Timeline, 2014

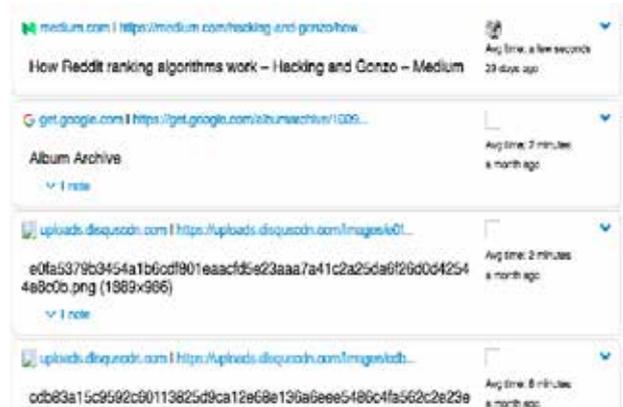


Figure 5. Eyebrowse, Zhang et al, 2016

currently collect and mine to better target products to individual consumers'. These aims intersect with my own, with the difference that I propose methods for web users to externalise representations of web browsing using non-digital externalising models. I use a graphical comic format in this case study as a way of exploring the possibilities of representation beyond the predominantly textual representation of the browser history list, to investigate how it may elicit more personal responses than digital materials.

Workshop

4.6 Setting

The main research workshop for this case study took place over two days in December 2013 at FACT, a public arts centre in Liverpool with a regular programme of temporary exhibitions and events, a cinema, and cafe. The research space was positioned near the main street entrance, adjacent to the reception desk, and clearly visible from outside the building, in a space custom designed for collaborative creative work. The space could accommodate 30 to 40 people, and people used the space for many different purposes including sitting and reading, drinking coffee and chatting, participating in scheduled workshop activities, and taking part in language classes. The co-working space was opposite the cinema box office, and alongside the venue's main visitor passageway. All these factors combined to make the space highly visible and accessible.

4.6.1 **Sample**

Holding the workshop over two days meant a high number of participants and a diverse population, ranging from pensioners taking advantage of reduced weekend cinema prices, to freelance designers. A wide group of exhibition visitors, cinema goers, families, and young professionals came into the space. This sample included participants from 18 to 87 years old, professionals and students, and gallery visitors, alongside comic enthusiasts who explained to me how they had just come from a local specialist comic shop.

This should be considered a purposive sample (Robson, 2011) since it was made up of people visiting FACT on the day of the workshop, and who were motivated to participate. They were specifically asked if they wished to participate, and further asked if they were familiar with their own browser history list. Participants were thus chosen on the basis of showing interest in the task and having the time and inclination to take part. The strengths of such a broad sample include the range of responses produced and the different ways participants used the materials. Weaknesses include the difficulty of appealing to those unfamiliar with comic books, or with the browser history list function..

4.6.2 **Methods**

This case study involved participants drawing comic book versions of their browser history lists. The drawing method was complemented

by stimulated recall interviews, during which participants spoke about what they had done, with their drawings on the table in front of them; these were recorded with audio.

The data were initially analysed using the three categories of schematic, symbolic, and isomorphic representation (Dix and Gongora, 2011) which offered a way to classify externalisations and address the question: What effects do the material properties of externalising models have on how experiences of digital systems are represented? Highlighting interview transcripts alongside the comic drawings, I looked for examples of visual representation, in the form of comic drawings on paper, revealing experiences of web browsing. I grouped these visual representations according to how the categories of representation contributed to the process of externalisation.

4.6.3 Procedure

Participants were introduced to the activity, given a printed information sheet about the aims of the research, and asked to sign a consent form before starting the task. There were no specific instructions about how much of the browser history list participants should include, nor how far back they should go through the list. In addition, there were no limitations placed on how many sheets the participants could use. The paper sheets featured a choice of panel layout (shown in Figures 6-9). A range of materials was supplied, including pens, pencils, coloured fibre tips, brushes and coloured ink. No time limit for the task was specified.

I was present to answer any questions and provide or replenish materials as needed. After the task was completed, participants were asked to describe what they had done and why. These interviews were recorded, and the completed comic used as a stimulus to talk around the topic of web use and browser behaviour, and to help them remember the motivations and reasons for visiting the various sites shown in the drawings. The form of these interviews was semi-structured—allowing the participants to speak freely about what they had done, but returned to topics directly related to the research questions. When the comics were completed, they were returned to me for storage and analysis.

4.6.4 **Results**

The results of this case study comprised 33 comic drawings. Ten were classified as featuring schematic representation, seven as featuring isomorphic representation, and four as featuring symbolic representation. In addition, 25 of the 33 were classified as featuring elements of all three categories of representation. Alongside the 33 completed paper sheets, 6 spoken interviews were completed and transcribed. More generally, the drawing workshop was used by participants as a leisure activity, and some people spent up to an hour on the task. Where I was unable to conduct interviews with participants because of the number of people present or because they did not agree to do so, the comics were of limited use. In addition, some comics were not useful because they were not

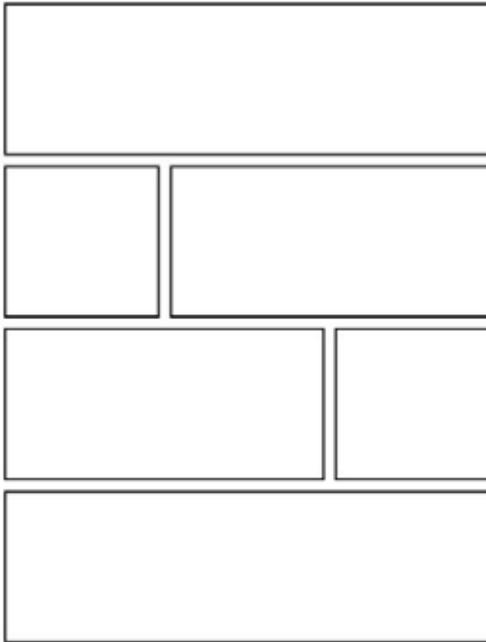


Figure 6. Graphic layout a



Figure 7. Graphic layout b



Figure 8. Graphic layout c

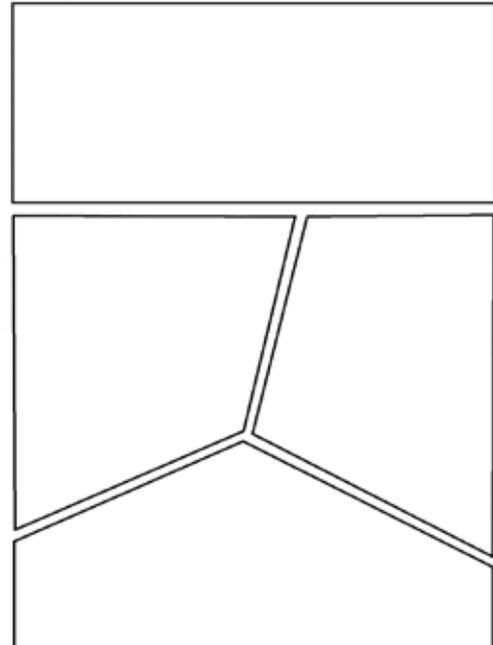


Figure 9. Graphic layout d

representative of browser history. The data were valid in addressing the research questions because they demonstrated the qualities of browser experiences, and how participants felt about using the internet. Participants reflected on the design characteristics of the visual model and the responses show how the structure of the activity influenced the resulting representations.

4.7 Analysis

When analysing the data from this case study, I highlight sentences and passages in the interview transcripts where respondents mention the activity, their drawings, the model and its characteristics, and where they relate their experiences of using the browser history list directly to the comic drawings.

I then identified specific quotes and drawings that refer to the qualities of isomorphic, schematic, and symbolic representation mentioned by Dix and Gongora (2011). My analysis of participant interviews thus relates to the research question: What design characteristics of visual and physical models externalise people's experiences of digital systems? by following pre-existing categories and deriving new ones in reaction to interim findings. The question: What effects do the material properties of externalising models have on how experiences of digital systems are represented? led to asking the participants about the configuration of the boxes in their drawings, the graphical language they used, and how they used colour, texture or notation to externalise their experiences with their browser history lists.

4.7.1 **Schematic representation**

Dix and Gongora (2011) describe schematic representation as 'rendering aspects of the final item... in a different medium, or some way distanced from it'. They give examples of sketches and floor plans in architectural design. In the context of representations of web use, I apply this category to drawings that show semi-abstract, condensed or synthesised interpretations of browsing experiences. Schematic representation as a category of analysis also evokes Palmer's (1978) concept of non-equivalent representations, in which a representation preserves different information about the same objects. The central panel of Figure 11 shows thoughts about an upcoming marriage emanating from the head of the participant. The wedding venue, a grand civic building, is shown in a thought bubble alongside rings, money, clothes, food, and guests—all in their own separate bubbles. Viewed separately, these are representations of individual objects but arranged visually in the panel they work as a schematic of the topic of marriage as explored through various websites.

4.7.2 **Isomorphic representation**

Isomorphic representations (such as Figure 10) take on the visual, spatial and dimensional characteristics of their object; i.e. an architectural model shows the precise proportions and shape of a finished building. In this analysis I take isomorphic to refer to representations that are a close match with the subject they represent, i.e. they are informationally equivalent representations

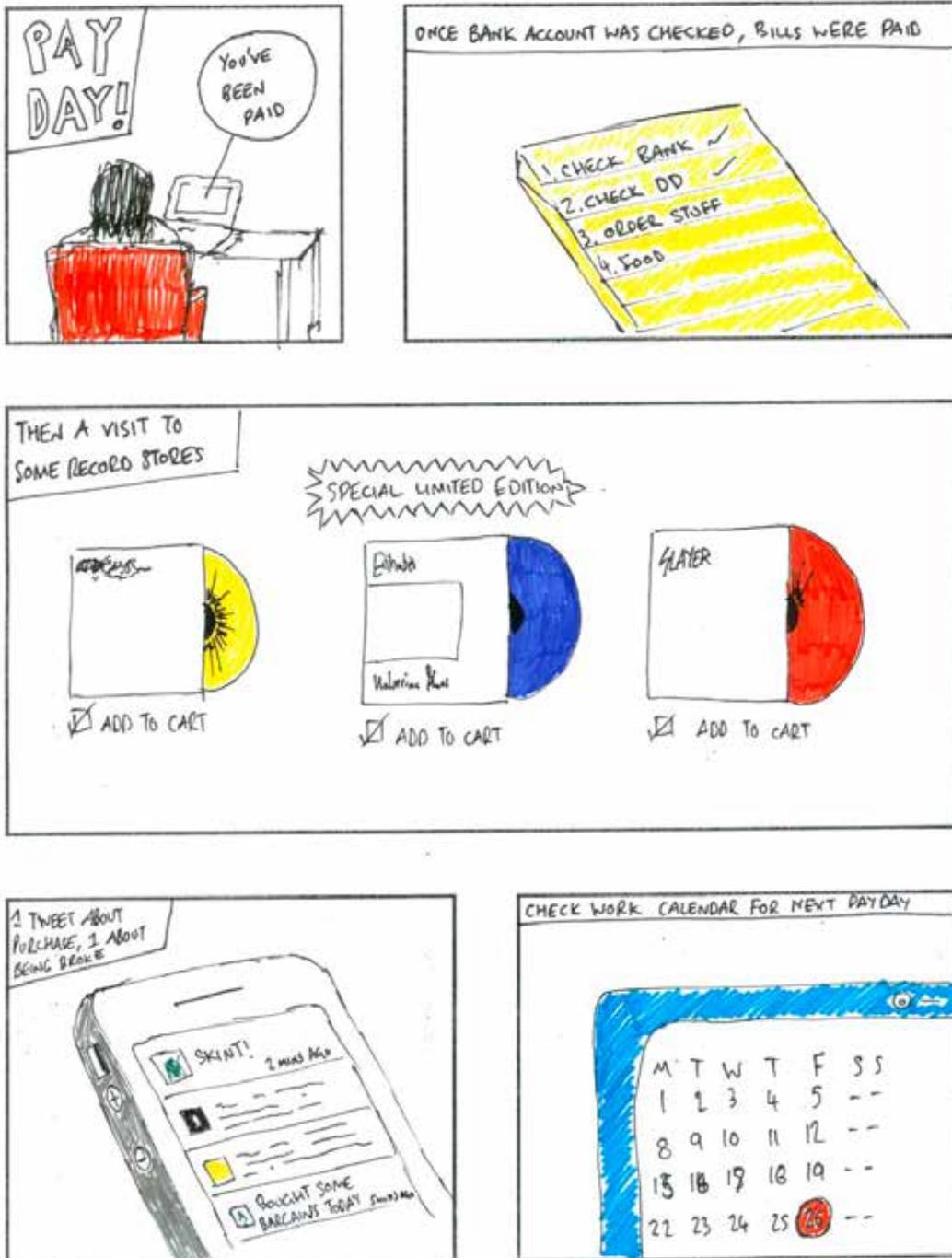


Figure 10. Isomorphic representation

(Palmer, 1978). Figure 10, a story of payday, music and work, shows the author at their desk. A lined yellow pad, coloured records in their sleeves, an iPhone, and a calendar are also shown. The yellow pad and iPhone are drawn accurately and are easily recognisable. Figure 15 shows faithfully rendered representations of digital objects. The central panel shows a progress bar loading a web page, the first and last panels feature drawings of a digital clock, both illustrated accurately. In these examples, as in most cases, isomorphic representations show physical objects.

4.7.3 **Symbolic representation**

According to Dix and Gongora (2011), symbolic representations 'deal with more abstract concepts, ideas, criteria or properties'. When considering web browsing, such actions as searching, reading, scrolling, or scheduling can be shown symbolically. Symbolic representations are examples of meaning-based representations (Anderson, 2000) that are abstracted from perceptual details, i.e. they involve moving from specific experiences to general categorisations of experience. The first panel of Figure 11, showing a pile of physical books, is symbolic of learning and study. The books are annotated with 'text book', 'serious', and 'heavy' to show academic intent. The penultimate panel shows the participant as a Minecraft character—she has depicted herself as a blocky, pixellated figure symbolic of many hours playing the game at home. The colonnaded building is symbolic of officialdom and civic power. The second panel of Figure 14 shows the author pulling down a

curtain, symbolising carrying out a web search and opening the way for an inundation of search results.

4.8 Discussion: Design characteristics

The data from this case study show that the design characteristics of the comic book format are, firstly, that it affords both naturalistic and abstract representation. Secondly, paper and pens allow for a high degree of personalisation. Finally, non-digital materials are accessible and inviting. In terms of the effects these material characteristics have on how digital systems are represented, the data show that experiences as common and specific as searching the web are too abstract to show in isomorphic form, and too detailed to show in symbolic form. Participants below describe a typical web experience:

“This is an intentionally messy stream of consciousness that gets more blurry towards the end”

L.

J explains a way of working online that leads to unfocused and fragmented activity:

“I generally have multiple browsers open and lots of tabs open in all of them... I often open things, don't pay much attention to them and intend to go back to them”

J.

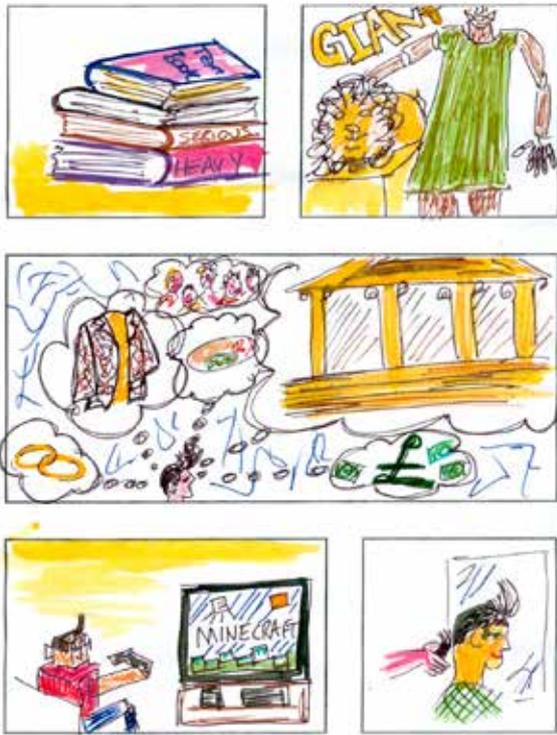


Figure 11. Central panel marriage thoughts

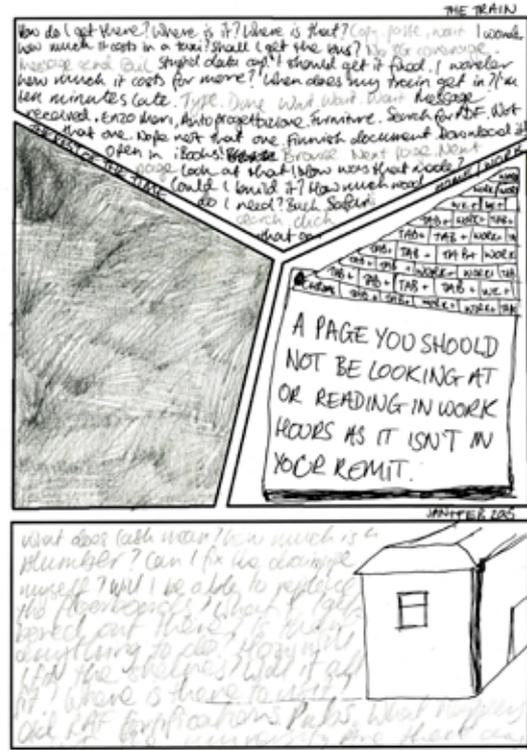


Figure 12. Centre left panel, fog



Figure 13. Top Panel, blocking out colours



Figure 14. Central panel web search results

These impressions connect to Forlizzi and Ford's (2000) emphasis on mental models and the importance of flow in experiences of digital systems. Experiences of digital systems not guided by an understanding of flow may be described as unstructured or abstract.

An abstract experience in this context is one which does not progress towards any specific conclusion. Using the web can be an experience that lasts a minute or an entire afternoon; it also combines clearly defined activities, such as online shopping, or checking email, with less defined aims such as reading the news or participating in social media. An isomorphic representation of such a diffuse experience itself needs to be diffuse, such as the 'fog' shown in Figure 12. L describes the difficulty of depicting a day's browsing in visual form:

"If I was actually going to do one (a drawing) like last Friday's browsing history... then it wouldn't even fit on (the page) because there are so many ideas all the time and there are so many things I'm looking for all the time"

L.

Symbolic representations such as the pile of books shown in the top left panel of Figure 11 can only be symbolic approximations of the experience of online reading or academic study. Browsing experiences are too de-materialised to show in isomorphic representations. Externalising models should therefore prioritise

schematic or symbolic representation. For example, through schematic responses, digital systems can be expressed as fleeting, fragmented, or disembodied. With reference to Figures 12 and 13, the characteristics of experiences depicted by participants include descriptions of confusion, loss of time, frustration, lack of focus, and out-of-body feelings:

"I can look back and see exactly when I started using Ebay or Facebook or whatever it was that see time as a vacuum and be like 'wow that was an hour ago'... 'oh my gosh terrible'"

F.

"you can just kind of switch off a bit... you almost feel like your breathing has stopped"

F.

Representations that capture these characteristics therefore do not take the precise shape of a real world object, unless it is used symbolically or schematically to stand for a different mode of experience, such as an emotion. This is what Anderson (2000) calls a meaning based representation, i.e. one that deletes perceptual details but retains the relationship between elements. Symbolic representation is most useful when participants draw an aspect of web browsing using the attributes of an identifiable object, such as the duck in the lower left panel of Figure 14. The implications are that the material characteristics of externalising models influence how people assign symbolic attributes to various objects.

4.8.1 **Visual modelling**

The activity of illustrating the browser history list in comic-style drawings allows for a wide variety of individual experiences to be externalised. This is because empty boxes printed on a paper sheet do not specify any single particular outcome:

“I thought perhaps there was an openness to interpreting it in any way as to how you might represent those things”

J.

For example, the variety of participant responses includes the naturalistic drawing of Figure 15, the schematic representation in the central panel of Figure 16, and the symbolic drawings of Figures 17 and 18. There is also considerable variety of representation shown from one panel to the next within individual drawings. For example, the first panel of Figure 15 shows only the face of a digital clock, while the second is a detailed representation of someone sitting in front of a computer screen.

One of the effects of the material characteristics of externalising models is thus what degree of abstraction they afford; the associated design characteristics include what level of abstraction in participant representations the model is designed to externalise. For example, using the web was described by J below as involving a non linear way of thinking:

“Browser history doesn’t reflect a single linearity through any particular way of thinking. What it does reflect is... the different parts of my life... which is why I’ve broken out of the boxes and put arrows connecting different parts”

J.

(Figure 17)

The wider findings from this case study relate to the effects of the model on how experiences of digital systems are represented. These can be summarised as re-differentiating, distancing, unflattening, and abstracting.

Using the web can result in an impression of ‘fog’, ‘zoning out’, and comments such as “oh my god, what have I done with my time?” Many participants reported this experience. There is very little differentiation between web experiences in terms of navigation or visual recognition, i.e. most social media sites look and work in similar ways, online clothes stores look familiar and it may be hard in retrospect to tell one from another. There is also little differentiation between sites, pages, and platforms. Davis (2001), Thatcher et al (2008), and Dutton and Blank (2015), all report similar effects relating to procrastination, loss of time, and overuse of the internet.

One main way the comic form works is by unflattening the experience of using the web. Unflattening means using an externalising model to give dimension to an otherwise flattened experience. Flattening

describes the way web browsers reduce very different experiences such as shopping, learning and scheduling to one automatically generated text-based list, with no regard for how they involve motivations, actions and consequences. The richness of human experience and any sense of the context in which individual experiences are formed is lost in the process. More generally, unflattening refers to the process of giving emotional qualities to digital systems. One example is L's comment about using capitals to express anger:

"The capitals is something to do with the fact... I'm angry with myself for doing so much (online) work at the moment"

L.

Re-differentiating websites from one another is one aspect of unflattening the experience. Although the browser history list does this with chronological precision, that linear compilation of visited sites does not seem to accurately represent the subjective experience of visiting those pages. Whether an accidental site visit of ten seconds' duration, or a deep dive into a particular topic, the browser history list has no way of differentiating experiences. The fog of lost time is expressed in succinct graphical form. The comic book form thus utilises a set of narrative conventions that are useful to participants in constructing a representation of their web use that reveals more than the browser history list is able to.

Distancing refers to the way externalising models allow participants to reflect on their browsing experiences by representing them in a separate medium. The effect is to foster a new perspective on web use:

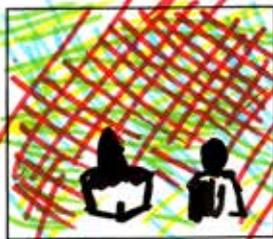
“it was very good to reflect on everything we’ve been experiencing”
M.

“I don’t really, sort of, think about it - but I might now I think”
J.

Participants saw the value of externalising browser experiences in visual form as a way to gain new knowledge about their own online habits. Interviews reveal the value of reducing a series of site visits or searches to a single image:

“all these different elements combine to create a typical web experience so it’s interesting to see how people pick apart the different things they view or see or experience”
M.

This finding scales to the three different levels of detail visible in the drawings. Firstly, at the scale of a single image within a panel, such as the shape in the top panel of Figure 19, secondly a single panel, such as the top panel of Figure 20, and finally the predominantly abstract representation of Figure 21. This indicates the importance



More than one Octopus..

Figure 19. Top Panel, blocking out colours

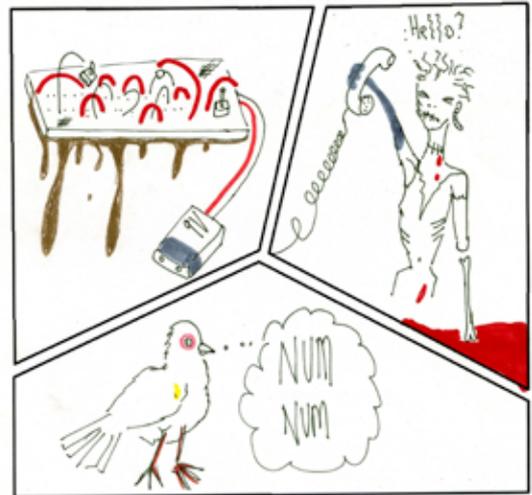
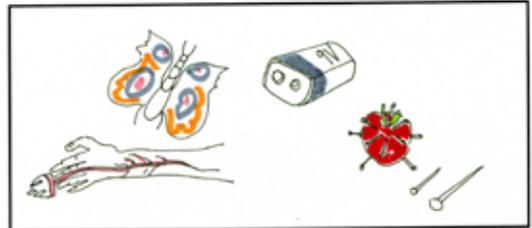


Figure 20. Four different websites

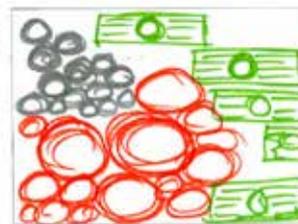
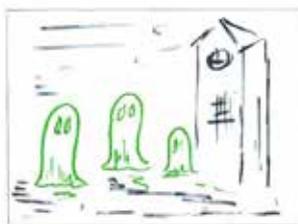


Figure 21. Abstract representations

of design characteristics that allow for abstraction, materials with which participants can easily create abstract representations, and activities supportive of abstraction, such as drawing.

Abstraction refers to the process of condensing a highly structured computational activity into a single impressionistic representation. As opposed to unflattening and re-differentiating, abstraction is a way of re-integrating experiences into coherent accounts of how time is spent, without having to be specific. Abstraction also allows for varied readings, something the browser history list is designed to avoid. In addition, abstraction is used in two ways: to join multiple browser experiences together, and to depict non-visual aspects of browser experiences, such as listening to music. The difference between abstraction, unflattening and distancing, is that abstraction is a result of distancing; they are both a result of moving away from the immediacy of experience. Unflattening, by contrast, implies a movement towards more detailed description.

4.9 Conclusion

This case study shows the use of a visual externalising model, addressing the research question: What design characteristics of visual and physical models externalise people's experiences of digital systems? The design characteristics of the model include accessibility, flexibility and customisability (as shown in Figure 22). These are shown to be important characteristics in the process of externalising experiences of using a web browser to visit multiple

websites. The analytical categories of isomorphic, schematic and symbolic representation are shown to be of limited use because they seem to all be present at once in most drawings.

The effects of these characteristics and limitations of the analytical categories is shown in the diversity of responses and in the way they allow for unflattening in the form of re-differentiation, for distancing in the form of modal transformation between text and image, and for abstraction in the form of individual visual signifiers. These are all effects of the material properties of the model. Drawing is an activity that supports the externalisation of representations of the experience of web browsing in multiple ways. Firstly, it allows for distancing and abstraction. Secondly, the processes and techniques of drawing are familiar to participants of all ages. Finally, drawing allows for a constrained range of expressions intimately connected to the design characteristics of the model, for example the number and arrangement of boxes on a page. These findings open possibilities for further exploration of the material and design characteristics of externalising models, for example into three dimensional materials and more abstract representations. The next chapter therefore reports on the results of a workshop featuring a physical externalising model.

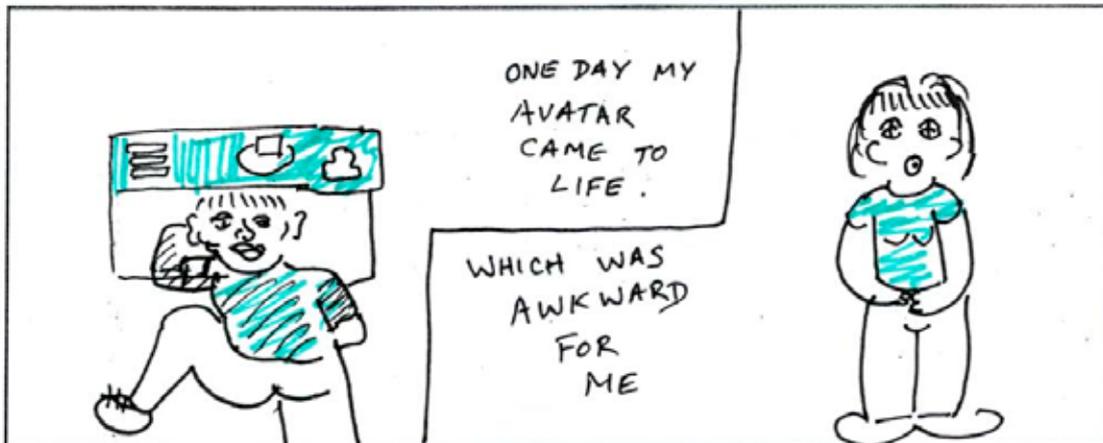


Figure 22. Customised panels

Chapter 5: Social Network Models

Introduction

Following the browser history comics of the first case study, I turn to digital social networking. Where the browser history list automatically creates a record of web pages visited, it does not discriminate between them. It captures all web-based experiences, not experiences of any particular digital systems. Moving on from the two-dimensional representation of comic drawings, this case study uses physical modelling to address the research questions: What effects do the material properties of externalising models have on how experiences of digital systems are represented? and What design characteristics of visual and physical models externalise people's experiences of digital systems? I position this case study as an exploration into materials and how they can be configured to design externalising models of experiences of digital social networking.

Digital systems can appear fixed and unchanging. For example, there is no immediate or easy way to adjust personal relationship settings on Facebook. This case study explores the design and use of a physical, non-digital model to represent personal social networks. Connections are made physically by stretching rubber bands between coloured pins. The emphasis is on how people choose to represent their social networks, what they choose to show, and how the process contributes to uncovering an otherwise invisible set of relationships.

6. The Guardian Digital Agency was sold to Kantar in July 2014 and thus no longer exists in the same form as when this case study was conducted in April 2014.

This case study builds on the categories of analysis established in the first case study. It is the result of a multi-partner collaborative design project that emerged from a CX event held at the RCA in April 2014. The main partner organisation is Design for Social Change, a social enterprise. The other partner is the Guardian Digital Agency⁶, an in-house design business of the Guardian newspaper. The workshops described in this chapter took place in Elephant and Castle, London and Hamburg, Germany. First, I discuss previous work related to the representation of social networks, then describe the methods used, including details of the models I designed. Next I define the sample, setting, and procedure of the case study and present my interpretation of the resulting data, using categories of analysis developed from the first case study. Finally, I discuss the findings from the case study and relate them to the research questions.

5.1 Research questions

In the first case study, the questions are addressed using comic drawing. Findings are limited to categories of visual representation and the types of externalisation they elicit. The primary research question: What design characteristics of visual and physical models externalise people's experiences of digital systems? is here addressed using physical modelling, observation and stimulated recall semi-structured interviews. One important distinction here is between social networks in general and digital social networks. I manage this by emphasising to participants that the activity

involves modelling their digital social networks, but observe that the distinction is often elided by participants.

The secondary research questions: What effects do the material properties of externalising models have on how experiences of digital systems are represented? and: What types of activities externalise representations of experiences of digital systems? are addressed through exploring other, more physical materials than drawing on paper, and through an activity involving modelling with physical materials.

5.2 **Knowledge exchange**

This case study is a collaboration between three partner organisations. Design for Social Change (D4SC) is a London based social enterprise operating at community level to implement strategies of urban engagement and social change in areas of rapid gentrification and transformation. D4SC hosts events, connects globally with similar organisations, and provides a platform for street-level actions. The Guardian Digital Agency is an in house design team at The Guardian newspaper, a UK national daily. They provide data visualisation design services to commercial clients. The third project partner is Dr Kevin Walker from my host institution the Royal College of Art. He provides a research framework for the collaboration and guides the research element of the project. Guidance focuses on how to structure the workshop events so that the outcomes are analysable, and the importance of ethical

research procedures when working with members of the public.

D4SC proposed a week-long residency in a publicly accessible space, during which a series of community-facing events focus on data literacy, data localism, and expressions of local interest in the changing area of Elephant and Castle in South London. The reasons for this collaboration and the resulting knowledge exchange are to bring together expertise from various domains in a public-facing context. D4SC's experience in organising and running events at a small scale (max 30 participants), and their ability to motivate participation in a creative workshop is a source of strength that connects with the CX aims of outward-facing research. The Guardian Digital Agency are interested in bringing their skills to a different context, i.e. a non-commercial one, and contributing to the wider aims of the project.

The second reason for the collaboration is to counter the assumptions of the 'smart city' agenda⁷. Greenfield (2013) argues that the many global smart city initiatives, from Brazil to Portugal, are predominantly designed to serve the corporate interests of technology providers, with citizens often conceived as unwitting data sources. My social network models are therefore intended to reveal to people how they are connected to each other, and highlight the intangible benefits of social connection. The topic of data politics in this case study is energised by discussion about how much data the knowledge providers of digital social networking systems gather and analyse about their users.

7. Vanolo (2013) argues that smart city policies disguise the moral nature of technologies by representing them as inescapably good. He shows how the current discussion around connected cities 'relegates social importance to the invisible periphery of a technological discourse' (Vanolo, 2013:14).



Figure 23. Relational map, Bagnoli, 2009.



Figure 24. Social network map, Roseneil, 2006.

The final reason is to increase data literacy. The Guardian Digital Agency delivered a talk and workshop on the capture, design and visualisation of urban data, intended to increase citizens' data literacy and thereby democratise access to smart city technologies. My own involvement was in the construction of the space in collaboration with D4SC and the organisation of two days of physical social network modelling.

5.3 Previous work

Representations of social connections are used in psychology, for example by Bagnoli (2009: 555) who uses 'relational maps' (Figure 23) with the aim of developing creative ways of discovering how young people show their networks. She follows Prosser and Loxley (2008) in providing a 'basic scaffolding' (2008: 556) for participants, allowing them to construct their own representations. Roseneil (2006) uses similar diagrams (Figure 24) to help people arrange their social relationships in expanding concentric circles, with distance from the centre indicating degree of closeness. This was done during the research interview process.

In another psychological study, Josselson (1996: Figure 25) elicited network diagrams from her participants. These maps use a representation based on the solar system. Participants were asked to place themselves at the centre of their relational system and indicate 'planets' as social connections placed around them. The focus of the study is the qualitative nature of connections rather



Figure 25. Network map, Josselson, 1996.



Figure 26. Social network map, Batada and Chandra, 2006

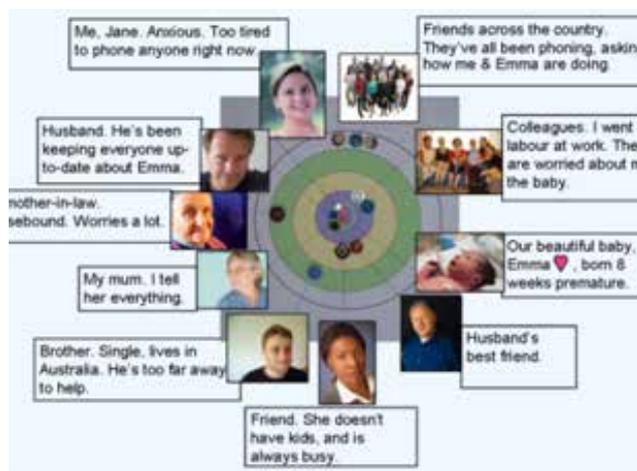


Figure 27. Support networks, Moncur, 2008

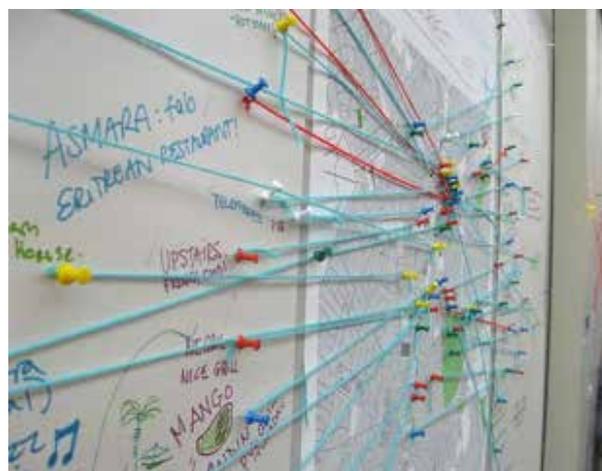


Figure 28. Knowledge distribution model. Photo: Mooney, 2010.

than the shape of the network or the materials used.

In a study of stress in teenagers in Baltimore, USA, Batada and Chandra (2006: Figure 26) used hand-drawn maps of personal relationships alongside a questionnaire, audio journals and a pile-sorting activity. Moncur (2008: Figure 27) used a physical network mapping technique to capture information about how new parents represent their support networks. Her method used a board pre-printed with concentric circles, on which participants placed buttons and sequins. The researcher gave instructions to place the 'baby' button at the centre of the network and further buttons to represent the new parent, partners, friends, family and colleagues.

Figure 28 shows a string and pin model of a knowledge network. This was used in a public exercise to elicit points of interest from local residents in Brixton, London. It performs a representational function that externalises distributed group understandings. In 2008 the visual analytics research group at Aviz in Saclay, France ran a science fair workshop using magnets and rubber bands to model the fictional social relationships in the Harry Potter novels (Figure 29). The 3D printed social network models created by Hemsley (2013, retrieved 08/08/2017), shown in Figure 30, are intended to provide an alternative way of observing social networks to that afforded by on-screen representations. They are intended to augment analysis of social networks, as well as provide an individualised representation to users.

Models that use pins and rubber bands have been used to teach mathematics (Coleman, 1978) and more recently to show group thought patterns (Figure 31, Domestic Data Streamers, 2014). These studies are relevant to my research because they provide a rationale for the representation of social networks in physical and visual form, but do not specifically address experiences of digital social networking.

There are many systems designed to produce personalised digital social network diagrams. For example, LinkedIn's InMaps shown in Figure 32 is a typically dense and complex personal digital network representation. These are difficult to navigate and their legibility is limited; they prioritise the number of connections over the nature or characteristics of the relationships.

Although many of the examples of network modelling and data representation shown here work as externalising models, and some from therapeutic situations involve a personal account of their making, they do not focus on experiences of digital systems. They are intended as guides or supports to a wider process such as talking about relationships, but do not concentrate on specific use of materials or the effects of those materials on the process of externalisation. There is therefore a gap in the literature and practice of visual and tangible social network modelling, where analysis of the characteristics of visual and physical models intended to

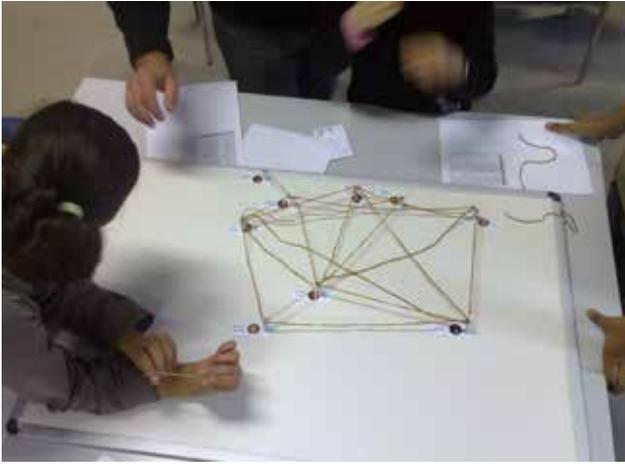


Figure 29. Aviz wokshop, fête de la science, 2008.



Figure 30. 3D printed social network, Hemsley, 2013.



Figure 31. Domestic Data Streamers, 2014.

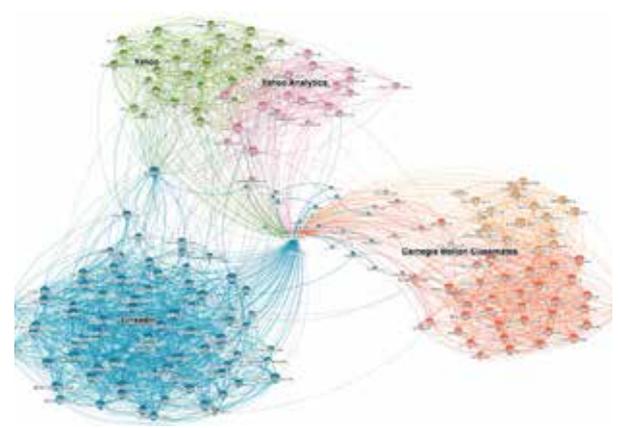


Figure 32. Diagram of LinkedIn connections

externalise experiences of digital social networks receives analytical scrutiny from the perspective of design.

5.4 **Workshop: Setting**

The research workshop was carried out over two days in a ground floor business unit in South London. The unit had three large shop-front windows to the street, making all the activity inside visible to passers-by. As the workshop progressed over two days, the space was populated with examples of completed network tiles. This provided some inspiration to participants about what the outcomes could be, and also worked as a visual tally of the number of respondents. The contrast with the first case study, which was conducted in a popular public building housing an art gallery and cinema in central Liverpool, was that this case study took place in an improvised creative space, furnished only for the week of the workshop. Participants were thus confronted with an unfamiliar situation offering a range of activities over a single week, of which social network modelling was just one. The space faced a busy London street with regular pedestrian footfall. The design of the facade, a former shop-front with large glass windows, meant passers-by could easily see in. These factors influenced the sample, which was drawn from passers-by and from pre-arranged groups.

5.4.1 **Sample**

The participants in this study were drawn from two categories: invited and passing. I invited a group of 20 undergraduate design students from the nearby London College of Communication (LCC), along with their teachers. The reason for inviting this group was to populate the space and guarantee a minimum amount of data to analyse. The limitations of this sample was that the student group was not representative of the local population, as only five of them lived locally and many were living in London for the first time. The students had a high degree of ethnic diversity, with participants from eight countries including Greece, India, South Korea, and China. They were all between 18 and 25 years old, and included 13 women and 7 men. This group were all resident in London for the duration of their studies, but only four were from London and none from Elephant and Castle.

The second category of participants were passers-by. By asking them what drew them to participate, I discovered that they included members of local community groups, local activists, and local residents. People visiting a local health centre, tourists, and others visiting London temporarily also participated. This second sample was thus more representative of the local population than the student group. The gender balance was 15 female to 12 male. These participants were also older, between 30 and 65 years, 5 from the local area and 22 from elsewhere. Ethnic diversity was considerable, with participants from Turkey, Somalia, Italy, and Nigeria.

The workshop was staged again in Hamburg, Germany on a street in the Sternschanze neighbourhood, a similar urban environment to the London location of Elephant and Castle. Apart from an invited group of six local activists, participants were all passing pedestrians. I carried out the research in English and German, and all communication materials and consent forms were presented in both languages. This was a convenience sample, as it was limited to those people and organisations to which I had immediate access. Convenience sampling is justified in situations where it may be difficult or impractical to gather a random sample (Gray, 2014), such as a two day visit to a foreign city, or a short duration workshop in a public place. The research sample in Hamburg consisted of 28 people, aged between 25 and 65. Of the 28 participants, 15 were male and 13 female. All but two were resident in the local area.

In both Hamburg and Elephant and Castle, there were problems associated with convenience sampling, including its lack of representativeness. Because my research concentrates on the design of externalising models rather than statistical generalisability, this lack of representativeness does not compromise the applicability of case study findings. Erickson (2012) and Maxwell (2013) support this aspect of qualitative research. They explain how an emphasis on the uniqueness of local situations and the particular qualities under investigation limit the possibilities for generalisation to the wider population, but do not necessarily prevent the application of findings to subsequent and related case studies.

5.4.2 **Methods**

Qualitative methods were used, including interviews and observation. I chose to model digital social networks using physical materials as a development of the two-dimensional drawing method used in the first case study, and as a way of finding out about possible characteristics to inform the design of externalising models beyond graphical representation. The main method used in this case study was semi-structured, stimulated recall interviews, as described previously. I started each interview with the questions: How do you think this task would have been different if I had asked you to simply write out a list of your digital social connections? and: How have you decided where to place all the connections? These interviews were recorded using portable audio recording devices including a smartphone and MP3 player.

The model I designed for this case study consists of a square cork tile painted white, into which coloured pins, standing for people, are stuck. These pins are then connected with rubber bands of corresponding colour to form a network of joined points.

5.4.3 **Procedure**

I explained the intentions and background of the research to the participants, describing the materials, the work space, and the task. Participants could choose where to sit and no specific duration was given for the task. I provided a printed information sheet about the aims of the research, and participants were invited to sign a consent form before starting the task.



Figure 33. London workshop.



Figure 34. London workshop set up with students



Figure 35. Hamburg set up



Figure 36. Completed tiles

There were no specific instructions about who should or could be shown in the model, nor about how many, or how few connections it was necessary to show. Printed A3 sheets were provided which featured a legend (shown in Appendix 7) with colours matched to categories, for participants to refer to while doing the task. These categories corresponded to types of relationship: partner, friend, colleague and other. Participants were limited to one tile only, and to the specific materials and colours described.

Participants were handed a white painted cork tile, given a copy of the printed legend, and shown the piles of pins and rubber bands. The instruction was brief—to place a white pin for yourself, then extra pins for the people in your digital social network. The next step was to connect the pins with correspondingly coloured rubber bands, and then annotate the represented individuals with text. Interviews were later transcribed and annotated, paying particular attention to the role of materials in the process of externalisation. When the white tile models were complete, the participants were invited to display them along the walls of the room.

5.4.4 **Results**

During the two workshops that constitute this case study, 40 tiles were completed by 55 participants. Fifteen participants wished to talk about their experiences of digital social networks but were too busy or unwilling to complete the modelling task. The tiles were created using the same materials in each case, and were accompanied by 17 semi-structured stimulated recall interviews,

captured in audio recordings. The remaining participants either did not wish to be interviewed, or I was unable to conduct the interviews due to pressure of time and resources.

5.4.5 Analysis

When analysing the data from this case study, I first looked for connections between observations about the physical models themselves in participant interviews, and then synthesised the resulting data into a set of findings. I looked for common themes and comments that referred to the qualities of the model or activity, and related these spoken comments to the physical objects and their configuration. The interview analysis connects directly to the research questions by concentrating on the material properties of the model. The process of analysis thus involved comparing what people said with what they did, and developing a set of findings by integrating the two responses. The research questions are addressed through the effects of re-differentiation, distancing, unflattening, and abstraction shown in the models.

5.5 Discussion

Unflattening: dimensioning digital experience

The nuances of human social experience—degrees of friendship, inclusion in circles of work or family connections, and the different roles people embody in a network of social relations—are flattened by digital social networks to ‘friend’ or ‘contact’ or similar terms. Physical externalising models allow for unflattening. This term refers to the process of re-dimensioning the experience of digital social

networking and re-introducing the enriching complexities of lived experience. Unflattening is a metaphorical idea, but in this case study there is also a literal element to the term, since pushing pins into a surface and linking them with rubber bands is not an activity confined to a flat page or computer screen. The use of a physical externalising model thus affords adding subtlety to an otherwise flattened digital experience. Figure 37 is described by B below:

“Here I’ve got a group of students who have become friends, but they worked for me... so I also have a kind of working relationship with them and they’ve also worked in other studios of other friends of mine so they kind of connect to several groups”

B.

Unflattening also involves distinguishing between individuals and using materials to indicate degrees of connection. G comments on how friendship contexts are important aspects of unflattening relationships. Finally, A comments on the differences between physical and visual representation. Literal unflattening ‘feels good’ and is ‘much nicer than drawing with a pen’:

“So these three pins, they stay for people I’m connected with via business, but they are also friends so I will try to use two of them”

G.

(Figure 38)

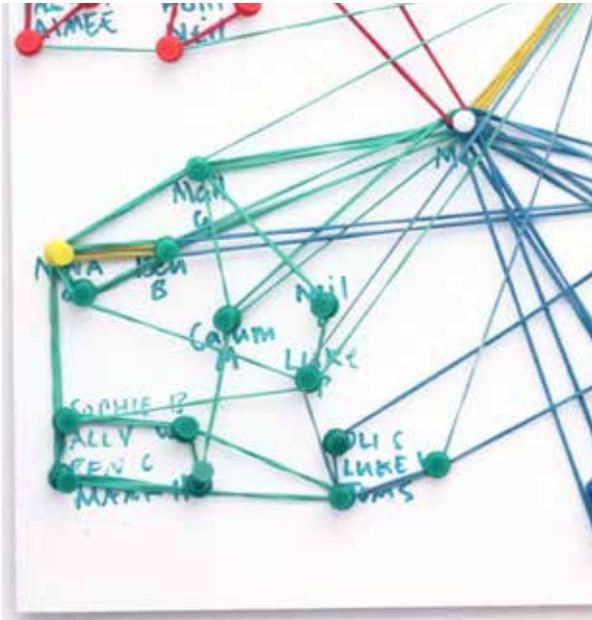


Figure 37. Connecting to several groups

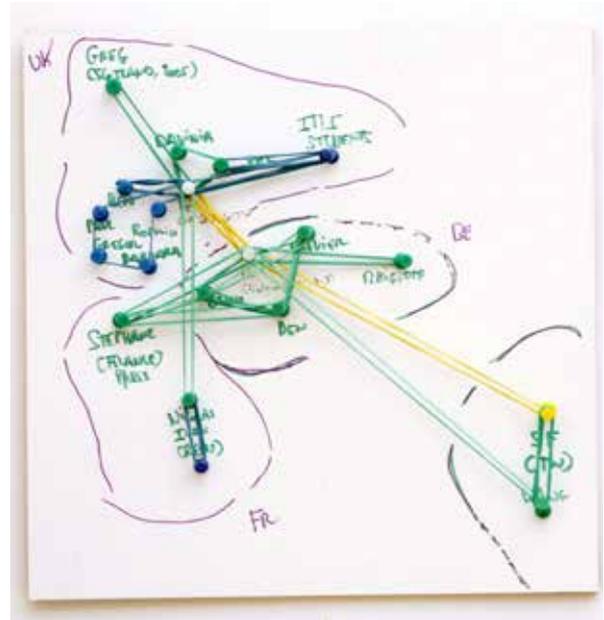


Figure 38. Connection via business.

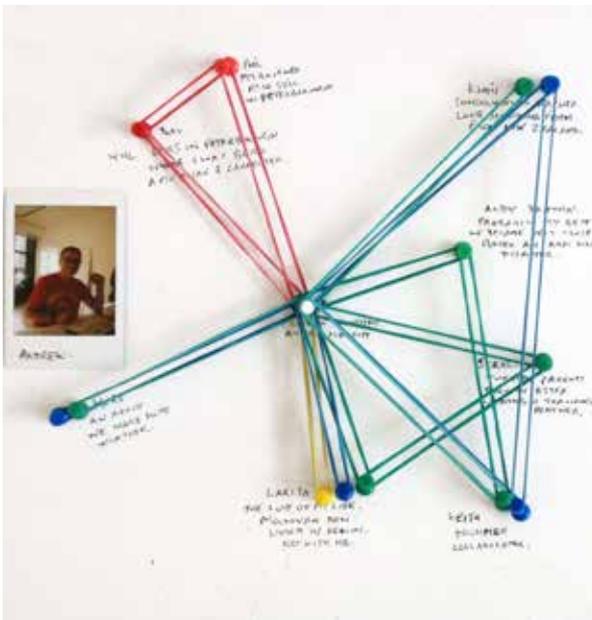


Figure 39. It feels good to link them up

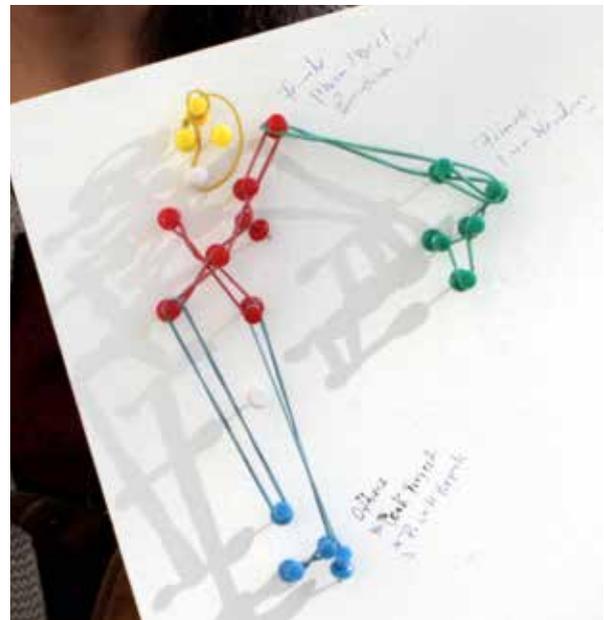


Figure 40. Three 'partner' pins.

“It’s tactile with the rubber bands and that. It’s much nicer (than drawing with a pen)... yeah, and it feels good to link them up”

A. (Figure 39)

I use the term unflattening, which emerged from the previous case study, as a way of describing one of the effects of the material properties of externalising models and how they externalise people’s experiences of digital systems. Unflattening in this case study means adding context to relationships and defining them more precisely than digital social networking systems allow. One important way physical externalising models allow for unflattening is by encouraging re-differentiation of identity.

5.5.1 **Redifferentiating identity**

Most digital social networking systems do not allow the user to assume multiple identities from the same account or operate multiple accounts from the same log in details. Facebook, Twitter, Instagram, and LinkedIn all enforce this limitation. The various roles assumed by participants in their social networks are therefore flattened to a single name, profile picture, and description. This is often an overly simplistic representation of social relationships as S demonstrates:

“Can I have two personalities and be in two places at the same time? I think I’m somewhere between family-and-partner and family-and-my-project”

J.

As explained in the previous case study, re-differentiating is a neologism I use to describe the way externalising models work to help distinguish experiences of digital systems from each other. Participants in this case study expressed surprise at the degree of connectivity present in their networks and in what the models revealed about embodying multiple identities. The constraints of materials may, however, have created the impression that only a single identity was possible. The models show how participants added additional pins and connecting bands to signify different identities rather than, say, annotating a single pin. So the materials may have been constraining, but also allowed the participants to adapt them to personal uses, an example of Onarheim and Wiltchnig's (2010) dual capacity mentioned in Chapter 2 (P. 30). Other people in the network were also sometimes assigned multiple identities:

"I would like to make my point clear that I do not have three partners. I try to say that there are three of these pins because he (my husband) is having different functions, and therefore there are different pins there, even though it's just one person"

J.

Figure 40 shows the tile mentioned above with three yellow pins representing 'partner'.

Another way of re-differentiating the nature of relationships in a network model is to assign multiple identities to the same person. Figure 41 shows how the participant used yellow, green, and blue (indicating partner, friend, and other respectively) pins to describe the same person in their network:

“She was a partner... at one point, so she’s got the yellow... (pin) and then... she’s something else which I can’t define, and she’s a friend as well”

A.

Re-differentiating involved categorising the intensity of particular relationships and deciding who should be represented by what colour of pin:

“I wasn’t sure who to put because it’s quite hard to differentiate between friends and people that you kind of put in an ‘other’ box”

S.

“Even on Facebook I feel really bad because... I feel like I don’t have 400 friends. I have maybe 20 friends and 400 people who should be in the ‘other’ box”

S.

Figure 42, described by S above, shows how people are distributed across an individual’s network tile. Figure 43 shows differentiation

between degrees of friendship and casual acquaintance, distinctions flattened by digital social networking systems.

5.5.2 Distancing

Models can reveal how people interpret their experiences of digital systems by providing the means for distancing. This allowed participants to pull back from the enveloping nature of digital systems and reflect on their feelings, impressions and interpretations of them. Distancing was seen when participants had finished the network modelling task and were asked to describe how they had configured their social network model. Distance here refers to what the view of a whole network affords that a single connection or social media conversation does not. For example, although 'Jason' is not connected to everyone on the tile shown in Figure 44, R expresses surprise when reflecting on her network:

"Jason knows everyone actually, that's the interesting part... which, it's quite impressive now that I'm thinking about it - that he's connected to everyone, yeah everyone - wow!"

R.

These moments of surprise were provoked by the way the model afforded discovery. The number of pins placed depended on how participants interpreted the task, with some people showing multiple connections between sub groups (Figure 45) and others single-direction connections to themselves (Figure 44).

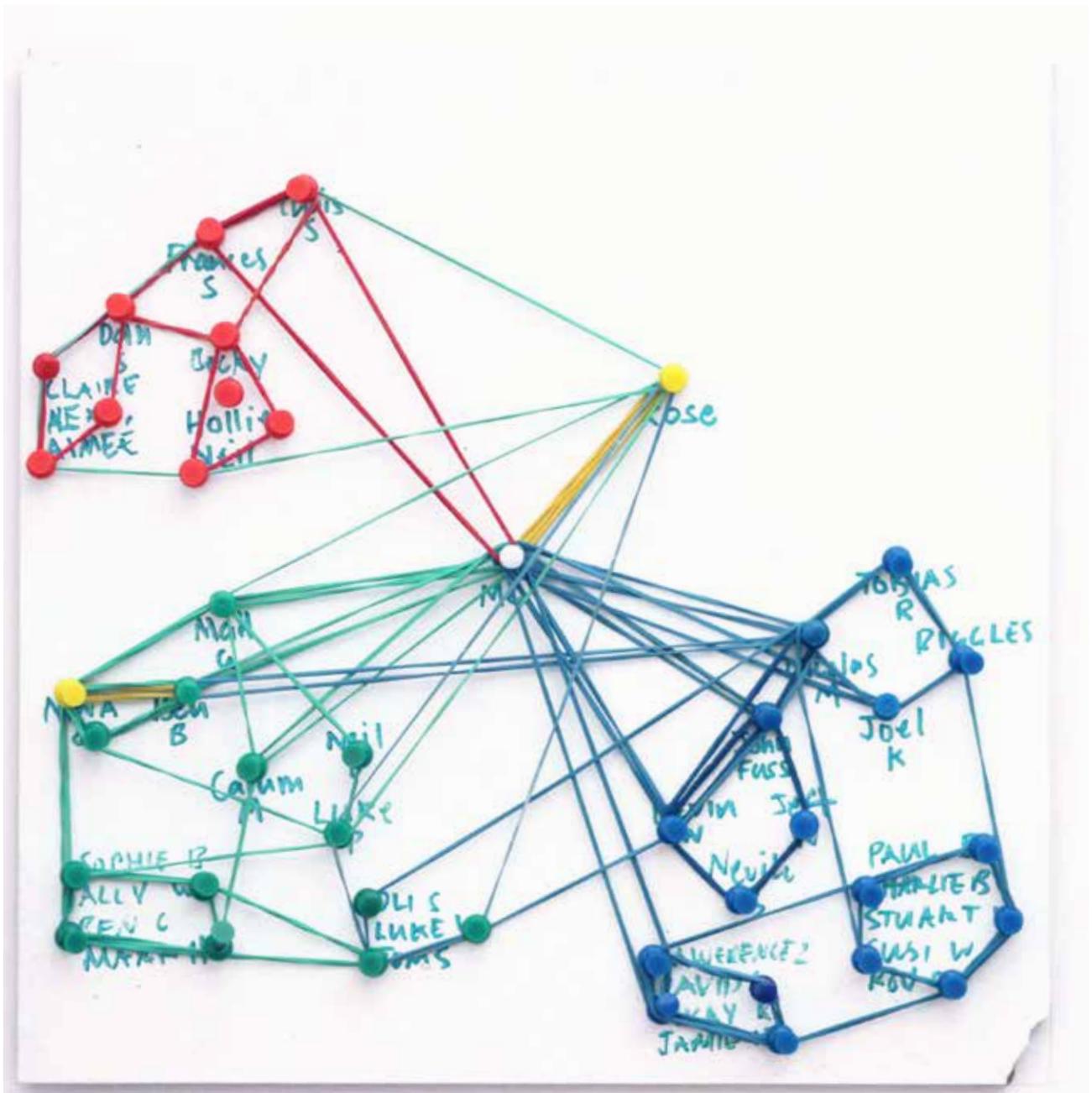


Figure 45. Who makes the cut and who doesn't?

The post-task interview contributed to the sense of distancing. Only when standing up from the table, creating literal distance and talking about what they had done, did the participants begin to 'read' the model they had created, and in some cases correct it:

"I put my mum there, then I felt a bit bad about putting her there because she's kind of far away and she's actually really close to me"
S.

This physical distance was created in two other ways. Firstly by placing the completed model on the wall, secondly by holding it up for the participant to look at from a distance. Since the tile was a restricted canvas, by distancing themselves from the immediacy and undifferentiated categorisation of 'friend' or 'contact', participants were able to create network models that more accurately reflected their social networks. This was enabled through the activity of placing and connecting pins, and having to make choices about categories. The physical constraints of the tile and other materials thus enabled distancing:

"I found myself er... kind of judging levels of friendship which was quite interesting. You make the cut, you don't make the cut"
B.

(Figure 45)

5.5.3 Abstracting

A social network is an intangible thing. It cannot easily be described, observed or represented. Making a physical model of a social network therefore suggests a degree of abstraction. The design characteristics of physical and visual models that externalise experiences of digital systems include the possibilities they present for abstraction. This connects to Dix and Gongora's (2011) category of schematic representation, but goes further by applying their thinking, which is confined to the studio design process, to non-designers in a semi-public context. The process of abstraction draws on spatial and geometrical metaphors of circles and proximity. Figure 46 is described here:

"We live in a very tight relationship so I was trying to mark the distance between my friends and people which I'm related to right now, and the intensity of the contacts"

A.

Abstraction was also seen when participants described their representations in more general terms:

"I went for a kind of geographical approach so I could see part of my life being here, part of my life being there, and the third part that's here"

G.

(Figure 47)

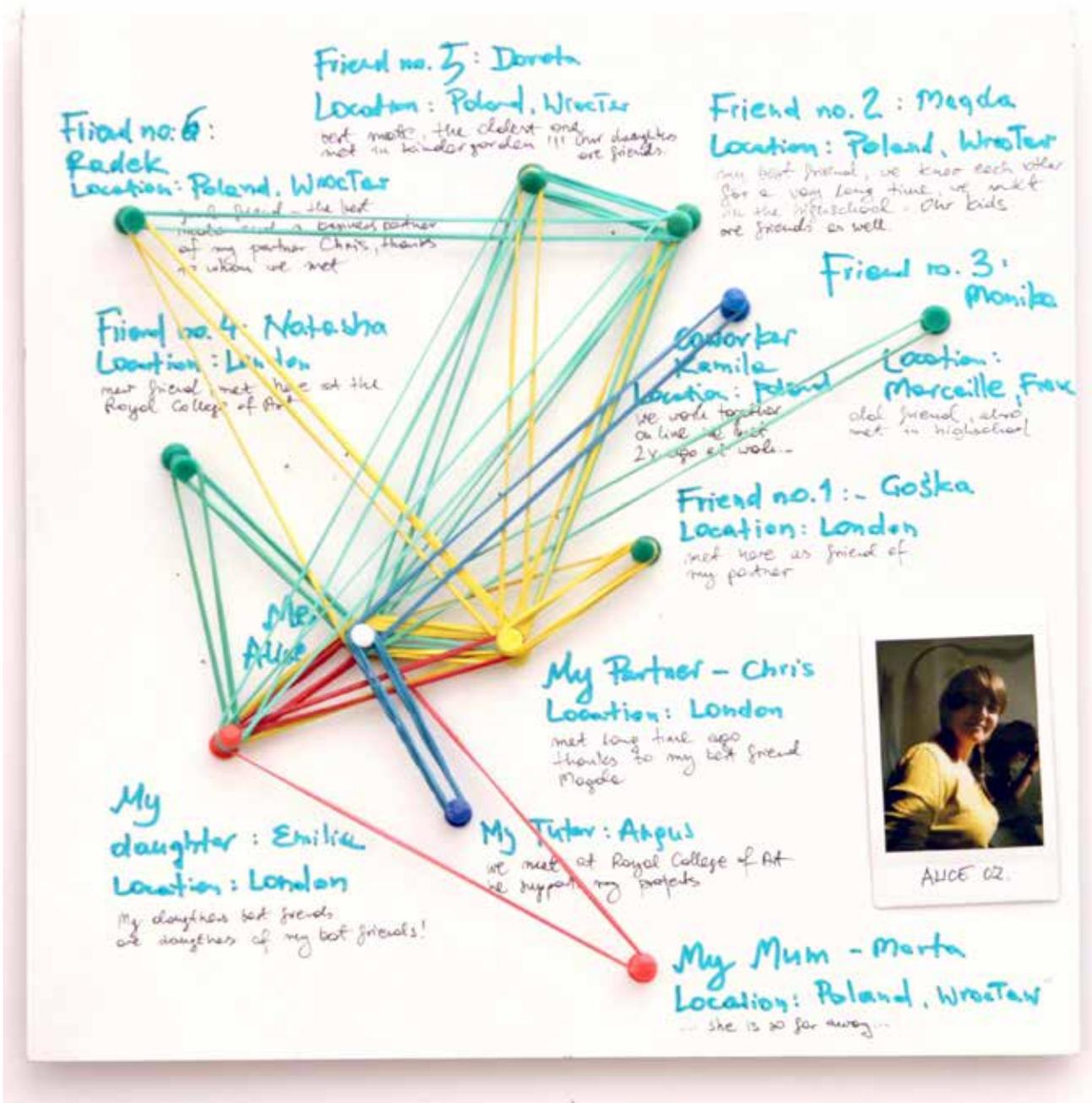


Figure 46. Spatial and geometrical metaphors

Abstraction is further shown by the way people in a participant's network were distributed spatially across the tile. The mapping of proximity to indicate friendship levels is visible in figure 48:

"So these three are, like, my inner circle so I've put my inner circle over there"

S.

In a more formal schematic representation, visible in Figure 49, the social network was shown as a clock face:

"I've put, let's say my best friends, and I've put these (other) ones further because they are most recent. So this is the most recent friend I made, and... my partner, which is on the top"

R.

Abstraction was seen to be an important effect of creating models that externalise experiences of digital systems. This chimes with Anderson's definition of meaning-based representation that moves from specific experiences to general categorisations of the properties of an experience (Anderson, 2000).

5.5.4 **Scale**

The network models worked at varying scales. This became apparent at different moments during the activity. Many networks contained sub-groups (See Figures 48 and 50) that were eventually

connected to each other. At the moment when participants were asked to describe their models, the entire network became visible both to the eye and to the mind. This sense of progression towards a personal telling of experiences is what activities and models that externalise experiences of digital systems should aim for:

“This guy, I played in a band with him about 15 years ago, something like that, and we had this arm wrestling competition, and my arm broke and er, bizarrely, and er... after that we became really really, best friends really. This guy, I met when I was living in Wimbledon and then we just trained together in the street, running and that”

A.

(Figure 51)

Digital social networks are designed to be delivered at large scales⁸. In order to provide a consistent service to so many people, they must feature a high degree of standardisation. The subtlety of personal relationships, and how they connect to each other is often lost in systems designed for order and regularity at such mass scales. Successful designs of models intended to externalise experiences of digital systems are thus ones that encourage diversity of expression and interpretation and allow for a scaling of materials and activities.

5.5.5 Discovery

Making digital social relationships physical, and constructing them personally, elicits discovery and surprise. The process of creating self-constructed representations also gives a sense of authorial

8. Instagram had 150 million active daily users in March 2017 (Statista.co), while Twitter had 319 million active monthly users in the April of 2017 (Statista.com).

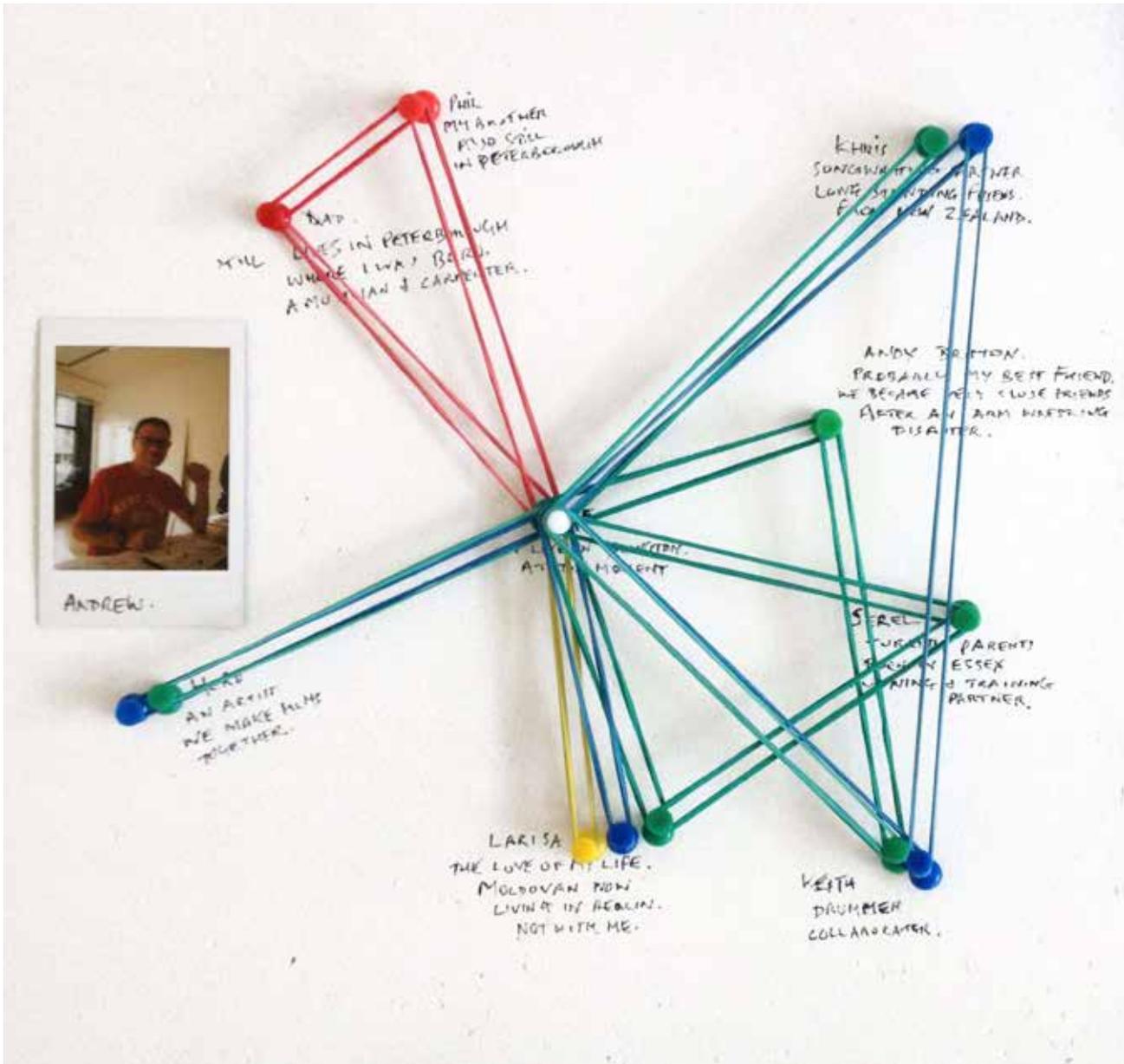


Figure 51. Telling personal stories

ownership and individuality, which is often flattened out by digital systems. This is an effect of the material properties of the model which constitute one aspect of its design characteristics:

“It was interesting to see who knows each other from the thing (the model), and then nobody from Peterborough knows anybody from here”

A.

(Figure 51)

“Oh! quite interesting what this says about my life, because my partner has, like, the smallest part here”

S.

(Figure 52)

One effect of these discoveries was that participants started to adjust their models in light of what was revealed. Five participants moved pins to a different location on the tile while discussing their models. Ten participants added or removed connections during interviews. This demonstrates how flexible models of digital social network experiences allow for adjustment and change. They are not fixed understandings, but subject to transformation.

5.5.6 **Creativity**

A further effect of the design properties of the activity was that the physical nature of the activity was found to be rewarding in various ways:

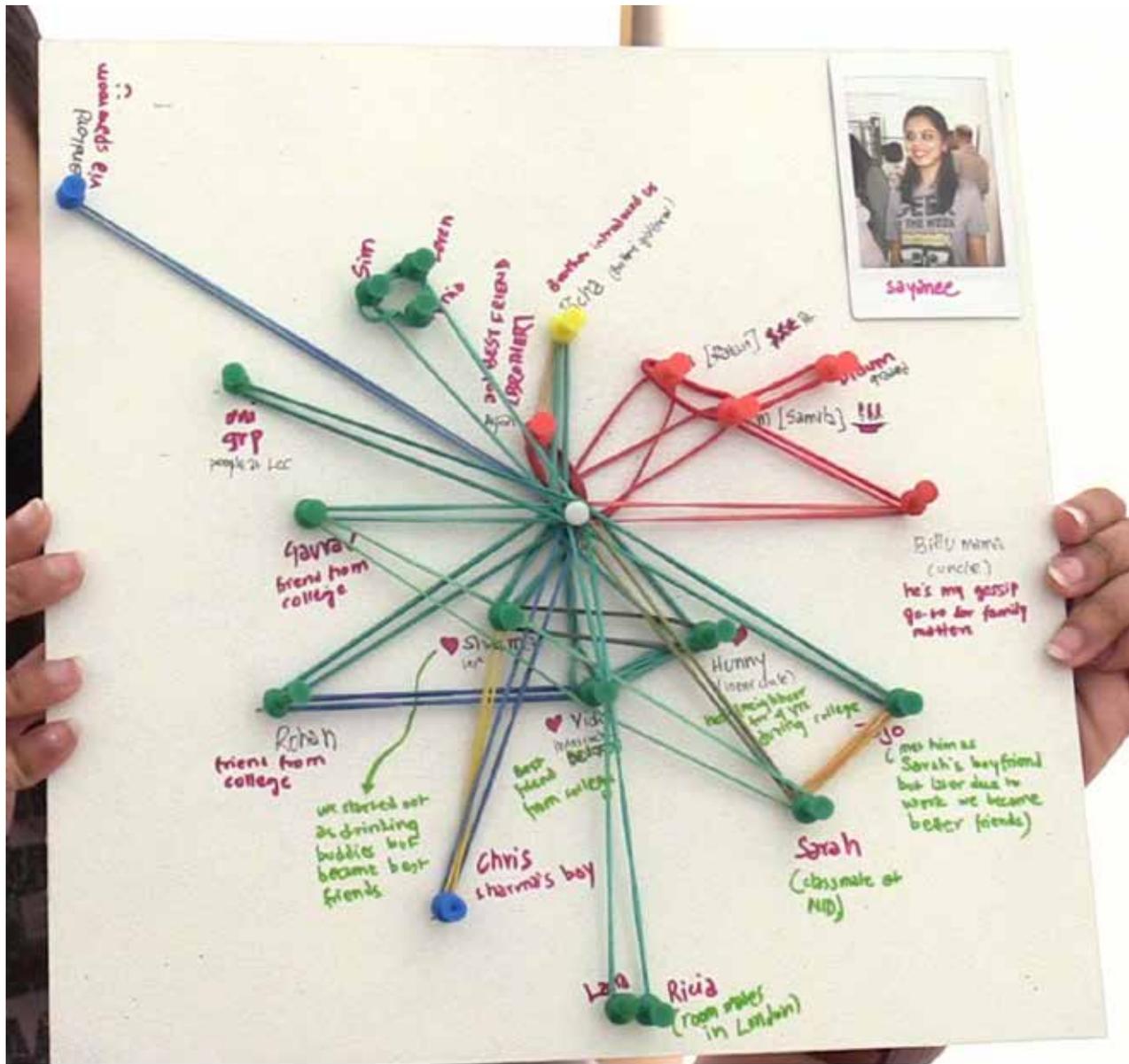


Figure 52. Discovering hidden relationships

"I think this idea, I like it. It gives a lot of flexibility, freedom of locating people and connecting the points"

M.

"This is playful and a lot of fun... there's this physical act that makes it playful and joyful"

S.

"This is really good because it makes it into a piece of art"

R.

These reactions reflect Hassenzahl's (2008) emphasis on the hedonic qualities of experience, with particular reference to design. Similarly, Marshall et al (2007) find tangible models to be useful when activities are exploratory or expressive. The design characteristics of physical models intended to externalise experiences of digital systems thus include flexibility, directness, and the possibility for individual expression. The effects of these characteristics on how experiences of social networks are represented include the possibilities for re-differentiation of identities, and realisation through distancing and abstraction. The implications for the design of externalising models points to ways of including these qualities in materials and activities. The view expressed by R above that the choice of materials, combined with the activity, makes the network model 'into a piece of art' is revealing because R seems to suggest the transformation is a property of the materials rather than an effect of his own efforts.

5.5.7 **Usability**

Designing externalising models that are modular, open to interpretation, immediately understandable and made of relatively familiar materials is a complex task. The ways materials combine should be constrained, but should offer sufficient variation so that they can be used in stimulating activities. For example, respondents said the limited materials palette allowed them to concentrate on their networks rather than having to work out how to use the materials. The materials should thus be separately unremarkable, but possible to combine in novel and surprising ways.

5.5.8 **Adaptation**

Turning to the types of activity that support the externalisation of experiences of digital systems, participants felt their ability to create individual representations was their main reward for doing the activity. Presenting the material elements of the model separately, i.e. placing a pile of pins, a blank tile and rubber bands on the table, left the position, density and extent of the network representation in the hands of participants. This is evident in the wide variation of responses.

5.6 **Analysis**

Developing my analytical approach from the previous case study, where the emphasis was on representation, in this case study I was more interested in the different modes the model offered for externalisation. Participants annotated their models by writing names and places and then spoke about what they had done in

interviews. These modes thus move from the physical—pins, rubber bands, cork tiles—to the written annotations and then spoken interviews. In my analysis I prioritise the stimulated recall interviews, since this is where the model and its annotations were described in most detail by participants.

The interviews revealed the transition between tacit and explicit thinking described by Dix and Gongora (2011). They define tacit thinking as thinking something without being aware of thinking it. By contrast, explicit thinking is 'consciously available, we know we are thinking it' (2011: 3). So creating models of a form of tacit thought (the extent and configuration of a personal social network) helps to transform it into explicit knowledge through the processes of distancing, abstraction, re-differentiation and unflattening. The interviews also demonstrate the disambiguation of mental images referred to by Cox (1999).

The method developed for this case study has subsequently been used by researchers in London (Tidey, 2015, pending publication), Lancaster, UK (Green, PhD thesis, 2016) and Genk, Belgium (Constantinescu, 2015). In Lancaster, the method was used to externalise distribution networks in a design task related to the movement of goods and services through a community. In London, participants were asked to model their personal social networks; the findings show how the process worked to identify influential people in a Twitter group. In Genk, where the physical modelling method was used to map business activity in the Winterslag neighbourhood, the

researchers noticed two main behaviours: firstly, their participants did not stick to the colour codes for network entities and invented their own; and secondly, the participants were reluctant to stick the pins in themselves because they felt the model was overly complex. The researchers thus created the network representations on behalf of participants. Since I did not experience either of these behaviours, there may have been differences in the way the activity was described or framed for the participants that account for them.

The instructions to participants in this case study were to use the materials available to create a physical model of their digital social networks. In the subsequent stimulated recall interviews participants mentioned social media channels such as Facebook and Twitter, (see Appendix 2, p. 277, 286) as hosting the relationships they had shown on their tile. In other interviews and models however the distinction between representations of digital social networks and social networks in general is less clear. This may be partly accounted for by the average age of the sample and also by the way digital social networks encode many diverse aspects of social relationships, such as work, leisure and family life. The network of social relationships shown in the models thus simultaneously depicts and transcends the experience of the digital systems where they are encountered. The research question; what design characteristics of visual and physical models externalise people's experiences of digital systems? is addressed here through the explicit reference to digital social networking in the instructions, through the placing of

pins and connections as discrete entities, and through the triggering of reflections about digital social networking evident in interviews. Therefore, this case study has direct applicability to how people specifically experience digital social networks, in relation to their broader (offline) social networks.

The question what effects do the material properties of externalising models have on how experiences of digital systems are represented? is addressed through participants being limited by material constraints to those digital social network relationships they deemed most significant, which could fit on the tile and be connected using the space and materials available.

Finally, one way of reconnecting the tiles to explicitly digital social networks is to use them as elicitation methods in order to inform the production of digital products. By recognising the effects, such as flattening, distancing, and abstracting, revealed in the models, user researchers may reach a richer description of human experience with which to develop new systems and interfaces.

5.7 Conclusion

In this chapter I report on a case study focused on models of digital social networks. Social network platforms impose a proprietary and inflexible structure on the experience of online socialising, and there are a limited set of interactions possible, such as 'follow', 'like' or 'add contact'. In addition, the data entered by users

belongs legally to the technology provider and is often sold to third party companies for targeted advertising. The activity and model developed for this case study, involving pins connected by rubber bands stuck into a cork tile, counteracts some of these controlling effects. The way it does this is by affording distancing from enveloping interactions, unflattening experiences, re-differentiation of identities, and abstracting away from specific to general experiences. Distancing is shown when participants gain an overview of all their connections and a sense of the extent and character of their digital social network. Unflattening is shown when models are used to represent the various qualities of social connection in a network. Re-differentiation is shown in the way participants assigned multiple identities to individual people, and abstraction in the diagrammatic and explicative arrangements of the various models.

The physical models give people a level of authorial control over the representation of their digital social networks, evident in the way they were changed during stimulated recall interviews. The diagrammatic nature of the modelling activity lends extra importance to participant interviews, because only in interviews did the detailed explanations of the models emerge. The interview data shows that people welcomed the opportunity to explain their representations of digital social networks by infusing them with the rich human detail of personal relationships.

The physical network models feature design characteristics including tangibility, adaptability, and individuality. These characteristics affect the way digital systems are represented in the following ways. They elicit a wide range of network arrangements, allow participants to tell their personal stories about how their networks grew, and let participants assign multiple roles to individuals.

I explain how the analytical categories relate to the design of externalising models and to the making of external models. As described in the introduction, I focus in this case study on the effects of material choices on the process of designing externalising models. I reflect on the collaboration and knowledge exchange embodied in this case study and describe some possible limitations. The next chapter describes a third case study which introduces the importance of metaphor creation into the process of making physical externalising models, and the implications for the design of activities that support the externalisation of representations of experiences of background digital systems.

Chapter 6: Background relations in digital systems

Introduction

This chapter describes the third and final case study of my research. There are some important differences between this and previous case studies. Firstly, this case study was conducted in a private office setting, as opposed to the public and semi-public spaces of case studies one and two respectively. Secondly, the purpose of this case study was to bring about a change in the working practices of the partner organisation and it involved participants working together and being interviewed in pairs and groups. Thirdly, the participants in this case study were encouraged to create their own models from materials provided. Finally, my purpose was to focus on how people experienced the background phenomena of digital systems. Background digital systems are defined as supporting digital phenomena such as algorithms, image metadata and cloud computing, upon which many digital systems depend.

6.1 Research questions

This case study addresses the primary research question: What design characteristics of visual and physical models externalise people's experiences of digital systems? by asking participants to design their own externalising models. By relinquishing some design responsibility to participants, the intention was to give meaningful agency to them over the creation of representations. The second research question: What effects do the material properties of

externalising models have on how digital systems are represented? is addressed through the selection of specific materials, organised into complementary groupings, made freely available to the participants. The third research question: What types of activities externalise representations of digital systems? is thrown into focus by the specific attention paid to the design of activities rather than the pre-design of physical or visual models.

6.2 Knowledge Exchange

This case study was conducted at the offices of Tactical Technology Collective (TTC), an NGO based in London and Berlin. TTC describe themselves as 'a non profit that explores the political and social role of technology in our lives' and working 'with an international network of partners to assist rights, accountability and transparency advocates and activists to use information and digital technologies effectively in their work' (tacticaltech.org, retrieved 19/04/17). In the context of this work, TTC trains people, including journalists and activists, to communicate securely and secure digital evidence of human rights violations. Much of the training involves TTC staff explaining complex digital systems such as algorithmic profiling or data encryption to their workshop participants.

For this case study, TTC had the aim of developing their existing workshop methods, which involved participants drawing and writing their understandings and experiences of digital systems. They wished to explore a specific range of digital phenomena including

9. Image metadata is the digital information captured when digital images are created that is not visible in the image but sits alongside the pixel information in the digital file. Image metadata exists in several formats, such as EXIF and IPTC-IIM, which are populated in machine readable fields and can describe various attributes of images such as, location, time, type of camera, exposure settings, and author.

10. Image metadata has emerged as an issue in human rights because activists who may be sharing unencrypted images online expose themselves not by the content of their images, but by the associated metadata, which may also be much easier to intercept.

image metadata, cloud computing, algorithms, and digital personal profiles. Their aims intersected with my research, particularly in the use of materials and range of activities. One challenge was framing the use of digital systems, such as image metadata⁹, in relation to experiences, since, for example, users of digital images can remain unaware of the metadata their images contain. I addressed this issue by considering the workshop topics as constituting 'background relations' (Verbeek, 2015) to digital systems and worthy of attention because of the way people experience them, for example image searching, or targeted advertising based on digital personal profiles.

The CX programme supported the development of this case study by providing an institutional framework sympathetic to the requirements of multi-partner collaborative research. This support took the form of funding, advice, supervision, and network building. The desire to test my methods and approach in an applied setting led me to contact TTC, for whom externalising experiences of digital systems is directly relevant to their work. My aim was to structure the creation of models that could be used to externalise experiences of background digital systems such as image metadata¹⁰ in physical form, using everyday materials. The intention was to provide a means for TTC to help their partners recognise the importance of image metadata for activism and advocacy.

TTC occupies offices in London and Berlin. TTC staff run workshop activities around the world with the purpose of making digital phenomena more apparent conceptually, physically and visually. TTC as an organisation thus represents a context for my research with a direct practical application for models that externalise experiences of background digital systems.

6.3 Previous work

Physical manifestations of digital phenomena are commonly focused on digital data (Gwilt et al, 2012, Vande Moere and Patel, 2009). These objects and models concentrate on a specific data set and use physical materials to model it in three dimensions. They are concerned with representing structured digital data in novel and experimental ways, but do not emphasise the everyday experiences of digital systems that my research focuses on.

Vande Moere (2008) explores the material properties of physical objects in the context of physical representations of digital data. Physical visualisations create what Vande Moere and Patel (2009) call metaphorical distance. By this they mean 'the distance between the chosen metaphor and the data itself and between the metaphor and the perceived reality' (2009: 4). Metaphorical representations are well suited to the externalisation of experiences of digital systems since they can 'capture the relational structure of the signified object rather than just its features' (2009: 9). This connects with Palmer's (1978) idea of non-equivalent representations and the structure governing the preservation of relations between objects.

Jansen et al (2013) investigate physical visualisations from the perspective of how effectively they convey information. The focus is therefore on comparative productivity and analytic goal-directed tasks, not the externalisation of experiences of digital systems that my research explores. Nevertheless, there are some key points relevant to my research, such as how the materials of a physical visualisation determine its ability to represent digital data. Pousman et al (2007) use the term 'casual information visualisation' to mean visualisations that do not focus on productivity, and that do not support a single interpretation. They may be artistic or interpretive visualisations instead of strictly functional ones. Gwilt (2015: 39) points out how physical objects afford 'multiple sharing, commentary and reinterpretation' and thus have uses beyond the literal representation of specific digital data. This emphasis on the qualities of physical materials is reflected in the way I frame my research around the qualitative effects of material properties and the design characteristics of physical externalising models.

Finally, in response to the research questions, I am interested in the design characteristics of externalising models, and the effects of those characteristics, and so refer to Brereton and McGarry's (2000) findings related to how physical materials work to embody the abstract and conceptual qualities of experience. They show how designers actively seek physical props and models to help them think through problems. They also find that the context within which an object is used is important for how it is understood. Finally, they

find physical representations 'need to make a trade off between exploiting the ambiguity and varied affordances of specific physical objects and exploiting the power of general representations' (2000: 223).

6.4 Workshop: Setting

The setting for this case study was the offices of TTC in Berlin. The difference from previous case studies is that this case study was conducted in a real world setting, one with a pre-existing set of aims and objectives. Another point of difference is that TTC staff worked together in groups to model aspects of experiences of digital systems that the organisation deemed important and useful. The space for the workshop was a standard office environment with work desks and tables, a top-floor office space familiar to most of the participants as their daily workplace. The room was large enough to work in groups, but offered limited possibilities for rearrangement. I left the arrangement of chairs and work desks in place, configured so that people faced each other across shared tables, so as not to disrupt the workspace too much, and placed the workshop materials on a separate communal table accessible to all.

6.4.1 Sample

The sampling strategy for this case study was in line with action research methods (Stringer, 2013). TTC selected the participants in advance, being those to whom the research would be most



Figure 53. Workshop in TTC office.

relevant. The group was made up of eight women and three men, all aged 25 to 35. The nationalities represented were British, German, American, Lebanese, Italian, Greek, Indian, and Bulgarian. In age, gender, educational background and nationality, the participants were representative of TTC's staff in general.

This group were the people in the organisation with responsibility for delivering training to others on aspects of digital systems, including image metadata, personal profiles, and personal data privacy. All had knowledge of digital systems from the perspective of technical infrastructure. The sample thus comprised a knowledgeable group of participants for whom the physical modelling exercises were directly relevant to their daily work. This sample helped address the research questions in an applied context, one where the research aims were a close match with the partner organisation's own aims. This is a form of criterion-based sampling (Gray, 2014: 221). The sample can be generalised to a population of educated, technology-literate professionals, but is hard to position as representative of the wider population.

6.4.2 Methods

A participatory workshop involved people working in pairs and groups of three. The workshop took place over two days in May 2015. A feedback session was held with the whole group the day after the workshop, which was recorded and transcribed. As in the previous case studies, I captured data using stimulated recall interviews, talking to each group about what they did with the

completed models in front of them, during which they were asked to describe what they had done, and how the physical materials and the day's activities had affected the modelling exercise. The difference from the other case studies is that, often, the participants talked in pairs or groups rather than alone, since they created representations collaboratively. Gray (2014, 402) explains that joint or group interviews can include differing or corroborating information perspectives, and include detail that one person may omit or overlook.

6.4.3 Procedure

The initial instructions given to the participants were to work in pairs to model one of four background digital systems, algorithms, personal profiles, cloud computing or image metadata, using the materials provided. The initial activity was constrained to one hour. Participants were limited to the materials available, but no specific instructions were given about the scale or properties of the resulting models. Instead, participants were limited to the materials made available to each group and the topic they should work on. I was present throughout to conduct semi-structured interviews and capture photographic documentation. At the end of each activity participants presented their models to the whole group, explaining what they had done and why.

Materials were chosen to complement each other as a stimulus to creative exploration. Groups of materials were placed on the

tables, available to use as required. A collection of materials, such as foil, string, paper, tape and pins was also freely available to all, initially mapped to specific topics but then left as unassigned to any particular subject. I did not specify how the materials should be used, merely made them available in distinct combinations as follows:

Table 1 - Personal profiles.

Cork spheres, copper rods, magnets, felt strips.

Some pairings of materials suggest ways of constructing without prescribing how—i.e. magnets are a way of connecting materials without glueing or taping. Felt strips can be tied together or pinned. These materials were initially chosen for this topic because they connect in different ways so as to evoke how a digital personal profile is constructed through the adjustments of specific categories of information such as age, gender, or occupation.

Table 2 - Algorithms

Transparent plastic tubes, coloured ink, fishing line.

Tubes could be filled with coloured liquid, fishing line could be used to suspend or connect invisibly. These materials were chosen to relate to algorithms because they suggest movement, circulation, containment and repetition.

Table 3 - Cloud computing

Perspex rods, pipe cleaners, wooden beads, transparent Perspex hemispheres. Spheres could be filled, pipe cleaners connected to

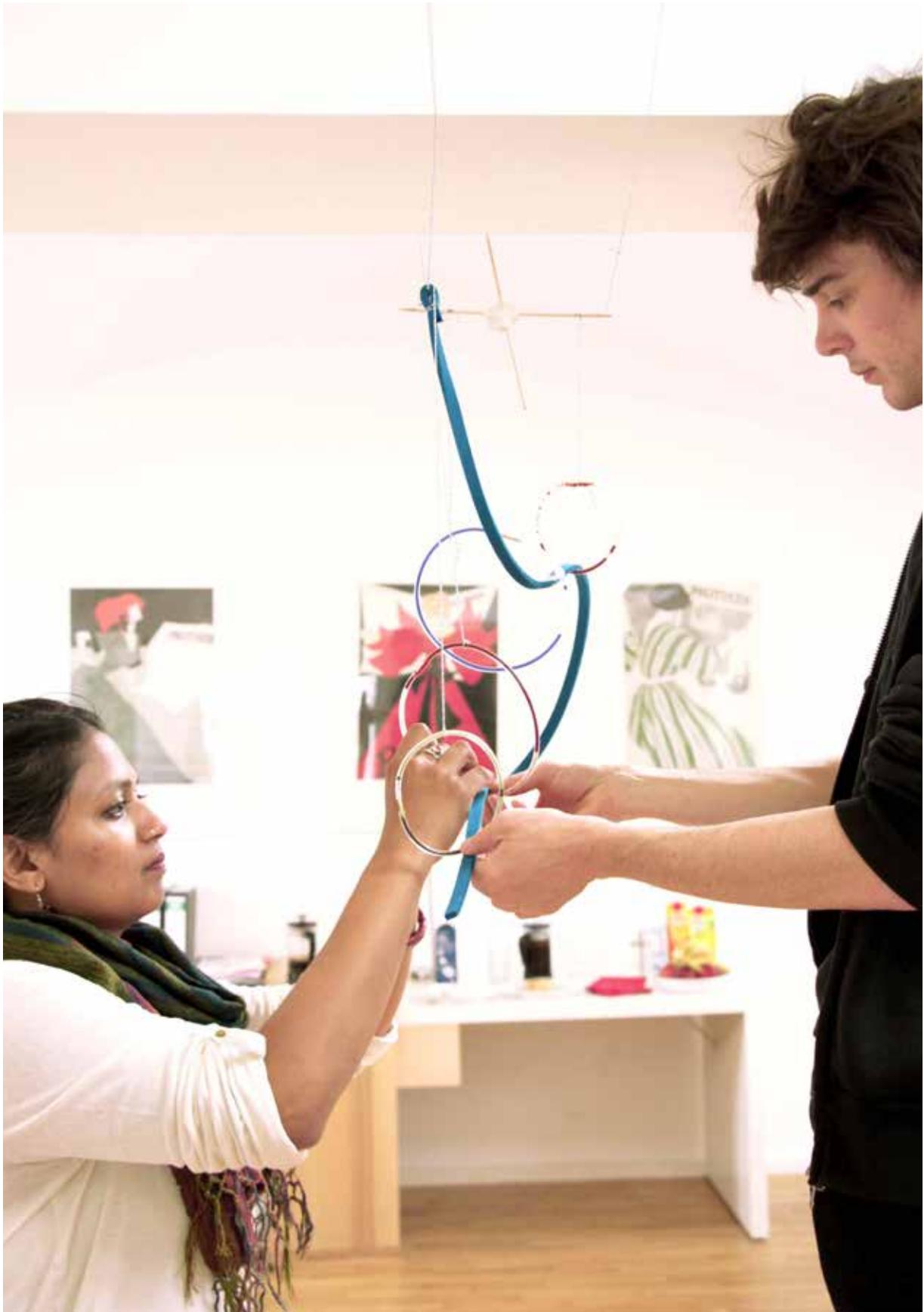


Figure 54. Working with physical materials

each other, wooden beads rolled or strung. Hemispheres evoked habitats or ecosystems. These materials were chosen to represent cloud computing because they play on the way cloud computing involves interacting with a visible interface that conceals an invisible phenomenon.

Table 4 - Image metadata

Reflective metallic card, coloured paper, paper straws.

Straws could connect to each other or be filled, metallic card could reflect paper colours. These materials suggested image metadata firstly because there are usually many individual entities of metadata and because image metadata can be used to represent people and behaviour.

6.4.4 Results

Over two days, the participants produced ten physical models, working in groups, using the materials provided. Four were of image metadata, three of algorithms, two of personal profiles, and one of cloud computing. These used the materials specified above, with the addition of models constructed out of folded paper. The varied forms these models took can be seen in Figure 55; a key to these images is provided in Figure 56. I conducted ten stimulated recall semi-structured interviews, talking to participants in a separate room. These interviews were done in pairs or groups, with the physical models in clear view as a prompt to discussion and description. At the end of each activity, the presentations by

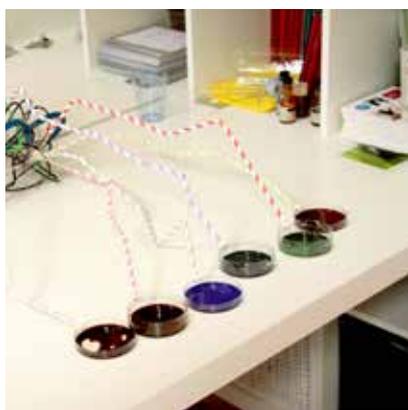
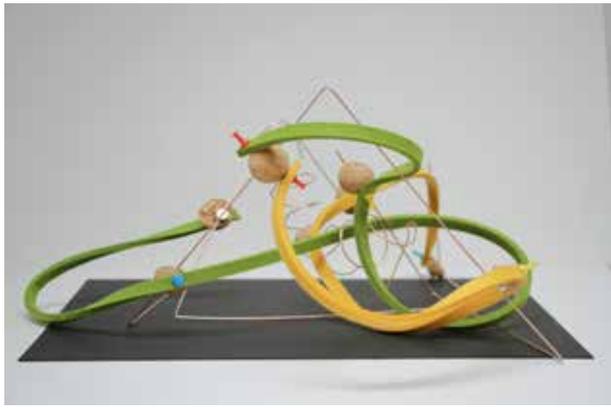
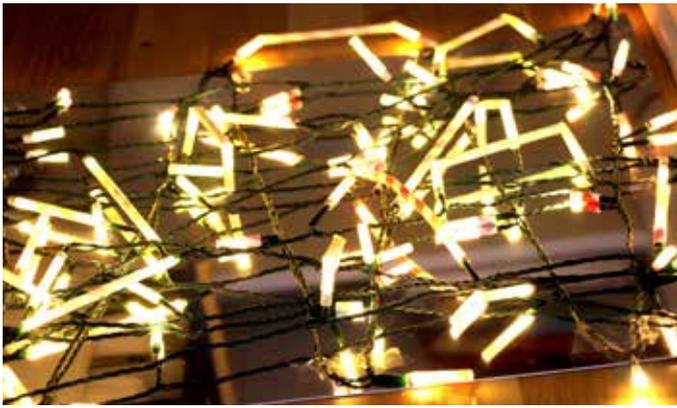
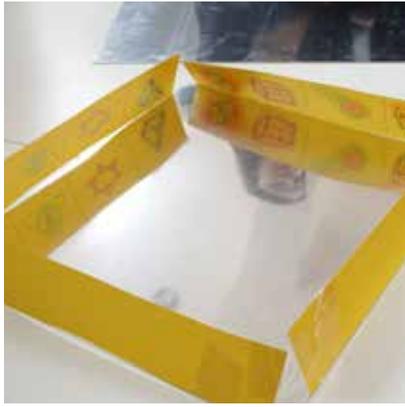


Figure 55. Self-constructed externalising instruments.

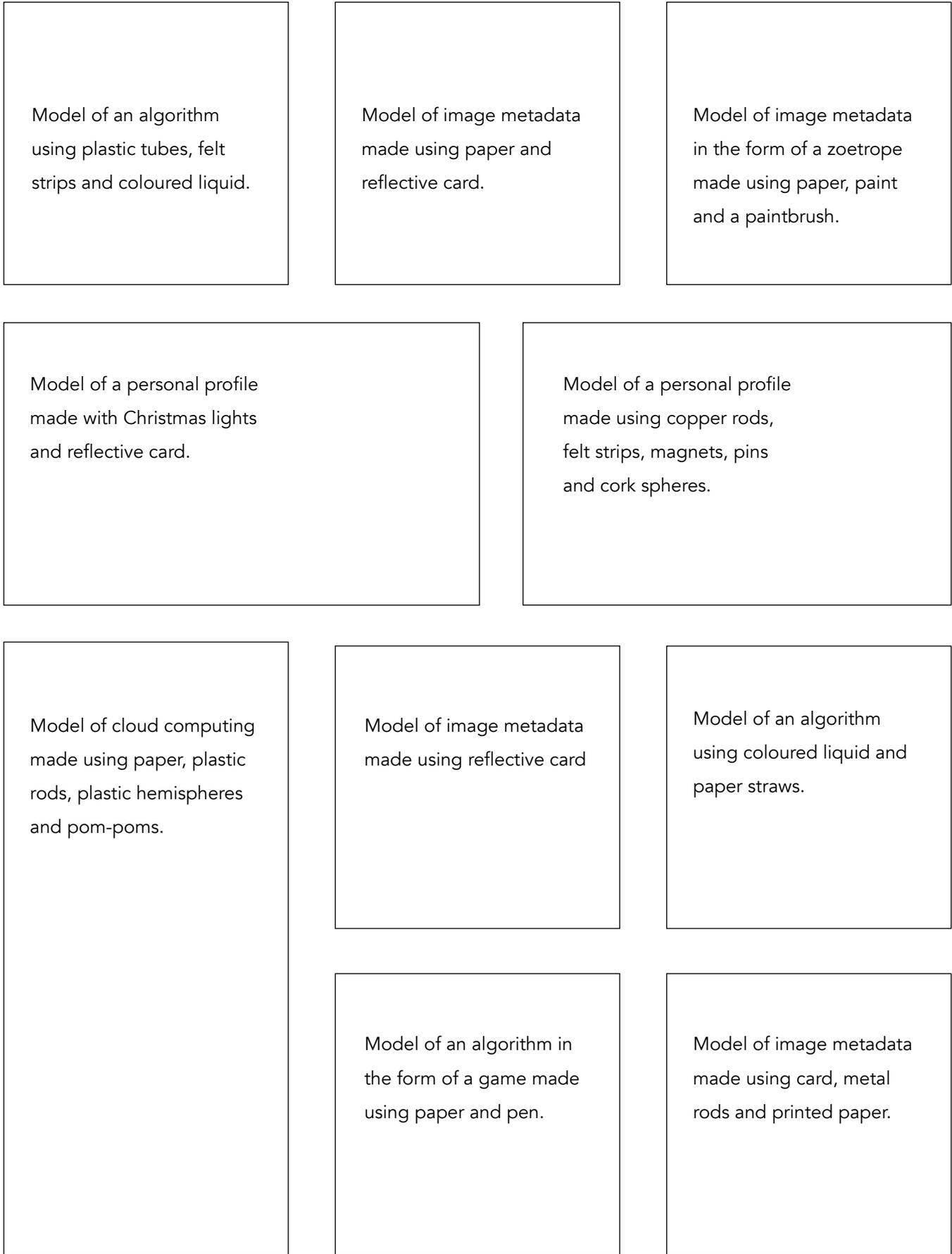


Figure 56. Key to Figure 55.

participants often took the form of games, performances or other role playing scenarios.

6.4.5 Analysis

Analysis of this case study followed a similar pattern to the previous case studies. After transcribing interviews, I looked for examples of re-differentiation, unflattening, abstracting and distancing explored in the second case study. This provided a connection to the analytical categories developed in response to the data in this case study. I concentrated on those parts of the transcript where participants spoke about the materials, the activities, and their impressions of the effects of making physical models on how experiences of digital systems were represented. Like analysis for the previous case study, I identified the themes that appeared repeatedly in the transcripts and related those themes to the physical models by highlighting specific comments about the activities and how they were reflected in the properties of the models.

6.5 Discussion: Activities

Research question three asks: What types of activities externalise representations of experiences of digital systems? This case study shows how physical modelling using a wide range of materials, working in pairs and groups in a private setting and within a constrained time limit, supports externalisation of experiences of background digital systems through social interaction and shared interpretation. Making physical models provided a new vocabulary

to communicate, for example, the abstract quality of image metadata:

“I know when I want to talk about image metadata next... you have new language now in which to do that depending on the person. From that sense it was really great for me”

A.

The types of activities that support externalisation are shown in this case study to include individual and group working, physical modelling, and performative explanation. The term ‘performative’ is used here to denote the way participants devised and acted out various scenarios, asking other participants to take part in the game playing situations they designed. These scenarios were devised to demonstrate a particular digital sub-system. For example, one group made a game to demonstrate the way algorithms determine what digital systems can do, concentrating particularly on the way experiences of digital systems are constrained by the routes and pathways an algorithm follows (Figures 58 and 63).

This connects with Palmer’s (1978) definition of representations that are informationally equivalent, i.e. the game preserves a set of relations pertaining to the experience of algorithmic systems but is not itself the same as an algorithm. This game is also a meaning-based representation, abstracted from perceptual details (Anderson, 2000) but otherwise features an enactment of an



Figure 57. Collaborative working

immaterial phenomenon. The background relations established by the algorithm are transformed through physical modelling into an experience. One function of such externalising activities is that they are involving—they encourage participation and engagement by others. This addresses the research question: How do physical models externalise experiences of digital systems? by putting background digital systems into physical form so that they may be experienced as sculptural models, performances, or spoken explanations and thus critiqued and commented on.

6.5.1 **Collaboration**

The workshop featured collaborative working, a point of difference to the previous case studies. Collaborative activities produced social cohesion, however temporary, as the participants worked to model the same digital systems, taking turns to use the materials on offer:

“everyone goes off and does things, and it kind of becomes a glue... and so you’re actually setting norms for how the group then behaves, so it’s part of the social dynamic”

D.

Returning again to the research questions, the types of activities that externalise experiences of digital systems should take account of how materials such as straws and string afford and mediate interactions between participants. Tactility allowed modes of communication beyond what text or images could offer:

“I think any time you have something that’s hands on, and touchable and tactile, it allows for these other modes of understanding and so that can only be a good thing”

R.

Thus the increased physicality and materiality of models in all three case studies added to correspondingly increased opportunities for understanding across visual and tangible modes.

6.5.2 **Materials**

Using non-digital materials in collaborative work encourages meaning-based, non-equivalent representations (Anderson, 2000) such as the model of an algorithm using felt, coloured liquid and plastic tubes shown in Figure 55; i.e. they are abstracted from their original perceptual details (clicking a mouse), and transposed into new perceptual details (blowing through straws).

Using non-digital materials to model experiences of digital systems was seen to have a contextualising effect:

“(using non-digital materials is) a strength entirely because usually digital things do generally distract you... it takes away from focusing on just the activity at hand”

R.

“I think it (tangibility) puts digital entities in context, like with the



Figure 58. Tangibility has implications for usability.

image metadata we started with, I think it was because we were working with physical objects”

R.

Tangibility has implications for whether the participants could use the techniques, materials and methods of externalisation independently of knowledgeable trainers. One aim of this workshop was to develop the skills of TTC staff so that they could deliver similar workshops for their stakeholders. Tangibility of materials is therefore an important element. Non-digital, tangible materials were positive for this work because of the wide variation in expertise with digital systems that TTC trainers encounter around the world. Tangibility was deemed to grant access to different and more embodied understandings than working with computers or digital materials:

“It brings an intuitiveness, something that’s quite natural to pick something up and twist it and play with it and that internally then develops ideas”

V.

“And this is not at all how our brains work when we are sitting at a computer, and that’s really important because we no longer work this way, and in fact it’s quite rare to work this way”

V.

Working with physical materials to externalise experiences of digital systems thus afforded the development of new ways of

communicating those experiences, and helped to make visible some of their hidden effects.

Figures 59, 60, 61, and 62 show examples of tangible interactions and models developed by TTC participants. The findings suggest that tangible materials break down some significant barriers to engagement for expert and non-expert participants alike, firstly by concretising abstract experiences:

“The kind of example we made has more value than hours of meetings because it made clear what you are thinking and the people can create a prototype and we can confront something that is concrete”

H.

Conversely, they provide abstraction from which new approaches to interpretation can be built:

“(physical modelling) kind of defamiliarises these concepts that we work with everyday and allows you to re-enter terms in a new way”

J.

Finally, they augment existing perceptions of digital systems:

“we think image metadata as being about visibility and invisibility but introducing (physical) structure... just takes it into another realm,



Figure 59. Foam, paper, plastic hemispheres

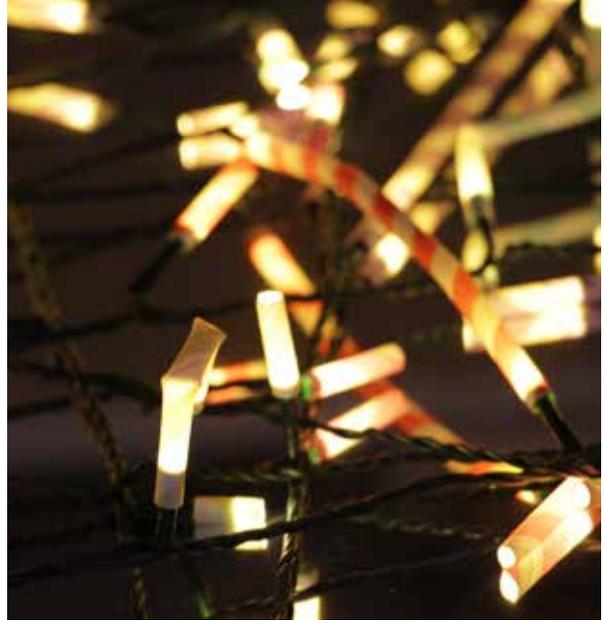


Figure 60. Lights, paper straws



Figure 61. Paper straws, felt, stickers



Figure 62. Reflective card.

you have new language now. From that sense it was really great for me”

S.

6.5.3 **Material properties**

Here I address the question: What effects do the material properties of externalising models have on how experiences of digital systems are represented? One effect of the material characteristics of externalising models in this case study was that they allowed for meaning based representations to have very different perceptual details. The variety in perceptual details, i.e. the different tangible qualities of felt, plastic, or wire, meant non-equivalent representations were more likely to be produced, and thus a wide variety of alternative representations emerged from the activity. The design characteristics of externalising models should thus feature materials that combine in various ways to make models of different sizes and shapes. For example, small scale materials permit greater distancing:

“If you use smaller materials, you get an overview of the entire object or artefact”

B.

Their table-top size allowed the viewers to see all sides of the model, and the participants were able to display multiple facets of digital systems:

“I think it’s important to know that they are all different textures and shapes and sizes; I think that really enables this... way of visualising things, you are not stuck within the same framework of thinking”

G.

Shifting frameworks means moving away from explanatory accounts, such as may be prioritised by written text, towards more developed and multimodal externalisations involving spoken explanations, physical demonstrations, or performative expressions (Figure 63).

“it always surprises me how it’s possible to put these materials in front of anyone... while they are talking people start taking things and twisting them and playing with them, and even the twisting at some point became an idea actually building up to what we wanted”

V.

In their study of the significance of physical materials for designers, Ramduny-Ellis et al (2010) found that ‘the inherent physical properties of... materials and the ways in which designers interpret and manipulate them give rise to subtle patterns of behaviour’ (Ramduny-Ellis et al, 2010: 1). In their study of a design activity they found that designers using modelling clay produced designs that were grounded in daily experience. Using different materials thus has an influence on the conceptual qualities of a physical representation. The model shown in Figure 64 is described below:



Figure 63. Performing algorithmic processes

“These magnets are movable on this... infrastructure of different profiles, and moving them means that the shape of the profile changes and also that the two profiles’ relation to each other changes”

K.

6.5.4 **Metaphor**

Participants using physical materials showed a higher degree of abstraction than those doing comic drawings, perhaps because comic drawing is an activity with a set of well-understood signifiers, such as bubbles for speech or panel layouts for sequencing. This abstraction took the form of metaphorical representations. When creating externalising models for image metadata, algorithms, cloud storage, and online profiles, participants turned to metaphors:

“(If we had been told to do a drawing) I think it would have been different in the sense that you wouldn’t have been able to use as many metaphors... to visualise certain concepts”

V.

“I feel just by working with this (material) we could get some other metaphors out of it”

K.

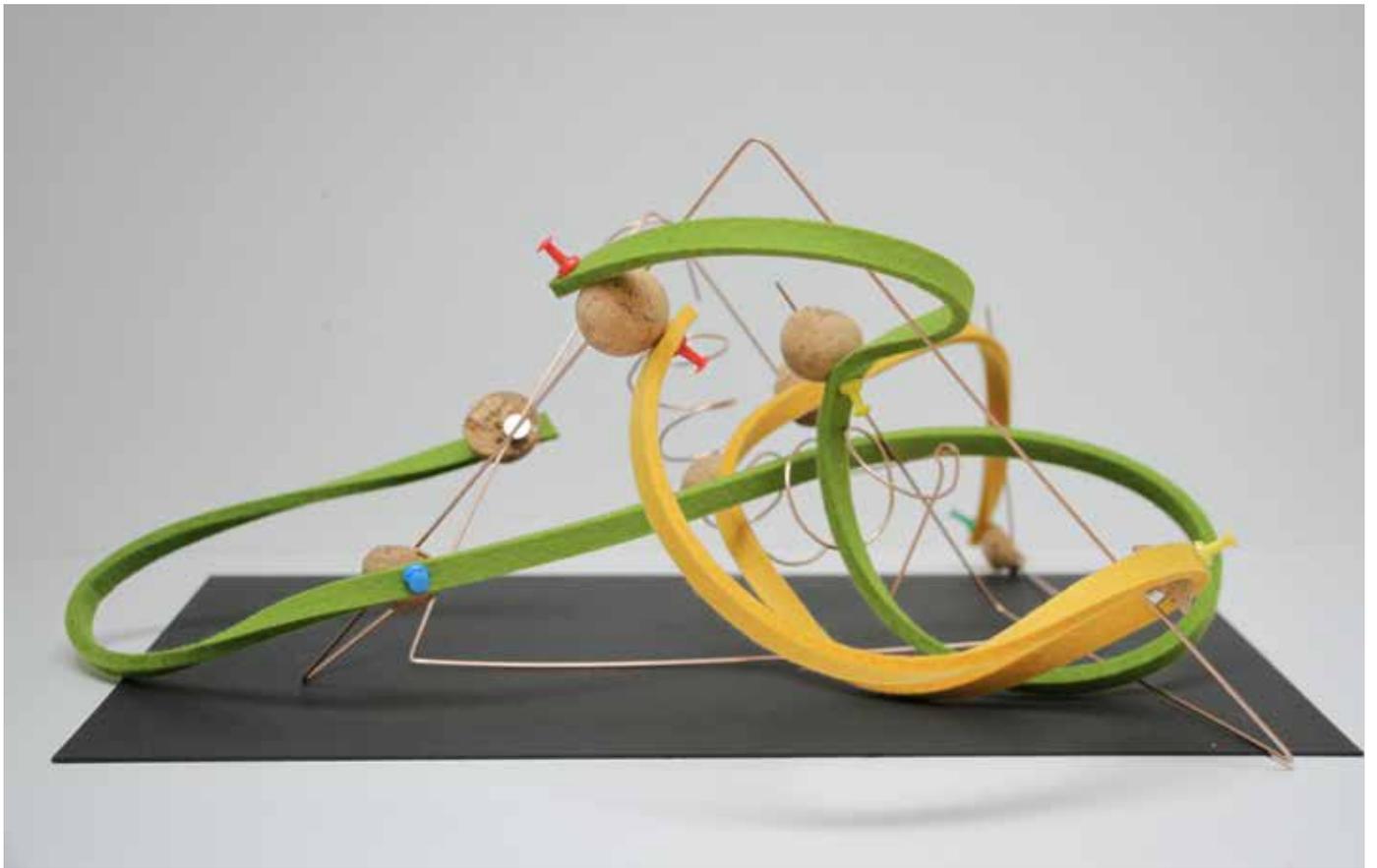


Figure 64. Model of a personal digital profile



Figure 65. A cardboard Zoetrope as a model of image metadata.



Figure 66. Flip book as a metaphor to explain image metadata.



Figure 67. A child's game metaphor to represent algorithms.



Figure 68. Metaphors for a digital personal profile.

There was also a recognition that the dominant metaphors used to convey abstract digital phenomena, such as padlocks for privacy and keys for security, are obsolete and ineffective:

“I think that, especially in the privacy world, there’s a lot of really tired metaphors and visuals... I think we need better metaphors”

P.

“So (we were) not just designing artefacts you can actually use, but here’s how to generate new metaphors that might be more useful, more appropriate or more relevant, or for different audiences”

I.

Metaphorical representations work to externalise experiences of digital systems because they ‘capture the relational structure of the signified object rather than just its features’ (Vande Moere and Patel, 2009: 9). Digital systems are a good example of complex relational structures. For example, personal digital profiles consist of highly personal identifying information, both textual and visual, submitted to a structured system the purpose of which is to populate a database and verify users in future interactions. Using metaphors configured from physical materials allows some of this related complexity to be shown.

Forišek and Steinová (2013) find that metaphors abound in the language of computer science. They conclude that the use of

metaphors to communicate the complexities of digital systems is 'a trade on both pre-existing and emerging similarities between computational and traditional domains' (2013: 7) but that the traditional domains are highly culturally dependent. A metaphor that communicates effectively in one culture may be useless in another. This is relevant to my research because it establishes the importance of metaphors in this case study and provides a caveat for drawing general conclusions about the applicability of metaphors outside of TTC and the work they do.

My findings suggest that providing free access to a limited range of materials stimulates the development of new metaphors. This gives participants the opportunity to make things with a wide range of materials with the understanding that different materials appeal to different people for different tasks. For designers this means selecting 'families' of materials that are creatively suggestive of different applications in an externalisation activity. This case study shows that families of materials may be selected to be complementary, such as pens, card and tape, or to be contrasting, such as felt strips, plastic tubes and copper rods. Some materials were deliberately provocative and difficult to work with such as cork, coloured liquid, and magnets. This led to experimental metaphorical representations.

6.5.5 Distancing

Distancing is both cognitive and embodied. Cognitive distancing involved a number of steps. Firstly, thinking about a digital system,

such as image metadata. Secondly, considering how digital image metadata systems are used to define and categorise images. Thirdly, developing a physical design concept for how to represent that experience, and finally selecting the best materials from those available to create a model of the experience. This stepping back in the mind from the immediacy of digital systems also involved a physical stepping back. When participants were creating their physical models they were closely involved in the fine detail of modelling, but also periodically stepped back from the work tables to see what they had done, or get a sense of what to do next.

6.5.6 Unflattening

Unflattening in a physical sense was most obvious in the fact that this case study focused on sculptural modelling. The materials provided, such as spheres, tubes and fabric strips, were not paper sheets or tiles but fully dimensional objects and components (Figures 65 and 68). As with the social network models, unflattening in a metaphorical sense was seen as a process of adding context to experiences of digital systems. For example, in a model of image metadata, the participants created a fully rounded narrative scenario in which a fictional politician was exposed in a lie through evidence provided by the image metadata on his smartphone (Figure 66).

6.5.7 Explanation and demonstration

The participants used physical models to explain and demonstrate the effects and procedures of background digital systems. The



Figure 69. Designing a game to demonstrate algorithms



Figure 70. Playing the algorithm game.

physical models were supporting devices for spoken or enacted explanations. For example, Figure 69 shows participants designing and making a game to demonstrate how algorithms work. This game was then staged, with other participants taking part in the demonstration. Figure 70 shows participants playing the game as a group. One aspect of algorithms—how an initial state leads to a specific outcome—was thus demonstrated through the design and playing of a game in which physical models were used as supporting materials. Physical models were also used to scaffold a narrative explanation of image metadata in the form of a constructed narrative scenario. Both these examples involved participants assuming roles in a game-like situation devised by someone else, or enacting a scenario designed to be supported by physical models.

These findings are consistent with the tenets of meta design (Giaccardi, 2008) in which designers are seen as producing the circumstances for others to be creative. Another advantage of this approach is that it ensures aims and objectives are in line with partner expectations and meet their criteria for success.

The participants' reactions highlight contrasting aspects of meta design applicable to TTC and their training activity: firstly, understanding that the way activities are organised is the workshop shaping process and that it may be important for this shaping process that it is allowed to unfold rather than being planned in exhaustive detail; and secondly, related to control, meta design

implies a lessening of control on the part of designers (Giaccardi and Fischer, 2008). Participants should be permitted to create the representations they find personally useful or informative. Designers provide the materials, the workspace, and the time.

6.6 Conclusions

In this chapter I describe a study in which employees of a global NGO create physical models of experiences of a variety of background digital systems. I did not create a model in advance for participants to complete; the resulting models are thus unpredictable and more open to experiment than either the browser history comics or the social network models. Participants did not work alone but in pairs or groups, and the stimulated recall semi-structured interviews also followed this pattern. I did not specify in advance the digital systems to be modelled, unlike the browser history list and digital social networking, but worked with TTC to identify the experiences of digital systems most relevant to their work and future aims. Finally, the sample was drawn from employees of an existing organisation, and the setting was their offices instead of the public and semi-public settings of browser history comics and social network models.

The categories of analysis identified in the social network models case study—unflattening, abstraction, and distancing—were seen to be valid for this case study, suggesting the possibilities for further work in this area. Each was observed to a different degree, implying they may have been more or less present depending on the experiences of digital systems being modelled, the materials

available, and the nature of the modelling tasks. The emergence of metaphor as an important quality in the communication and representation of experiences of digital systems was shown in this case study when participants spoke directly about the obsolete metaphors they currently use.

In response to the question: What design characteristics of visual and physical models externalise people's experiences of digital systems? the case study shows that the design characteristics include a juxtaposition of various sculptural materials, and a contextual distancing involving performance and narrative. The question: What effects do the material properties of externalising models have on how digital systems are represented? was addressed through the use of sculptural materials with a range of properties. These were found to encourage the emergence of new metaphors and support experimental and playful solutions. The third research question: What types of activities externalise representations of digital systems? was seen in the collaborative nature of the workshop, the experimental creative approach taken by participants, and their willingness to be inventive and exploratory in a familiar setting.

In the next chapter I bring the findings of all three case studies together and discuss the implications for design practice and research.

Chapter 7: Discussion

Introduction

In this chapter I summarise the findings of my research and discuss their implications for design researchers, and a set of guidelines relating to the design of externalising models and activities. Finally, I discuss the limitations of my research and possibilities for future work.

7.1 Summary of findings

In response to the question: What characteristics of visual and physical models externalise people's experiences of digital systems? I arrived at the following findings. These are arranged in hierarchical order, with an initial emphasis on strategies for the design of externalising models that are intended to be useful for design researchers. These strategies include abstraction, narrativity and adaptation.

7.1.1 Abstraction

Abstraction is an important strategy to adopt in the design of externalising models because it allows participants to show the elements of their experiences of digital systems, such as frustration or confusion, that have no obvious visual or physical analogues. The models provided participants with different visual and physical languages, along a range of abstraction, which they could augment through annotation. In this way they allowed for nuance to emerge. The resulting representations used abstraction to show how digital systems were experienced by assigning various representational functions to them.

7.1.2 **Narrativity**

Narrative representation is shown to be a strategy used by people making their own externalising models . Participants created sequential visual narratives, and where those were abstract, they gave a narrative driven account in the semi-structured interviews. Narratives were also present as personal stories. These stories included accounts of personal relationships and how they developed into a network of connections. In addition, narrative explanations were present in the form of fictional scenarios as participants designed a descriptive structure around the representations they created, often in the form of a performance. An associated finding here is that the models alone carried insufficient detail to represent how digital systems were experienced. Interviews were needed to capture the meaning of the models in richer detail. These interviews often took the form of narrative accounts.

7.1.3 **Adaptability**

The design characteristics of models demonstrated the usefulness of adaptation. The participants found it important that they were able to change the model, both during the activity and after they had finished. These changes were prompted when participants explained what they had done and, realising they could correct omissions, made changes to their models, particularly if they were three-dimensional ones. This finding connects in the third case study to the importance of authorship, particularly with regard to shared understanding and how the design of self-constructed representations was decided by the participants.

The ways these strategies are noticeable is firstly, in a set of effects visible as a result of the representational strategies used. These findings respond to the second research question: What effects do the material properties of externalising models have on how experiences of digital systems are represented? the findings show:

7.2 **Effects**

The effects include unflattening, distancing, re-differentiation, abstraction and metaphor development. Unflattening is both literal and metaphorical, and refers to how the material properties of models can be used to give physical dimensions to what are predominantly digital screen experiences. The effect of unflattening on practice-based design researchers is found is that it offers a way for models of externalisation to be developed independently of any particular set of materials. Unflattening as a metaphor refers to how the models worked to give conceptual and emotional depth to experiences of digital systems by adding rich human detail. This effect provides a way for practice-based design research to conceptualise an approach to making artefacts intended to reveal intangible experiences.

In addition, the strategy of abstraction affords practice-based design researchers a way of conceptualising models of externalisation that do not rely on direct representation or do not depend on showing only surface effects.

7.2.1 **Distancing and metaphors**

Distancing refers to an effect of both abstraction and narrativity that allows practice-based design researchers a way of pulling back from the attention-absorbing influences of digital systems sufficiently to be able to represent them externally. Distancing was also shown when the participants were asked to describe their models showing the benefit to practice-based research of having a physical model to stimulate discussion. This provoked reflection on the wider experiences of digital systems, such as completing a personal profile, or making a new online friend. The development of new metaphors to describe experiences of digital systems was found to be an effect of the design strategies deployed, particularly abstraction. The effect for practice-based research is that the making and deployment of instruments of inquiry (Dalsgaard, 2017) can be a rich source of new metaphors with which to communicate.

7.2.2 **Accessibility**

An effect of the strategy of adaptation on the design of externalising models was found to be accessibility. Design complexity was found in how those materials were combined and configured, which in turn depended on the combination of strategies used in the design of the model. The effect of this finding for practice-based research is that it indicates the importance of using everyday materials and emphasises the importance of how externalising models are designed.



Figure 71. Drawing browser history comics

These findings thus demonstrate how practice-based design research may draw on the design strategies of abstraction, narrativity and adaptability to bring about effects that include distancing, metaphor development, and accessibility. The goal here is to provide a scheme for design researchers to create models for externalisation or to create the set of constraints and conditions whereby participants can create externalising models for themselves.

7.3 Design guidelines

In this section I discuss the implications of my findings. This forms the basis of design guidelines. This section is divided into material properties and activities. The material properties and activities discussed in this section are seen as a consequence of the design strategies described in section 7.1. There is thus a hierarchical relationship established between design strategies and the material characteristics of externalising models.

7.3.1 Materials

The material properties of externalising models should include the possibility for abstract representation and should be freely available.

Materials shape participant responses and have an influence on how effective externalising models are, by affording some, and preventing other, types of representation. For example, constrained physical modelling elicits schematic representations while sculptural making elicits performative explanation. Where design researchers do not intend materials to be used in any specific manner, they can be combined in unexpected ways. For example, string, ink, and clay have separate and familiar affordances and together do not suggest any pre-defined use. Materials should be easily obtainable from non-specialist sources. This implies using everyday materials in new and unexpected ways. For example, using stationary supplies familiar from office environments means models can easily be developed by participants themselves during the research process.

Design researchers using freely available materials also demonstrates an important strategic design approach: the imaginative potential for externalisation lies not in esoteric materials but in the tacit knowledge of participants about their own experiences of digital systems. Using familiar materials in design research means participants can enter the research process without having to learn new skills.

The materials chosen by practice-based design researchers for the creation of externalising models should be shaped by available processes, and easily customised, transformed and personalised.

Externalising models that rely on expensive and atypical production techniques are excluding and inaccessible. Processes such as welding, casting, 3D printing, or laser cutting require specialist equipment and dedicated workshop spaces. Design researchers using externalising models as part of their practice should therefore use production processes that are widely available, for example, folding, taping, cutting with scissors, or pinning. Wire can be twisted, reshaped, melted, folded and cut, yarn can be woven, tied, knitted and stretched.

The principle here is that participants can approach and manipulate materials without specialist or expert knowledge. Using commonly available materials in flexible configurations allows participants

to shape externalisations in their own ways. Customising means adapting an existing form in a new way, for example using paper straws to represent the elements of a personal profile. This relates to non-permanent fastenings and to accessibility of materials. Wakkary et al (2016) call this finish, saying 'finish is bound to the artefact's resolution and clarity in terms of its design and subsequent perception in use' (2016: 3). Thus materials and the ease with which they are combined determine the level of finish.

Personalisation means adapting existing forms and materials so that they are individually meaningful. An example from my research is where a participant stuck a pin into the top of another pin, to indicate his emotional and financial dependence on his partner. Materials should be easily transformable so that participants can change them to signify unexpected meanings—for example attaching cork spheres using magnets to represent the adjustable settings of a personal profile.

Practice-based design researchers should adopt a strategy of using non-digital materials for the design of externalising models.

Using non-digital materials to create models of experiences of digital systems was repeatedly found to be a strength. The participants said it allowed them to model digital systems readily and easily because physical materials were immediately approachable, could be used in collaboration, and resulted in personally satisfying representations. Most importantly, models made of non-

digital materials were shown to lead to abstract or metaphorical representations. Even the technically expert participant group of the third case study insisted that non-digital materials allowed them a degree of distance necessary for creating externalising models of experiences of digital systems. The work of Wojtczuk and Bonnardel (2010) is relevant here. They found that manual modelling during a design process was well suited to functional prototyping, but less well regarded from aesthetic or originality perspectives.

Digital technologies can be closed and unreachable. For example, adapting a browser history list to display a narrative visual sequence would require advanced programming skills. Tangibility is important, allowing externalisations to take many different physical forms, and for embodied involvement with materials. A notable aspect of this guideline is that it emerged from the third case study, which comprised a sample of technology-literate professionals who may have been expected to value digital materials over the physical or visual. The finding is thus qualified by the limitations of the sample.

Design researchers creating externalising models should consider the importance of constraints

Setting constraints means indicating what people should do, and with what materials. The carefully selected set of materials, such as the cork tile, pins and coloured rubber bands of the second case study, allowed adaptation, imaginative exploration and personalisation to be the focus of the activity. Materials should

be combined in constrained but complementary families. For example, one group of materials in the final case study contained wire, felt, cork spheres and magnets. This group thus had two metal materials, one malleable and one connecting; and two more yielding materials, one soft fabric and one spongy cork; diverse but reciprocal.

Norman (1988) explains how 'the thoughtful use of affordances and constraints in design lets a user determine readily the proper course of action, even in a novel situation' (1988: 82). So, when faced with an unusual set of materials (such as mirrored card, transparent plastic spheres, and coloured string) and an unexpected task (such as physically modelling cloud computing), imposing constraints clarifies and simplifies what participants should do.

The role of tangibility in externalisation is shown by McMillan et. al. (2015) who demonstrate the availability of affordances from physical media when modelling experiences of cloud computing. This relates to my findings in the way that the affordances of connection and self-identification were shown with pins and elastic bands, and the affordance of confusion and frustration through pen and paper. Dalsgaard (2017) shows how the use of physical and visual tools in the design process 'augment designers' capabilities for carrying out intended actions, they also guide their perception and understanding of design problems and solutions.' (2017: 21). This was evident in my research when physical models were shown to solve the problem of externalising invisible experiences.



Figure 72. Modelling social networks

7.4 **Activities**

Turning to the design of activities, this section explores the practical implications of developing activities for the co-design of externalising models. The third research question: What types of activities externalise representations of digital systems? was addressed through the design of activities that involved drawing, physical modelling and scenario building. The findings show that the level of structure and direction in the activities had an influence on the resulting representations. Drawing was structured to the extent that materials and subjects were decided in advance, but there was no set duration, or level of detail specified. The activity thus supported individual decision making about what to show and how to show it. The social networking modelling activity was described by participants as creatively satisfying, and revealing of hidden connections. Activities in the third case study led participants to perform their models. The effects of these findings for practice-based research include a consideration of how artefacts and activities should be integrated in a research encounter, and that the outcomes may be unexpected or unpredictable i.e. in the form of performances or stories.

The design of the activity for the Social Network Models case study involved careful integration of physical materials with the expected outcome, a completed physical representation of participants' social networks. The activity was prepared so that instructions were clear, materials understandable, and participation encouraged. This activity was a development from the browser history comics because

it centred around the production of a physical externalising model. Different qualities of tangibility, interaction, and construction were thus incorporated into the design of the activity. The development of this physical modelling activity through the practice element of my research was seen in the final case study; Background Relations and Digital Systems when externalising models took on fully dimensional forms. Designing this activity was the most complex as outcomes were not foreseeable, materials could be mixed in unexpected ways, and the topics being modelled were themselves complex invisible systems, such as image meta data. The activities thus also addressed the research question: What types of activities externalise representations of digital systems? I approached the design of a series of activities with the view that as the practice had emerged through the case studies so the association with physical materials had intensified. The final set of activities thus involved designing a set of constraints unrelated to materials, which were provided in attentively designed groups of contrasting and complementary textures, shapes and forms. By leaving the choice of materials up to participants, I was able to design activities by describing the task, setting a duration, and encouraging experimentation through examples and discussion.

Activities designed for the co-creation of externalising instruments should be balanced between simplicity and complexity.

Tasks should be easy to understand but scale at different levels of complexity. For example, drawing a narrative sequence based

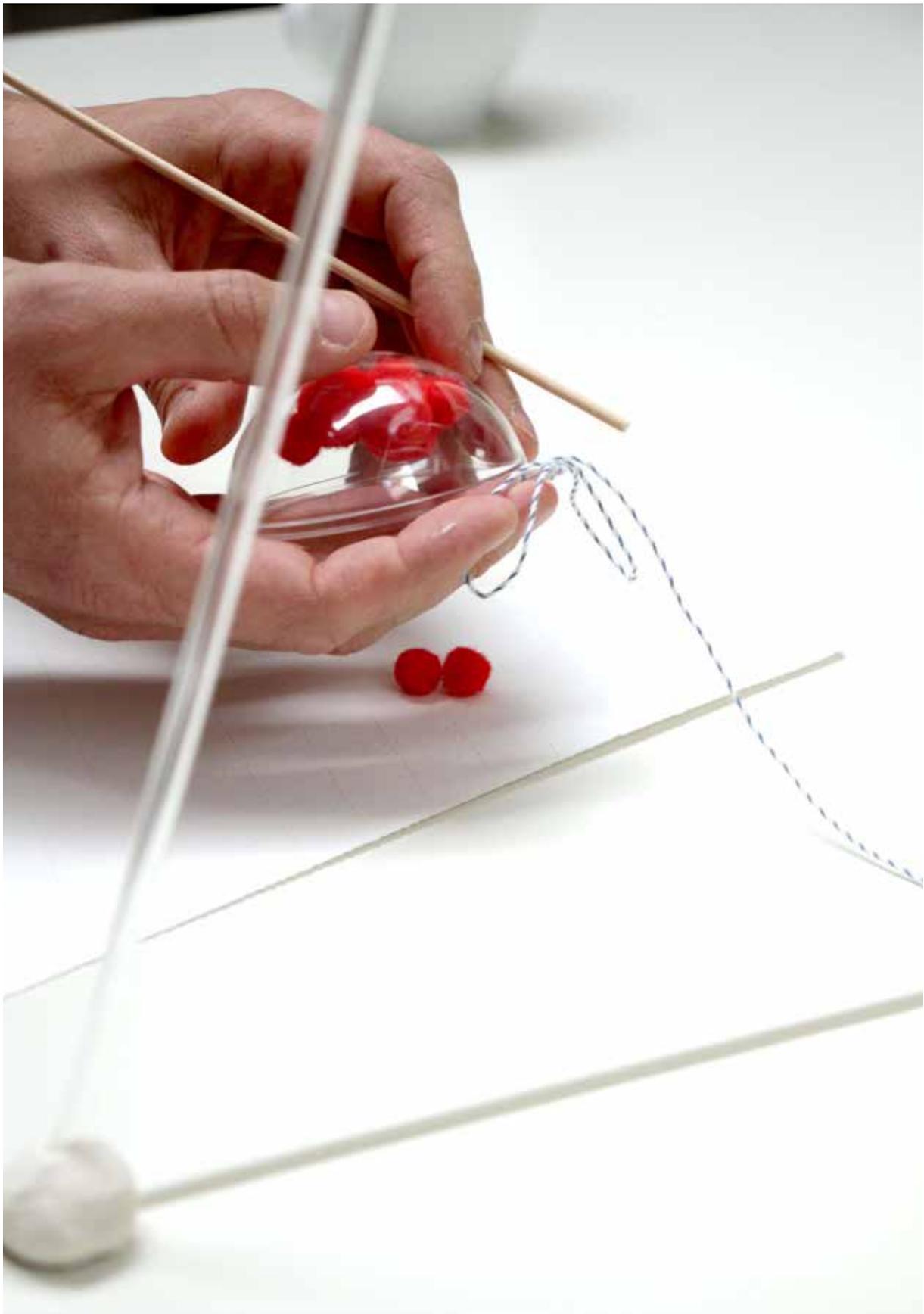


Figure 73. Self constructed representations

on the browser history list can be done with stick figures, or fully naturalistic character drawing, in pencil or with coloured inks, with a single pen or with various brushes. The task of creating a sequence can be a simple transcription of the first seven items in the browser history list, or can involve editing and curating a personalised story, emphasising certain actions or emotions and omitting others. Participants can choose what level of complexity to commit to the activity but its basic requirement should be simple to understand. Similarly, creating a physical model of digital social networks using pins and rubber bands can involve just five pins, all connected to a single person, or it can feature multiple groups and sub groups, all interlinked and connected to each other. The task scales in complexity depending on participant input. Wakkary et al (2016) refer to the fit of artefacts used in design research. 'Fit requires the artefact to balance the delicate threshold between being neither too familiar nor too strange' (2016: 4) and thus facilitate creative invention and open inquiry. This balance between task complexity and simplicity is referred to as inducing a state of 'flow' (Czikszentmihalyi, 1990) defined as a feeling of enjoyment and fulfilment when deeply involved in an activity.

Activities designed for the creation of externalising models should include opportunities for spoken explanation and creative satisfaction, and should not be over-structured.

The structure of activities should allow time and space for participants to explain what they have done and why. This can be done as a

series of staged encounters or left until the task is finished. Often new and surprising insights occur to participants during interviews in the spoken explanation of the model and its creation.

Activities should be designed such that spoken explanations are possible. This requires dedicated time and space. Participants can also interview each other and develop insight collaboratively. In this case designers could prepare opening questions, or a guiding structure for the interview process. The activity design should allow participants to hear about each others' representations, as it helps in shaping participants' views of their own models. Building this into activities means having enough space for all participants to meet together, and making enough time for a conversation to develop.

Creative tasks can be absorbing and satisfying in unique ways. The participants expressed enjoyment in the tasks themselves beyond what they offered in terms of insight into experiences of digital systems. So designers of activities intended to externalise experiences of digital systems should create tasks that are in themselves creatively rewarding. This means balancing simplicity and complexity, designing in goals and rules, and designing tasks that provide enough feedback so that participants can follow their own progress. This is supported by Walker (2010) who shows how goals, contexts and resources combine to provide a meaningful frame for the construction of meaning through artefacts in museums.

Design researchers should structure activities so that there is room for flexibility. For example, some participants in the first case study

wished to involve their whole family, some in the second case study had only five minutes available, and some in the third case study wanted to make a game rather than a standalone model. Activities should be designed so that there is enough resilience to adaptation that the original aims are maintained but variations are accommodated. Activities should also be designed to be sensitive to their immediate setting and the needs of participants. For example, in the third case study some participants had to leave the workshop temporarily to attend to urgent work tasks. In the first case study, some participants did not speak English as a first language, or have anything to draw with. All these situations called for an activity that could adjust to changing circumstances.

7.5 Conclusion

In this chapter I have discussed the findings from three case studies and suggested a set of guidelines for designers wishing to work on models and activities that externalise experiences of digital systems. These guidelines are intended to be applied to externalisations beyond digital systems. I have discussed the implications of my findings for design research, theory and methods. In the following chapter I summarise my research findings and contributions to knowledge and reflect on the research journey.

Chapter 8: Conclusion

Introduction

In the previous chapter I discussed the implications of my research for design practice with a view to practical design guidelines for designers of externalising models and the participatory activities intended to produce them. This chapter contextualises my research within knowledge exchange, CX and Digital Public Space. I encompass the broader political context and provide an overview of my research and its contribution to knowledge. Finally I identify opportunities for further work.

8.1 Context of this research

Since I started this thesis in Autumn 2012 there have been many developments in the wider awareness of the hidden mechanisms of digital systems and how we experience them. The documents leaked by whistleblower Edward Snowden in Spring 2013 showed how the security services of the USA and UK collaborated on a digital intelligence network that indiscriminately targeted citizens' digital communications, including all their web traffic, including social media profiles and content (Lyon, 2014, Bauman, 2014). This intelligence gathering paid specific attention to the algorithmic analysis of metadata, particularly in emails, social media content, and images (Margulies, 2014). The impact of the documents revealing the global digital surveillance operation was profound, reaching from the UK Select Committee meetings of November 2013 to the US Congressional Hearings in January 2016. The immediate impact on how people experienced digital systems was a general rise in

awareness of a loss of privacy (Lucas, 2014), and a rise in encrypted services such as popular messaging service Whatsapp (Apuzzo, 2016).

More widely, the topic of how power is exerted through digital systems can be seen in popular culture such as BBC 1's *Delete Delete Delete*, discussed in Chapter 4. A documentary broadcast on BBC 1 in Spring 2017 titled 'What Facebook knows about you' (May, 2017) exposed the concealed data gathering that Facebook uses to build detailed personal profiles of its users. The subject of so-called 'fake news', referring to inaccurate news stories that are deliberately distributed through social media systems, (Alcott and Genzkow, 2017) caused widespread disquiet, particularly the extent to which fake news may affect democratic processes (Lilleker, 2017).

This concern with algorithmic profiling, hidden mechanisms of control, and digital state surveillance in the UK was discounted in the Investigatory Powers Act of 2017, which requires domestic internet service providers (ISPs) to collect browsing data for all their customers and store it for 12 months so that it can be provided to a range of government services on demand. The law also obliges ISPs to remove any encryption on communications they may have in place for their customers. Against this background of both a growing awareness of how users are controlled by the digital systems they use, and the increasing reach of legislation empowering state surveillance of those users, my research is positioned as countering

some of these unfavourable effects. The intention is to provide design researchers with information about how to design for the externalisation of the ways people experience digital systems using visual and physical models, and provide the users of digital systems themselves with knowledge about how they experience those systems.

The Creative Exchange (CX) funded doctoral programme was the background against which my research took place. CX enabled and encouraged the initiation of collaborative design work in partnership with design professionals and associated academics. This structure implicitly advocated a case study method, and I carried out three case studies with different partners to inform my research. CX provided support, guidance and opportunity, connecting me with potential partners and contributing funding to individual projects. CX also provided a platform for dissemination of research in the shape of publications, exhibitions, showcases, and symposia. The stated impacts of CX have been to foster:

a) 'A shift from the concept of Digital Public Space as an online cultural archive, as initially proposed by the BBC, to a series of interactive digital public spaces with broader scope for business innovation' (CX final report, 2016). These digital public spaces in my case included a re-purposed shop-front, a city street, and a public gallery.

b) 'A shift beyond traditional models of PhD research to a more flexible and dynamic approach better suited to working with creative and cultural SMEs in the sector'. (2016) I used a model of PhD research familiar from case study methods, but involved a range of partners at various levels of engagement across each case study.

c) 'A shift from Knowledge Exchange to Creative Exchange, focusing on the distinctive quality and value of cross-sector collaboration in the Arts & Humanities'. My research specifically positions creative methods such as drawing and physical modelling as important ways of generating knowledge, and features partnerships with artists, academics, designers and NGOs.

CX acknowledges that its original intention to support inquiry into a national online cultural resource was radically challenged by the doctoral cohort to reflect the many diverse interests and values of CX research. I take DPS to refer to the physical and social spaces where I conducted my research and to the contexts in which people experience digital systems. I thus widen the CX definition and explore its potential for the generation of new knowledge.

8.2 Contributions to knowledge

My contributions to knowledge are in four main areas: experiences of digital systems, the design of externalising models, specific attention to externalising activities, and a focus on non-designers in non-studio settings. In this section I describe the contribution to knowledge in these four areas in more detail.

8.2.1 Experiences of digital systems

The focus on experiences of digital systems as the subject of externalisation in design research is an original position. Experiences of digital systems are addressed through the lens of design. Thus my research offers original findings on the topic of experiences of digital systems as revealed by visual and physical models in the context of design research.

In psychology, experiences of digital systems are certainly the subject of extensive research (Eastin and LaRose, 2000, Dholakia and Soltysinski, 2001, Correa et al, 2010) but not specifically how they are externalised in visual or physical form. Experiences of digital systems and the design and use of externalising models to reveal them are thus a new subject for research involving externalisation. Experiences of digital systems revealed as subjective personal representations have received attention in research as a subject of analysis. For example, Chang and Gomes (2017) use the concept of digital journeys to understand the digital systems of international students, Reed et al (2017) investigate the online dating experiences

of adolescents, Gangadharan (2017) finds that the experiences of digital systems of underserved populations hold risks related to privacy and security. None of these studies use visual or physical models as ways of externalising the experiences they analyse however.

As a discipline, experience design is well established (Shedroff, 2001, Hassenzahl, 2010, Kuniavsky, 2010) and refers to the creation of immersive or structured experiences that involve products, services, processes and environments. User experience design (UX) on the other hand refers to the creation of human-centred digital interfaces (Garrett, 2010, Marcus, 2006). UX design is concerned with the design of experiences in the form of digital products and services, and has a well established research field. In contrast, my research is not oriented towards the design of new interfaces, but deploys design methods and artefacts to investigate how people represent their own experiences of digital systems and the interfaces through which they are delivered.

Findings from my research show that focusing on experiences of digital systems allows participants insight into their own online behaviour, i.e. awareness of their position relative to their digital social networks, and a new way of communicating the workings of background digital systems.

8.2.2 Externalising models

The incorporation of visual and physical models as the central element of the research in the context of experiences of digital systems represents an original contribution. Significant findings are presented on the place for externalising models in the process of representing experiences of digital systems.

The role of models in design research is well explored territory. One strand of this work investigates how models are used in the design process (e.g. Ehn and King, 1991, Bertelsen, 2000, Dix and Gongora, 2011). Models in design are described by Dalsgaard (2017) as 'instruments that scaffold the design process' (2017: 5). Similar to Dix and Gongora (2011) and in sympathy with Hutchins (1995), Dalsgaard (2017) considers externalisation in design to be a function of cognitive distribution, allowing designers to get what they develop in their imaginations into the world in physical and visual form via prototypes, mock-ups, and models. Dalsgaard does acknowledge that these externalisations can become instruments of inquiry in their own right, but mentions only prototypes as examples of manifestations of specific concepts and instruments that allow designers to reflect (2017: 7).

The units of analysis of my research are the externalising models and what participants say about how they use and make them in the process of representing their own experiences of digital systems. Techniques for externalisation in design research include sketching, mapping, physical making and prototyping, all of which

are used in the development and communication of design ideas in professional practice. Externalisation in my research includes, but is not limited to, these methods. However, for me, modelling is directed towards the externalisation of experiences of digital systems, not the communication and processes of professional design practice. Wakkary et al (2016) find that prototypes in design are insufficient to explore the complexities of relations between people and digital systems. They propose 'the research product as an extension and evolution of the research prototype to support generative inquiries' (2016: 4), but do not foresee the participative creation of these research products nor that they are oriented towards externalisation of experiences of digital systems. My research thus makes an original contribution to knowledge in its application of participative externalisation techniques in the form of visual and physical modelling, to experiences of digital systems.

8.2.3 Externalising activities

My research makes a contribution to knowledge related to the design of activities intended to elicit experiences of digital systems. Original findings are presented on the topic of the design of collaborative externalising activities.

Developing collaborative co-design or co-creation activities is a well recognised area of design research (Sanders and Stappers, 2008, Liem and Sanders, 2011, Hanington and Martin, 2012), where it is understood as a way of involving people in the design of products

and services which they might use. In my research I extend this thinking and apply it to the design of activities intended to produce visual and physical externalising models. I consciously frame the development and delivery of these activities as design work that constitutes an element of the design practice of this PhD. Designing activities means considering the setting in which the activities are to take place, the time available to do them, the interaction patterns between participants, and the materials necessary to complete the activity. I find that the way instructions are communicated can affect how participants understand the activity, and that there is an important ethical dimension to gaining consent, ceding ownership and structuring collaborative work.

8.2.4 Non-Designers

My research makes an original contribution to the field of design research by positioning the experiences of non-designers with digital systems as the subjects of externalisation using visual and physical models.

The existing literature in design research on externalisation does not focus on non-professional participants. The things being externalised are usually design ideas related to new products and services (Wojtczuk, 2010, Dix and Gongora, 2011). The topic of externalisation in the field of design research includes studies that examine the role of instruments and activities in the process of externalisation but this research is confined to examination

of the design process as carried out by professional designers. Dalsgaard (2017) identifies a gap in the design research literature where instruments in design are concerned but does not venture outside professional studio practice in his analysis. Lim et al (2008) similarly explore prototypes as manifestations of design ideas generated by experienced designers. Wölfel and Merritt (2013) analyse design processes by investigating card based concept development artefacts in studio practice. Chafi (2014) like Dix and Gongora (2011) and Halskov and Hansen (2012) also concentrates on externalisation activities in professional design practice. She identifies sketching, physical modelling and digital modelling as key activities that designers do in the course of making their ideas communicable.

My findings show that externalising experiences of digital systems can be successfully carried out by non-designers using physical and visual models. The findings include: conducting design research in non-professional surroundings involves designing activities that people do not need specialist knowledge to do, using everyday materials that can be easily combined, and allowing people to customise and personalise their external representations as they see fit; participants who are not professional designers may need more time to understand the rationale behind an activity; and finally, if materials are chosen to embody 'the delicate threshold between being neither too familiar nor too strange' described by Wakkary et al (2016) participants may find the task rewarding and engaging.

8.3 Future work

My research has a number of dimensions for future work, including the possibility of exploring experiences of other types of digital systems, the design of alternative models for the externalisation of experiences of digital systems, the use of different materials, and the application of design guidelines to diverse contexts.

8.3.1 Different experiences of digital systems

The experiences of digital systems covered are limited by the time and resources to which I had access over the five years of doing this PhD. Future work could extend to the exploration of a greater range of digital systems such as internet banking or online shopping, the purpose being to enlarge the sum of knowledge about how to externalise other experiences. As technology develops, so experiences of digital systems are transformed and combined into new hybrid experiences. It would be interesting to explore how the techniques I have developed in this PhD might apply to new interpretations of new digital systems, such as virtual or augmented reality.

It would also be fruitful to apply a variety of externalisation techniques to a single digital experience such as web browsing. I designed an elicitation method based on comic drawing for the experience of web browsing, but it would be productive to find out how more physical externalising models might change participants' perceptions of their own browsing behaviour.

8.3.2 **Designing externalisation**

Future work includes designing types of externalising models at various scales. For example, in every case study I designed materials and activities that work at desktop size. Exploring room-sized or pocket sized externalising models could inform the design of externalisation in different ways. Establishing and supporting a field of design activity focused on the design of externalising models for other fields would also add to the future development of my research. Future work could also involve more extensive collaborative practices and activities with larger groups or over longer durations.

8.3.3 **Material exploration**

One clear direction for future work is the design and evaluation of digital externalising models. An important question here is whether using digital means to externalise experiences of digital systems simply adds another layer of complexity to the process, or presents new opportunities for representation. I have designed only non-digital externalising models but digital means may suit different digital systems. In addition, I have not set out to exhaust the possibilities of materials, so future work could involve specific kinds of 'families' of materials such as food or light, in the design of externalising models. I have not explored all the possible effects of each material, such as paper and drawing materials, and there may be many other uses for them beyond those described in this thesis.

8.3.4 Applications

I collaborated in my research with a university, a furniture design company, a public art gallery, an NGO, and a social enterprise. A direction for future work could be applying my research to other organisations, or adjacent fields. Externalising experiences of digital systems could also be useful as a feedback mechanism for large scale digital platforms such as the UK's Government Digital Services or the NHS.

8.3.5 Design guidelines

The design guidelines suggested in this PhD are based on a structured analysis of the data produced by three case studies. An avenue for future work is evaluating the design guidelines by testing their validity and applicability to different design scenarios, including other workshop settings and co-creation events. Looking at studies featuring externalising models designed by other researchers is another way of evaluating the guidelines. By evaluating their usefulness and reliability they can be improved and adapted to suit various design research objectives.

Appendix 1

Interview transcripts case study one

L

I: The first thing I'm going to ask you is to just to tell me a bit about what you've done. Talk me through it.

L: OK, so this is my train journey yesterday getting here, which is a stream of consciousness thing of well its obviously thats a fiction cos its not a real stream of consciousness. Um... of getting here and some things I was thinking about and other general repeated frustrations. and also functions that were happening cos I feel like part of my, things that happen on my phone in that way stop me, stop part of my train of thought because they act upon it. This is what work feels like at the moment which is like an endless stack of tabs, all of them should say work really, but usually I end up on a page and five minutes down the page realise I shouldn't really be dealing with that because I've got all these tabs to deal with. So thats my Google chrome. This is stuff I've been thinking about more generally because I'm trying to but a flat and I don't know erm... anything about how to do that so this is a stream of intentionally messy stream of consciousness that gets more blurry towards the end, because it seems like a scary process, and it all feels very blurry at the moment. And then this is just the rest of the time which is a fog of stuff which I think maybe this is probably influenced by the fact I'm tired at the moment, but also yeah feel like lots of the time I spend on the internet is just a fog of stuff and

um I don't process any of it properly and it all goes a bit fast. So these two are probably quite like a mirror equivalent of each other because I actually spend a lot of my time on the internet working and so its that, like if this is my leisure time this is also my work as well because I work and do freelance. so there's a conflation there so even though they look different they should probably look the same.

I: What do you think is the difference between doing a task this way and if I'd asked you to write out a list by hand?

L: er There wouldn't have been as many questions because this is about what I was thinking not what I was doing. erm... and erm... there wouldn't be as much subtext because this is a visual thing there's more opportunity for me to do things like use caps, colour in a big block of grey, make this all blurry and smudgy and to be forcibly like differentiating between my thought patterns and my actions, yeah

I: And how's that shown on there?

L: With the pen and pencil

I: Gotcha. um, let's talk a bit about task boundaries and how this engages with that idea, about the lack of task boundaries.

L: ummm that's why I picked this shape, because the others seemed, they were just, like, boxes and none of this, actually I probably wouldn't even have... this one would be a pyramid as well or something.

I: the bottom one?

L: Yeh. The bottom rectangle would be a mirror of the top

I: why?

L: because everything just is all together and it's impossible to differentiate because yup well because what I do is part of what I love as well, so I do music stuff, I write about music, I really like music so, there's like this conflation but also because I'm tryin' to do everything at once a lot of the time, so... I'll be tryin' to answer, I'll have a tab open to answer three emails about some freelance piece, I'll be tryin' to write three news stories, proof some stories that my colleague has written, research something that I wanna commission, and like, pay a bill and sort out my internet banking, and sort out, like get a home insurance quote, and you know er usually like two gmail chat tabs as well which is my own fault.

I: Can you tell me about about that lighthouse in there?

L: Oh yeah yeah yeah. so

I: you've got this sort of fog... you've sort of got this fog panel.

L: There's this fog and I nearly got, found a rubber and drew a light house as a beacon right at the bottom really small, like a centimetre or two tall, because... I've a research project that I do get into really really deeply online and end up on all sorts of weird web pages about foghorns and lighthouses so and that's another of the focus point of what I do but I never get round to do it and I never get round to dedicating the space of mind to do that so it would be very small.

I: mmmm. You've got er.. this is quite neat, this is quite messy, this is quite neat again but messy in a different way, and this is, it's not solid actually, you've done some, you know it's quite beautiful the way you've shaded it. Can you tell me a bit about that - the visual quality of what you've done?

L: er well the.. this dint (?) this one needs to be solid black, because it is a fog so its like, confusing but misty er this one.

I: the capitals one.

L: Yeah the capitals is probably got some thing to do with the fact I'm angry about, I'm angry with myself for doing so much work at the moment, this one

I: With the tabs - because that's quite a lot of work you've put into that.

L: the tabs is an again an exhibit of my frustration at erm.. just overloading myself in the last six months basically. erm... and work being quite high pressure to keep on top of it all, and it being very much weighing down on me. So, this is an exaggeration obviously but erm is probably a representation of how much I feel like having to do work online is like a burden at the moment er... this is really close together because I wanted to fit a lot of text in because people, my brain works quickly, everybody's brain works quickly and so keep that all tight without, cos there aren't any spaces ever. This, and yeah my pencil's got blunt but, er... in this bottom bit the rectangle er... it kind of ended up blurry because I feel a bit blurry about this whole house situation

I: down in the bottom panel there. And in that bottom panel you've got a, it's sort of the only bit of drawing you've done I'd say maybe, maybe if one was interpreting it in that way. Why do you think that's got drawing and the others don't?

L: erm... because I started drawing it and then I realised I was too tired to think about perspective erm... and I can't draw anyway. erm... and then I realised this was supposed to be the front and then I realised I'd done the roof totally wrong so it ended being the side so it was like a bodge job. It has a drainpipe because the flat

that I'm buying has a broken drainpipe. erm... and er I was gonna draw the big things that I'm thinking about but then I realised I was too tired to draw it. So I just left it at that and actually what I'm thinking about more is just this all the time

I: Your um, the mental model that you have in your head of what you've done online, what's that like? what does that look like?

L: Er... I wouldn't say it's a model, as much as like a mental map of all the places I've been in the last six months is a map that I could draw, so er.. it would be a collection of anecdotes and headlines rather than any sort of map or model

I: gotcha. Do you think that this task has allowed that model to be expressed?

L: er.. yeah a little bit, because, well because browsing's a... is a personal experience that's at the moment very much like a functional experience as well so Yeah I don't feel like I need to express it cos I know that I'm really annoyed about all this stuff sort of thing. but erm... yeah its a nice task to do er... but I well no, because I don't feel like this page is big enough for me to fit any depth in which is why I ended up doing the fog so if I actually was gonna do one like last Friday's browsing history when I wasn't even in in front of a computer for most of the day then it wouldn't really fit on because there's so many ideas all the time and there are so many things I'm

looking for all the time, so many alerts er conversations, like a lot of conversations with people via my browser, via gmail chat like, colleagues, friends, other acquaintances, getting in touch that it would yeah that this is too small

I: Do you think there would be any benefit in doing such a thing let's say at the end of every week? or the end of every day? or the end of every month?

L: ummm I dunno, I'd rather write, um I'd rather write er... if was gonna make time for a test like that I would rather do that thing where, the... automatic writing in the morning.

I: So, you're a writer - that's your idiom? you deliberately chose not to put any colour on it.

L: Er. well yeah I did actually, I like black pen a lot, I like keeping it simple and I think it was also a bit dark and I knew that if I started with all those felt tips I'd just hate it after 5 minutes and wouldn't never finish it. But no matter how crap your handwriting is it always looks alright in black ink so..., that was a choice for my own benefit.

I: Fair enough. You spoke a bit earlier about how you've been working online for a long time and that hasn't got less frustrating, its got more frustrating. What do you think you could do, with the tools available, to make it less frustrating?

L: with the tools available i.e. like, my computer and my browser?
things like that?

I: Yes

L: Um I don't want to use those at all, so my, which is why I'm doing a carpentry course. So, my way of making that less frustrating is to um, cut myself off from it a lot more, and you know, its, and I'm very very aware of the fact that, and I think this is true for most people, like the more time you spend online, the more time you think you're missing out if you're not on it. Like, its actually when you spend time away the less it becomes, it is a presence in your mind. I s'pose it's like the more time you spend on something the more time you think it's essential. and as soon as you manage to spend half an hour off it, you realise there are other experiences and places to gain knowledge. Cos I mean thats my problem is that I end up racking up all these tabs cos I think all this stuff sounds really interesting, should just go and read a book.

I: One of my problems with computers in general, the internet particularly and the browser history list specifically is that um, it just captures everything, it remembers everything, there's no editing or curatorial procedure in it and, just my consciousness and memory doesn't work like that.

L: Well actually, I would say because I've become hyper aware of like Google ads and things like that there's certain things now where I know where I always go Google incognito because I know that if I go and look for like Office, a pair of shoes. If go and look on Office I know that if I'm going to go to Office for a pair of shoes which I probably wouldn't anyway if I look at their site for 5 minutes I won't get away from it for the next six months. So I'm quite tactical about what I incognito and also thinking about data and things like that. Obviously If I wanna find, because Google filters all its searches so a lot of my browsing, I always go incognito to find films, music, things like that.

I: very sensible

L: Yes well you just don't find it otherwise so because they block it, they don't block it on incognito.

I: You said something earlier about how in certain technical situations such as you know when you've linked from Facebook or when you're on your phone or whatever - you lose your history. Can you tell me a bit about that? Any other circumstances that you find annoying that that happens?

L: er when, when chrome gets really slow and I have to delete my browsing history and all the caches which actually although it's all this data that Google, well just cos I'm deleting the cache I don't

think Google is gonna delete it as well. 'ooh thanks, Jenny wants to delete her history, lets delete from our servers then'. That's not how it works but erm, so that's annoying when Chrome slows down I wish it was better, cos they have commodified my data so I wish they would make it a decent product um and er yeah Facebook is annoying because er I find a lot of musicians and record labels and stuff post things on Facebook first now Twitter's... you miss half of it anyway so actually its hard to bookmark things like that on Facebook and Facebook's a bit of a mess with friends and professional things now.

I: Um, one of the things is the fact that the browser list has no hierarchy. Do you think that that contributes to this lack of boundaries between tasks?

L: um no. What contributes to my lack of boundaries between tasks is that everything, all my work, is online and much of the rest of my life has to be online now. You know, buying things, paying for things, organising things, speaking to people because it's all on the same device. I wouldn't say its necessarily the browser, it's cos I have to do all of that on the same device or and I would almost say that like, my phone is an extension of my laptop, so, they're not separate devices in that formal sense.

I: OK. Last question. Can you go over for me in three minutes, in a little bit more detail, the difference between these representations

that you've done, what do they show?

L: So, the first one, the top one it's called the train, this is my journey here yesterday which is really tiny snippets, sort of imagined stream of consciousness and what I remember thinking about then. Er, then underneath it to the right is one that's Home and Work which is er, me being angry about doing too much work in the last 6 months and that is a more general feeling just yeah probably like last 6 months and I feel that, er, very present just most days, and the fog is also most days you know. I check my phone when I get up, erm, and I wish I didn't, but I have to to see if anyone's sent me any ratty emails. Erm, so the rest is a fog of like loops that I lose the thread of. Erm, and then the bottom is er more specific time which is like last, not as specific as the top, but it's something that's kind of hovering in the background but not really moving. So I kind of need to know all this stuff but not urgently, which is January and February cos I'm buying a flat and I need to know all this stuff about plumbers and electricians and drainpipes, and, it all feels very fuzzy because none of the, because I don't actually know if I'm, no contracts are signed or and things like that so I don't know if I'm actually going to move. So this is like a behind all this daily stuff, really, that's like a specific 10 minute portion, this is most days. And this is thoughts hanging in the background of stuff that I google when I panic about it.

I: OK, this is most days was fog

L: Yeah and this is most days

I: The middle two are most days

L: Yeah, yeah, recently. Might change

I: Em, I think about 1 more minute. The experience of completing this, is there anything that you know now that you didn't know before?

L: Erm, not really because I've been thinking, this has all been very present in my mind recently. Erm, I did notice that I'd written this in caps. I think that I didn't realise that I feel guilty about this as well, about not doing as much work as I should do. But then I also I'm frustrated that I'm doing so much work. So, yeah, maybe I didn't realise that I felt guilty for reading something that's actually maybe interesting, maybe not.

I: OK. Brilliant, thank you so much.

L: That's alright.

M

I: We're recording

M: OK

I: Can you tell me a bit about what you've done here?

M: So you've asked us to do my Google search, erm things, so I did

.

I: Browser history.

M: Browser history, yup, which is mostly Google.

I: Is it?

M: Yeah, actually yeah cos it's just quicker, um yeah.

I: Can you tell me the story of what you've...

M: So the first one is from erm... from today and I'm really tired as well and I cant remember everything so It's from today which is being up all night making artwork with a load of people and this is um, Moonage looking into a cone, and that's it. I don't like being recorded...

I: Are you happy to continue?

M: Yeah it's OK.

I: And did you look that up then? Is that in your browsing history

M: Yeah, well, no, that was the first, I think that's quite a striking image and I probably remember that one, so I've picked that one to put in there. But that was the last thing that I looked at.

I: On your browser?

M: Yeah.

I: Oh OK. The video that we...?

M: Yeah.

I: OK. What's happening here?

M: That's um Lou Reed's Vicious youtube video.

I: You had a look at that? And is there a relationship between the purple panel and the black panel?

M: Oh, because this was mainly dark and her face was lit up, so I

was trying to make her light up and that was really good, that was the album cover and it was the same, no there was no relationship but it was... but it made sense.

I: And you've got a sort of coloured cross hatched, what, what's happening there?

M: It was that one, then that one.

I: And what does that mean?

M: That was um, I was trying to find out the name, if there was a word for more than one octopus, for a collective group that I've, um organised cos I wanted to call it Octopus but we had problems with it because I thought it sounded a bit like nursery school, but I like the idea of it being in lots of different places, but being part of the same sort of... thing, and something that changed within different places, and developed and transformed, cos' octopuses change colour don't they?

I: So... you looked up.. a dictionary?

M: No just putting 'more than one Octopus' to Google.

I: And what came up?

M: I can't remember.

I: 20 pictures of Octpuses...

M: Yeah, I can't really remember.

I: Then you've got a sort of coloured cross hatched... What's happening there?

The transcript is redacted here as per M's request.

I: And can you say a bit about this sequence and how it relates to your browser history list?

M: The sequence?

I: Yeah, cos you've got a purple to black, to a text panel and then this drawing and you looked through your browser history I think, but there must be probably a lot more in your browser history so there's probably quite a bit that you've left out it seems

M: This was the order. I think that but I don't normally go on there that often.

I: Do you ever look at your browser history list?

M: Um, no, not normally

I: Why not?

M: I don't know because the next day's the next day, and I don't really, sort of, think about it - but I might now I think, cos that's quite interesting. But I quite like, there's like, it's better to leave whatever it was in there.

I: How much would do you think you spend online, in say a day or a week?

M: Too much probably. Yeah.

I: I have the same feeling,

M: I communicate sometimes, because I run a collective, an arts collective, with lots of people and we started communicating on Facebook, and it means that I'm working quite a lot and it's doing my head in a bit. So it's like my day off, well I'm here but I'm getting messages, to me saying like I can't plan the map which I do, but they know that I'm here. And I obviously use, like Facebook cos I never have any credit so I use it to text, so yeah, and then I'm stuck on Facebook so, yeah, so it's not very good.

I: What I'm trying to get at with this research is the idea that the

browser history function is a list, but what you've done here is not like a list at all, it's quite different - can you say something about that?

M: I don't think my life is like a list, it isn't really necessary. It's very um, I don't think it's routine, I don't think that think I'm involved with... but I was in discussion with someone about that one (indicates drawing) recently um... because it was kind of, like, I know, cos it was one of them bizarre things like.

I: This coloured drawing here?

M: I hadn't seen the person that I was talking to for about, - I don't know, since last summer. I had a discussion about that, so I was just showing the picture. So that was last year but the discussion was... this year and then...

I: So during this discussion you searched for this image to...?

M: to describe something that happened last year but that's last year but that doesn't necessarily fall with the other, this is now...

I: The purple one?

M: This is music...

I: The black one?

M: OK

I: What do you think the process of doing this told you about what you do online, if anything?

M: I would probably have to think about it a bit more. I'm not really aware of like, different... maybe just not aware of um... how like, scattered it is, like, do you know what I mean? and not really related.

I: Sorry, what's not related to what?

M: I could probably relate it because its me that's done it.

I: It meaning the drawings?

M: But they're very different I don't think that they really connect.

I: The panels?

M: Yeah

I: How do you think it would have been different if I'd just asked you to write down in words what you'd done online?

M: Probably I guess um... but I maybe wouldn't have done because

drawing's just a bit more fun. I don't know. Um... probably um... I wouldn't describe visually... with one.

I: the purple one?

M: The purple one was an image I've picked out from that particular site, that stood out the most to me.

I: From which site? the blog that we've been doing?

M: Yes

I: So that's the closest in time?

M: Yes, yes, that's the closest in time yeah. So um... but um, but yeah, so if was just text it would just say the same of the site and it wouldn't depict the image that I would represent that, so it would be less personal. Maybe. um... maybe... I quite like that being text on that one, and then being images.

I: You have one text panel?

M: I thought that would look quite nice.

I: So you have done some arrangement of effect, a composition?

M: I must have done yeah.

I: Do you think that doing this has changed your attitude to the browser history list at all?

M: No. I don't think so. I won't know until after, so I don't know - but I might look at it a bit more, probably.

I: One of my intentions with this project is to design a system that would enable this to be a bit easier - so an automatic system for creating visual stories. Does that sound like something worthwhile do you think?

M: So would you grab an image and then drop it into a box sort of thing, or an app?

I: Maybe. Or do you think there's something special about hand doing it yourself that's better?

M: No, I think that um... most people would probably find it easier dropping an image in. Depends how many people you were to pick but um.. no, I quite like drawing it. I think you interviewing is another I think that's an interesting, quite an interesting... I was wondering what questions you would ask as well. It's an interesting thing so yeah.

I: Do you think the questions are the wrong questions, the right questions? inappropriate appropriate,? What would you ask me if you were doing it, if I'd done this and you were interviewing me?

M: erm.. I think maybe it would be interesting like, could you look at the same day last year and see the first 1.2.3.4. of the day, and do an image on that day, and then have... and then compare it, and see, and then ask how do you feel looking at the two things... I think that would be quite interesting. I don't know really the purpose, exactly.

I: So the purpose exactly is to try and get away from computer lists and to try and get into human story telling ability. So without me really explaining that much to you, you've created this quite coherent, holistic sequence of stuff you've done, and you've told me in detail about why you've done it. So that's the purpose, to try and get away from computer generated lists, and to human centred computer experiences.

M: OK. That's cool.

I: Can you tell me a bit about time, like, how long ago is this? which one is first and which one is furthest away in time?

M: So this is first and this is at last one

I: So today. So how long ago was that black one last week?

M: Oh OK

M: Yeah maybe Friday or something. I don't go on Google that often I don't go on the search too often

I: And what's the time difference between the black and the text would you say

M: What do you mean. That's on the album.

I: What do you think you would have done if you hadn't had access to your browser history list and you had to do it from memory.

M: Well yes, it would be a different question - what would your question be if it wasn't to look at your browser history?

I: Some people, I ask them to do this and they don't have any device with them with browser history on it so they can't check it, so they do it from memory. If you hadn't had your phone here would this be the same, or would it be different?

M: I think I probably would've forgotten. Yeah. All of it. So I don't remember...

I: And why do you think that is?

M: Because I think maybe we're not thinking we're just automatically doing things now/ Like, and then when you've not got it you recognise you've not got it. Yeah

I: OK. Is there anything you want to ask me?

M: How many people have you done this with so far?

I: I've done this with, I've probably got about 20 of these.

M: 20?

I: I don't have very many detailed interviews and stories about very many of them which is why I really wanted to do this with you

M: Because they're private, or because?

I: No, because I was in a situation with about ten people doing it all at once and I had to manage the situation lots of kids there, parents with kids, and I didn't have anyone to help me. I have lovely drawings but I don't have all the information about what they mean.

J

I: Can you tell me a bit about what you've done here.

J: OK, erm... I responded to what was kind of requested in terms of reviewing, I chose review the data um... in order to make the choices about what I would draw um... in that I could probably have guessed what it was but um... I generally find it easier to go to the information when kind of doing it. I feel that I took a relatively kinda straightforward approach to kind of representing those things I thought that perhaps there was an openness to interpreting it in any way as to how you might represent those things. I did it in a way of um... how I recognise those sites, so in the data history there's an icon that is attached to most web pages, um and therefore when I use that when I'm looking for something specifically I will use the visual recognition of that logo and identity in order to find the thing.

I didn't do the top four pages, predominantly because there's a lot of repetition in the user history in that predominantly I'd be using Facebook which would be predominantly because of this project and you know making posts etc etc, and I also generally use multiple browsers at the same time so you know the one that the I happened to look at the history was predominantly Facebook so I scrolled back relatively quickly through a few days um and therefore I picked things out that are somehow connected in my head so you know going from Facebook then through to Twitter which was um connected to the project we were working on at the moment then the circuit board having a visual resemblance to another logo identity that I was aware of and then somehow this all connecting up I guess to do with blocking out of colours

things that were relatively graphic or stark in their content. erm... and I didn't particularly want to go to any great lengths in visually representing things, so it was the choice of things that are fairly simple or straightforward and things that are recognisable in terms of I know exactly what those things are without having to look at the web pages in that I'm familiar with those sites having visited them regularly

I: So is this, the four panels that you've done, is this a synthesis of different browsers?

J: No, its just one browser.

I: So have you got parallel browser histories in other browsers and would they show something different?

J: Yeah, they would yeah.

I: So why did you choose this particular one?

J: Um... it was just the one that was at the top of the page often other browsers are hidden in the dock or whatever because um... generally I use them for thing where um... accounts don't allow you to be signed into multiple different identities in the same way, so its used in that way um... I guess this is the one that I use predominantly so that's the one that was you know at the forefront

when I opened the computer.

I: Do you ever look at your browser history?

J: Yeah.

I: Why?

J: Um.. for a variety of reasons. I guess the most common would be to find something that I've lost. So I have quite bad habits to do with web browsers generally. I generally have multiple browsers open and lots of tabs open in all of them and sometimes things get closed down that I didn't want to close down and therefore I'll be going back through history, I can't remember what it was. I often open things, don't pay much attention to them and intend to go back to them so the only way to locate specific things that come back to me is to go back through the browser history. Sometimes I do it for other reasons - out of interest about how much time I've spent doing certain things. So there's a, you know like I have relatively analytical set of behaviours to do with how I spend time so sometimes I wanna know what I've been doing in order to perhaps modify that or control it in some way.

I: And do you find that the browser history list is useful for that?

J: Erm... it's useful as a memory aid, like it doesn't really go into

that much detail about how time has been spent on certain things, its a long list isn't it? so it's of limited use but, um... yeah it can be useful as a little, like, basically it's the same thing, its an aid to memory so rather than having to remember exactly what you were doing or looking for you can use it in order to obtain that if it seems important to do so.

I: How much time would you say you spend online per day/week/month whatever?

J: Erm... Well I guess that a difficult question in that er.. I will generally spend all day either my lap.. whether I'm actually doing something online, the web browser will always be open, and... if I'm not at my computer, I will generally be using my phone whilst doing other things so, yeah unless yeah there are certain specific days or certain specific sets of activity where I wouldn't do that particularly around being with other people but yeah, like, um... I'll spend some days, like, you know, I dunno, like, 14 hours? online in some capacity other than you know eating and doing other things, it depends what you're doing on that particular day, but... yeah.

I: Quite often when I'm doing it, fairly similar patterns to be honest with my laptop and phone I might go to a shared resource computer with a bigger screen to do something visual say. In that situation it's really difficult for me to work out what I've done because its across different devices and possibly locations. Do you experience that?

J: Erm... not to a great extent because I do generally use my laptop for that. So, I have another computer here in the office but I don't really, I would always have my laptop open at the same time and I generally wouldn't use the other computer for that kind of activity and similarly at home I have another computer but that's used for specific tasks and therefore things are central, to do with online browsing, pretty centralised with the laptop. Obviously, occasionally you open a page because you need, it's easier to get the information from that, copy and paste it sort of thing but I wouldn't generally use computers for that.

I: Do you think this exercise that I've asked you to do would have been different if I'd asked you just to write out a list by hand and if so, how, how would that be different?

J: Erm ... um... it probably would have been different in that these 2 (indicates red and orange panels) are less, less common, so I probably would've, if I'd been doing it from memory I probably would've chosen the four sites that I would imagine I most regularly use. Whereas these (indicates red and orange panels) are not that. This one (indicates orange panel) is used quite regularly, this one (indicates red panel) is just used regularly at the moment because it's to do with something that I'm considering buying. So before that I wasn't aware of this site. So, um... these 2 (indicates red and orange panels) are more that they kind of stood out visually whilst scrolling through the browser history.

I: And do you think the fact that they stood out visually is an accurate reflection of the amount of your attention that's gone on them?

J: No.

I: OK

J: Just, just, yeah, no, like there'll be other things that have far more attention, but, some pages don't have the little visual icon so, erm, yeah, they were things that stood out visually in that kind of, in the way that you kind of flick through Twitter and certain things kind of stand out, um... so there are probably other pages um... that I would have... given more attention to in terms of actually reading something on them.

I: Sure. um, can you tell me a bit about the time sequence here. So are those (indicates top panels) the same day or are those separated by a week or ...?

J: Erm ... these (indicates black and white panels) are both today. These (indicates red and orange panels) are yesterday. Erm, those (indicates black and white panels) are everyday and you know interspersed, these. These (red and orange) are the first ones I came across that stood out to me to kind of make a note of them.

I: So, in some way on any given day, these two (black and white panels) would be present?

J: Yeah probably yeah, unless, unless it happened to catch me in a different state of mind like you know I could have chosen to approach the task differently to how I chose to approach it in this particular instance. So, I could have you know gone out of my way to look for something that is perhaps more particular. I don't consider these things to be interesting, they're just, they're just there.

I: Well it's great data for me that you haven't done that but of course not uninteresting if you had. You said at the beginning that you looked at the browser history list and the favicons kind of stood out to you and that dictated some editorial decision making - you used those because they're visual and this is a visual exercise, that's what you're saying. But beyond that, how have you decided what to put in and what to leave out?

J: Erm ... I haven't really. I you know, I went to the browser history, the entire, the first thing that I could see was all that site therefore it was, I didn't want, I couldn't have chosen again to just represent that one site across all 4 boxes in terms of a particular journey through that site in some way. I intended, I guess I already had it in my head that it would be 4 different sites when I went to look at the kind of history. This one kind of, was the next one that I came

to. I made a particular choice to use this particular instance of that because it connected to what I was doing at that particular moment in time and has a connection to the event I am working on. and then it was a kind of sequence that that connected to that, and that visually connected to that. So there were other ones that I skipped over but I didn't really, I didn't consciously think about it or kind of make a decision it's just that, it was done very quickly.

I: Sure. If our roles were reversed and I'd done this drawing, what do you think you would ask me about it?

J: Um ... I find that to be a difficult question in that I, I'm not sure I can get my head around in this moment in time what I would be wanting to get out of it. So... I haven't given what you're doing that much thought - to think about what it is that you are particularly wanting to get out of it, and whether that would be To answer that question I would have to in some ways have to feel that I was in a position where that would be something that I would do or to be able to kind of play out that that would be something that I would do and at the moment I can't.

I: Fair enough, totally fair enough. So, one of my aims is to make the argument that the browser history list is an algorithmically generated time stamp more or less, but the way that I live my life and the way that I perceive my experiences, it just isn't like that at all. It's a, if I was doing it, it would probably be a mist or a

bubble or a cloud or something like that. So, that's my intentions. So, I suppose my nearly last question would be that do you think this gets anywhere near being able to do that?

J: No, no, I guess It's also, because this is all history whereas a lot of, like, if you're talking about that actual way you experience it, all the pages that I haven't yet closed don't show up in the history. Therefore everything that is currently present within my use of a web browser, it is partially because these things probably... they may all be open all might be open as well as in my history. I didn't check that but it's quite possible. I often open another page rather than look to see whether I already have that page open. Erm, but it's yeah... it's fairly limited whereas use of browsers in my instance is fairly expansive in terms of the amount of things that I might look at, glance at, keep open for days or even, like weeks. Therefore you know this is a kind of, yeah there's a kind of, it says something but is it saying anything that's that interesting? Like, I guess most of us are aware that you use certain sites that you don't really give that much importance to personally but they are on-going element of your daily life. So you know the fact that these 2, yeah, I guess these are specific to the laptop. The phone would be different again. So, um, yeah.

I: OK. So this is my last question. I find it interesting that you've touched on 2 themes that I've identified in this research - what I'm calling kind of modularity and parallelism. So, from what you

said this facebook panel is a bit like a module and in fact there's a lot in there.

J: Yeah, so the other thing would be is that I also of pin a lot of tabs so they open immediately when the browser opens. So all these things, not this one () but the other three open automatically sort of thing so they're things that are just always there even if I, you know, when I load the browser I might not look at them but they load automatically so they're present.

F

I: Can you tell me about your drawing.

F: Sure, I guess like my browser was a bit more interesting today than perhaps it usually is. There wasn't any Gmail or Facebook in the previous 4 entries. This one (touches top panel) I was looking up incongruity or incongruous things cos I was thinking about... er... we've had a lot of that today with the er... dirty weekender workshop that we're on like incongruous food, the deconstructed banquet. Things that don't really go together like beetroot, profiteroles. So yeah I was thinking about butterflies and batteries, or like needles and fruit, veins that turn into wires and stuff like that.

Second in my list (touches middle left panel) I looked up the Dirty Weekender blog which I found very quickly on Google, er... so it was very good to er... reflect on everything we've been

experiencing yesterday and today. And then, in the third section, (touches middle right panel) I had to remind myself, I looked up the definition of necromancy, because er.. my friend posted a picture on my Facebook and said this person looks like you and it was like a sort of 50s cartoon woman who was ordering a book on necromancy, so I was like what does that mean again? something to do with the dead? What exactly...? So its when you, when you seek to communicate with the dead. And the 4th section (touches bottom panel) I was trying to remind myself the expression Birdy Num Num, what film that came from, and it was The Party by Peter Sellars.

I: What's the time relationship here are those two hours or two weeks apart (indicates top and bottom panels)?

F: Yeah, they're more like 2 hours apart so they're particularly like more they are interesting er... tabs probably because we're doing interesting things today, yeah.

I: Do you ever look at your browser history list?

F: Um...yeah I do and often I'm like, 'oh my god have I done with my time? did I really spend that much time on Facebook, or Gmail or Ebay, or whatever the hell it was' yeah.

I: And why do you think that?

F: Cos I can look back and I can see exactly when I started using Ebay or Facebook or whatever it was that I see as time vacuum and be like, 'wow that was an hour ago or an hour an a half ago' and be like 'oh my gosh, terrible'.

I: That's very familiar. How far back, when you were doing that, how far back would you go?

F: How far back? Um... probably just like the last hour, two hours, something like that and be like where have I sent my time on the internet exactly? Oh that's right, that Youtube video...

I: Would you say you spend a lot of time online?

F: Um... yes, yes I do, yeah um... and I have, I do try to incorporate periods into my time where I will inhibit my internet use, and er... also have periods where I delete Facebook and things like that because I actually want to remind myself what one does with the time once it's just not there anymore, like, so instead you might read a book or spend a bit longer cooking a meal etc. etc. so yeah, I do find it to be a pain sometimes because um... I can for sure be watching really interesting documentaries, or learning things. But, I mean, in the end sometimes it can be a distraction from just getting on with just making your own stuff.

I: How would this task have been different if I'd asked you to write out a list?

F: Um... it seemed to kind of repeat the same website a few times in a row, and that's interesting. I certainly often, like if I'm trying to find an old tab I was looking at sometimes I'll really have trouble finding it, I'm not quite sure really why that is. Sometimes it really doesn't make sense I'm looking for that thing in my history where the hell's it gone Aaaah!

I: One of my motivations for this research is that I find it really difficult to find out what I've done online but Google knows exactly what I've done. They know where I go, and how long I spend there.

F: Yup

F: They can tell a lot about me. Do you think that doing this kind of exercise might re-balance that situation somewhat?

F: Um... yeah, I mean I think so but then, I'm trying to really have awareness of how much time I spend online anyways already so it's just like an extra kind of like yup, Gotta keep an eye on that.

I: You spoke about time a little bit which I find interesting. Computer time is really different to human time and, certainly the way that computers represent time is very different so, I suppose normally a computer would do a time stamp, and then it's up to me to notice the difference between 14.21 and 16.20. 2 hours have gone by and what the hell have I done? but this what's happening in time is very different so human time versus computer time that's what I'm trying

to get at. Um... do you think this does anything about that?

F: Um... I mean, I feel like time speeds up with the computer. That's what it feels like.

I: And, why do you think that happens?

F: Er... You kind of um... you can just kind of switch off a bit, you know, you almost feel like your breathing kind of er... stops or something, I dunno, you just go into a zone and er yeah...

I: So there's lots of theories as to why that happens. Some people say that the internet is designed not to have any borders between tasks. So you can switch from paying a bill, to watching cat videos. You can even do it while you're trying to pay a bill.

F: Yeah! and then you can find that you're trying to do that even off the internet, as well.

I: Tell me a bit about that.

F: I dunno, I can find... I think the internet doesn't help your concentration. cos' like even off the internet you can be looking at your bills, then you just do the dishes, or then you, you know, do this and you know its kind of like jumping from to task without... just like you would on a tab, and you try to do this in real life.

M

M: OK, so what I did was I looked at my browser history in Chrome, and then looked at the tabs that I had open in Chrome.

So this first image here is... the browser icon for the website that's the first tab in my browser ... it's motionographer.com it's a motion graphics blog and actually some of the students here have there work I think it may or may not be the largest motion graphics blog in the work do the stuff that gets on there is pretty tight and pretty well know. The second image is UI elements which are found in Vimeo which is the second tab in my browser - and I just drew the first UI elements that came to mind, that I knew I could draw just from looking at the screen. This third one here is the URL er... the URL string for another site that's in one of these tabs. I believe it's this one right here, Resident Advisor. This is a link that FW (a fellow student) sent to us about an event that was happening I think sometime in March so... I basically just took elements of websites that were on the screen and draw them in each cell. So this is... this first box is this image right here (clicks browser to find tab) the Vimeo sketch is of this topic right here, Vimeo. This one we've just seen, this one is some research I've been trying to do on my favourite designer Paul Rand. I came across this website for a public broadcasting that he did back in the 80s but the video doesn't seem to have been posted so I'm trying to figure out how I can track this interview down....the I actually looked at the tab that comes up for

my browser history and just drew that. So I did it as a wireframe, that's pretty much it.

I think all these different elements combine to create a typical web experience so... it's interesting how people pick apart the different elements of things they view, or see, or experience every day.

V

I: So can you talk me through it...?

V: Browser history is a reflection of my brain, and the fact that the browser history is how the different parts of my life come together. So... there is no, there's a backbone that holds it together which is why I chose this format, because I recognise that there's an element in there that are about 5 or 6 different parts of my life. Browser history doesn't reflect a single linearity through any particular way of thinking. What it does reflect is... the different parts of my life that then end up having connections to them, which is why I've actually broken out of the boxes and put arrows connecting different parts. It's colour coded so that generally anything to do with... work and students is yellow based, that's based on sending emails to groups about logistics, but than also reading about branding to inform a set of students who've got blinkered thinking that their world can actually be expanded and reason for them to do that. The work the exhibition in Amsterdam is generally in blue... but

that's also connected with personal activity, so reading about um... smell stories which is a project being done by a...nother researcher in Canada, and then linking that through to... looking at FedEx about how to get items back to people who left them at my house. Looking up what to do at weekends, all then links in with reading about with how to do... how to use audio software in order to get audio to work, which then enables me to enter a competition. And... upside down is trying to work it all out in terms of political perspective, so anything in pink is reading analysis writing. Most of that is tremendously difficult so it's all largely upside down.

Appendix 2

Interview transcripts: Case study two

G

I: You put one in for yourself, white, wherever you want, it doesn't matter where, and if possible if you could describe what you're doing while you do it.

G: But, what I shall do is build a map of six people.

I: It doesn't have to be six people

G: OK and then describe how I am connected to them. OK

First I'll take my pin, and I will now position it in the centre but a little bit to the top, so that I have more space to put the other pins. I think I will start with a yellow one for my partner that's my beloved girlfriend Steffi, I'll put her beside me. Shall I already connect them or only position them? OK, I'll take a red one because we are deeply connected. Ah ja, that's true then. OK so I take the red one for bonding of the family and... then I'll set a pin for my friends Harry and Oliver. And I will use the green one to show the connection. The good thing is that we know each other since we were kids in school so both of them also know them for a long time. This is why I connect them with each other. And... the interesting is that um... I built my business around my friends so we have a nice connection between them and us. So these three pins, they stay for people I'm connected with via business but they are also friends so I will try to

use two of them. The good thing is that they are working too so they are also connected. Um... ja, and these two pins are for my two lovely girls. So this should make a very basic map, that is the most important for me.

J

I: OK ready?

J: Yeah. OK... I just gave birth, therefore family networking is the most important part of my life. It means these red things are representing my interaction with my parents at the moment, which is heavily increased since my son is born. My husband and myself we are seeing each other now much more than ever before, because before having a child we are working and working and working, so I am pinning, like lots of these little things because they're like my dad, my sister, which is now coming regularly from Berlin to visit us, and lots of other family members. Do I have to respect the colours here as well?

I: Mmm hmm.

J: And I'm now doing like the interaction between them?

I: Yes

J: So we are totally in touch to each other. OK so other, partner.. ah... so others is for me the topic job. What I'm trying to do, is to have

at the same time have my private projects. However, um...there is a book project that we have at the moment with our Grandma. We are trying to realise and this is um.. one thing which is like, um... which is very important to me, and also to my family because everyone has to fit into um... my time schedule now, even more than before because I have like questions like can you take care of my child because I have to this and that uym.. so I;m putting some more of these here because this is what I'm doing during the week when I'm not sitting with my child and going around in this lovely Schanze. OK, what else? Friends ja. Um... it's the first time that I'm not abroad and I'm in one city for more than a year, therefore lots of friends are here with me and I can see them on a very regular base as Im now a mu I have all these coffee dates. So, coffee dates with friends, family members, um... And its quite nice to have now these guys with me, and connect them as well. Because as there are only time slots I have due to my child, I try to see lots of them at the same time. Like, having birthday now together with all others or having like breakfast, or kind of lunch dates with more people. And partner ja. As I said, I have the possibility to see my husband much more, but it is always in the circle of family honestly because it has always a relation to the to do's we have now. Who is going outside with Nuja, or who is taking him to my mum's etc etc. Oh! quite interesting what this says about my life, because my partner has like, the smallest part here um... ja I think that;s it.

I: OK where are you?

J: Where I am? Which colour is me

I: White

J: Um... I'm here. No, I'm not here. Ja I'm here. Can I have two personalities and be in two places at the same time?

I: As many as you want.

J: OK, I think I'm somewhere between family and partner, and family and my project I try to realise. I think we have a pen problem guys. Oh, this is not working either

I: We need to buy a pen

J: I have one with me. I would like to make my point clear that I don't have three partners um.. I try to say that there are three of these pins because he's taking a very important part my life and he is having different functions kind of, and therefore there are more coins there, even though it's just one person. OK so, others is like the book project and there are things like my private projects I try to realise.

K

I: OK one question?

K: Ja?

I: How do you think this exercise would be different if you just had a piece of paper and a pencil?

K: Mmmm... I guess I would put less with a piece of paper and a pencil. Because it's kind of how do you say Spielerisch? yes, playful and its a lot of fun you put it in and so think what else can I think about? and then I put it in, even things that are maybe not so joyful. In real life it's kind of relieving to say; well that's work for money but I put it quite far away, and I pin it in so there's this physical act that makes it playful and joyful. So I guess I would have put maybe less people but maybe with the pencil I did it more specific, like writing more names, more relationships between different friends ja.

P

I: How do you think this exercise would be different if it was just a piece of paper and a pen?

P: I think it would be quicker and I think I would draw in more persons because you have trouble putting on the rubber and .. yeah I think it would be quicker, but this is also a very interesting way.

S&R

S: Um... I've put my father way over here, because I haven't seen my father in seven or eight years. And I've got my mum and my sister on this end because they're my family family, my blood family I guess. And... here I put... my band, which I've compiled in five people. Actually, we're more but then I'll just make sure that other people get have things left. So I've mixed them up because they are different, because they are a band and they're not, but they're also friends and then I put one in the core. So now I'm going to start coaxing dots with rubber bands.

I: If you did this exercise with a piece of paper and a pen, how do you think it would be different?

R: You'd think about it differently.

S: Yeah.

R: Just think about wording it in the first place. Writing it down there's more of a, a... its a bigger interface, this is very direct I think, very distinctive, a very distinctive way to visualise it. I think this works really well.

S: Yeah with a piece of paper and a pen, my friends wouldn't be three, I'd have five hundred because I would start feeling guilty for letting out some people and now you're just like OK, it's just... and

because you don't name people, my human psyche thing I don't feel guilty. I could have picked anybody and they won't know it's not written down.

K

K: These are my Facebook friends, people I know in real life, but don't know that much really. Maybe I'll start with the rubber bands I think.

So let's see, so I'm gonna connect my immediate to everyone if possible so that;s the immediate family and here's my... let I put Francisco's family here. There's no green left, I'm gonna change to yellow. So Sabina she's like a colleague of mine but she's also a friend of my wife Francisca.

So, then social network friends. Those are like people... people I hang out with yeah, people I communicate with, have contact with on different platforms, social networks like Facebook, or Twitter and stuff. People I've met, typically in real life but I really don't have too much to do with time in a physical basis. and they have less to do with Francisca, so they kind of go around Francisca and then... and the friends... these are like mutual friends. So my friends are gonna be yellow. So I have more grounds in the US than just one, but I'm just gonna have the one there because...

M

M: I think I don't have so much freedom with pencil because um... I might get confused with the... with the lines this is much more flexible. I can take out some nails and some rubber bands, and change it a little bit, um which I did because some of them they had strong connection to this guy so it was... I moved it a little bit to make it more flexible to connect to the rest. So I think this idea, I like it. It gives a lot of flexibility, freedom of locating people and connecting the points. The pencil will make a lot of mistakes so it will look much more crazy I think with a pencil.

S

I: Was meinen Sie wie wär dass anders gewesen dass zu machen auf mit einem stift und eine stuck Papier?

S: Also, Ich male normalerweise Ich glaube ich will mich damit Farben ausdrucken. Also... oder was zeichnen, oder... Weiss ich erst wenn ich stift in der hand habe... so zu sagen. Das war viel einfacher, weil dass sehr schon auch eingeteilt war, mann muss nicht überlegen OK... also. Mann war so war so was... war schon ein paar Sachen vorgegeben, ist ziemlich schon einfacher. Ist dan so... so... um... auseinander zu halten. Vor allem selber auch noch machen

D

OK well, this is me and my partner Charlotte, this is er my family and my brothers and they're all interconnected as family, and same with Charlotte's side. I'm more friendly with Charlotte's family than Charlotte is with mine... just because... I expect...they lived in the same city as us so I got to see a lot more of them while she's only met my family a couple of times.

I went shorthand with the friends because my friends, our friends, then Charlotte's friends there's cross over between them. Er... I s'pose didn't know where to put my Mum on this so that was er... so I decided to leave her because she died when I was fifteen,, and this is sort of I guess a living representation of what's happening so that's what I went with.

L

You started with your friends, then your family and these are your friends from Shanghai how do they know each other

M

I: Would you mind telling me where you started from?

M: This is me and next I put family first. So this is kind of my brother

my older brother and this is my parents, so this is one relationship with me. And next I put this relationship they are ... three couples and er... they know each other, they already friends when I met them and they introduced these couples.

I: So you kind of know these two people quite good friends?

M: Yea yes so still acknowledge this. So this is my girlfriend Mana and... I put one more couple relationship but these couples is not how can I say connected yet so I separated... yeah. This is Anastasia, when I met her I performed on the street, then she asked me something so we... Coincidentally, she was Nicolas' student so yeah... then spread our relationship. They they used to be a couple the split up so... I met him just once, couple of times so I don't really know him.

I: Your girlfriend knows someone right down here as well?

M: Yeah because... we a couple so it kind of couple relationship as I described... yeah.

I: And do your family know any of your friends?

M: Yeah... I didn't introduce yet kind of, separate - separate - separate

B

I: Was there anything surprising for you, once you did it?

B: Well it's always difficult with scope right? Where do you start? where do you stop? especially if you've got a lot of students and people you work with. But I've kind of got... um this is me in the centre this is the family, I've grouped the little... so this is my Mum and Dad, who are grouped to me, and then they're grouped to siblings, and then the siblings and their partners and children are in sub groups in there. Erm...and then I've got a similar thing going on with kind of friends, so there are kind of distinct groups of friends, and there are sub-groups within them. Actually, there's a group in there that went the RCA specifically... all went to the RCA together and then there's... then I've got some students who have worked for me.

I: Are these more of your students?

B: These are more friends actually, I've just run out of greens

I: Oh OK Ill get you some more...

B: So this is quite interesting, this is where I've got... so here I've got... a group of students who have become friends, but they worked with me in the studio, so I also have a kind of working relationship with them. But they've also worked in other studios of

friends of mine, so they kind of connect to several groups. And then here I've a kind of mixture of sort of current... so...there's you and Kevin in there a little team, with Neville and er... Jeff, put you in a little team there. This is the IMI team, so we have some connections between some of you guys and the IMI team from LCC. These are course leaders in my program so they kind of exist...have a relationship with those guys but also have a relationship with the... so that's Lawrence and the other program directors that I work with, so there's a kind of interrelationship there. And ether there are some relationships that exist across here like Olli, who teaches for me and is an ex-student who's a student of mine but also a student of yours, so there's some crossover with the IMI team. And then this is my partner Rose... and this is how she knows some of these people, so she knows these guys from being a student, she's worked for some of these guys, and obviously she has a friendship with my family group. So there you go - if that makes any sense.

I: I'm gonna replace some of these here with greens..

B: I found myself er...kind of judging levels of friendship which was quote interesting. You make the cut you don't make the cut and the same with colleagues actually. And that's probably quite temporal so its probably quite how I feel today right now.

I've tried to draw across the groups with the right colours, I've been quite strict with the elastic bands.

R

R: So this considered more to be like the ordinary face of a clock, and I've put let's say my best friends, actually most of them are since kindergarten, and I've put these ones further because they are most recent so this is the most recent friend I made, or this like, tutors and college friend now and yeah of course like my partner, which is on the top. We live here together so I spend more time with him than my family that is back home.

... So and here is like a lot of like managers, and ex co-workers, and directors and I was inspired, there were many of them but these the main ones.. and yeah I think that's the most, the really closest group actually, it could get much more expanded

I: Wow, so if it was going to expand what direction would it go in?

R: Friends definitely... family I don't think so, so it would be more on friends and other like a lot people from work because I've changed like five jobs, I've got quite,... I could put more people or from college so the networking around I think it would be more in friends and other people and not folks from the past or something like that.

I: So Jason he doesn't know any of you friends?

R: Jason knows everyone actually, that's the the interesting part, he knows everyone we're two years so... if I would connect I would connect with everyone in here actually. Which ... It's quite impressive

now that I'm thinking about it - that he's connected with everyone,
yeah everyone wow!

I: and that would almost make two centre points wouldn't it?

R: So yeah actually yeah, actually it should be because we're living
together two years so it would make yeah, that's true, interesting
point.

S

I: So can you just tell me about it, and how you know the people,
and how you're connected to them? and why it's in this shape?

S: OK so... um...how I've done it is, I'm really close to my brother
and my Mum and Dad that's how I, sort of, started. Um... and my
uncle, who's my Mum's - brother, not a real brother I think they're
cousins, but like he... if I ever want some family gossip I just text
him, because he always is up to date with all of that. Um... I'm
also really close to my Grandma, which is my Mum's mum, so um...
yeah, that's my family bit.

But, um... at the same time, I'm equally close to three of my best
friends. Um... they're all in India ... so um... he's in Italy, but we
haven't met for the last um one year or so, so... but obviously we
text and Skype regularly. So these three are, like, my inner circle,

so I've put inner circle over there. How met them, all of them were my batch mates in my uni my undergraduate studies, um and she was my neighbour so we were neighbours for almost 4 years, so throughout my hostel time she was my neighbour. With Sharma it was kind of funny cos um, we only used to meet at parties and drink together, but we never had a conversation, like a sober conversation until we, er moved out of college and then we started meeting socially otherwise, and we kind of realised that we were like birds of the same feather so she kind of like became my best friend after college but she's sort of like part of the inner group. She introduced me to Sara, who was her friend, and Sara introduced me to Jojo her boyfriend at the time, but then later on him and I were working on project together so he became a better friend of mine than Sara. Um... since I've moved to London Lana and Risha have been like my flatmates, roommates of sorts so I'm kind of close to them now, even though I don't stay in the same house. So um... I kind of still hang out with them. Erm... Rohan, Gaurav they're again like friends from college, from undergrad, er... so back in India er... but I still talk to them regularly cos' they're kind of funny people, so.

Umm.. this is the three girls that I'm close to around here, in London, so then Sim, Loven and Rania, yeah the three girls here. We started off like having lunch together almost every day and its been six months so, we're kind of close, um and this is the rest of the uni group yes all of them yeah. And um my landlord, he is here so I live in eh same house as him so obviously... like he has the ground

floor and I take the first floor so obviously like yeah, has to feature in this and I met him on sparrow, so that's that. I think I missed someone though, yeah the yellow. She's gonna be my sister in law, my brother's getting married, well he's not getting married, but he's sort of engaged

S

S: So er, this is obviously me, that's my mum, met at birth, er... my brother. These are my really close friends... from back home, that I met when I was super young and I feel like they're my kind of grounding circle. Um... and these are the people I met at Uni here, um and for the blue ones I wasn't sure who to put because it's quite hard to differentiate between friends and people that you kind of put in an 'other' box. Even on Facebook I feel really bad, because I feel like i don't have 400 friends, I have maybe 20 friends and 400 people that should be in the 'other' box rem so I just put just to kind of illustrate that the annoying guy who serves coffee outside the tube station and er neighbour with the guinea pigs.

Yeah, my husband and my sister in law I put down as family because they're not... I dunno, partners felt a bit of a bizarre... label...for it. I mean I see them as family, so...

I think everybody has those like people that when... you kind of define yourself by in relation to, constantly even as you evolve you, you... kind of still, you know you keep checking if you're like doing

the right thing or not in comparison to these people and their opinions.

I: Can you tell me about their geographical distribution?

Ah, um...it is not, er on purpose... so, I just started because... I dunno it's the first thing I thought about the friends and then I put my mum there, then I felt a bit bad about putting her there because she's kind of far away and she's actually really close to me, and we get along really well so er... then I thought of moving her here but then the whole like thing didn't really work out, and I put obviously the people I don't know furthest away. I guess it's kind of like an epicentre thing and then just rolling out.

I: So do you think you would have put this one closer if you hadn't had so many rubber bands?

S: Yes, maybe yeah

I: D'you wanna move it? You can if you want.

S: Yeah but then I wrote the thing down.

I: It's OK just do an arrow, that's fine

S: I put probably her here, she's very close to me.

I: Wherever you want

S: See this is actually a very accurate representation of what happens in life, you know you just get swamped with all of these relations.

N

N: I went for a kind of geographical approach so I could see part of my life being here, part of my life being there, and the third part that's here, now in the UK. UK, Belgium, and my partner's from Taiwan, and I've spent a bit of time there as well, so that's the way it kind of goes. There's a bit of a country and France as well. I kind of felt it from last week because I came back to Belgium, and we could have meeting all the friends back in Belgium, friends I haven't seen for some seven or eight years so kind of re-building that kind of network as well.

I: Two of you?

N: Yes absolutely, yeah I think with, there's probably a bit of a... because of the language, when you're foreigners, there's probably a bit of a schizophrenia there. You know the friends? And I think somehow here the way they work is more about networking, the blue is stronger, the green is stricter there. I don't know if you have any experience similar to that?

I: Tell me about other, what are they?

N: So, the blues?

I: Yeah

N: The blues is students that I've been teaching over the year, you know, colleagues. The Ben, the Paul, the Baba the Romain, other people that I've been in contact through LCC you know you could put Kelly in there and other people like that.

I: So, this is geographical?

N: Yes, that's the island of Taiwan. That's where I met my er, my wife. So, it's kind of a, almost kind of a geographical approach, this kind of movement, there's a tension. There are friends there, so... it's just one friend that I put there, but it's the same ball of family friends that we have there so... yeah.

A

A: Do I link them up with any colour bands? It's like an interesting, er project. Yeah, so it took me a while to get my head, when I was looking at them I was thinking 'How can I relate to this? you know' so I'll just though Oh I'll just think of the first people that come into my mind, you know that are close friends, and people that I work with or people that I've worked with in the past who are friends.

So that's why I've got, some of them are very good friends but I've kind of worked with them like this guy I met him 20 odd years ago and we've been writing songs ever since, and this guy Keith, I met him at the same time and we worked together on different projects and they, did work together in a band but they don't see each other any more. This guy, I played in a band with him about 15 years ago, something like that, and we had this arm wrestling competition, and my arm broke and er, bizarrely, and er after that we became really really, best friends really. This guy, I met when I was living in Wimbledon and we... met in a.... a gym, and then we left the gym and then we just trained together in the street, running and that so he's a friend from there. Hero is a girl that I... make films with, and she's an artist. Yeah my Dad is a musician and a carpenter, not anymore he's retired but he lives in Peterborough where i was born and my brother's still there. And... Larissa was the love of my life, but she's er in Berlin and not with me so... Does that make sense

I. Yeah absolutely, we spoke a little bit about this earlier. Can you tell be about what's er...?

A: As she was a partner... at one point, so she's got the yellow... thing, and then... she's something else which I can't define, and she's a friend as well. And then...so some of these people are, like so Chris is like a good friend and we work together, and the same with Hero... and Keith. Have I linked Keith with a?... he's linked yeah they know each other and yeah so I need to link Keith to me as a friend, that's the final er... Yup.

I: So... when I conceived of this idea I thought I'll have to come and do this for myself and I discovered a few things because my social network is sort of a vague internal idea really, so my question now for you is... making it explicit in this way in a physical form, did anything emerge that was unexpected to you?

A: Erm, yeah I s'pose it was how certain people knew each other from.. in different ways. Like from it could have been through a project and then became friends. And then, like what I met this girl I was living in Wimbledon, and they became friends as well, and through the thing so yeah it was interesting to see who knows each other from the thing, and then nobody from Peterborough knows anybody from here ...

I: It's a bit of an island up there. And do you think it would have been different if you'd just done it with pencil and paper?

A: Yeah.. I think this makes, this is really good because it makes it into a piece of art, then in a way its kind of, it's a more yeah, it's tactile with the rubber bands and the coins and that. It's much nicer yeah and it feels good to link them up.

A: Yeah, I'm sure everyone has their own way of linking them up.

A

I: Do you want to start off by saying... You started with yourself and who was the next person you added on?

A: I've added the people who are most important for me right now. So this is me in the centre, this is my daughter, my partner.. so we live in a very tight relationship so, I was trying to mark the distance between my friends and people which I'm related to right now, and the intensity of the contacts. So, I also marked the relationships between my friends, and my family, my partner so yeah that's how it looks like.

I: You've numbered your friends around here...

A: OK so, first I marked the friend which I met here, I met her thanks to my partner Chris. And we quite often see each other because they live not far from here, they live here in London.

Then I marked my best friend Magda she lives in Poland in Wroclaw, our relationship now is not so intense and I regret that. Then I have another friend who I miss a lot this is Dorota we met very long time ago, and our kids are friends too, so I marked the relationship between them, and my daughter as well.

Yes here is my friend from the college Natasha, which is important to me and she is very supportive. Here a friend of my partner which is also very important, and my professional relationships like my

tutor Angus who helps me lead my projects right now, so we seeing each other quite often. And my co-worker in Poland, we cooperate online so its not so intense contact, but it is...

I: Did you find anything interesting when you were making it? like did you discover relationships you hadn't really thought of before?

A: I don't know maybe the intensity, that I was starting to think how the distance between my friends related to the intensity so when I moved here to London I lost this contact, it's not so intense even if we have internet and everything.

I: It's still harder to keep in contact

A: Yeah the relationship changed.

I: Thank you

A: It was a nice project thank you.

Appendix 3

Interview transcripts: Case study three

C

C: We were speaking about algorithm. An algorithm is something really abstract because in some way they are that much stuff, which you as user with your mobile device, or with your search query on a certain (...?) you have to hope that the algorithm solve your problem. But in fact algorithm is like a receipt, a sequence of procedure that your input data get processed to get some output. What we want to display is that algorithm, also if they can seem neutral, because they are just some code that are managing some input. IN the fact an the end they are not, they depend on the kind of input and they depend from who has developed the algorithm, which has been the bias of that developer, team, and company. So we made out a game.

I: Maybe if you could describe a bit more about the materials you chose, or were you quite limited by what was there?

J, A, L & H

L: No we just... I don't we needed to use many, it felt quite free. We had... so we were in the old cloud group and we had these bowls and we had these tubes and lots of tubes to use but we really didn't really think about he materials

Other observations like this one that we made, or how you experience the day something you thought this would be, other these are many questions at once but these are the questions in my head. Is this useful for work moving forward? Yesterday we talked about how you explain complex topics in simple terms can you use materialisation?

H: I feel that it can be useful for us, one is exhibition definitely, exhibition brainstorming because the kind of example we made has more value than hours of meetings because it made clear what you are thinking and the people can create a prototype and we can confront something that is concrete. Another aspect is that probably for us it has been a good exercise, but for some trainer that dedicate, not one hour on a specific task but one day, to that task cause that trainer in the next training has a tool to present concrete that are present the trainers and so it's something meaningful otherwise what we have done is just prototype - interesting, but this night we're gonna forget.

J: What I think what was really nice about this, is that it kind of defamiliarises these concepts that we work with everyday and allows you to reenter terms in a new way. I think that that's what's been primarily valuable about it for me

A: I would say the making of the image metadata was... that we did together.. was really interesting because it was just a very different

way to think about image metadata. The move to sound, to make it interactive. We were talking in our group that we think image metadata as being about visibility and invisibility but introducing structure, which is what the dodecahedron did that just takes it into another realm, which I know when I want to talk about image metadata next... you have new language now in which to do that depending on the person. From that sense it was really great for me.

A: I think I had the same with the profile and the cloud was quite funny, both right away said "we're not doing anything with the cloud" so how can you materialise the cloud if you don't talk about the cloud? I thought it was super interesting to think about concepts like swarm and motion and also when we started with the profile, we started with the characteristics first...

J&K

I: OK so, I guess first just sort of tell me a bit about what you have done, and where did you start from?

K: Erm, so we wanted to make an object for a profile, what does a profile mean? and I think we started with, sort of, what are the characteristics of a profile? and what are the characteristics that we wanna to like come back in the object or the artefact. And I think um... I have some sort of characteristics here that we wanted to

encapsulate, and one was erm, there's an element of danger in it. We got triggered by the magnets because they were dangerous, but also because there's an element of danger in it in in profiling because it can be used for good and for bad. But you don't know it and you can't control it. It's complex erm... someone else creates it, so you don't create it but somebody creates it - an algorithm er... It has predefined fields, like your name, your birthday, for instance, things that you put in there yourself. Then er... it doesn't have to be true so the example I gave... so I can have a profile with a company that says like I'm two feet tall, African American and like 50 er.. and still this a profile that is attached to me and doesn't have to be true er.. its really quantitative, so its created by a lot of data and its very fluid.

I: So you talked a bit about um... using the fact that magnets were dangerous in the design. How have you used the materials?

J: So we had like um... obviously a lot of things... going on here. So this, the magnets really sparked a lot of ideas, in addition to being dangerous they're obviously highly magnetic, which means that they stick to each other, and to like, this copper wire so this is kind of our starting point. And what we configured here is that the copper wire essentially is representing the infrastructure um... of the profile itself so it's something that um... many different kind of infrastructures are laced into each other to create this superstructure, um and on that superstructure these corks attached to the magnets

kind of can move, um... and.. the

K: the different data points,

J: exactly, different data points and they're different shapes because different data is collected so like names, images this kind of stuff, and this felt which is like much more malleable and soft, is representing the actual profile um... so its attached at the data points and then it kind of like veers out wildly um... and that can be said to be because of extrapolation or because people don't really fit on this kind of sharp infrastructure and the coins are representing for different type of data collected. Do you wanna...?

K: Yeah, so for the green is the active part, so the things we fill in ourselves really knowingly, like if you create a Facebook account it's your name and your birthday, and things like this, or you email or you give for instance your previous email or your phone number, so these is really active data. The blues are metadata so these are things you give out unknowingly, so it can be your location data, it can be your IP address, it can be date, time stamp - things like this. Then the yellow pins are noise, so infrastructure also creates data, this is what we call noise and its something you can't control and it er... gets attached to your profile and the red is inferred data. So its like um... because we now are all in tactical tech, our location is at tactical tech they might say we are all like an activist for instance and they stick that to our profile. So these are the different things

and er.. we also things and er... we also thought like, it would be nice to have... two profiles. So the sort of the soft material, the green is one person, and the yellow is another person and depending like, people can also play around with the data points because it moves around the infrastructure, so you get a different thing. You can stick new pins in it, but it also connects, and it usually connects either at inferred data or at meta data level but we have like currently have inferred data because it's where the profiles get together.

J: Right. So like, we would both be on this point as left wing activists.

K: Yes, yeah.

I: So um, yeah, I kind of want to talk about like, the, what the difference in materiality makes to exploring this idea of profiles. You've talked a bit about the magnets being movable, and stuff the pins, so what difference do you think it being a physical object makes, as opposed to a paragraph of writing about or a drawing for example?

K: Well a) it's way more fun! and you can sort of instead of like a paragraph or a drawing, you can show things that otherwise you have to read. Like, I would like if people started experimenting with it, like moving it along and sort of get a feel of how sort of these things happen, that if you could write, would take you maybe three pages to write - this is one viewpoint.

K: Yeah, and I also think that like, in terms of really like, connecting and generating more ideas I think that this is great, right? If you're writing you're obviously come up with new ideas as you go along but this is framing what you're talking about in a different way, which might like, lead you to make different metaphors or um... to think about things like, um... adjacent to each other in a way that you wouldn't if you were writing, yeah.

J: And for me it also sort of shows the complexity and scale of things. Let's say that we had infinite number of these bolts and sort of the wire we could make a gazillion profiles, and it looks super complex but then yeah it shows like the scale and the quantifiable side of things.

I: What about if you took this object to a different context, so, I dunno in a really tiny village somewhere, a poor kind of place or... somewhere completely different where we are now, how do you think people might react to it? Do you think you could explain it to them in a similar way?

K: I think they would say what a beautiful object! I dunno. um... it's hard because we're obviously we're like pretty specialised in all of this so like these ideas that we're dealing with I think make sense to us particularly at this point - what do you thin about sharing this?

J: I think about sharing it, I think what people might find difficult is that it's super abstract. I mean a profile people might would about a face or something else that would hit home closer. It's really hard to explain the concept profile and I think for people in a small village, like say a small village in Tanzania, this would completely not hit home because you first have to explain like other things like data and we talk about meta data like, oh meta data! But meta data is already a really complex issue. So this is constructed of a lot of complex issues, and I think a way to materialise that could be like make it more identifiable, like a face for instance or like a house or yeah, something like that.

I: So do you think if we had maybe different materials you could.. make it better?

K: Maybe but I also think that the audience that you're making it with like I think that with these materials you could make a appropriate object for a different audience, but you would have to go on making it with that audience in mind.

I: erm... yeah so one final thing is just like er... do you think this kind of process is a good... or how do you think it might be a good way of this kind of introducing new kinds of metaphors? Because often, I mean, like you mentioned, like a house or a face are quite kind of typical metaphors for a profile is this a way of a lateral way of finding a different way to talk about it?

J: I think this may be the like, if you in a way the process would, but then I think, I would think it would be interesting to experiment with ways, if you like, if we had a constraint on the material, but not completely. But if you predefine some of these pins, like say these pins are a specific type of data, and er.. so that it becomes more intuitive for people who don't know what a profile is to work towards what something complex is. Like another thing could also be a spider web you could then still make other sorts of metaphors, but I think maybe predefining what some of these things what some of the characteristics are might make it easier.

K: Yeah and again that's dependant on audience right?. Like, if you're working with other people in the sector who are already very familiar with this, maybe like, I feel just by working with this we could get some other metaphors out of it.

I: OK can you show me a bit how you can interact with the piece?

K: Yeah so, I mean these can move up and down, and... the one that is attached to both kind of therefore manipulates the shape of both of these profiles um.. and I think what's interesting about moving it too is that the two profiles cross each other in different ways if you move it differently you know? It would be easy find different connections.

I: And the.. structure itself, like can you move that around?

K: Yeah so the structure itself also changes, and... um J said a nice thing where different... it was the structure is the infrastructure that the profiles exist on. Companies are always coming in and out of business also changing the landscape. And it's nice showing that they move in relation to each other so nobody has like meta control over all of the movements they're all pretty like co dependent.

K: So, these magnets are movable on this, kind of, infrastructure of different profiles and um moving them means that the shape of the profile changes and also that the two profiles relation to each other also changes.

P

I: So tell me a bit about it

P: Well, so this is similar to J's idea with the um... where you look into.. into something and see something else. So its a zoetrope. So I just put it onto a paintbrush with a CD um... so I tried to think what was around me and what might be around other people. So paintbrush, CD, and then just, card that I cut out and then in the inside I put theses numbers so you see 1,2,3 and then there's also a cartoon strip that's kind of on repeat, so the cartoon strip is meant to align with the numbers, so when you look through it, you can kind of see a bit of a story, but not the whole story, So this is meant to be the meta data and this is meant to be the, the content, so you

always see the meta data but you don't always see the whole story, you just see bits of it. And then I just put a torch in cos I thought it looked cool!

I: You improvised quite a lot with the materials, tell me a little bit more about how you wanted to make it something that everyone could produce.

P: I thought maybe this would be fun for workshops and also for travelling to workshops because sometime when we go to workshops we can only take hand luggage so I thought about how I could make it with the stuff we have here. I wanted to use material that was assigned us because we had quite cool things but um... I just couldn't think of anything. But I like the black, I really like the black look, I think it looks quite suave and there were some black things there so I just carried on with the black theme. And... and then I've actually done this before once before with an Arduino, and so the CD idea, there's this motor, and then you can plug it to an Arduino and push a button and it rotates a certain way - so a very simple Arduino project so that's where I got the CD idea from.

I: So do you think maybe you could adapt the idea if you had different materials or resources around you?

P: Yeah I think it could look a lot better, and also I was thinking maybe it would make more sense as well to have that, you know the

bird in the cage one? it's a very simple game where you have the bird on one side, and then the cage in the other, and then have a string and then you tighten the string, and the bird looks like it's in the cage. I just made it with this but I'm sure you could make it with anything and make it look better.

I: It's lovely as it is!

P: No, I think this could make more sense um... as a... I suppose I just wanted to think of a game that people were also familiar with in other places. I don't know if that's true, I know the bird on a string thing is a common thing I think globally, I don't know about zoetropes. But it's quite similar to the whole idea of looking through metadata to see the content.

I: Yeah so, how do you think that metaphor might be, help to explain what metadata is all about?

P: I think for meta data for most people is seen as like extra add on information but its not the kind of, the crux of the issue. I think what I like about this and what I like about J's thing is that it's putting meta data at the forefront. It's saying metadata is the important thing and the rest of the stuff is kind of glimpses of reality, but this is what's important and this is what er... people are looking out for whether it's government agencies or whoever. And so that's why I like looking at things through the eyes of metadata and having

metadata be at the forefront um.. so that people stop thinking of it as a kind of after thought and start er... experiencing it in real life. And I was thinking you could have, so similar to how he has it, you could have it labelled different ideas so like location or exif or camera angle or whatever. And so the you could start having an idea of the different lenses of metadata you could look through.

I: And what about the process you made it by cos in your group you sort of did three separate things. How do you think, do option its easier to work on your own? or is it, getting the ideas from other people, does that work? what do you think is the optimum group number?

P: I think I prefer working in groups, and I think its more fun to work with others. So, I think three is a really nice group number, three or four. Our process was um... yeah I don't think ideal, um and I think next time if we're in the same team then we'll work on our own projects together. Um... and I think there's... but I think for this one... after we realised that we would do separate things, that this was just like... OK well I could just make this, and at least produce something.

I: Yeah

P: But I really like the other ones that made like the more communal sculptures. I think the other ones are quite scupturey, I think that

they would look really good set up already, and what I wanted to make was an actual object for people to yeah... handle and to play around with and that they could also replicate rather than, maybe more like a process, rather than a... make a finished sculpture.

I: Do you think you will be influenced by what other groups have done in your next project?

P: UM... I think definitely, yeah I really like this... your group ha ha! um because I think it was important and I think maybe this is where we should have, we went a bit wrong at the start where we.... I like that your group sat and had a list of all the important things that they wanted to have. And everything, all the data points made sense, and everything was colour coded and it all fed back into a big idea of what um of what you were trying get across. And then I like the bio tech one yeah I like the idea of humanising something that we can understand. And then. yeah maybe actually the cloud one was my favourite, because instead of going to that whole cloud metaphor that's inaccurate... acknowledge the fact it's inaccurate and then have, have it as like a.. a kind of fake, kind of what's the word? mirage of reality and then have the actual way it functions underneath. I think that's really cool.

I: How do you think materials help create new metaphors? The obvious one for a cloud is the white fluffy cloud, but when you materialise it how do you think that changes?

P: I think um... going to the material shop yesterday was really um... interesting for me because I think with the cloud we were stuck because it was so obvious to want to have fluffy white things like we had balloons we had loads of things... but the problem... we realised we shouldn't have any of those things because it was going influence people to much to continue that tired metaphor. And I think that, especially in the privacy world, there's a lot of really really tired metaphors and visuals, and I think that's because... and I think that's starting to change when more artists and more graphic designers and... security people are working on this. And I think we need better metaphors and better visuals, because if you look at the visuals to describe privacy they're like very er... similar to each other. So you're going to have binary codes, padlocks um... eyes. Eyes with Facebook in them is very popular, like CCTV cameras, and then you just repeat that over and over again and I think it's really basic the visual (kind of) metaphors for privacy.

I: So using these abstract materials is quite a good way of having to think about it in a different light?

P: I think so and I think not having obvious ones was essential. So, by having the bio stuff, the food colouring, the tubes and stuff, it was obvious that that would, that they had go away from something more like a list or more, like, how you would imagine an algorithm to look, I think that was very cool. I mean the only problem is that's one line of enquiry and then they've... you've kind of alienated all

the other ones. But yeah I thought it was an interesting... And I think by having J's already done object there, that would influence us as well and there was a lot of kind of lights and there was Christmas tree lights and torches and so I think that would influence us... and a lot of reflective surfaces to think about this smoking mirrors metaphors

I: Do you think it was good to have J's example there already, or do you think that maybe influenced you too much, or constrained you?

P: It didn't the others, so I don't know if, as a group, you could say that it influenced the whole group. I, only cos no one else was focusing on it I knew he was interested in seeing how that could useable and um... I like the idea of looking through something. But I think obviously you can't replicate very easily what he did at all and so that's why I thought of this idea, but I don't think it influenced the others so I don't think you can say it unduly influenced us.

V

I: So could you start telling me about what your theme was and what you've done?

V: Yeah, our theme was the cloud... and we basically came up with, with a list of what the cloud means and what the implications are, and upon describing it realised it that the cloud is this kind of

ephemeral visceral you know, image that's very strong in peoples' minds so in our creation here we decided to create the this tower that is this um.. kind of fancy representation of what a cloud is but in reality the structure of a cloud it's kind of happening elsewhere and it's really not what we perceive to to be.

I: Mmm Hmm OK, so um ... you talked a bit about the cloud being quite an obvious metaphor, how do you think using these different objects and materials has reinterpreted the metaphor or made a new metaphor maybe?

V: Yeah I don't know if we made a new metaphor but the idea was to kind of make it as attractive and as high, and you know, it kind of detracts from what's really happening and what's really happening is that you have these corporations who are kind of, selling you this idea of security, and this idea of saving data eternally, and this idea of privacy when in reality things are quite transparent, so you may have these users, these individual who are funnelling their information through a service provider, or company, and in reality the information is being stored in these.. different servers in very particularly political geographic locations. So this idea that the cloud is not geographic and is across borders is actually a false notion and so that's what we were trying to address here. Se here we have a server in Berlin, and here we have a server in Silicon Valley. The idea being that day is controlled through a political means. But also not just that, the data is actually not as private as

users think it is, it's transparent.

I: Yeah

V: So it kind of links up these transparent domains, attempting to relay that issue.

I: OK, and, for instance, lets say you'd had the same task but you... were told to do a drawing, or write a paragraph about what the cloud meant, how do you think that might have been different to what you've done here?

V: I mean, I think it would have been different in the sense that you wouldn't have been able to use as many metaphors in a way, to visualise certain concepts. So if we had to write it, which is how we actually we started the process, is coming up with a list of things, a list of adjectives that describes the cloud is, um... and that only takes you so far because you can't then imagine what that structure might be. And so I think what these objects allowed us to do is to visualise it in a way that a two dimensional space doesn't allow you to visualise it. Um .. and so for example this idea of separating what the perception of the cloud is, versus how it really functions allows you to work in these kind of two levels to address these different perceptions.

I: And so lets say you... Do you think using these materials is maybe a more transferable way of explaining something? If you were trying

to explain the concept of the cloud to different people do you think this is a good way or a bad way of doing that?

V: Oh it's definitely a good way! I mean, I think anytime you have something that's hands on, and that's also movable, and touchable and tactical, it allows for these other modes of understanding and so that can only be a good thing.

I: Definitely. Do you think it was good to work in a team, how many people were in your team and do you think that was a good way of doing it?

V: Oh yeah, of course.

I: Do you think it would be better with more people? Or less people?

V: We were working with three people, and I think that was a manageable size which was quite nice, we are all throwing in our own ideas. But also um... coming up with ideas as we're working on it, so it wasn't a fully fledged thought-out process. And I think that's what was... as a learning process that's what's nice about it is that you can kind of change ideas, come up with new ideas. And then also the fact that you're given these kind of random materials, to then fit into a narrative allows you to think in a way, that if you had too many materials to work with maybe would be overwhelming, or just a piece of paper and a pencil, would not allow you to explore

certain things.

I: Do you think if you had equal number but of different materials, Do you think there could be better materials? or for example this dome is not a very commonly found object do you think maybe using everyday materials, or anything different that came to mind would be better?

V: I don't think it would be better or worse um.. I just think that it's kind of nice to be handed a specific amount of matter that you then have to be creative with. I think if we had other materials we could also work with them, but I think we would have come up with something different. So that was the fun thing about having parameters within which we were working.

I: Maybe you can go into a bit more depth about what's going on here with this felt and the pom poms here?

V: The pom poms represent um... the initial point with the users and their data, and this is their end point where they're being saved and so you have these kind of back ups um... of servers that represents the cloud of where the data is being saved. So the idea is that it's not, kind of, this ephemeral, you know data is just floating in the air, it actually does go somewhere specific, and actually probably more than one place. That is being controlled by a particular um... entity. So these little balls just represent this transfer of data that they're being saved elsewhere, and that there's always a mediator.

And I think that's one thing that people often forget as users is that they're saving data somewhere and thinking its a very personal and private transaction when in fact there's always mediator.

I: Is there anything, having finished it, you would change about the design of your piece?

V: I mean think it actually visualised quite clearly what it was that we were after. I mean, I think there is a million ways in which we could visualise it. This is just one, but I think it's quite nice...

Appendix 4

Consent forms and information sheets

BROWSER STORIES

You are being invited to take part in a research study. Before you decide whether or not to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully.

The purpose of the project is to ask the question: What new understandings might emerge from the narrative arrangement of the browser history list?

In the context of this project I'm interested in asking the questions: How do people see their browser behaviour? Can a narratively organised account change impressions of what we do online? How do personal accounts of browsing differ from algorithmic accounts? How can browser history be shown as a visual story?

Do I have to take part?

It is entirely up to you to decide whether or not to take part. If you do decide to take part, you will be given this information sheet to keep, and be asked to sign a consent form. If you decide to take part, you are still free to withdraw at any time and without giving a reason.

What will happen to me if I take part?

If you agree to take part, you will be asked to visually represent a part of your browser history list.

What are the possible risks and benefits of taking part?

Possible risks of taking part in this project are the provision of your personal browser story to the researcher. Every appropriate measure will be taken to ensure your personal contribution remains anonymous or confined to the limits of the research project. Possible benefits to the individual include a greater understanding and awareness of online behaviour and browsing activity.

What should I do if I want to take part?

If you want to take part you should sign and return the attached consent form.

What will happen to the results of the research study?

The results of the research will be used in a doctoral level thesis. The relevant degree is a PhD by project. There is a chance the thesis or sections of it will be published at sometime in the future, and in such case, all attempts will be made to distribute copies of publications to participants and ensure their consent in publication of the data.

Who is organising and funding the research?

I am conducting the research as a student at Royal College of

Art, London. The research is funded by the Arts and Humanities Research Council (AHRC) a national funding body.

Contact for Further Information

Please contact John Fass (info@ied.rca.ac.uk) for any other information related to this research project. If you have any concerns about the way in which the study has been conducted, you can contact the Chair of the University Research Ethics University, Royal College of Art London

Thank you for taking time to read this information sheet, your participation is greatly appreciated and valued.

Date

25/02/14

Information sheet case study two

SOCIAL NETWORK MODELS

You are being invited to take part in a research study. Before you decide whether or not to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully.

The purpose of the project is to ask the question: How can physical social network models show the quality and extent of personal social connections?

In the context of this project I'm interested in asking the questions: How do people see their social networks? Can a narratively organised model of social connections contribute to planning decisions? How do personal accounts of social connections differ from algorithmic accounts? How can social connections be shown as an annotated physical story?

Do I have to take part?

It is entirely up to you to decide whether or not to take part. If you do decide to take part, you will be given this information sheet to keep, and be asked to sign a consent form. If you decide to take part, you are still free to withdraw at any time and without giving a reason.

What will happen to me if I take part?

If you agree to take part, you will be asked to show and explain how six people in your network are connected to you.

What are the possible risks and benefits of taking part?

Possible risks of taking part in this project are the provision of your personal social network to the researcher. Every appropriate measure will be taken to ensure your personal contribution remains anonymous and confined to the limits of the research project. Possible benefits to the individual include a greater understanding and awareness of social connections and influence on planning decision making.

What should I do if I want to take part?

If you want to take part you should sign and return the attached consent form.

What will happen to the results of the research study?

The results of the research will be used in a doctoral level thesis. The relevant degree is a PhD by project. There is a chance the thesis or sections of it will be published at sometime in the future, and in such case, all attempts will be made to distribute copies of publications to participants and ensure their consent in publication of the data.

Who is organising and funding the research?

I am conducting the research as a student at Royal College of Art, London. The research is funded by the Arts and Humanities Research Council (AHRC) a national funding body.

Contact for Further Information

Please contact John Fass (info@ied.rca.ac.uk) for any other information related to this research project. If you have any concerns about the way in which the study has been conducted, you can contact the Chair of the University Research Ethics University, Royal College of Art, London.

Thank you for taking time to read this information sheet, your participation is greatly appreciated and valued.

Date

23/03/14

Information sheet case study three

BACKGROUND RELATIONS

You are being invited to take part in a research study. Before you decide whether or not to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully.

The purpose of the project is to ask the question: What are the characteristics of artefacts and activities whose purpose is to reveal understandings of digital experiences?

Do I have to take part?

It is entirely up to you to decide whether or not to take part. If you do decide to take part, you will be given this information sheet to keep, and be asked to sign a consent form. If you decide to take part, you are still free to withdraw at any time and without giving a reason.

What will happen to me if I take part?

If you agree to take part, you will be asked to model a sequence of different themes including; personal digital profiles, image metadata, cloud storage, and algorithms.

What are the possible risks and benefits of taking part?

Possible risks of taking part in this project are the provision of your ideas about your own digital experiences to the researcher. Every appropriate measure will be taken to ensure your personal contribution remains anonymous or confined to the limits of the research project. Possible benefits to the individual include a greater understanding and awareness of digital experiences, and increased knowledge about training activities.

What should I do if I want to take part?

If you want to take part you should sign and return the attached consent form.

What will happen to the results of the research study?

The results of the research will be used in a doctoral level thesis. The relevant degree is a PhD by project. There is a chance the thesis or sections of it will be published at sometime in the future, and in such case, all attempts will be made to distribute copies of publications to participants and ensure their consent in publication of the data.

Who is organising and funding the research?

I am conducting the research as a student at Royal College of Art, London. The research is funded by the Arts and Humanities Research Council (AHRC) a national funding body.

Contact for Further Information

Please contact John Fass (info@ied.rca.ac.uk) for any other information related to this research project. If you have any concerns about the way in which the study has been conducted, you can contact the Chair of the University Research Ethics University, Royal College of Art London

Thank you for taking time to read this information sheet, your participation is greatly appreciated and valued.

Date

05/04/15

Consent form case study one

I understand that I have given my consent for the following to take place: to visually represent my browser activity and be filmed or photographed whilst doing so.

I understand and have had explained to me the appropriate health and safety procedures for my part in this research.

I understand and have had explained to me any risks associated with this activity.

Data Consents

I understand that I have given approval for my participation data to be published publicly online, exhibited in the final report and outcome of this project and may be used in future reports, outcomes and exhibitions.

I understand that my involvement in this study, and particular data from this research, will remain strictly confidential. Only the researchers involved in the study will have access to the data. It has been explained to me what will happen to the data once the experimental programme has been completed.

Statements of Understanding

I have read the information leaflet about the research project, which I have been asked to take part in and have been given a copy of this information leaflet to keep.

What is going to happen and why it is being done has been explained to me, and I have had the opportunity to discuss the details and ask questions.

Right of withdrawal

Having given this consent I understand that I have the right to withdraw from the programme at any time without disadvantage to myself and without having to give any reason.

Statement of Consent

I hereby fully and freely consent to participation in the study which has been fully explained to me.

Consent form case study two

I understand that I have given my consent for the following to take place: to physically model my social network and be filmed or photographed whilst doing so.

I understand and have had explained to me the appropriate health and safety procedures for my part in this research.

I understand and have had explained to me any risks associated with this activity.

Data Consents

I understand that I have given approval for my participation data to be published publicly online, exhibited in the final report and outcome of this project and may be used in future reports, outcomes and exhibitions.

I understand that my involvement in this study, and particular data from this research, will remain strictly confidential. Only the researchers involved in the study will have access to the data. It has been explained to me what will happen to the data once the experimental programme has been completed.

Statements of Understanding

I have read the information sheets about the research project, which

I have been asked to take part in and have been given a copy of this information leaflet to keep.

What is going to happen and why it is being done has been explained to me, and I have had the opportunity to discuss the details and ask questions.

Right of withdrawal

Having given this consent I understand that I have the right to withdraw from the programme at any time without disadvantage to myself and without having to give any reason.

Statement of Consent

I hereby fully and freely consent to participation in the study, which has been fully explained to me.

Signature

Consent form case study three

I understand that I have given my consent for the following to take place: to physically model digital phenomena and be filmed or photographed whilst doing so.

I understand and have had explained to me the appropriate health and safety procedures for my part in this research.

I understand and have had explained to me any risks associated with this activity.

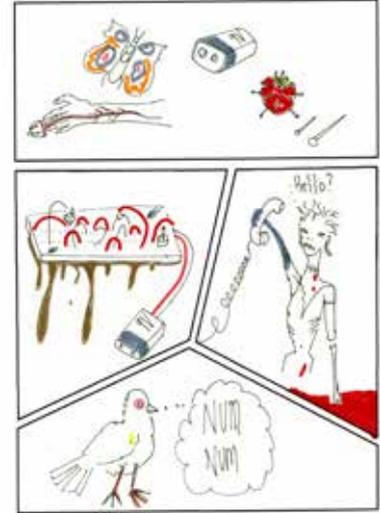
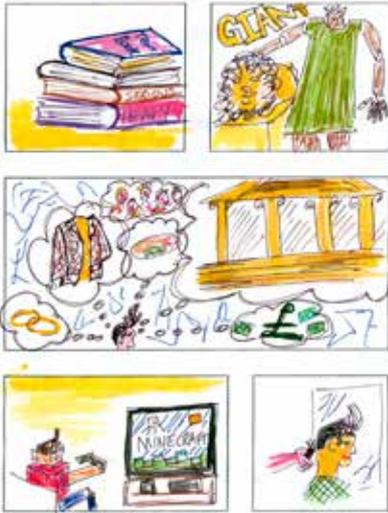
Data Consents

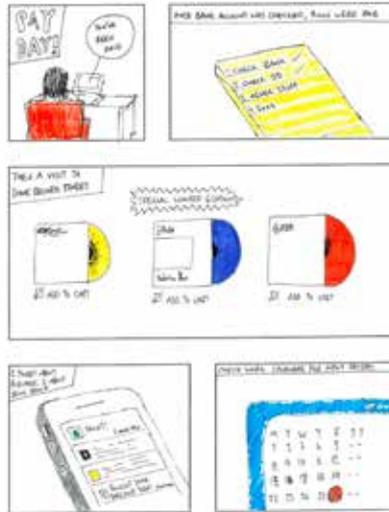
I understand that I have given approval for my participation data to be published publicly online, exhibited in the final report and outcome of this project and may be used in future reports, outcomes and exhibitions.

I understand that my involvement in this study, and particular data from this research, will remain strictly confidential. Only the researchers involved in the study will have access to the data. It has been explained to me what will happen to the data once the experimental programme has been completed.

Appendix 5

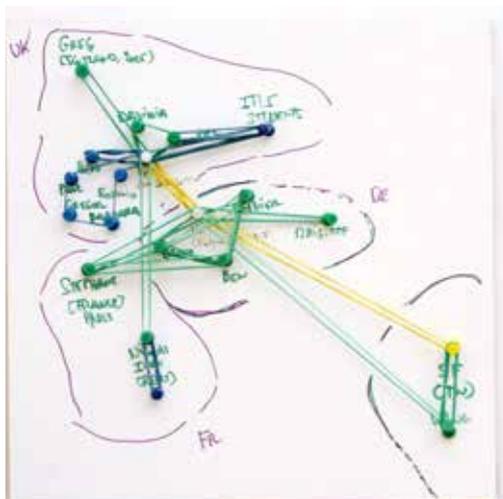
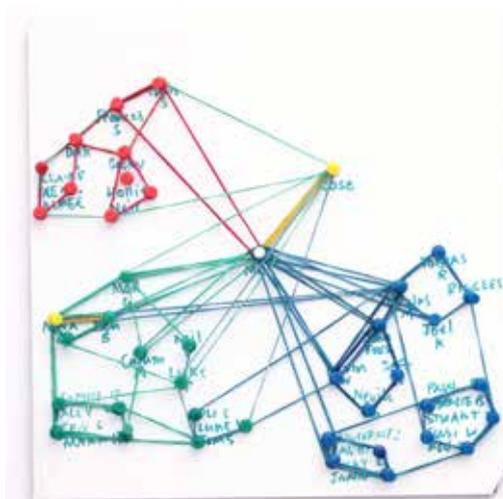
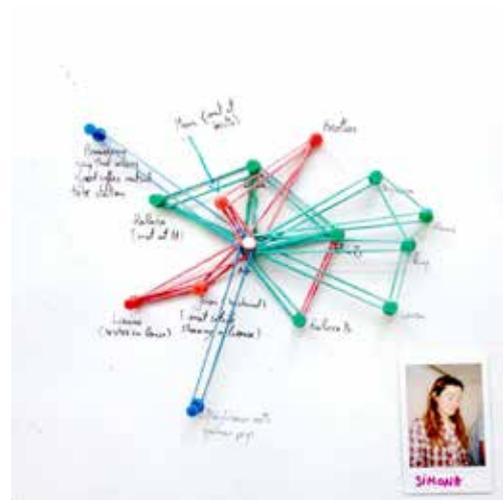
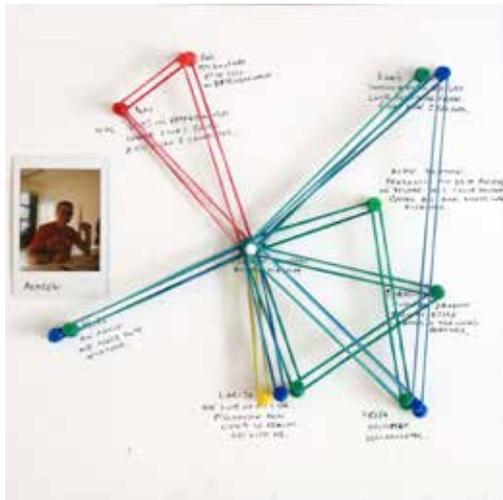
Browser history comics

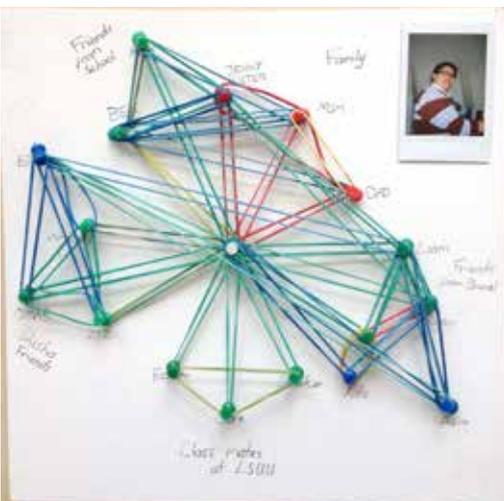
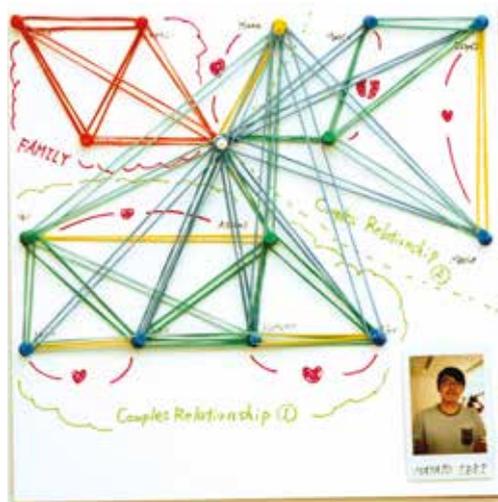
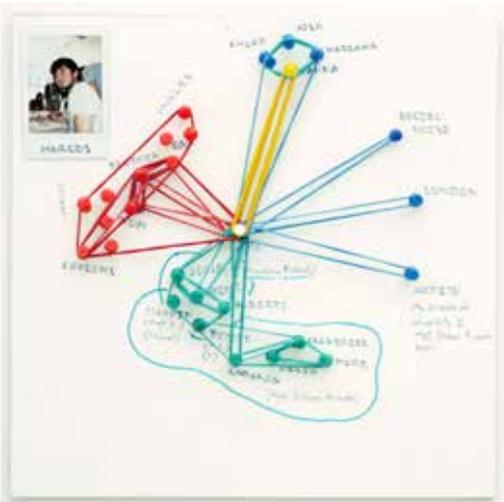
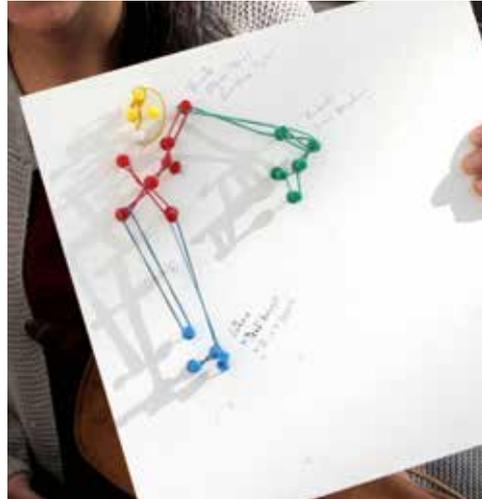
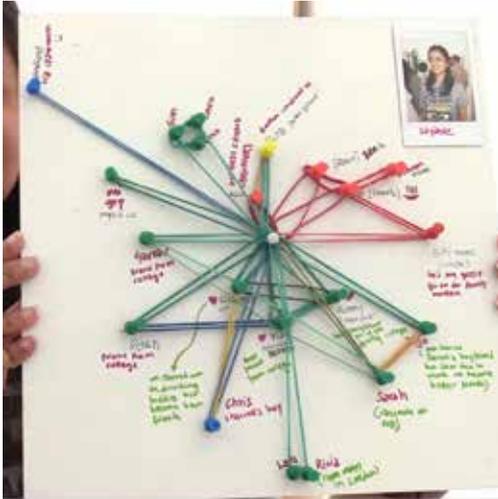




Appendix 6

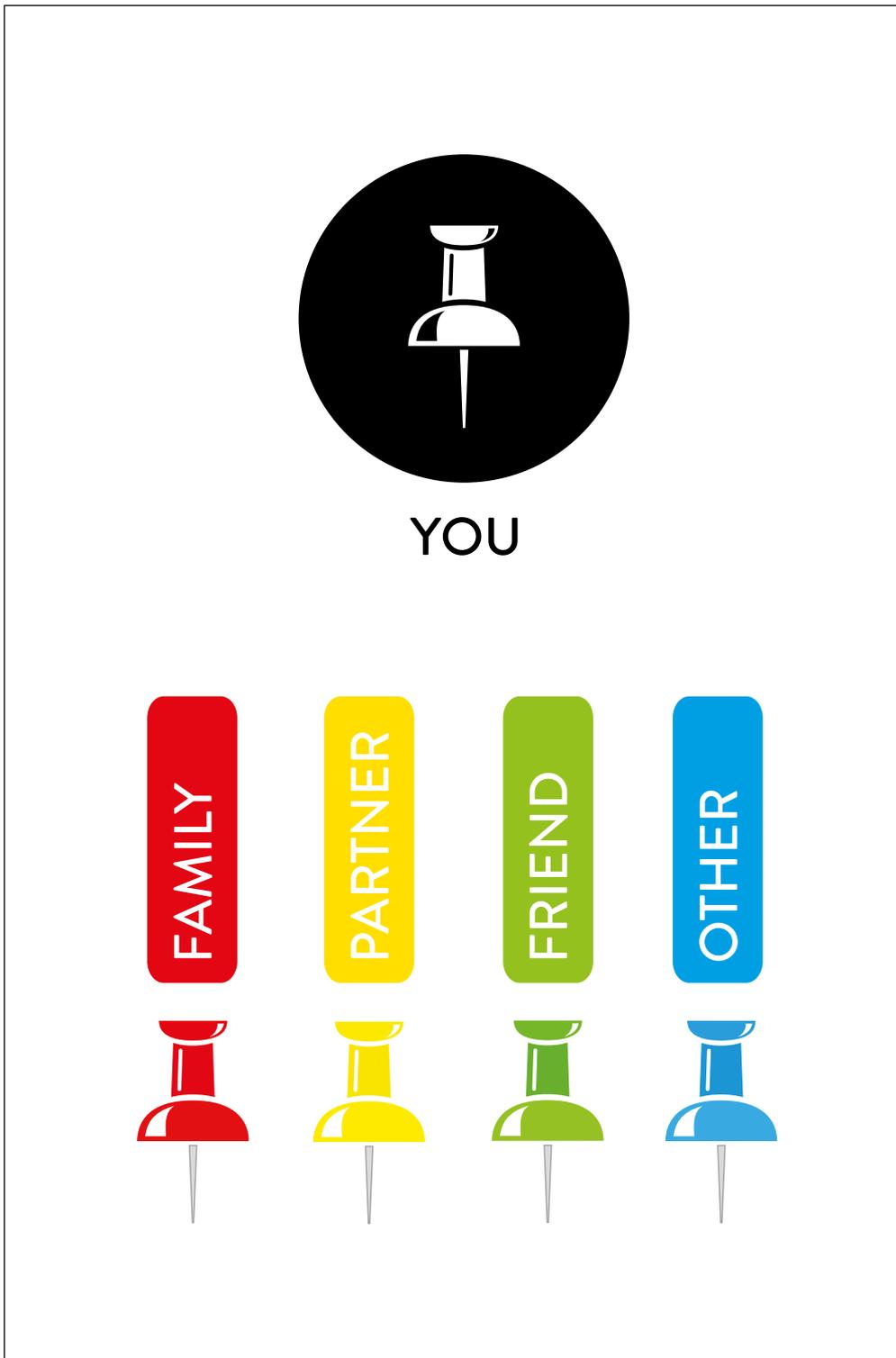
Social network tiles





Appendix 7

Key to materials, case study two.



Appendix 8

List of publications

Fass, J. (2016) Self Constructed Representations, Design Research in Participatory Situations, Cumulus Hong Kong.

Fass, J. (2014) Physical Social Networks and Visualisation. Death of the Desktop workshop at IEEEVIS 2014.

Fass, J. (2014) Control and freedom: Designing for autonomy. Proceedings of CHI 2014, Toronto, CA.

Fass, J. (2014) Telling about browsing. Proceedings of CHI 2014, Toronto, CA.

Fass, J. (2014) Networks, Correspondence, And Browsing: Making Sense Of Digital Experiences, NordiCHI 2014.

Fass, J. and Walker, K. (2013) Robotic displays based on de-computation. Proceedings of CHI 2013, Apr 2013, Paris.

Fass, J. (2013) Stuff, self and stories: Designing digital social life. Proceedings of CHI 2013, Apr 2013, Paris.

Fass, J. (2012) Designing for slow technology: Intent and interaction. DIS 2012.

List of references

A

Ageh, T. (2015). Digital public space. <http://thecreativeexchange.org/launchpad>. Accessed, 8/08/2017

Adami, E. (2013). A social semiotic multimodal analysis framework for website interactivity, National Centre for Research Methods Working Paper, 2013.

Alben, L. (1996) Quality of experience: defining the criteria for effective interaction design. *interactions*, 3, (3).

Allcott, H., & Gentzkow, M. (2017). Social media and fake news in the 2016 election (No. w23089). National Bureau of Economic Research.

Altaboli, A., & Lin, Y. (2011). Investigating effects of screen layout elements on interface and screen design aesthetics. *Advances in Human-Computer Interaction*, 5.

Anderson, J. R. (1978) Arguments Concerning Representations for Mental Imagery, *Psychological Review*, 85, (4).

Anton, A., Earp, J. B., Young, J. D. (2002) How internet users' privacy concerns have evolved since 2002 , *IEEE Security & Privacy*, 8, (1). IEEE.

Ardito, C., Buono, P., Caivano, D., Costabile, M. F., & Lanzilotti, R. (2014). Investigating and promoting UX practice in industry: An experimental study. *International Journal of Human-Computer Studies*, 72, (6), 542-551.

Armstrong, H, Stojmirovic, Z. (2011) *Participate*, Princeton Architectural Press.

Aviz

<http://dataphys.org/list/harry-potters-social-network/> accessed 29/11/2014

Ayers, E. Z., Stasko, J. T., (1995) Using Graphic History in Browsing the World Wide Web, Gvu Technical Report, Georgia Institute of Technology.

B

Bagnoli, A., (2009) Beyond the standard interview: the use of graphic elicitation and arts-based methods, *Qualitative Research*, (9), 547.

Batada, A., & Chandra, A. (2003). Shifting the lens: Utilizing a multiple method approach to explore perceptions of stress and coping among urban African American adolescents. Baltimore, MD: Bloomberg School of Public Health, Johns Hopkins University, November.

Baird, D. E., & Fisher, M. (2005). Neomillennial user experience design strategies: Utilizing social networking media to support "always on" learning styles. *Journal of educational technology systems*, 34, (1), 5-32.

Bauer, M. I., & Johnson-Laird, P. N. (1993) How diagrams can improve reasoning. *Psychological Science*, (4), 372-378.

Bauman, Z., Bigo, D., Esteves, P., Guild, E., Jabri, V., Lyon, D., & Walker, R. B. (2014). After Snowden: Rethinking the impact of surveillance. *International political sociology*, 8, (2), 121-144.

Bazely, P. (2013) *Qualitative Data Analysis*, Sage Publications.

- Benford, S., Giannachi, G., Koleva, B., & Rodden, T. (2009). From interaction to trajectories: designing coherent journeys through user experiences. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 709-718. ACM.
- Bennett, J. (2010) *Vibrant Matter*, a political ecology of things, Duke University Press.
- Besançon, L., Issartel, P., Ammi, M., & Isenberg, T. (2017). Hybrid tactile/tangible interaction for 3D data exploration. *IEEE transactions on visualization and computer graphics*, 23(1), 881-890.
- Binder T., Brandt, E. (2008) The Design:Lab as platform in participatory design research, *International Journal of CoCreation in Design and the Arts*, 4, (2).
- Bird, S. E., & Dardenne, R. W. (1997). Myth, chronicle and story. Social meanings of news: A text-reader, 333-350.
- Bloomberg, L. D., Volpe, M. (2012) *Completing Your Qualitative Dissertation*, Sage Publications.
- Blandford, A., Furniss, D., & Makri, S. (2016). Qualitative HCI research: Going behind the scenes. *Synthesis Lectures on Human-Centered Informatics*, 9, (1), 1-115.
- Blythe, M., Monk, A., Park, J. (2002) Technology biographies: field study techniques for home use product development. In: Ext. Abstracts CHI ACM Press.
- Blythe M. (2004) Pastiche Scenarios, *Interactions*, 11, (5) Special Issue: More Funology.
- Brandt, E., Grunnet, C. (2000) Evoking the future: Drama and props in user centered design, Proc. Participatory Design Conference.
- Brandt, E. (2007) How Tangible Mock-Ups Support Design Collaboration, *Knowledge, Technology & Policy*, Vol. 20, No. 3.
- Braun, V., Clarke, V. (2014). Thematic analysis, In *Encyclopedia of critical psychology*, 1947-1952, Springer New York.
- Brereton, M., McGarry, B. (2000) An Observational Study of How Objects Support Engineering Design Thinking and Communication: Implications for the design of tangible media, Proc. CHI '2000.
- Briscoe, G. Lockwood, J. (2013) Creative Gardens, The Knowledge Exchange Conference Queen Mary University.
- Brody, N., Fass, J. P. (2014) Digital Public Space and the Creative Exchange A human-centred approach to the common good, Proc. ICTVC.
- Browseback*
<http://browseback.en.softonic.com/mac> accessed 06/01/2013
- Bruckman, A., Bandlow, A., Forte, A. (2009) HCI for Kids, in *Human-Computer Interaction: Designing for Diverse Users and Domains (Human Factors and Ergonomics)*, Eds Sears and Jacko, CRC Press.
- Bruner, J. (1991) The Narrative

Construction of Reality, *Critical Enquiry*, University of Chicago.

Bruner, E. M., Turner, V. W. (Eds) (1986) *The Anthropology of Experience*, University of Illinois.

Bryant, D. J., & Tversky, B. (1999). Mental representations of perspective and spatial relations from diagrams and models. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 25, (1), 137

Buckingham, D. (Ed.). (2008). *Youth, identity, and digital media*, 119-142, MIT Press.

Burden, S. E., Topping, A. O'Halloran, C. (2015) The value of artefacts in stimulated-recall interviews, *Nurse Researcher*, 23, (1).

Burns, R. B., (2000) *Introduction to Research Methods*, Sage Publications.

C

Cadoz, C., & Arliaud, A. (2004). Extension of external representation to interactive and multisensory simulation of physical objects. Interaction between learner's internal and external representations in multimedia environment: A state-of-the-art, 166-225.

Chafi, M. B., (2014) Roles of Externalisation Activities in the Design Process, Linköping University Electronic Pres.

Chandra A, Batada A. (2006) Exploring stress and coping among urban African American adolescents: the Shifting the Lens study, *Prev Chronic*

Dis, 3, (2).

Chang, S., & Gomes, C. (2017). Digital journeys: A perspective on understanding the digital experiences of international students. *Journal of International Students*, 7, (2), 347.

Chastenay, P. (2016). From geocentrism to allocentrism: Teaching the phases of the moon in a digital full-dome planetarium. *Research in Science Education*, 46, (1), 43-77.

Chau, D., & Lee, C. (2017). Discursive construction of identities in a social network-educational space: Insights from an undergraduate Facebook group for a linguistics course. *Discourse, Context & Media*.

Cocks, M., Moulton, C. A., Luu, S., & Cil, T. (2014). What surgeons can learn from athletes: mental practice in sports and surgery. *Journal of surgical education*, 71, (2), 262-269.

Cothey, V. (2002), A longitudinal study of World Wide Web users' information-searching behavior. *J. Am. Soc. Inf. Sci.*, (53), 67-78.

Correa, T., Willard Hinsley, A., Gil de Zúñiga, H. (2010) Who interacts on the Web?: The intersection of users' personality and social media use, *Computers in Human Behavior*, 26, (2), 247-253

Coyne, R. (1995) Communication systems and development: the pragmatic approach, *Development Bulletin* (35), 4-7.

Cox, R. (1999). Representation

construction, externalised cognition and individual differences. *Learning and instruction*, 9, (4), 343-363.

Craik, K., (1943) *The Nature of Explanation*, Cambridge University Press.

Cross, N. (2006). *Designerly ways of knowing*, Springer London.

Csikszentmihalyi, M. (2008) *Flow*, Harper Perennia.

Cui, H., Biersack, E. (2011) Trouble shooting interactive web sessions in a home environment. Proc. ACM SIGCOMM workshop on Home networks (HomeNets '11). ACM, 25-30.

D

Dalsgaard, P., Hansen, N. B., (2012) The Predictive Role of Material Design Artefacts in Participatory Design Events, NordiCHI 2012, ACM.

Dalsgaard, P. (2008) Designing for inquisitive use. Proc. DIS '08. ACM, 21-30.

Dalsgaard, P. (2017). Instruments of inquiry: Understanding the nature and role of tools in design. *International Journal of Design*, 11, (1).

de Rivera, J. E., & Sarbin, T. R. (1998). Believed-in imaginings: The narrative construction of reality. American Psychological Association.

Delete Delete Delete
<http://www.bbc.co.uk/programmes/b07662zs>

Dempsey, N. P. (2010) Stimulated Recall Interviews in Ethnography, *Qualitative Sociology*, 33, (3), 349–367.

Demetriadis, S. (2004). Interaction between learner's internal and external representations in multimedia environment: a state-of-the-art.

De Saussure, F. (1916). *Nature of the linguistic sign*. Course in general linguistics.

Desmet, P., Hekkert, P. (2007) Framework of Product Experience, *International Journal of Design*, 1 (1).

Dewey, J. (1934) *Art as Experience*, Penguin Books.

Davis, R. A., (2001) A cognitive-behavioral model of pathological Internet use, *Computers in Human Behavior*, 17, (2), 187–195

Dholakia, U. M., & Soltysinski, K. (2001). Coveted or overlooked? The psychology of bidding for comparable listings in digital auctions. *Marketing Letters*, 12, (3), 225-237.

Dib, L., (2010) Of Promises and Prototypes: the archeology of the future. *Limn*, 1.

Diefenbach, S., Kolb, N., Hassenzahl, M. (2014) The 'hedonic' in human-computer interaction: history, contributions, and future research directions. Proc. DIS 2014, ACM.

Diefenbach, S., & Hassenzahl, M. (2009). The Beauty Dilemma: beauty is valued but discounted in product choice. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 1419-1426, ACM.

Dix, A., Gongora, L. (2011) Externalisation and Design, DESIRE 2011 the Second International Conference on Creativity and Innovation in Design, 2011.

Domestic Data Streamers
<http://domesticstreamers.com/case-study/data-strings/> (Retrieved 08/08/2017)

Döring, T., Sylvester, A., Schmidt, A. (2012) Exploring material-centered design concepts for tangible interaction. CHI '12 Extended Abstracts on Human Factors in Computing Systems. ACM, 1523-1528.

Drever, E. (2003) Using Semi-Structured Interviews in Small Scale Research: A Teachers Guide, SCRE Centre.

Dutton, W. H., Blank, G. (2015), 'Cultures on the Internet', *InterMedia*, 42, (4/5), 55-57.

Duval, R. (1999). Representation, Vision and Visualization: Cognitive Functions in Mathematical Thinking. Basic Issues for Learning.

E

Eastin, M. S. and LaRose, R. (2000), Internet Self-Efficacy and the Psychology of the Digital Divide. *Journal of Computer-Mediated Communication*, 6, (1).

Edelman, J. A. (2011) Understanding Radical Breaks, PhD Thesis, Stanford University Graduate Studies Dept.

Ehn, P. Kyng, M. (1992) Cardboard Computers: Mocking-it-up or Hands-on the Future, Proc. Design at Work, L. Erlbaum Associates Inc.

Elsdon, C., Kirk, D., Selby, M., Speed, C. (2012) Beyond Personal Informatics: Designing for Experiences with Data. Proc. Human Factors in Computing Systems (CHI EA '15).

Erickson, F. (2012). Qualitative research methods for science education. In *Second international handbook of science education*, 1451-1469, Springer Netherlands.

F

Fallman, D. (2003). Design-oriented human-computer interaction. Proc. SIGCHI conference on Human factors in computing systems, 225-232, ACM.

Ferguson, E. L., Hegarty, M. (1995) Learning with Real Machines or Diagrams: Application of Knowledge to Real-World Problems, *Cognition and Instruction*, 13, (1).

Finke, R.A. (1990) *Creative Imagery: Discoveries and Inventions in Visualization*. Hillsdale, N.J. : Lawrence Erlbaum.

Fischer, G. Giaccardi, E. Ye, Y. Sutcliffe, A. G. Mehandjiev, N. (2004) Meta-design: a manifesto for end-user development, Communications of the ACM, 47, (9).

Flick, U. (2009) *An Introduction to Qualitative Research*, Sage Publications Ltd.

Forišek, M., Steinová, M. (2013) Explaining Algorithms Using Metaphors, SpringerBriefs in Computer Science.

Forlizzi, J. Ford, S. (2000) The Building Blocks of Experience: An Early Framework for Interaction Designers, Proc. DIS2000, ACM.

Forsythe, P. (2009) The Construction Game - Using Physical Model Making to Simulate Realism in Construction Education, *Journal For Education In The Built Environment*, 4 , (1).

G

Galitz, W. O. (2007) *The essential guide to user interface design: an introduction to GUI design principles and techniques*. John Wiley & Sons.

Gangadharan, S. P. (2017). The downside of digital inclusion: Expectations and experiences of privacy and surveillance among marginal Internet users, *New media & society*, 19, (4), 597-615.

Garrett, J. J. (2010). *Elements of user experience, the: user-centered design for the web and beyond*. Pearson Education.

Geertz C. (1973). *The interpretation of cultures*. New York: Basic Books. (Original work published 1960)

Geoboard
<http://www.uv.es/gutierre/archivos1/textospdf/GutJai87.pdf> (Retrieved 08/08/2017)

Giaccardi, E., (2005) Metadesign as an Emergent Design Culture, *Leonardo*, 38, (4), Pages 342-349.

Giaccardi, E., Fischer, G. (2008) Creativity and evolution: a metadesign perspective. *Digital Creativity* 19,(1), 19-32.

Golsteijn, C., & Wright, S. (2013). Using narrative research and portraiture to inform design research. In IFIP Conference on Human-Computer Interaction (pp. 298-315). Springer Berlin Heidelberg.

Google History Timeline
History Timeline <https://chrome.google.com/webstore/detail/historytimeline/>

Gray, D. E. (2014) *Doing Research in the Real World*, Sage Publications.
Greenfield, A. (2013) *Against the smart city*, Do projects.

Gwilt, I., Yoxall, A., & Sano, K. (2012). Enhancing the understanding of statistical data through the creation of physical objects. In DS 73-1 Proc. 2nd International Conference on Design Creativity, 1.

Gwilt, I. (2015). Big Data–Small World: Materializing Digital Information. *Handbook of Research on Digital Media and Creative Technologies*, 33.

H

Hansen, N. B., Dalsgaard, P., (2012) The Productive Role of Material Design Artefacts in Participatory Design Events, Proc. 7th Nordic Conference on Human-Computer

- Interaction: Making Sense Through Design.
- Hansen, N. B., & Halskov, K. (2015) Generative design materials in DIY digital art creation.
- Hart, J. (2009) Remote working: managing the balancing act between network access and data security, *Computer Fraud & Security*, (11), 14–17, Elsevier,
- Hartson, R., (2012) *The UX Book*, Morgan Kaufman.
- Hassenzahl, M. (2008) User Experience (UX): Towards an experiential perspective on product quality, Proc. 20th Conference on l'Interaction Homme-Machine. ACM.
- Hegarty, M. (2004) Diagrams in the Mind and in the World: Relations between Internal and External Visualizations, A. Blackwell et al. (Eds.) LNAI 2980, 1-13, Springer-Verlag Berlin.
- Hegarty, M. (1992). Mental animation: Inferring motion from static displays of mechanical systems. *Journal of Experimental Psychology*, 18(5), 1084.
- Hemsley*
<http://dataphys.org/list/3d-social-networks/>
- Hirsch, T., Forlizzi, J., Hyder, E., Goetz, J., Kurtz, C., & Stroback, J. (2000). The ELDer project: social, emotional, and environmental factors in the design of eldercare technologies. In Proceedings on the 2000 conference on Universal Usability, 72-79, ACM.
- Hitsch, G. J., Hortaçsu, A., Ariely, D. (2010) Matching and Sorting in Online Dating, *The American Economic Review*, 100, (1), 130-163, American Economic Association.
- Hodge, R. and Kress, G. (1998) *Social Semiotics*, Cambridge: Polity Press
- Houde, S. Hill, C. (1997) What do Prototypes prototype? in *Handbook of Human-Computer Interaction* (2nd Ed.), Eds. M. Helander, T. Landauer, and P. Prabhu (eds.): Elsevier Science B. V.
- Hutchins, E., (1996) *Cognition in the Wild*, MIT Press.
- Hyrskykari, A., Ovaska, S., Rähkä, K.-J., Majaranta, P., Lehtinen, M. (2008) Gaze Path Stimulation in Retrospective Think-Aloud, *Journal of Eye Movement Research* 2, 4, (5), 1-18.
- I**
- Ihde, D. (1990) *Technology and the Lifeworld: From Garden to Earth*. Indiana Univ. Press.
- Ingold, T. (2013). *Making: Anthropology, archaeology, art and architecture*, Routledge.
- J**
- Jain, R. (2001) Digital Experience, *Communications of the ACM*, 44, (3).
- Jansen, Y., Dragicevic, P. (2013) An Interaction Model for Visualizations Beyond The Desktop, *IEEE Transactions on Visualization and Computer Graphics*, 19, (12).
- Jansen, Y., Dragicevic, P. Fekete, J-D. (2013) Evaluating the efficiency of physical visualisations, *Proc. CHI*, 2593 - 2602.
- Jansen, Y., Dragicevic, P., Isenberg, P., Alexander, J., Karnik, A.,

Kildal, J., Hornbæk, K. (2015). Opportunities and challenges for data physicalization. Proc. 33rd conference on human factors in computing systems, 3227-3236, ACM.

Johnson-Laird, P. N., (1983) *Mental Models: Towards a Cognitive Science of Language, Inference, and Consciousness*, Harvard University Press.

Josselson, R., (1995) *The Space Between Us*, Sage Publications.

Jung Malte F., Mabogunje Ade. (2010) Design Knowledge Coaching- A Conceptual Framework to Guide Practise and research. 16th International Conference on Engineering Design. ds publications. 415-416.

K

Kaptelinin, V., & Nardi, B. A. (2006). *Acting with technology: Activity theory and interaction design*. MIT press.

Kidd, C. D., Orr, R., Abowd, G. D., Atkeson, C. G., Essa, I. A., MacIntyre, B., Newstetter, W. (1999) The aware home: A living laboratory for ubiquitous computing research. In International Workshop on Cooperative Buildings, 191-198, Springer.

Kiefer, C., Collins, N., & Fitzpatrick, G. (2008). HCI Methodology For Evaluating Musical Controllers: A Case Study. In NIME, 87-90.

Kiesler, S., Goetz. J. (2002). Mental models of robotic assistants. In CHI '02 Extended Abstracts on Human Factors in Computing Systems (CHI

EA '02). ACM, 576-577.

Kirsh, D., (1997) Interactivity and MultiMedia Interfaces, *Instructional Science*, 25, (2), 79-96.

Knoblauch, H., Baer, A., Laurier, E. (2015) Visual Analysis. New Developments in the Interpretative Analysis of Video and Photography. *Forum Qualitative Sozialforschung*, 9, (3), Accessed: 08/10/2015.

Kolko, J. (2010) Abductive Thinking and Sensemaking: The Drivers of Design Synthesis MIT, *Design Issues*, 26, (1).

Kosinski, M., Stillwell, D., Graepel, T. (2013) Private traits and attributes are predictable from digital records of human behavior, *PNAS*, 110, (15), 5802 - 5805.

Koskinen, I., Zimmerman, J., Binder, T., Redstrom, J., & Wensveen, S. (2011). *Design research through practice: From the lab, field, and showroom*. Elsevier.

Kress, G., van Leeuwen, T. (2001). *Multimodal Discourse: The Modes and Media of Contemporary Communication*, Oxford University Press, 1-2.

Kress, G., (2007) *Visual and verbal modes of representation in electronically mediated communication: the potential of new forms of text*, in *Page to Screen: Taking Literacy into the Electronic Age*, Ed. Ilana Snyder, Routledge 2007.

Kuniavsky, M. (2010). *Smart things: ubiquitous computing user experience*

design. Elsevier.

L

- Landau, S. (2014) Highlights from Making Sense of Snowden, Part II: What's Significant in the NSA Revelations Security & Privacy, IEEE, 12, (1).
- Landay, J. A., Myers, B. A. (2001) Sketching interfaces: Toward more human interface design. *Computer*, 34, (3), 56-64.
- Larkin, J. H., Simon, H. A., (1987) Why a Diagram is (Sometimes) Worth Ten Thousand Words, *Cognitive Science*, 11, (1), 65-100.
- Laurel, B. (2003). *Design research: Methods and perspectives*. MIT press.
- Law, J. (2009). Actor network theory and material semiotics. The new Blackwell companion to social theory, 141-158.
- Law, E. C., Roto, V., Hassenzahl, M., Vermeeren, A. P., and Kort, J. (2009) Understanding, scoping and defining user experience: a survey approach. In Proc. of the 27th international Conference on Human Factors in Computing Systems CHI '09. ACM, 719-728.
- Lee, Y. (2008) Design participation tactics: the challenges and new roles for designers in the co-design process, *International Journal of CoCreation in Design and the Arts*, 4, (1).
- Lévi-Strauss, C. (1963). *Structural anthropology*, 1, Basic Books.
- Liang, R. (2012) Designing for Unexpected Encounters with Digital Products: Case Studies of Serendipity as Felt Experience. *International Journal of Design*.
- Liem, A., & Sanders, E. B. N. (2011). The impact of human-centred design workshops in strategic design projects. In International Conference on Human Centered Design, 110-119, Springer.
- Lilleker, D. (2017). Evidence to the Culture, Media and Sport Committee 'Fake news' inquiry, Eds. Bergendahl, N. M., Grimheden, M, Leifer, L., Skogstad, P., Faculty for Media & Communication, Bournemouth University. Proc. ICED 09, 9.
- Liu, Z. Stasko, J. T. (2010) *Mental Models, Visual Reasoning and Interaction in Information Visualisation: A Top-down Perspective*, IEEE transactions on visualization and computer graphics 16, (6), 999-1008.
- Loftus, E. F., David, D. (2015). Remembering disputed sexual encounters: a new frontier for witness memory research. *J. Crim. L. & Criminology*, 105, (811).
- López-Arcos, J. R., Vela, G. F. L., Padilla-Zea, N., Paderewski Rodríguez, P. (2016) Interactive Narrative design for geolocated experiences." Proc. XVII International Conference on Human Computer Interaction, 1. ACM.
- Lucas, G. R. (2014). NSA management directive# 424: Secrecy and privacy in the aftermath of Edward Snowden.

Ethics & International Affairs, 28, (1), 29-38.

Lyle, J. (2003) Stimulated recall: a report on its use in naturalistic research *British Educational Research Journal*, 29, (6).

Lyon, D. (2014). Surveillance, Snowden, and big data: Capacities, consequences, critique. *Big Data & Society*, 1, (2), 2053951714541861.

M

MacDonald, C. M. (2015). User experience librarians: user advocates, user researchers, usability evaluators, or all of the above? Proc. Association for Information Science and Technology, 52, (1), 1-10.

MacInnis, D. J., Price, L. L. (1987) The Role of Imagery in Information Processing: Review and Extensions, *Journal of Consumer Research*, 13.

Maes, P., Wexelblat, A., (1999) Footprints: History-Rich Tools for Information Foraging, Proc. CHI'99 ACM Press, 270-277.

Mäki, U. (2005) Models are experiments, experiments are models, *Journal of Economic Methodology*, 12, (2), 303-315.

Manker J., & Arvola, M. (2011). Prototyping in game design: Externalization and internalization of game ideas. Proc. HCI, ACM.

Manovich, L. (2013). *Software takes command* (Vol. 5). A&C Black.

Marcus, A. (2006). Cross-cultural user-experience design. *Diagrammatic*

representation and inference, 16-24.

Margulies, P. (2014). Dynamic Surveillance: Evolving Procedures in Metadata and Foreign Content Collection After Snowden. *Hastings LJ*, 66, (1).

Marshall, P., Rogers, Y., Hornecker, E. (2007) Are tangible interfaces really any better than other kinds of interfaces? In: CHI'07 workshop on Tangible User Interfaces in Context & Theory.

Martin, B. Hanington, B. (2012) *Universal Methods in Design*, Rockport.

Martinelli, A., Meyer, M. von Tunzelmann, N. (2008) Becoming an entrepreneurial university? A case study of knowledge exchange relationships and faculty attitudes in a medium-sized, research-oriented university, *The Journal of Technology Transfer*, 33, (3), 259-283.

Mayer, R. E., & Gallini, J. K. (1990). When is an illustration worth ten thousand words? *Journal of Educational Psychology*, (82), 715-726.

Mayr, E., Schreder, G., Smuc, M., W. Windhager, (2016) Looking at the Representations in our Mind: Measuring Mental Models of Information Visualizations. Proc. of the Sixth Workshop on Beyond Time and Errors on Novel Evaluation Methods for Visualization (BELIV '16), Michael Sedlmair, Petra Isenberg, Tobias Isenberg, Narges Mahyar, and Heidi Lam (Eds.). ACM, 96-103.

Maxwell, J. A. (2013) *Qualitative Research Design*, Thousand Oaks.

McCarthy, J., Wright P. (2004) *Technology as Experience*, MIT Press.

McDonald, A. M., Cranor, L. F. (2010) Beliefs and Behaviors: Internet Users' Understanding of Behavioral Advertising, *TPRC*.

McLellan, E., MacQueen, K. M., Neidig, J. L. (2003) Beyond the Qualitative Interview: Data Preparation and Transcription, *Field Methods*, 15, (1), Sage.

McMillan, D., Brown, B., Sellen, A., Lindley, S., & Martens, R. (2015, November). Pick up and play: understanding tangibility for cloud media. In Proceedings of the 14th International Conference on Mobile and Ubiquitous Multimedia (pp. 1-13). ACM.

Michel, M. C., & Smith, B. (2017). Eye-tracking research in computer-mediated language learning. *Language and Technology*, 1-12.

Miles, M. B., Huberman, A. M. (1994) *Qualitative Data Analysis: an expanded sourcebook*. Thousand Oaks, Sage.

Miller, B. D. (2016) *Above the Fold*. Simon and Schuster.

Milton, A., Rogers, P. (2013) *Research Methods for Product Design*, Laurence King.

Mindretrieve
<http://www.mindretrieve.net/> accessed 06/01/2013

Moncur, W., (2008) Using Personal Social Networks to Tailor News to Family and Friends, ACM.

Mowlabocus, S. (2016) *Gaydar culture: Gay men, technology and embodiment in the digital age*. Routledge.

Moreton, S., Dovey, J. (2013) Curating Collaboration: The Experience of Collaborative Innovation in REACT, http://www.react-hub.org.uk/sites/default/files/publications/curating%20collaboration_final.pdf accessed 11/03/16.

Morris, L., Cruickshank, L. (2013) New design processes for knowledge exchange tools for the New IDEAS project, Knowledge Exchange conference.

Muller, M. J. (2003). Participatory design: the third space in HCI. *Human-computer interaction: Development process*, 4235, 165-185.

N

Nakhimovsky, Y., Eckles, D., & Riegelsberger, J. (2009) Mobile user experience research: challenges, methods & tools. In CHI'09 Extended Abstracts on Human Factors in Computing Systems, 4795-4798, ACM.

Newcomb, E., Pashley, T., Stasko, J. (2003) Mobile computing in the retail arena. Proc. SIGCHI Conference on Human Factors in Computing Systems ACM.

Newell, A. F., Carmichael, A., Morgan, M., & Dickinson, A. (2006). The use

of theatre in requirements gathering and usability studies. *Interacting with computers*, 18, (5), 996-1011.

Norman, D., (1988) *The Design of Everyday Things*, Basic Books.

O

Onarheim, B., & Wiltschnig, S. (2010) Opening and constraining: constraints and their role in creative processes. Proc. 1st DESIRE Network Conference on Creativity and Innovation in Design, 83-89. Desire Network.

P

Paivio, A. (1990). *Mental representations: A dual coding approach*. Oxford University Press.

Palmer, S. (1978). Fundamental aspects of cognitive representation, In E. Rosch (Ed.), *Cognition and categorization*, 259-303, Erlbaum

Parry, A. (1997). Why we tell stories: The narrative construction of reality. *Transactional Analysis Journal*, 27, (2), 118-127.

Pätsch, G., Mandl, T., Womser-Hacker, C. (2014) Using sensor graphs to stimulate recall in retrospective think-aloud protocols, Proc IliX'14, ACM, 2014.

Payne, S. J. (2012) Mental Models in Human Computer Interaction, in *Human Computer Interaction Handbook: Fundamentals, Evolving Technologies, and Emerging Applications*, CRC Press.

Payne, S. J. (2007) Mental models in human-computer interaction. *Human-Computer Interaction Handbook*, 63-75.

Pedell, S. (2004). Picture scenarios: An extended scenario-based method for mobile appliance design. Ozchi2004.

Petersen, M. G., Graves, M., Hallnäs, L., Jacob, R. J. K. (2008) Introduction to the special issue on the aesthetics of interaction. *ACM Transactions on Computer-Human Interaction* (2008).

Pierce, J., (2014) On the Presentation and Production of Design Research Artifacts in HCI, Proc. DIS 2014, ACM.

Pinboard

https://shop.aph.org/webapp/wcs/stores/servlet/Product_Graphic%20Aid%20for%20Mathematics_1-00460-01P_10001_11051 accessed 29/11/2014

Pohlmeyer, A. E., Hecht, M., Blessing, L. (2009) User Experience Lifecycle Model ContinUE. *Der Mensch im Mittelpunkt technischer Systeme. Fortschritt-Berichte VDI Reihe 22* : 314-317.

Pousman, Z., Stasko, J. T., Mateas, M. (2007) Casual information visualisation: depictions of data in everyday life, *IEEE Transactions on visualisation and computer graphics*, 13, (6).

Prior, S., Ballie, J., Kearney, G., Maxwell, D. (2014) Participations, *Journal of Audience and Reception Studies* 10, (2), pp. 260-274.

Prosser, J., & Loxley, A. (2008). Introducing visual methods, NCRM Review Papers.

Punch, S. (2002) *Interviewing Strategies*

with Young People: The Secret Box, Stimulus Material and task based activities, *Children and Society*, (16).

Pylyshyn, Z. W. (1973) What the mind's eye tells the mind's brain: A Critique of Mental Imagery, *Psychological Bulletin*, (80), 1-24.

R

Ramduy-Ellis, D., Dix, A., Rayson, P., Onditi, V., Sommerville, I., Ransom, J. (2005) Artefacts as Designed, Artefacts as Used: Resources for Uncovering Activity Dynamics, *Cognition, Technology & Work*, 7, (2).

Reed, L. A., Tolman, R. M., & Ward, L. M. (2017). Gender matters: Experiences and consequences of digital dating abuse victimization in adolescent dating relationships. *Journal of Adolescence*, 59, 79-89.

Ricoeur, P. (1984-88) *Time and Narrative*, trans. Blarney and Pellauer, 3, (1).

Robson, C. (2011) *Real World Research*, Wiley.

Roberts, J. C., Walker, R. (2010) Using all our senses: the need for a unified theoretical approach to multi-sensory information visualization. In *VisWeek Workshop*.

Rose, G. (2012) *Visual Methodologies*, Sage Publications.

Roseneil, S., (2006) The ambivalences of Angel's 'arrangement': a psychosocial lens on the contemporary condition of personal life, *The Sociological Review*, 54, (4), 847-869.

Ross SE, Moore LA, Earnest MA, Wittevrongel L, Lin CT, (2004) Providing a Web-based Online Medical Record with Electronic Communication Capabilities to Patients With Congestive Heart Failure: Randomized Trial, *J Med Internet Res*;6(2):e12.

Roth, W. M., & Jornet, A. (2014). Toward a theory of experience. *Science Education*, 98, (1), 106-126.

Rowe, V. C. (2009) Using video-stimulated recall as a basis for interviews: some experiences from the field, *Music Education Research*, 11, (4).

S

Sanders, E. SonicRim, (2002) From User-Centered to Participatory Design Approaches In *Design and the Social Sciences*. J.Frascara (Ed.), Taylor & Francis Books Limited.

Sanders, E. B.-N. Stappers, P. J. (2008) Co-creation and the new landscapes of design, *CoDesign*, Vol. 4, No. 1.

Sanders, E. B.-N., Pieter Jan Stappers, P. J., (2014) Probes, toolkits and prototypes: three approaches to making in codesigning, *International Journal of CoCreation in Design and the Arts*, 10, (1).

Scapin, D. L., Senach, B. Trousse, B., Pallot, M. (2012) User Experience: Buzzword or New Paradigm?. ACHI 2012, The Fifth International Conference on Advances in Computer-Human Interactions.

Scaife, M. Rogers, Y. (1996) External Cognition: how do Graphical Representations work? *International*

- Journal of Human-Computer Studies*, 45, (2), 185-213.
- Jacko, J. A., & Sears, A. (2012). *Human Computer Interaction Handbook*. CRC Press
- Sennett, R. (2008). *The craftsman*. Yale University Press.
- Shedroff, N. (2001) *Experience design 1*. New Riders.
- Shrestha, S. 2007. Mobile web browsing: usability study. In Proc 4th international conference on mobile technology, applications, and systems and 1st international symposium on Computer human interaction in mobile technology (Mobility '07). ACM, 187-194.
- Sokoler, T., Löwgren, J., Eriksen, M., Linde, P., & Olofsson, S. (2007). Explicit interaction for surgical rehabilitation. Proc. 1st International Conference on Tangible and Embedded Interaction, 17–124, ACM Press.
- Steen, M. (2013) Co-design as a process of joint inquiry and imagination. *Design Issues* 29, (2), 16-28.
- Stenning, K., Cox, R., Oberlander, J. (1995) The effect of interactive multimedia interfaces upon representation selection. In J. Lee (Ed.), Proc. First International Workshop on Intelligence and Multimodality in Multimedia Interfaces: Research and Applications. design research, *International Journal of Design*, 2, (1), 55-65.
- Stone, D., Jarrett, C., Woodroffe, M., & Minocha, S. (2005). *User interface design and evaluation*, Morgan Kaufmann.
- Stringer, E. T. (2013), *Action research*, Sage Publications.
- Suchman, L. A. (1987) *Plans and situated actions: The problem of human-machine communication*. Cambridge university press.
- ## T
- Thatcher, A., Wretschko, G. Fridjhon, P. (2008) Online flow experiences, problematic Internet use and Internet procrastination, *Computers in Human Behavior*, 24, (5), 2236–2254
- Tuch, N. A., Trusell, R., Hornbæk, K. (2013) Analyzing users' narratives to understand experience with interactive products. Proc. SIGCHI Conference on Human Factors in Computing Systems, ACM, 2079-2088.
- Turner, V. W., & Bruner, E. M. (Eds.). (1986). *The anthropology of experience*. University of Illinois Press.
- Turner, V. *From Ritual to Theatre; The Human Seriousness of Play*, PAJ Publications.
- Turner, P. (2016). A make-believe narrative for HCI. In *Digital Make-Believe*, 11-26, Springer International Publishing.
- Tversky, B. (2011). Visualizing thought, *Topics in Cognitive Science*, 3, (3), 499-535.
- Tversky, B., Bryant, D. J. (1999). Mental representations of perspective and spatial relations from diagrams
- Stolterman, E. (2008) The nature of design practice and implications for

and models. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 25, (1), 137.

U

Ur, B., Leon, P. G., Cranor, L. F., Shay, R., Wang, Y. (2012) Smart, useful, scary, creepy: perceptions of online behavioral advertising. In Proceedings of the Eighth Symposium on Usable Privacy and Security (SOUPS '12). ACM.

V

Vande Moere, A., (2008) Beyond the Tyranny of the Pixel: Exploring the Physicality of Information Visualization, Proc. 12th International Conference Information Visualisation, 469-474.

Vande Moere, A., Patel, S. (2009) The Physical Visualization of Information: Designing Data Sculptures in an Educational Context, Chapter, *Visual Information Communication*, 1-23.

Vande Moere, A., & Patel, S. (2009). Analyzing the design approaches of physical data sculptures in a design education context. *Visual Information Communications International (VINCI'09)*.

van Leeuwen, T. (2005) *Introducing Social Semiotics*, Routledge, London.

Vaughan, L. (2017) *Practice Based Design Research*, Bloomsbury Academic.

Verbeek, P. P. (2015). COVER STORY Beyond interaction: a short introduction to mediation theory. *interactions*, 22, (3), 26-31.

Vyas, D., Heylen, D., Nijholt, A. (2009)

Collaborative Practices that Support Creativity in Design, ECSCW 2009. Springer, 151-170.

W

Wakkary, R., Odom, W., Hauser, S., Hertz, G., Lin, H. (2016). A short guide to material speculation: actual artifacts for critical inquiry. 23, (2) , 44-48.

Wakkary, R. (2009). Experience in Interaction Design: Five Propositions. In CHI'09 Workshop on Building a Unified Framework for the Practice of eXperience Design.

Walker, K. (2010) Designing for meaning making in museums Visitor-constructed trails using mobile digital technologies, PhD Thesis.

Wardrip, P. S., Brahms, L. (2015). Learning practices of making: developing a framework for design. Proceedings. 14th international conference on interaction design and children, 375-378, ACM.

Weinreich, H., Obendorf, H., Herder, E., & Mayer, M. (2006). Off the beaten tracks: exploring three aspects of web navigation. Proc. 15th international conference on World Wide Web, 133-142, ACM.

Weiss, R. S. (1994) *Learning From Strangers: The Art and Method of Qualitative Interview Studies*, Free Press.

Werner, M. (2011) *Model Making (Architecture Briefs)*, Princeton Architectural Press.

Westerlund, B. (2007) A workshop method that involves users talking, doing and making. Proc. Human Machine Interaction Conference,

HuMaN'07, IEEE.

White, H. (1985) *Tropics of Discourse: Essays in Cultural Criticism*, The Johns Hopkins University Press.

Wiberg, M., (2014) Methodology for materiality: interaction design research through a material lens", in *Personal and Ubiquitous Computing*, 625-636, Springer-Verlag.

Winn, W. (1989). The design and use of instructional graphics. In H. Mandl & J. R. Levin (Eds.), *Knowledge acquisition from text and pictures*, 125-143, Elsevier.

Winnicott, D. W. (1960). The theory of the parent-infant relationship. *The International journal of psychoanalysis*, (41), 585.

Wojtczuk, A., Bonnardela, N., (2014) Designing and Assessing Everyday Objects: Impact of Externalisation Tools and Judges' Backgrounds, *Cognitive Ergonomics for Situated Human-Automation Collaboration*, 2014.

Wojtczuk, A., Bonnardel, N. (2010). Externalisation in design: impact of different tools on designers' activities and on the assessment of final design.. 75-82. European Conference on Cognitive Ergonomics, Delft, The Netherlands, August 25-27, 2010, Proc. 28th annual conference of the European Association of Cognitive Ergonomics.

Wölfel, C., & Merritt, T. (2013) Method card design dimensions: a survey of card-based design tools. In *IFIP Conference on Human-Computer Interaction*, 479-486, Springer.

Won, S. S., Jin, J., & Hong, J. I. (2009) Contextual web history: using visual and contextual cues to improve web browser history. Proc. SIGCHI Conference on Human Factors in Computing Systems, 1457-1466, ACM.

Y

Yaneva, A. (2009). Making the social hold: Towards an actor-network theory of design. *Design and Culture*, 1(3), 273-288.

Yee, J. (2017) The researcherly designer/the designerly researcher in *Practice based Design Research* Eds. Laurene Vaughn, Bloomsbury 3PL.

Yin, R. K. (2009) *Case Study Research: Design and Methods*, Thousand Oaks, CA, Sage.

Yliverronen, V., & Seitamaa-Hakkarainen, P. (2016). Learning craft skills. Exploring preschoolers' craft making process. *Techné Series-Research in Sloyd Education and Craft Science A*, 23(2).

Yuille, J. C. Catchpole, M. J. (1977) The Role of Imagery in Models of Cognition, *Journal of Mental Imagery*, 1, 171-180.

Z

Zhang, J. (1997). The nature of external representations in problem solving. *Cognitive science*, (21), 2, 179-217.

Zhang, A, X., Karger, D., Blum, J. (2016). Eyebrowse: Selective and

Public Web Activity Sharing. Proc. 19th ACM Conference on Computer Supported Cooperative Work and Social Computing Companion (CSCW '16 Companion). ACM,122-125.

Zhang, X.,Wakkary, R., Maestri, L., Desjardins, A. (2012) Memory-storming: externalizing and sharing designers' personal experiences. Proc. DIS '12, ACM.

Zweifel, C. Van Wezemaela, J. (2012) Drawing as a qualitative research tool, an approach to field work from a social complexity perspective, *Tracey Journal: Drawing Knowledge*, 5, 1-16.

Selected bibliography

- Armstrong, H., Stojmirovic, Z. (2011) *Participate*, Princeton Architectural Press.
- Bazely, P. (2013) *Qualitative Data Analysis*, Sage Publications.
- Bennett, J. (2010) *Vibrant Matter*, Duke University Press.
- Cross, N. (2006) *Designerly Ways of Knowing*, Springer, 2006.
- Csikszentmihalyi, M. (2008) *Flow*, Harper Perennial.
- Davies, M. B. (2007) *Doing A Successful Research Project*, Palgrave Macmillan.
- Denzin, N. K., Lincoln, Y.S. (Eds.) (1994) *Handbook of Qualitative Research*, Sage Publications, 1994.
- Dourish, P., (2004) *Where the Action is: The Foundations of Embodied Interaction*, Bradford Books.
- Erickson, T., McDonald, D. W. (Eds) (2008) *HCI Remixed*, MIT Press.
- Gibson, W. J., Brown, A. (2009) *Working with Qualitative Data*, Sage.
- Gray, D. E. (2014) *Doing Research in the Real World*, Sage.
- Hutchins, E., (1996) *Cognition in the Wild*, MIT Press.
- Ingold, T. (2013) *Making*, Routledge.
- Johnson-Laird, P. N., (1983) *Mental Models: Towards a Cognitive Science of Language, Inference, and Consciousness*, Harvard University Press.
- Kaptelinin, V. Nardi, B. A. (2009) *Acting with Technology*, MIT Press.
- Laurel, B. (Ed.) (2003) *Design Research, methods and perspectives*, MIT Press.
- Lidwell, W. Holden, K, Butler, J. (2003) *Universal Principles of Design*, Rockport.
- Löwgren, J. Reimer, B. (2013) *Collaborative Media*, MIT Press.
- Maxwell, J. A. (2013) *Qualitative Research Design*, Thousand Oaks.
- McCarthy, J., Wright P. (2007) *Technology as Experience*, MIT Press.
- McCloud, S., (2001) *Understanding Comics*, William Morrow Paperbacks.
- Norman, D., (1998) *The Design of Everyday Things*, Basic Books.
- Robson, C. (2011) *Real World Research*, Wiley.
- Rogers, Y., *HCI Theory: Classical, Modern, and Contemporary* (Synthesis Lectures on Human-Centered Informatics) (2012), Morgan & Claypool Publishers.
- Rose, G. (2012) *Visual Methodologies*, Sage Publications.

- Saffer, D. (2007) *Designing for interaction*, New Riders.
- Sennett, R. (2009) *The Craftsman*, Penguin.
- Schön, D. A. (2011) *The Reflective Practitioner*, Ashgate Publishing Ltd.
- Shedroff, N. (2001) *Experience design 1*. New Riders.
- Simonsen, J. Robertson, T. (Eds) (2013) *Routledge International Handbook of Participatory Design*, Routledge.
- Smith, H., Dean, R. T. (Eds.) (2010) *Practice-led Research, Research-led Practice in the Creative Arts*, Edinburgh University Press.
- Tidwell, J., (2005) *Designing Interfaces: Patterns for Effective Interaction Design*, O'Reilly Media.
- Young, I., (2011) *Mental Models*, Rosenfeld Media.
- Yin, R. K. (2009) *Case Study Research: Design and Methods*, Thousand Oaks, CA, Sage.
- Vu, K-P. L., Proctor, R. W., (2004) *Handbook of Human Factors in Web Design*, CRC Press.