Materialising data experience through textile thinking

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Author's declaration

This thesis represents partial submission for the degree of Doctor of Philosophy at the Royal College of Art. I confirm that the work presented here is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis. 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.

Signed …Marion H A Lean..   Date…June 10th 2020..

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Abstract

In our digitally enabled lives, we are constantly entering into relationships and interacting with data. With little regard for their technical ability, consumers are obliged to accept and live with data experience. Digital literacy and information technology skills help to navigate these technologies, but little is known about the intimate practices of interacting with data from digital systems. The aim of this practice-based research is to identify how knowledge and experience of physical materials can offer novel processes and value to progress communications regarding digital use. This study draws on theory and practice from textile design and sets out to position textiles as a research discipline. Embodied methods are used to explore human relationships with textiles and materials to create physical representations which can be used to generate and share insights from people's varied engagements with technology and data. Findings are presented which are valuable to the fields of both textile design and the field of data physicalisation.

The methods employed engage the human body as a research tool using the senses to explore and create meaningful experiences with technology. Material handling, model-making, workshops and sensory ethnography, all captured on film, facilitate an embodied approach to explore the experience of data. Through this approach, alternative readings of everyday technology emerge. The theoretical contribution of this thesis is the paradigm of textile thinking as a research methodology. Textile thinking refers to the actions and mindset of textile designers. In this study the tacit knowledge employed by textile designers is presented as a challenge for reporting on design activity and is responded to through the use of embodied methods for engaging materials in research. Textile thinking approaches are embodied in practical experiments which invited people to express how they engage emotionally in relationships with technology and data. The field of textile design is interrogated to identify the unique characteristics of the discipline which are valuable research tools.

Practical research shows that physical data representations enhanced through material choice can be used as opportunities for engagement to examine how people connect emotionally with information. The findings showed that this methodology increased the likelihood of sharing insights into the use of digital products and could be used to elicit emotional responses to technology and data experience. The types of responses included childhood memories, sensations, individual insights into the comfort of

technology and engagement with information. This broader understanding shows how this approach can be used by designers, to stimulate an interest in using data and to improve engagement with the digital world through design. The outcomes offer new references and broader perspectives for textile design as a research discipline, supporting a paradigm shift to explore and accept new ways of approaching research and developing design theory.

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Preface

My research originated in a traditional route of drawing, printing and making with materials on a practical degree in a national centre for textile design, Dundee. Taking a research approach early on sparked my curiosity in developing tools for perception and understanding. On a Masters course in Critical Design at Goldsmiths, I interrogated the social and cultural implications of physical materials as an approach to the design of health communications. This work led to my professional experience developing wearable technology which connects people across continents using haptic feedback, which facilitated my learning about functionality in sensory stimulation for data representation. These observations of tactile sensibility developed into my hunch that the discipline of textiles which centres around the sense of touch has the potential to critique the practices of technology and data, which are typically screen-based, untouchable and immaterial. With my background in materials and making, I developed a textile design approach to research, and I describe this on the journey that follows.

Woven, spun, interlaced, layered. Networked, joined, combined. Textiles are those things which are connected. From the Latin 'texere', meaning to weave, stories, people and their everyday lives have been historically held together by making, craft and materials. In 2020, digital technology makes it possible to connect with, to be in touch with and to learn from people and their daily practices across the world. This thesis is about making connections, and the term textiles refers to the links or exchange between things. Between events. Between concepts. Textiles, embedded with meaning, made with logic and built for function, are used to represent personal connections and interactions with tacit knowledge, and with digital technology. Physical textile-material is used to connect people with their feelings and connects people with their communities virtually through textile, a fibre optic cable. The activities in this study use technology to connect to the body and use materials to connect to technology. The methods I have employed engage the human body and the senses for designers to explore and create meaningful consumer technology experiences.

Introduction

A constant train of novel technologies and applications are being developed which use data in new ways to offer ever faster, sharper transactions in every aspect of life. Advances in the development of hardware features which support embedded technologies such as Bluetooth low-energy, flexible batteries, conductive yarn and coatings have enabled devices to become smaller, more adaptable and easier to conceal. This creates wider opportunities for new novel consumer technologies in wellbeing and personal security as well as wearables for use in health screening, for example long-term pulse monitoring. Fitness trackers and other consumer goods – for example, Internet of Things (IoT) products such as smart thermostats have served to create a shift in the acceptability of sensors for homes and bodies (Jansen, 2019). These devices enable data output to be delivered across the world through virtual systems with the potential to impact a multitude of functions in our daily life. In our digitally enabled lives, we are constantly entering into relationships and interacting with data. With little acknowledgement of their levels of technical ability, consumers are obliged to accept and live with information experience. Digital literacy and information technology skills help to navigate these technologies, but little is known about the intimate practices of interacting with data from digital systems such as personal data that is collected and presented on devices such as physical activity trackers, which reveal intimate aspects of the body's behaviour.

In this thesis, I describe the feeling of being connected to our data and to a wider digital ecosystem through virtual means, as opposed to physical connections in the material world as "data experience". The concept of data experience, however, is something which is un-touchable. Digital data, for example, cannot be physically held – it exists only virtually. Data from sensing devices and personal computing technologies, including wearable fitness trackers have been shown to influence decision-making and behaviour change in various contexts. In-depth research, such as that by Finkelstein (2016) and Piwek (2016) reports on the effective use of these devices in lifestyle programmes, such as those enabling weight loss. The behavioural changes and physical implications are reported; however, the actual interpretations of, and relationships with, the data are yet to be explored. Personal physical activity efforts, as well as less tangible bodily data such as heart rate, are processed, transferred and displayed, rendering the body's physicality as a flat, two-dimensional representation displayed on a screen. Systems and

technologies that have been designed to educate and reveal information about the body through data display rarely express as aesthetic which is true or relevant to the human condition, tending instead to take a reductionist approach to the body. An interest here in the affective interactions of technologies and data is found in experiences where a representation of human-data assemblage evokes a bodily response (Lupton, 2018, p.82). In the case of products such as health tracking applications (easily accessible through a smartphone), a one-size-fits-all quantification of data and digital display limits the inclusivity of experience and influence with data. While closely observed user testing can reveal insights into the success of operational procedures of devices designed to support everyday virtual transactions, the personal feelings about, and responses to these representations are unseen and largely unreported. Motivated by Trevor Hogan's research in data physicalisation (2016) my thesis explores the use of tactile data in design research and explores the use of qualitative interface and display suggesting that this is an alternative format to support decision making with data (Lockton, 2017, p.1845). The hypothesis I examine in the current work is that by using a new methodological approach it is possible to increase knowledge about, and insights into, the ways in which humans respond to data experience.

In the material world, physical encounters trigger sensation and emotion which is mediated through the sense of touch. Human engagement with objects, surface and material spark individual connections and responses. In this thesis, 'Materialising Data Experience through Textile Thinking', 'materialising' refers to the concept of 'making real': in other words, to reveal data responses using physical material. However, it is possible to move beyond the physical by examining the impact of a range of material choices, patterns, colours and material manipulation that enable relations and interactions in the material world. Personal relationships with materials are embedded with intimate narratives and enacted in daily physical interactions through memory, identity and choice. Considering the cultural implications of, and influences on, materials and choices for design has a significant impact on user adoption and experience. For example, McCann's study of clothing for active ageing (2016) found that participants were sceptical of certain fabrics and technologies. O'Connor (2010) described the negative cultural connotations associated with DuPont's Lycra when it was first introduced: housewives were considered lazy by their social circles for choosing to use fabric which does not need ironing. In my practice-based research, I examine typically unreported relations with materials and the use of tacit knowledge in textile design activities to consider embodied practices with data. The actions and mindset of textile designers in research settings are of significant interest. Textile design researcher and

educator Elaine Igoe's study 'In Textasis: Matrixial Narrative of Textile Design' (2013), which challenges depictions of the textile design process which are linear and based on objective analysis, has been a key motivation for my research, in its proposition of collecting understandings which are based on lived experiences. My thesis explores how human relationships with textiles and materials can be used to create physical representations to generate and share insights from people's varied engagements with technology and data. A broader understanding can be used by textile designers to stimulate interest in using data to improve the way it is used and to explore relationships with the digital world. While it is expected that practice-based methodologies for exploring issues in new contexts inevitably produce novel outcomes and approaches, it has been proposed by researcher Johan Redström that theory, too, can be made using the conceptual frameworks of a design 'programme'. To support the development of appropriate design objectives and values for textile design-led approaches in data experience, I present this thesis in a programmatic structure for design adapted from Johan Redström's *Making Design Theory* (2017).

Aims and Objectives

In order to test the hypothesis that by using a new methodological approach it is possible to gain new knowledge which can reveal insights into the way humans live with data experience, the aim of my research is as follows:

To explore people's relationships and interactions in the material world, and generate applications from these insights to learn about how people experience engagements with data from digital systems.

Objectives:

- To identify aspects of textile design which can be used to develop a research approach
- To explore the types of data and technology that can be examined using textile design in research
- To examine insights and responses that reveal the emotional and sensorial impacts of interacting with digital technologies and their data

This thesis first identifies how data experience can be addressed from a textile design perspective, and then reports on the activities and outcomes of designed encounters in

a diverse range of settings. It describes experiments and their outcomes which address the question:

What is the value in applying textile thinking to gather insights about human data practices?

Contribution

Through this thesis my aim is to give form to both data experiences and textile design research activities, and is relevant for designers engaging with scientific fields – data science, for example which demand new tools and methodologies for inquiry. I present a survey of the current state of textile design research, exploring its methods and approaches as a set of characteristics for textile thinking. This practical research contribution is useful for textile design researchers as a tool to aid collaboration in multidisciplinary settings; for example, to communicate one's approach. This is also relevant to textile design practitioners, and researchers can use this as a framework to identify and find value in aspects of their existing practices.

This investigation expands the understanding of textile design as a research discipline. The theoretical contribution of this thesis is the paradigm of textile thinking as a design research methodology. This thesis is grounded in textile design as a basis but is driven by an interest in challenges in other fields. The specific contribution my investigation offers is a novel positioning for textile design research which addresses aspects of the human relationship with technology. This is illustrated using practical case studies to present applications for textile thinking which are "not just for textiles" but ones that may be considered as methodological approaches for researching in other fields.

Drawing on the tacit knowledge and actions of the textile designer, I have gained a new understanding about how to capture experiences from an embodied approach to learning about people's technology practices. I have collected evidence of intimate practices with technology and reported on textile design-like activities. Making explicit certain aspects of tacit thinking in materialisations of the tacit on paper and on video reveals new applications for textile design activities. I make a research methods contribution by adding to the exemplars of embodied design practitioners, demonstrating these practical activities and their outcomes and value in research contexts.

Textile design is not generally recognised as a field concerned with technology and data experience. My study uses a programmatic structure to support an emerging space in order to develop textile design objectives in the context of data experiences. This is developed from the format proposed by Redström (explained further in Chapter One). The focus is on generating methodologies for exploring design issues from new perspectives. I developed a design research programme to establish the types of issues which could be addressed and the approaches and knowledge that was required to support an investigation into data experience. The textile thinking programme is a methodology which applies knowledge and practices from textile design to address challenges in other fields. The programme is positioned as a methodology for textile designers to use experimental design practice for knowledge production in research settings.

A textile thinking programme which focuses on how to explore data experience is an outcome of this thesis. The paradigm of textile design provides value through the disciplinary grounding found in the literature, in design practice and in the academic community. The challenges addressed are situated in the domains of human-computer interaction (HCI), digital heath and governmental social research. I designed research activities which engaged different communities to identify the types of concerns which can be tackled through this approach, and these were carried out in case studies. I explored them in practical experiments which invited people to express how they engage emotionally in their relationships with technology and data. Practical outputs and responses collected through research activities in each case study indicate the types of products which a textile thinking approach to data experience produces. Textile thinking approaches led to findings relevant to the context of data experience. Collectively, the research activities were original, and in fields where it is unusual to find a textile design researcher. However, through the application of textile thinking characteristics, the reframing of data experience as a space which could be a "textile problem" (explained in Chapter Two) makes the spaces, topics and mode of inquiry appear appropriate. This is now shared and recognised as research practice for exploring the experience of data. The programme enables new practical understandings of what textile design is and demonstrates a new theory of what textile design can be.

Chapter One, Methods, opens with an overview of relevant design methods which enable critique and offer alternative perspectives for the consumer technology experience. This overview is followed by descriptions of the main approach of practice-based research within this thesis. The chapter then explains the specific methods used in this study alongside my application of these in creative practice.

Chapter Two is a review of the field of textile design research collated to establish disciplinary precedence of the employment of textile approaches to challenges in other fields. I note here that a lack of literature and reporting on the thinking and activities of textile designers contributes to the marginalisation of textiles as a discipline. This contextualises the significance of the thesis in

      a) responding to this gap in the literature, by reporting on activities

      b) establishing approaches for reporting on specific activities

I identify seven characteristics drawn from textile design research literature and practice to create a criterion for textile thinking as a research methodology.

Chapter Three presents and reviews communities of practice which are exploring human relationships with data. Focusing on representation, I report on issues which may be problematic for the lay person interacting with data experience, including those of emotional responses and developing critical perspective. Examples from art, design and HCI illustrate ways that data representation is being designed to evoke emotional response and meaning. It situates data physicalisation as a research field which may benefit from the new approaches in data representation and experience explored in my thesis.

Chapter Four comprises three practice-based research inquiries designed to explore the value and impact of embodied methods used to develop alternative data representation. The outcomes are a collection of alternative physical-material data experiences. The findings, responses and individual insights into the comfort of technology are presented to reveal the value and impact of designing novel data experiences and representation. This contributes to discussion on data collection and representations which are multisensory. The final case study includes the presentation of potential applications.

Finally, Chapter Five draws on the structure for programmatic design research (described in Chapter One) to demonstrate the process by which an area not typically associated with textile designing (data experience) has been addressed in this thesis to offer a new strand within the textile design research field. This structure is used to establish the textile thinking programme as a way of exploring new research spaces from within traditional design disciplines by showing relationships and routes for exploring parallel fields. The conclusions of the study present the value of engaging textile design approaches in data experience.

Chapter 1: Methods

This chapter first provides an overview of the design methods which offer an alternative framing for the technology experience that informed the approach of this investigation. This is followed by a description of the overarching methodology and an introduction to specific research activities described in the case studies. Table 1.1 illustrates examples of design practice which informed the selection of methods explored in this thesis.

There were three research phases

a) Desk-based research on textile design research theory and data experience

b) Case studies – utilising practical endeavours and workshops to generate physical outputs and ethnographic insights as data

c) Identification and analysis of textile design approaches which contribute to the research area by revealing alternative perspectives on consumer experience of technology

Table 1. 1 Examples of practice which informed selection of design methods

Example	Relevance in this thesis	Design Method
"Biocouture", Suzanne Lee, 2012	Used design to offer a critical perspective and potential alternatives to the status quo (alternative textiles and garment production)	Critical Design
"Biolace, Carole Collet, 2017	Used design to offer a critical perspective and potential alternatives to the status quo (explored new avenues and framings for synthetic biology)	Critical Design
"Critical Artefact Methodology", Simon Bowen, 2009	Object or scenario used as a tool to expand the design space, enabling designers and users to work together for alternatives	Critical Design
Horse-riding as an embodied research method, Kristina Höök, 2018	Focuses on developing ways to engage with the body in a slow design process	Embodied Design
"Nose First", Kate MacLean, 2019	Demonstrates the value and uniqueness of the subjective experience as insight for design research	Embodied Design
Sensory Dinner Spoon Collection, Jinhyun Jeon, 2016	Provided meaning and value through designed embodied experiences (enhancing the use of everyday tools – cutlery)	Embodied Design
"Designing Embodied Smart Textile Services", Martijn ten Bhömer, 2016	Designed physical objects to help stakeholders develop ideas about immaterial concepts (the service and experience of wearable devices)	Externalisation
"Representing Experiences of Digital Systems", John Fass, 2018	Used physical representation to learn about research participants' experiences with digital systems	Externalisation
"Tranquilitie", Galina Mihaleva, 2017	Presented novel ways of raising awareness through design-suggested speculative approaches to restrict exposure to unwanted data using interactive textiles (noise pollution)	Critical Design
"The Future Starts Here", Victoria and Albert Museum, 2018	Displayed prototype designs, both those in production and speculative technology ideas to engage the audience with future thinking	Design Exhibition

Design Research Methodologies

Embodied Design Methods

Embodied methods are qualitative research approaches which use the human body to engage with research topics. Embodied methods are used in design to explore relationships between the body, material and space as a way of motivating creative thinking. The overall aim is to engage both subjective experience and the physical human presence to stimulate the research process.

Two key approaches to embodied design relevant to this thesis, movement and the senses, draw on Richard Shusterman's philosophy of aesthetics as a methodology for designing aesthetic interactions. Shusterman, who developed somaesthetics in response to a "philosophical prejudice against the body", described it as "the critical, ameliorative study of the experience and use of one's body as a locus of sensory aesthetic appreciation (aesthesis) and creative self-fashioning" (Shusterman,1999, p.302). This approach honours the subjective and embodied knowledge generated through somatic practice and close observation of the senses, instead of relying on theory alone. He writes: "...knowledge of the world is improved not by denying our bodily senses but by perfecting them", suggesting activities which support an understanding developed from "knowledge of one's bodily dimension" and the lived experience (Shusterman, 1999, p.299).

In a time of rapid technological development, engaging the body in the design process is a way of reconnecting with feeling and awareness in other contexts. Placing value on bodily experience, and closely observing this, disrupts the perception of everyday activities and interactions. Attending to the body can involve a consideration for design of non-screen-based interactions, such as haptic feedback (communication through touch) from behaviour change technologies. Given the pervasive and thus intimate nature of these technologies, it is desirable for embodied design practitioners to be engaged in their development.

The term embodiment, used by theorists in studies of phenomenology and perception including Merleau-Ponty (1945) implies an understanding of the world based on one's subjective experience and sensations, facilitated through physical and social engagements with the world. This understanding, enabled through "bodily ways" of knowing used to consider human behaviour and experience can be included during

design processes which acknowledge that the body is not in isolation but part of a myriad of practices, sensations and responses (Höök, 2018, p.xxi). In relation to movement, Kristina Höök's text *Designing with the Body: Somaesthetic Interaction Design* (2018) suggests an alternative to fast-paced design approaches by focusing on developing ways to engage with the body in a slow design process that she terms "soma design". In soma design the aim is to focus on the senses and felt experience as inspiration in contrast to traditional design approaches, which are based on logic and reasoning. Höök suggests methods in which "bodily ways of being" may become part of the design process. Examples include Feldenkrais, a somatic movement practice; paying close attention to the ways we flick, pinch and swipe the screens on our smartphones, and listening to the ways our bodies eventually start to relax into position while learning to ride a horse. Höök shares ways that embodied experiences such as horse-riding can be examined to enable a deeper understanding of the subjective through embodied experience, and how this might be implemented for design direction. Soma design encourages thinking about how we experience ourselves in the world by gaining deeper understandings of bodily sensations and using these as starting points for design. Höök reasons that, fundamentally, outcomes of soma design represent ways that interactive systems and sensations in the body can be adapted for design. Höök proposes methods for engaging with the body to engender *"*bodily ways" of knowing. Recommendations for making the subjective experience of the felt body "reachable" for designers include focusing on experience rather than function, and Höök suggests identifying methods, including non-language-based means, to describe "experiences of bodily interactions that can serve as inspiration to design" (Höök, 2010, p.xx). Investigating the design of "unknown technologies" which employ methods aiming to *"*elicit nuanced, imaginative, and implausible responses that challenge and stretch what we consider possible*"*, Kristina Andersen and Danielle Wilde used the technique of estrangement to reimagine the human body, by engaging with physical materials in workshop activities to consider "physical form and texture for the body-feeling that has been identified" (Andersen and Wilde, 2012, p.63). In "The Magic Machine Workshops: Making Personal Design Knowledge" (2019), Andersen and Ron Wakkary explore how material practice is used to engage participants in practical making, using their imagination as a means of developing new knowledge. Their methodology employs a group workshop structure for ideation and the construction of imaginary technological objects. Rather than generating objects based on what they do, the approach, which includes providing limited materials, enables creative observations, leading to novel functionalities. The material practice enabled the lived experience of a speculatively designed product or interaction through embodied ideation. By creating a safe space to take risks, the activities provide insights

into how individuals respond and develop through the process of design. These examples show ways that embodied ideation engaging the physical body, and 'body-feeling', can be incorporated into a research process for design, and how design can be used as a tool for research.

Embodied approaches which employ the senses evoke reaction and response and can be used to consider design for user experiences which draw on multisensory engagement, for example in wearable technology (Tomico and Wilde, 2016). The 2018 exhibition "The Senses: Design Beyond Vision" at Cooper Hewitt, Smithsonian Design Museum, was a timely indication of a reaching for, return to, or "recovery of" our senses (Sontag, 1966) as a way of interacting with and interpreting the world. Kate McLean's "smell maps", featured in the exhibition, reiterate the value and uniqueness of the subjective experience as insight, in this case into place. McLean's smell map of Singapore details reports of "curry, jasmine and manila rope". McLean's PhD thesis (2019) documents methods such as "smell catching". Jinhyun Jeon's "Sensory Dinner Spoon Collection" (2016) recalls the "Design Beyond Vision" manifesto's "wisdom of the body", (Lipps, 2018, p.9) presenting simple utensils which "embrace sensory knowing". The form, material and weight contribute by providing meaning and value through embodied experience – enhancing the everyday use of the dessert spoon. These objects and experiences enable an engagement with the body as a tool for perception, through experience, placing value on subjective material engagement. Removed from the one-size-fits-all objective design of many digital systems and displays, these examples focus on the individual and their unique responses. No two people will have the same experience when they eat with Jeon's sensory cutlery: does everyone experience data in the same way?

Rather than *not* designing for the eye, since we have whole bodies which help us to gather information the emphasis in this study is on finding ways to explore and design for this understanding. Designing in this way offers the potential for intuitive, personal interactions and experiences. These examples show ways that embodied methods, the physical body and "body-feeling" can be incorporated into design outcomes to enhance experience and connections with everyday objects and practices.

Textile designers engage the body through touch. Their design processes draw on tacit knowledge and relationships with physical material. This embedded knowledge and experience intuitively and seamlessly influences their design choices. However, their specific decision-making acts are rarely examined. Interaction design and materials

researchers Oscar Tomico and Danielle Wilde (2016) note that material potential can be explored by recontextualising its properties, and thus experiences. In this research I explored a range of materials "out of context" – for example, in research workshops. The activities (described in Chapter Four) invited research participants to consider their own decisions in relation to material choice, with a particular focus on emotional connection. I encouraged engagement with the senses during the brainstorming stages in the case study workshop activities. Physical material handling initiated dialogue around emotional response, perception and interpretation based on subjective experience and felt interactions with the physical-material world. As embodied methods, these activities explored relationships with material using the body, and aimed to reveal insights into tacit decision-making with textiles used for designing with data. Rather than measuring efficiency in data-driven systems based on reasoning and logic, which ask us to engage with information, I used embodied methods to engage with felt experiences outside of language, and to probe personal meaning-making during intimate experiences of the material world (Tomico and Wilde, 2016). Individual responses are important in this thesis to explore ways that technologies exist beyond their intended functionality, to look at the ways that data is interpreted and experienced, and to consider what might be meaningful insights for design.

Normally used at the early stages in a design process, embodied methods are not typically set out as repeatable and transferable methods for design. They can appear unusual and even uncomfortable to an outsider. The nature of activities in embodied design make sharing successes problematic, for example translating the impact of performative actions in workshop settings, the development of tools and models and trialling wearable technologies. Danielle Wilde, Anna Vallgårda and Oscar Tomico (2017) propose a framework using the terms "disrupt", "destabilise", "emerge" and "embody" to support analysis and demonstrate the value of using the body during creative processes outside of their specific events and context, for example once a research workshop has ended. "Disrupt" and "destabilise" refer to the types of interactions and change which are enacted in the embodied method: the term "emerge" questions the types of responses or ideas which are revealed through the process, and finally "embody" aims to contextualise where this type of approach brings value and what type of design can be generated as a result. As part of three case studies in this thesis, I collaborated to make four short films (Appendix 7 and described in Chapter 4). Their purpose is to demonstrate the essence of designed experiential encounters; to present the type of work being carried out (including participant feedback), and as a tool for reflection on the research activities and their findings. The films collectively demonstrate

the nature of the embodied design activities and are presented to enhance the written descriptions of the research programme's values and themes, in particular time-based elements of interactive models and their reactions. Interaction design researcher Bill Gaver (2012) proposes the use of annotated portfolios, where individual artefacts, or collections of designs, present the values and themes of a research programme. For this thesis I developed visual diagrams indicative of the textile designer's mood board or portfolio of examples to indicate the relations and value of each experiment and its findings to the overall research agenda, themes and scope, such as Figure 1.2 (found on page 33). The films complement this by bringing the experiential activities and context of this research to a wider audience.

Vallgårda (2009) and Andersen (2013) have described the complexity of human interactions and relations as too vast for visual and textual depiction. Material engagement and representation can be used to connect with people in different ways. Andersen describes tacit knowledge used in making as "embodied non-verbal thinking" (Andersen, 2013, p.63). In the Making Magic Machines workshops, participants carry out making activities without specific opportunities for dialogue. As the activities are carried out mainly in silence, when it is time to "present" the outcomes of their work Andersen and Wakkary note that "ad-hoc" and "on the spot" interpretations which are given. Their observations are suggestive of the inner and embodied dialogues going on throughout making that connections with materials and physical actions afford. The authors suggest that the use of language and words may even "collapse emotional and embodied reasoning" used in the making processes. This informs aspects of this thesis which contribute to the area of embodied methods and ideation by considering the design of activities which draw on and capture the tacit engagement in the design process through film, the designer's own words (verbally and written) and making.

I use embodied methods in this thesis for data collection and to support the creative process for data representation. Ethnography is used in case studies to gather insights into people's behaviours with technology. Ethnography refers to methods used to observe and engage research participants in their own home and working environments. The data collected is qualitative, based on real-life observations. Patricia Leavy (2017) includes the following activities in her description of the work of ethnographers: "..actively and attentively participating, observing, spending time in, talking with others about, and examining artifacts (e.g.book, films, YouTube videos, blogs, photographs) related to cultural experience" (Leavy, 2017, p.142)

In design, ethnography is used to learn about a problem space to inform the development of products and services based on the observed needs of target groups as opposed to making decisions based on designers' own culture and needs. Sensory ethnography offers alternative forms of expression, which are found through participation and observation. For example, design anthropologist Sarah Pink proposes that information can be revealed by engaging in shared experiences. Throughout this thesis, I use various approaches to extract understandings of experiences which are unspoken and unseen: for example, using logbooks during design activities with a student group (Case Study 2) and bringing previously unknown personal practices with technology into strategy and decision-making settings through physical and visual display (Case Study 3). However, Pink (2009) also encourages reflection on knowing in practice: the researcher should be aware that this does not need to be, and often cannot be, expressed in words. Thus, the practice and research activities described in this thesis may also be explored in the accompanying films.

Alan Dix and Layda Gongora (2011) use the term 'externalisation' to describe physical representation which is used as part of a design process: for example, prototyping a product or representing a 'problem space' as a "link point between the tacit and explicit, enabling unreflective embodied action to become the subject of analytic reflection" (Dix and Gongora, 2011, p11). Using externalisation as a means to explore others' (especially non-designers') experiences of digital systems, John Fass (2017) used methods that included model-making and comic book-style drawing. The approach does not focus on research for design (for example, designing 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" (Fass, 2017, p.222). Martijn ten Bhömer (2016) used models to explore experience in his study of the use of prototypes for "embodied sense making". Physical objects helped stakeholders develop ideas about immaterial concepts such as services. Bhömer found that physical prototypes could be used at the design meeting stage to imagine the product in use, to illustrate the product in relation to the body and to propose intangible design features and smart textile services, including digital functionality – for example, sound. Others, for example Gaver et al, (1999), used physical objects as probes to support novel data collection which prompted ideation for design research.

In this thesis I used physical objects for inquiry and for representation, to engage others. Exploratory case studies (CS1 and CS2 in Chapter Four) focus on how others' experiences and feelings were gathered and represented using embodied design

ideation of models and design prototypes. In Case Study 3 I used embodied methods in the data collection phase, then employed innovative means to share new knowledge and findings with stakeholders, using a physical display. The mode of inquiry here is about identifying and addressing themes which emerge as part of a 'research through design' process; engaging design to explore other fields. And in researching for design, gathering insights and ethnographies which reveal areas that can be addressed through design intervention. On the synthesis of research and practice, Owain Pedgley offers a structure for establishing value in research through design processes and capturing design activities.

My approach in this thesis can be illustrated using Pedgley and Paul Wormald's (2007, p.464) "Model 2" for integrating design into academic projects, in order to: "Devise improvements in design methods (e.g. Pursue a design project to help conceive and develop new design procedures, information, priorities, and tools)". The practical case studies illustrate this: the process of a design project resulted in novel workshop activities used in group settings to engage diverse groups with the topic of data experience. The outcomes of these design projects are used to inform the design of new interventions for governmental social research, as shown in Case Study 3. On defining design through practice and making, Redström, whose work engages computational technology as a material in design supports experimental approaches, says: "Designing surely needs its routines, its methods- but as I have discussed, there are important differences between foundations for explaining regularities and what is needed for making a difference." (Redström, 2017, p. 141)

In my research, the settings and environments I engaged in contributed to the experiences and dialogues in each encounter and can be seen to expand the boundaries of textile design, or to create new practice. The aim was to generate discussion and critical perspective through design. Each experience was intentionally open ended, offering spaces rather than solutions, alluding to the proposal of design researchers Monika Buscher and Leon Cruickshank (2008) for "living cultures", with additional "focus" of design on "designing infrastructural support for creative appropriation or design in use as well as on 'designing' practices, communication and interaction" (Buscher and Cruickshank 2008, p.4). Facilitating encounters and engagement created space to pose questions, and through planned but open interactions new ideas emerged.

My practice-based enquiry engages critical design as a research approach by revealing knowledge which results from practical activities that suggest alternative technology practices in a contemporary context. Critical design is used to challenge and explore concepts from science and technology, based on understandings and behaviours in material culture. Critical design is positioned as a research approach when a design outcome is used to probe and test attitudes and behaviours to particular scientific and technology-led proposals. A speculative product or scenario can be used to engage users as a means of gathering insights on potential future impact. The process can also be used as activism to reveal alternative consequences from different perspectives in order to develop critical thinking and responses to perceived solutions. Through critical practice, design can shift from problem-solving to problem *finding*.

Critical design artefacts are employed as a provocation by creating a level of curiosity which is required to initiate dialogue. The critical design artefact and experience provides stimulation for both the researcher and its audience to explore the status quo, and can suggest potential future scenarios. Alternative framing offers the potential to expose inter-relational factors in complex challenges, as alternative points of intervention. Stuart Walker is a designer and educator whose work focuses on the use of creative practice to disrupt the status quo and identify new roles for design. Writing about creating objects to incite change, Walker (2017) supports design that encourages reflection on "the way things are" through visual and tangible statements which represent the loss and disconnect created by distractions in our obsession with commodity.

As a tool for analysis, critical design can be used to explore habits and behaviours and foresee potential problems in future trends. The designs are a *critique*, themselves an interpreted analysis of a situation. On the practices of textile designers, Elaine Igoe (2013) writes that though many are working in ways that explore and expose current world issues, most would not recognise that their work can be situated within a design research context. This view suggests that critical design can be used as a form of analysis, where the object or the designer need not necessarily be formally considered in a critical design context: rather, through novel outcomes and innovative design approaches – for example, designing new forms of textiles – a critical perspective can be taken about existing design products and processes. For example, through her practice of 'growing garments', Suzanne Lee's Biocouture presents a critical perspective

and alternative possibilities for the status quo of textiles and garment production (Lee, 2012). Design researcher Simon John Bowen (2010) has described the use of "critical artefacts", which can allow people to consider their role and the possibilities of designed products and future scenarios. Not to be taken as practical products, these artefacts can contribute to a consideration of previously unthought-of situations. Sustainable design researcher Carole Collet has used critical and speculative design approaches "as a means to an end" to explore and learn rather than to produce finished products. The Biolace project explored new avenues and framings for synthetic biology (Collet, 2017). In this way textile design activities support the development of critical perspectives.

Critical design offers alternative perspectives; however, it has been negatively described as an elitist approach. At the launch of Matt Malpass's book *Critical Design in Context* (2017), design professor Lorraine Gamman (2017) described critical design as "posh-boy design", suggesting that designers take on the role of highlighting societal issues, therefore claiming a position of power. By suggesting that people are not living life properly and merely opening up discussion, it is as though the critical designer mocks the way things are without offering solutions or understanding. Rather than positioning the designer in a self-assumed elevated position, Bowen's doctoral thesis "A Critical Artefact Methodology" (2009) aimed to involve the critical reveal, or critical reflection, as part of the design process, so the object or scenario was used as a tool to expand the design space, enabling designers and users to work together to consider alternative outcomes.

In this study, I use critical design to question the way things are by presenting interpretations and analysis through design. Artefacts are created which can be read to offer perspectives on themes and concerns in the context of data experience. The approach avoids positioning the designer as an authority: instead, the designer is a facilitator, who enables and learns from others.

Overarching Structure

In this study I use qualitative research to obtain and analyse insights on the use and experience of technology, gathered through interactions in designed experiences and encounters. This approach used mapping, workshop activities, discussions and exhibition as a means to engage others with the research; findings consist of insights

and responses which have helped develop the themes and agenda to form the research practice. I collected evidence and findings through ethnographic (physical and sensory) approaches, including spending time with workshop participants and exhibition visitors and learning from their activities, feedback and observed actions. The encounters described in the case studies enabled me to spend time with respondents exploring their experiences through different mediums whilst also observing their activity and interactions in their own environments, as well as in designed settings.

Programmatic Design Research

Redström is a researcher who focuses on generating methodologies to explore design issues from new perspectives. His work, which engages computational technology as material for design, investigates the potential for developing agency in new technological textiles and the generation of novel aesthetics, experiences and creative relationships. Through practical design, his approach examines new possibilities for the behaviours of textile materials afforded by computational things and for novel technological experiences facilitated through textile treatment. In *Making Design Theory* (2017), Redström presents the design programme as a structure to accommodate design research in new and experimental settings. He proposes the programme as the set of values and beliefs from which the projects are designed and by which they are influenced, acknowledging the foundations of the paradigm. The creation of a worldview for design to be implemented for the purpose of design research provides a set of hypotheses and questions which continuously lead, reflect and are informed through experimental design to develop paths which shed light on poorly understood questions, creating starting points and a framework for research.

In her thesis "Computational Composites, Understanding the Materiality of Computational Technology", Anna Vallgårda (2009) used Redström's concept of the programme to introduce and describe various individual and institutional design approaches, such as critical design. Drawing from Redström's illustration of a university course as an example, it is possible to make sense of the understanding of the programme as a set of broad design goals, the fundamental processes and the values used to interpret the outcomes of design. In this way programmes can be understood as principles, or schools of thought, which guide research and offer understandings for new design approaches.

Thus, from the inside, the design program is a call for action: "This *is* what designing is!" From the outside, the design programme allows us to ask questions: "Designing *could be* this; what would be its implications?" (Redström, p.97)

To explain "what we do", Table 1.2 illustrates the way that we can move between using the particular "products" of design, say a chair, a healthcare system or the Stretch Orchestra Installation (Case Study 1 this thesis) to explain what type of design we do. To using the more general types of activities that were involved in the concept development and physical production to explain what design is for example, planning, drawing or mood-boarding.

Table 1. 2 Mapping Design outcomes from unusual to typical

Particular	General
Products of design: for example, a chair	Actions that are recognised as "design": for example, drawing
Products that do not resonate with the idea of "design": for example, a new healthcare system	Actions that are recognised as "design": for example, planning
Products that do not resonate with idea of "textile design": for example, interactive physical representation of personal data feedback (CS 1)	Actions that are recognised as 'textile design' for example, collecting, mood boarding (Igoe 2013)

Figure 1.1 shows a diagram I developed to visualise elements of Redström's programmatic design structure. Figure 1.2 shows the specific activities and outcomes of this thesis overlaid to the structure to illustrate elements of the textile thinking programme used to explore data experience. Table 1.3 is a detailed description of the elements of programmatic design research I used in my research to develop the textile thinking programme. Appendix 1 contains a review of programmatic design research as proposed by Redström in relation to the context of this thesis.
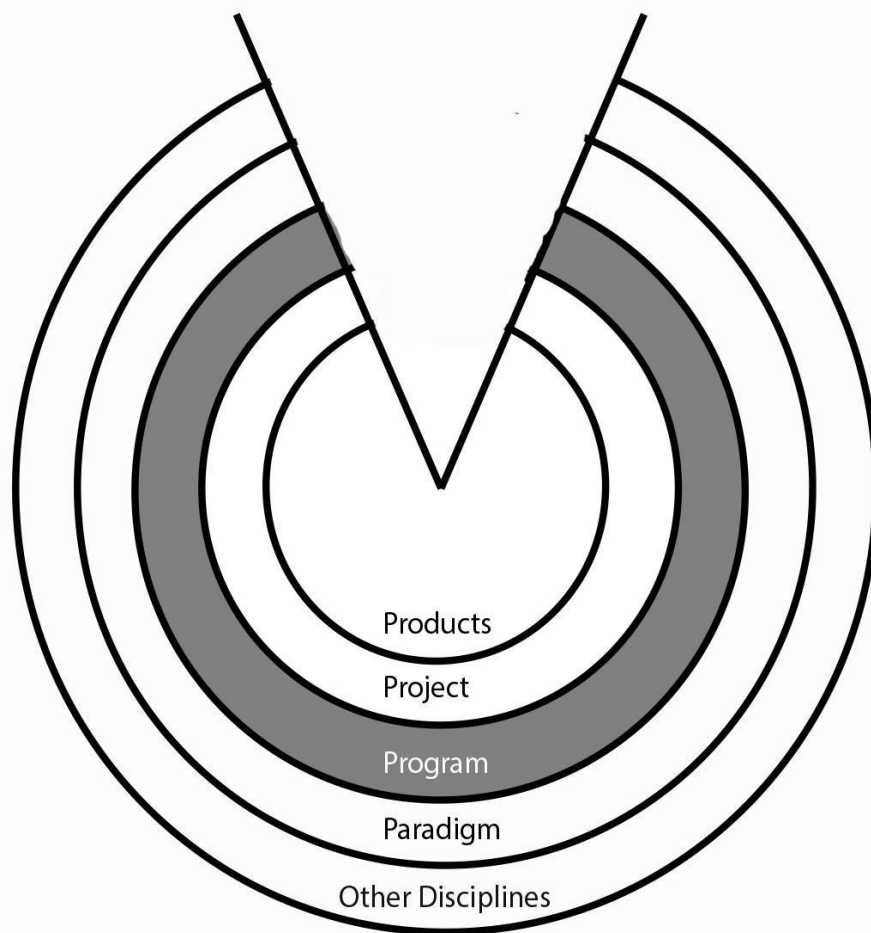
Figure 1. 1 Diagram based on Redström's Making Design Theory *(2017)*
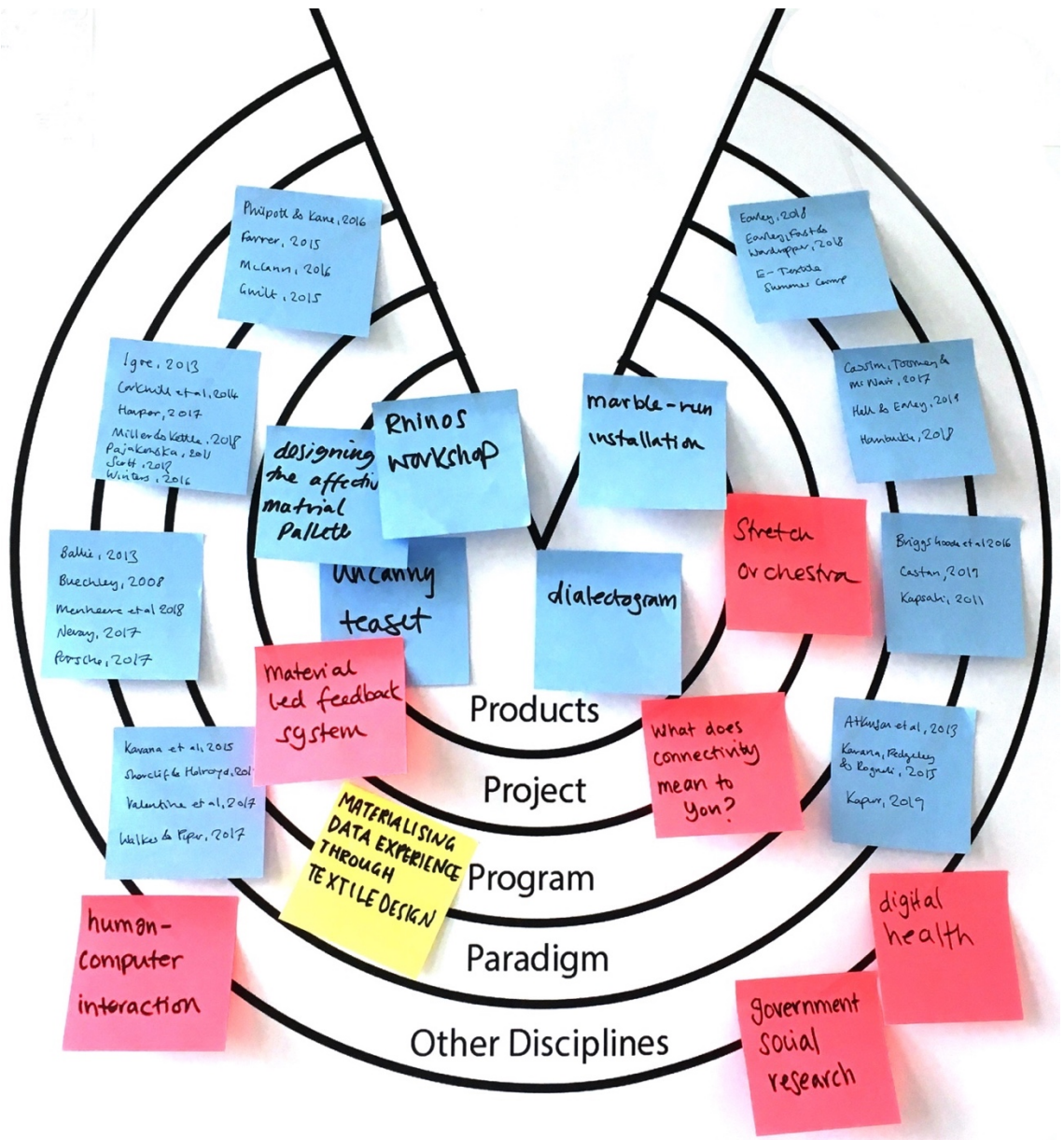
Figure 1. 2 Mapping my research actions to Redström's Making Design Theory *(2017)*

Table 1. 3 Redström's elements for programmatic design in the context of this study

Elements of *programmatic design research* (Redström, 2017)	Description	Elements of *programmatic design research* illustrated by examples in this study
Other Disciplines	• Areas of research which contextualise the problem area which is outside of the paradigm • Areas that have influenced and inspired development of the programme. • This is also the area where these outcomes of the research may contribute as a form of problem-solving or by offering to address issues identified within those spaces.	For this study, these disciplines include digital health, human-computer interaction and government social research
Paradigm	• The area of textile design research • Ideas and notions of textile thinking as an approach, discipline or method	• Practice and literature in textile design research • Characteristics of textile design research identified and grouped in Chapter 2, 'Textile Thinking' and Table 2.2, Characteristics of Textile Thinking
Programme	• The agenda which has directed the research, grounded in the paradigm as a base, or toolbox, but created from interest and challenges in other fields. • The programme expresses the values and the types of problems and challenges of interest and is supported by typical examples as products of the programme. • The programme is formed in response to issues identified as problematic in the 'other disciplines' as a prompt to approach and explore the relevant fields, identify problem areas and suggest a methodology to develop and adapt approaches which could lead to alternative solutions and contributions	• Textile Thinking Programme • This thesis embodies the Textile Thinking Programme by presenting objectives, processing values and typical examples • In Figure 1.2 the programme is situated in the centre ring in the round diagram to represent its being embedded in the formation of, and in relation to, influences and insights
Projects	• Practical activities and experiments used to explore topics of interest • Activities in context: the particular environments in which the practical elements of the research were explored	• Three case studies in this thesis can be described as "projects"
Products, or "typical examples"	• Outcomes of the programme • Prototypes, objects and provocations • Feedback and findings from experiences • The designers who emerge or are changed as a result of engaging with the program • Methodology as contribution to knowledge for the paradigm and other fields	• Design of activities carried out in the case studies: "Designing the Affective Material Palette" "Defamiliarisation" 'Data materialisation' • Outcomes of activities carried out in case studies: "Stretch Orchestra" installation "Making Sustainability Visible" "Uncanny Tea set" "Fibre Dialectogram"

Role of the Designer-researcher

The role of the designer I adopted in this study is one of a facilitator, learning and embedding myself and being aware of different contexts and communities to bring together and support exchanges incorporating and giving agency to a range of stakeholders: designers, users and industry. Insights gathered from activities carried out in research settings are pieced together to form analysis and proposals. The approach I employed aligns with textile design, but also adapts aspects of embodied practices and critical design, concerned with the ways we interact with and perceive the world and ourselves through designed objects, technology and lived experience. This qualitative inquiry approach aligns with the method of the interpretive bricoleur. Bricolage was first used in anthropology by Claude Lévi-Strauss to describe piecing together thoughts and appropriating meaning. The term is drawn from the French term for to tinker, meaning to use what is at hand and combine it to form new artefacts. Norman K Denzin and Yvonna S Lincoln (2005) use the term "interpretative bricoleur" in reference to the process of analysis or sense-making. The interpretive bricoleur-researcher acknowledges their personal positioning and motivations for research, and recognises their own influence through reflection while developing tools and outcomes. This approach, used in the design research context, echoes the role of the studio designer who gathers many aspects of information and materials, for example in a mood board, then through a process of reflection develops a design proposal based on elements, or an essence, of this collection. The outcome is a cumulation of both the designer's knowledge and style and the attributes of the materials and insights used within the design process and product.

Case Study Approach

In this thesis, new knowledge is found in the understanding and grouping of approaches used in the research process. These collectively present new understanding and references for supporting textile design practice, and thus can be expressed as 'practice led'. Due to its exposure to, and experience in, other fields, this study is also somewhat practice based. Designed artefacts and the responses to them, as outcomes, are useful findings for other fields. The positioning of the investigation outside of the textile discipline enabled the methodology and value of the study to be tested as a transferable medium for research.

The elements of practice in my research are described in case studies. Case studies offer the opportunity to observe a range of perspectives relative to a particular phenomenon. Each simultaneously offers insights which collectively contribute to the understanding of a wider contextual area (Kawamura, 2011). The case studies are opportunities to collect exploratory data which illustrates a representation of the types of outputs and responses which arise in diverse settings (Mills and Birk, 2014).

Writing about meaning-making in practice-led art and design research, Fabia Ling-Yuang Lin (2018) suggested that thematic analysis can be used at any stage of the creative process to identify which aspects are unique and which are common patterns, and to enable a reactive relationship with the creative process. Activities in the case studies (outlined in Table 1.5) took place over twelve-month period and the data was analysed in cycles, as described in *The Handbook of Arts-based Research* (Leavy, 2017). This approach provides a structure for the researcher's subjective knowledge to be valuable as research knowledge. The process was cumulative and comparative: the types of responses and topics which arose, and the learning about process and resources that was gained, were acknowledged and used to inform subsequent activities. During the collecting of data, it was necessary to quickly generate themes, as well as identifying early insights and repeated anecdotes: a particular example here was the challenge of responding to and gathering information during discussion with very enthusiastic and animated participants in Case Study 3. I created an analysis framework which meant that early insights which were emerging could be situated, and this helped to support the interpretation of similar topics as they arose. Based on the concept of a theory of change, where interventions are mapped to a project's potential impacts, theory is used during analysis. To support the analysis of responses and themes from discussions, interviews and workshops, Deborah Lupton's (2015) theory of the affective and sensory dimensions of data, described in Chapter 4 of this thesis, was used to identify where particular activity has led to insights of this nature. This was used to ground the micro responses about the experience of data and technology. By reporting and reflecting on design activities, I used theories of the characteristics of textile thinking (outlined in Chapter 2) to support macro interpretations of the contributions of and to textile thinking and potential areas for intervention in the context of data experience (Leavy, 2017).

Thematic Analysis

Thematic analysis focuses on extracting patterns to form meaning in qualitative datasets, in response to an exploration of a set research question. I identified thematic

analysis as an appropriate method for this thesis as it enables participants' individual experiences to perform as the object of study. Within datasets, for example, interview outcomes and workshop observations, coding as annotation and written descriptions are used to note key moments and interesting characteristics. These codes help to organise the data in order to categorise aspects and observe patterns which can be used to identify themes. Collectively the codes are used to form an interpretation of the data, which can then be sorted into themes (Braun and Clarke, 2006). Thematic analysis in this thesis is both inductive and deductive. Through inductive analysis the patterns in data provide insight to develop theory; deductive analysis uses theory to interpret the data. In this thesis, a range of research activities and settings led to different types of outcomes and data which I examined in response to the overall research aims. I chose thematic analysis as it is flexible and it enables categories to be established within extensive databases. Flexibility can also present challenges, however: thematic analysis presents vast themes, and this can obstruct a focus on one particular aspect. I addressed this using the programmatic structure to form conceptual boundaries. The diagram in Figure 1.1 adapted for this thesis, based on Redström's structure for programmatic design research (2017), supports a visual mapping of themes which provided an understanding of the types of knowledge each research activity generates. I used various forms to present the findings visually as a thematic map in the context of my research aims and activities (Braun and Clarke, 2006).This includes physical diagramming, using themes written on sticky notes (Figure 1.2), developing a visual tool to quickly identify themes during rich conversation (described in CS3) and finally a rich depiction of themes (as well as data) in detailed mapping, presented as a dialectogram in collaboration with illustrator Mitch Miller (full drawing in Appendix 11).

In this thesis, I analysed data in accordance with the research aims, forming patterns for consideration in two main areas:

- Issues raised in encounters with research participants about data experience (in workshop and individual discussions, design outcomes and exhibition visitor comments)
- Findings on, and aspects of, the process of these activities which can be attributed to the practice of textile thinking in this context (in films, participant logs (CS2) and stakeholder feedback (CS3).

I analysed the data to identify common responses during design activities and interactions with data physicalisation experiences (data physicalisation is explored in Chapter 3). I developed themes based on the outcomes of research activities, with

particular focus on establishing potential contexts for applied textile thinking. These can be understood as microscopic and macroscopic analyses (Pedgley, 2007). The first is concerned with short-term goals related to decision-making and findings related to the data experience projects and programme outcomes. The second relates to more longitudinal activity related to findings from the thesis as a whole and the forming of the programme for textile thinking. An outline of the type of data collected at each stage is shown in Table 1.4 (found on page 42), and each case study activity shown in Table 1.5 (found on page 50).

Throughout the case study activities, I took notes and developed these into regular reports, alongside photos and video recordings. I used films to record research activities, and these included participant responses. These supported the development of insights as findings and value of the experiments. Being able to view the films again, and share them with others, became a space for thematic analysis as I extracted particular elements and explored new meanings. For example, in the film for Material-Led Feedback System (Case Study 2) a participant talks about engaging with the "language of materiality". This demonstrated an individual interpretation of the project but can also be used to describe the wider research agenda. This shows how the films played a part in the reporting of the case studies, and the development of the programme itself was identified and analysed in this written description.

In their study on developing a collaborative manifesto, Holly Robbins and Elisa Giaccardi (2019) noted that the kind of value they had expected to find in the research environment shifted. The authors emphasise value in the interactions which take place during collaboration and lead to other paths, providing a scaffold in fields and areas that the original research framework had not previously considered addressing. This resulted in unexpected outcomes which revealed wider concerns not previously included in the objectives, enabling the researchers to identify further scope in the research. Identifying the types of conversation topics and themes which arose during the experiments provided the basis for their subsequent projects. The authors propose that less focus should be placed on the outcomes or artefacts of collaboration as symbols of knowledge, instead addressing the exchanges which occur during the "doing of design", and how these elements are taken forward into future endeavours. In my research, films as research products were a way of documenting observations and analysing the outcomes of findings in the case studies alongside the descriptions and notes as project reports after the encounters. The films also served as reflection to inform future research, which

included an invitation to deliver a professional workshop based on the activities shown. A discussion of the use of films as research products is found in Appendix 8.

Alternative Approaches to Research in this Context

A textile design study exploring human relations with elements that are other than human, or non-human, including interactions with physical textiles and non-physical 'data', could have been framed using more traditional methodologies. I review the lenses of object-oriented ontology, material thinking and feminist new materialism through the work of others, including Igoe (2013); Ingold (2010); Wilde and Underwood (2017) and Lupton (2015, 2019), and this inspired reading on affect and non-human forces in atmospheres created by presence of data (Lupton, 2017). Material culture, immateriality and belief (Miller, 2005; Harper, 2018) and the cultural, social and metaphorical significance of textiles, materials and things contributed to my hunch that textiles could be a probe (Gaver et al 1999), or proxy, to discuss concepts such as affect and experience. Others have taken psychoanalytical approaches, looking at the role of the feminine, agency and gender in textiles (Plant, 1998, Igoe, 2013, Pajaczkowska, 2016). Claire Pajaczkowska suggests that "textiles are culturally situated on the threshold between the functional and the symbolic" (Pajaczkowska, 2005, p.23). I touch on these approaches, and though there is literature which would support it, in this thesis they have not been fully engaged; they do, however, present scope for further study.

The approach takes multidisciplinary engagement and embodied methods such as object creation to explore aspects of human relations with technology and experimental means for engagement (Earley and Goldsworthy 2017, Earley, Forst and Wardropper, 2018, Huron et al., 2017). This is appropriate to the emerging nature of the practice-led research described here, which engages others in exploring alternative experiences of technology and data through practically applied textile thinking and design. This methodology is a complementary approach which sits alongside existing work and literature on lenses and research practice within textiles and design, emerging technology and data experience.

My intention is that those who engage with the research will be able to develop a critical perspective on the design and experience of emerging technologies, regardless of technical know-how.

Specific Methods

The practical activities in this study are generative in producing new knowledge for both the design research practice and personal scholarship. Table 1.4 outlines the chronology and steps taken i) to review the field of practice ii) to expand my knowledge base and iii) for data collection.

Table 1. 4 Research methods in this study

Objective	Methods	Actions
Reviewing the field of practice and testing interim knowledge	Literature and practice review	Desk-based research
		Attended professional textile technology trade shows
		Attended academic textiles research events
	Present research in professional forums	Exhibited and interacted with the public at Work in Progress shows 2016, 2017, 2018 (RCA)
		Smart Textiles Salon exhibit and review exercise
Expand my knowledge base to relevant aligning disciplines	Participate in formal education programs and placements	Attended short course "Introduction to Somatics" (The Place, London)
		Humanistic HCI Summer School (Center for Ubiquitous Computing at the University of Oulu, Finland)
		Industry Placement (Footfalls and Heartbeats Ltd., Nottingham)
Data Collection: Test research experiments with different participants in groups	Pilot design workshops	Pilot workshops of materials and affect (RCA, Queen Mary University of London, Design Research Society Conference- PhD by Design) Data: *observations of interactions with workshop tools*
Data Collection: Deliver research experiments with different participants in groups	Design workshop	'Stretch Orchestra' workshop (CS 1) Data: • *observations* • *discussion with workshop participants* • *design prototypes and ideation*
	Public Exhibition	'Stretch Orchestra' exhibition (CS 1) Data: • *observations* • *exhibition visitor feedback and conversation*
	Design workshop	Material-Led Feedback System workshop (CS 2) Data: • *observations* • *discussion with workshop participants* • *design prototypes and ideation* • *participant daily logbook entries*
	Ethnographic enquiry	Workshops and interviews (CS 3) Data: • *Discussions with research participants* • *Results of semi-structured interviews* • *Visual outcomes of mapping activities* • *Participant 'log' page entries*

I note that a lack of literature and reporting on the thinking and activities of textile designers contributes to textiles as a discipline being overlooked and therefore contextualise the significance of the thesis in terms of:

   i.   responding to this gap in the literature by reporting on activities
   ii.   establishing ways of reporting on specific activities (written format, presentation and film)

I present the tacit knowledge employed in textile designing as a challenge for reporting on textile design activity and I respond to this through use of embodied methods for engaging materials in research. The specific methods of inquiry in this study begin with a review of my field of practice led by desk-based research and insights from a number of trade shows, conferences and exhibitions which I attended. Exploring data experience from a textile design perspective in this study has called upon implicit knowledge, unseen but felt, the rarely articulated approach of the textile designer (Igoe, 2013). I review the current state of textile design research in Chapter 2. This includes insights gathered from formal literature and academic publications and participation in a range of professional academic engagements, including design research conferences and textiles research group activities. I deploy the textiles way of thinking, textile thinking, developed by scholars within the field of textile design research as a framework, or as a toolbox for research and design within the particular context of researching the experience of systems and technologies. The phenomenon of textile thinking as a practice is materialised through practical research outputs and encounters informed by examples from literature and practice in the field. Having reviewed and identified an area within the experience of digital health which could be addressed with the textile thinking approach, I designed a studio experiment as a prop to initiate discussion and permit access to new communities. Employing my own creative studio practice, I created a provocation to explore issues connected to screen-based representation of the body and host discussion on the emergence of the body positive movement on social media. Using the familiarity of materials as a proxy for tricky technological concepts and unknowns created a space to engage others before venturing into new territory.

On developing frameworks to challenge and critique concepts associated with new technologies in 'IT + Textiles' Redström, Redström and Mazé offer:

When introducing new kinds of objects, such as new technologies, there is not much in terms of traditions, expectations and interpretations to lean on and react against. In fact, such a framework must be developed along with the object itself. This places the designer in a difficult position, since not only the object but also all aspects of its eventual use need to be envisioned. Thus, methods such as probing into possible use scenarios and user expectations become a way to get to know the object to be designed and help us build the framework needed for understanding the design problem. (Redström, Redström and Mazé, 2005, p15)

(A)dressing Stigma' (Figures 1.3 and 1.4) is made with a material which is both reflective and transparent. The prototype suggested a garment which would offer the wearer protection in online spaces for example Instagram by making them appear the same as everyone else: the lives of others are reflected onto them. Alternatively, when the wearer is feeling 'body positive', the jacket becomes transparent and the wearer's body is revealed. The piece was intended to generally challenge a technology-will-save-us narrative by critiquing the social media lifestyle and concerns around loss of autonomy in the context of media portrayals of fitness and weight management.

Figure 1. 3 (A)dressing Stigma (a) Photograph by Kirsty Smith

Figure 1. 4 (A)dressing Stigma (b) Photograph by Kirsty Smith

The work was exhibited at the Design for Safety conference with the Lloyd's Register Foundation at the RCA (2018) and at the Intelligent Textiles Mass Customization conference (ITMC) Prototypes Salon in Ghent (2017). Exhibiting provided an opportunity for me to discuss with other designers and engineers the kinds of projects and themes being addressed in their work, and to assess the current state of practice from an alternative perspective – inside. Presenting at the Design for Safety conference validated the use of models and prototypes as a provocation for addressing wider societal concerns: for example, issues around online security. The prototypes at ITMC were mainly driven by specific applications, such as in healthcare; however, others, including Galina Mihaleva's Tranquilitie, presented novel ways of raising awareness through design. The dress exhibited suggested speculative approaches to restricting exposure to "unwanted" data (for example noise pollution) using interactive textiles which responded to live data streams. The relevant information acquired from these experiences and community interactions enabled me to learn about the types of teams and approaches involved in creating the physical prototypes, and the issues being addressed. Following the ITMC salon, I undertook close reading of the prototypes on display with the aid of the salon catalogue. This served as a review and understanding of the types of research and development taking place within textiles and technology, and an opportunity to offer critical perspective as well as challenge the identification of textile thinking in other practitioners' work. My purpose in engaging with the community was to support the accepted challenge of establishing a position from which to enter into new domains not as technologist, or social scientist, but as textile thinker.

To expand my knowledge base in relevant disciplines, formal participation in educational programmes and placements informed the context of tracking technologies and data representation and experience detailed in Chapter 3. Driven by the issues in data practices identified in Chapter 3, I explored representation and experience using textile design approaches to reveal insights about everyday data interactions. To expand my knowledge of embodied methods, a short course in somatic practice, a human-computer interaction design summer school and an industry placement informed my development of specific activities that were then enacted in workshop activities in the case studies. These are described within the individual case study accounts in Chapter 4. The short course and summer school informed aspects of the practical design experiments. Spending time in an industry environment gave me a wider knowledge of the area of textiles technology and sensor systems. This also provided a technical understanding of a particular product, which I then incorporated in experiments as a probe for data collection.

As the research began to involve others, concepts which were still forming required explanation. The use of the term "data materialisation" proved important in differentiating the process from that of data visualisation. The aim was to communicate the idea that rather than a representation of data, the materialisation was about the whole experience of that data engaged with by the viewer in the material world. The concept of data materialisation is used throughout this report as:

- A tool to interpret data, information or new concepts using relatable aspects of the material world
- An outcome as a response to, or analysis of, data as a means of communicating information using concepts from the material world

This is used to enable perception and understanding and to elicit a particular reaction or response: for example, a deeper emotional engagement with information. The definitions in Table 1.6 describe data materialisation in comparison to similar concepts. Data materialisation as a subset of data physicalisation is expanded on in Chapter 3.

Table 1. 5 Terminology descriptions

Data Visualisation	*"General term that describes any effort to help people to understand the significance of data by placing it in a visual context"* (Data Visualisation Summit, 2018)
Data Physicalisation	"Traditional visualisation map data to pixels or ink, whereas physical visualization map data to physical form" (Jansen, 2014)
Data materialisation	Brings data to life by applying the affective and sensory dimensions and essence of our interactions with the material world as a way of meaningfully communicating and interpreting data (Lean, 2018)

Data Collection: Overview

This study explores alternative ways of navigating and designing with data. My approach is to draw on the senses, eliciting emotion and memory, employing the magic and mystery found in unarticulated relationships with materials. To gather insights and responses to existing practices with technology, I designed case studies as data collection opportunities. The aim was to explore how to elicit the knowledge and experience of materials found in textile design and to investigate ways that this understanding can offer novel processes and value for data physicalisation. The resources and methods for making data physical, using materials, potential applications and value, varied between contexts – from speculating on technologies for fitness data on a rugby pitch to demonstrating personal and emotional responses about connectivity to stakeholders of a government grant scheme.

Data collection included workshop activities, personal studio practice and public exhibition, as well as spending time in new environments, including a design workshop at a rugby team clubhouse and a government department. By engaging the body as a research tool in these settings, I employed an embodied approach to research which includes material handling, model-making, workshops and sensory ethnography to explore the experience of data, through which alternative readings of everyday technology emerged. I designed activities to enable new ways of thinking and addressing problems, using tools and concepts from the field of textiles. This approach responds to

the 'challenge' proposed by Lupton of developing methods that might reveal knowledge about the affective and sensory dimensions of digital health tracking. The workshops had a guided (involving set activities) yet open-ended structure in terms of potential outcomes.

Textile-based workshops, including community-based interventions, are well documented (Heimdal and Rosenqvist, 2012; Pajaczkowska, 2010; Briggs-Goode et al, 2016). Amanda Briggs-Goode et al. (2016) suggest that collaboration with other disciplines offers a multi-layered experience for textile design practice as a 'hybrid practice', for example with users at the centre rather than at the end. A workshop study by Briggs-Goode et al. (2016), in which a multidisciplinary team came together to develop a new methodology, took a holistic view of experiencing rather than a medical approach, setting the aim of behaviour change to fit societal norms. Feedback from participants of a co-design session set in non-medicalised care practices using craft described the experiences using the term "flow". The authors offer that the workshops enabled a pleasant atmosphere:

> There was loss of self-consciousness and lack of awareness of things going on around them, which displaced anxieties and facilitated relaxation. (Briggs-Goode et al., 2016, p.64).

This recalls John Dewey's thinking in *Art as Experience* (1934) and John McCarthy and Peter Wright's discussion of "an experience" as being memorable on account of its feeling – subjectively experienced in relation to a single overriding "felt" quality (McCarthy and Wright, 2004)**.** In the case studies in this thesis, concerned with personal and embodied experiences, I took careful note to observe the atmosphere and group dynamics as a measure of success; for example, participants working together, talking and levels of excitement noted by aspects of laughter and sound in the space. I collected feedback by video interview after the activities, and I identified an overall feeling of "trying something new", with some commenting that they didn't know if we were doing the right thing because they were "just having fun" echoing Briggs-Goode et al' "facilitated relaxation".

Data Collection: Outline of Case Studies

The following is an overview of the case studies used in my research to test new contexts and applications for an alternative data representation experience using materials. Table 1.6 shows the objectives and activities in individual research activities. Each case study is detailed in Chapter 4. Case studies are identified as 'CS'.

Table 1. 6 Case study research activities

Objective	Activity		
	Case Study 1	**Case Study 2**	**Case Study 3**
Expand knowledge	Intelligent Textiles industry placement: learn about functionality and applications (Footfalls and Heartbeats Ltd., Nottingham*)* Design workshops with sports group: test activities and potential applications	Cross-disciplinary design workshop with MA students at RCA: test activities and potential applications	UKRI Policy Placement with Building Digital UK Formal and informal learning opportunities: engaging with external parties and peers to learn about the topic of broadband
Data Collection	Workshop activities with sports group: Workshop activities with student groups: material mapping and making alternative data representation Workshop Activities with sports group: Trying out technology used to engage research participants with their own experience of similar devices or applications Conversations held at public exhibition of installation provided space for insights about personal technology practices	Workshop Activities with student groups: material mapping and making alternative data representation	Ethnography: Illustrated log entry and mapping exercise at B4RN Computer club (probes)
Data Representation and Analysis	Analysing insights: considering the bigger picture of data provides the opportunity to form new interpretations of value in data representation Films of workshop and exhibition used to present research activities and participant commentary: insights	Workshop participant logs: written experience provides individual insights and can be used to prompt conversation Film interviews from show how participants have developed their own perspectives on the scope of the research	Practice-based research methods results in hand-drawn research landscape map Sharing findings with Stakeholders and Steering group: Government Social Research and BDUK analyst team through report, presentation and dialectogram

Case Study 1. Stretch Orchestra workshop and interactive data installation

To explore a textile design approach to representation and experience of physical activity data, I designed a workshop which engaged a community sports group. Members of a women's rugby team took part in a textiles workshop held at the rugby team's clubhouse. Team members participated in material mapping, trialled a wearable technology and took part in design activities to share ideas about data communication. To explore a textile design approach to representation and experience of physical activity data, I designed a workshop which engaged a community sports group. Members of a women's rugby team took part in a textiles workshop held at the rugby team's clubhouse. Team members participated in material mapping, trialled a wearable technology and took part in design activities to share ideas about data communication.

Outcomes of workshop activities with a sports group led to the design of an interactive installation of physical activity data. Stage two of Case Study 1, 'Stretch Orchestra Installation', shown at the London Design Festival 2018, was an open, public invitation. The installation was part of an exhibition with members of the London Doctoral Design Consortium. Visitors to the show ranged from students and researchers to families, children and a work team on a corporate 'bonding day'. This opportunity provided me with a platform to demonstrate applied textile thinking in action through sensory ethnography, through interactions with the installation and by listening to visitors' comments and discussing issues surrounding data experience. To support this case study, an award from the Get a Move On (GAMO) network provided financial as well as contextual support. Their involvement served as a first point of validation for textile thinking in new domains. The GAMO network supports the objectives set by the Engineering and Physical Sciences Research Council, "Transforming community health and care through the delivery of tested technologies that promote wellbeing by providing timely, individualised feedback that encourage appropriate physical activities" (https://getamoveon.ac.uk, 2018).

Case Study 2. Material-Led Feedback System

Material-Led Feedback System was a week-long workshop with Masters-level art and design students. I introduced participants to material mapping activities and in groups they designed material-led data representation experiences. Invited speakers delivered talks on the themes of data, materiality, experience and agency, and participants visited

the exhibition "The Future Starts Here" at the Victoria and Albert Museum to consider audience responses to their designs. Personal responses to workshop activities were documented in logbooks, which provided a rich review of their interpretations of tasks. This written information, their verbal feedback and the data experience issues addressed and demonstrated in the outcomes contribute to an understanding of the types of issues that this textile thinking programme can address.

Case Study 3. Textile thinking as Knowledge Exchange: with Building Digital UK

To test textile thinking in a new setting, a three-month placement with Building Digital UK (BDUK) supported by UK Research and Innovation (UKRI) provided an environment in which I could apply the learnings and themes which had arisen during the research thus far. Here, knowledge exchange took place through the following:

a) Transferring learnings from exploratory encounters which led to findings in the applied setting b) Learnings from the new context which contributed to an understanding of the scope of the research programme

c) Personal scholarship: developing criteria to analyse and deliver research findings to high-level stakeholders.

Ethnographic inquiry supported my development of an evidence base for the benefits of gigabit-capable internet. Engaging an illustrator, rather than taking recordings, proved to be a novel action in this setting to initiate dialogue. Approaching the topic from a non-technical perspective, asking instead: "What does connectivity mean to you?" led to a range of personal and emotional anecdotes from research participants. I delivered the results of this study to stakeholders in the form of a hand-drawn, detailed map of the research. This data materialisation will inform the design of future schemes to encourage the uptake of new fibre connections, as well as contributing to the design of future research projects.

The methodological approach explained in this chapter supports the practical implementation of the characteristics of textile thinking described in the following chapter.

Chapter 2: Textile Thinking

This chapter provides a review of the field of contemporary textile design research in multidisciplinary settings. A key objective of this thesis is assessing the scope of textile thinking as a practice for design research enquiry. In order to critique, one must acknowledge the foundations, then relate to the discipline. Here I offer a review of the current state of textile design research, collated in relation to disciplinary precedence to inform approaches for research that explores data experience. I present the hybrid role of the textile designer who performs frequent collaboration in cross-disciplinary encounters, with a portfolio spanning a range of fields, collected knowledge and ability to flourish in other disciplinary environments. This, combined with tacit and learned wisdom from the field is the ideal training to identify, develop and lead multidisciplinary research challenges. I introduce the concept of "textile problems", which describes:

- The challenge of underrepresentation and acknowledgement of textile design as a research discipline
- The framing of issues in other fields which can be addressed through textiles-led approaches

Identifying textile thinking

Using the Term Textile Thinking

"Textile thinking" is used in this study to mean the understandings developed through the practice of using textiles to explore new concepts and design challenges. This is thinking in practice, used as a descriptor to acknowledge the work of textile design researchers. It has developed from the term used to describe ways of thinking that is *like a textile*. Textiles and art practice writer Pennina Barnett refers to Michel Serre's "sack thinking" to explain textile thinking as "modes of thought that twist and turn and stretch and fold" (Barnett, 1999, p4). This is thinking which is open to ideas, instead of being rigid and closed. This is expanded using an analogy of the continuity of the fold: "thinking in the continuous present" and dipping into the hollow of the fold to "see what happens" (Ibid, p10). Soft logic and pliable thought are described as elastic and mouldable, like something soft which can be limitlessly reconfigured and reconsidered. Soft logic is one that transforms rather than resists, permitting endless possibilities, solutions and new beginnings. "Textile thinking draws together thoughts, images and ideas across disciplines and across cultures. It shapes, stretches and folds them to create new encounters, new ways of describing the world." (Barnett, 2009, p.5)

Elaine Igoe is a textile design researcher and educator whose doctoral thesis "In Textasis: Matrixial Narrative of Textile Design" (2013) challenges depictions of the textile design process which are based on observed activities and outcomes and objective analysis, presented, for example, by James Moxey (2000) and by Alison Shreeve (1997), rather than on lived experience. Igoe's thesis provides a formal basis for using the term to describe the practical application of soft logic embodied in the acts of textile designers. Tacit knowledge for textile design is activated through making, and in particular material handling, engaging the sense of touch. Textile design processes require a knowledge of materials and their application potential, developed through experiments and making. Igoe's investigation into the habits and processes of traditional textile designers explores the type of perceptual and intellectual decision-making that takes place in practice. For example, in her criticism of Rachel Studd's description of textile design problems as "triggers", Igoe proposes that rather than designing as a reaction, designing is undertaken as a dialogue and exchange. Igoe suggests that a lack of reporting on the textile designer's tacit interpretations of the "design problems for textile designs" and not fitting into the design's typical "problem solving" language contribute to the challenge of positioning the discipline in development of design theory; she finds the terminology "mechanistic, and transactional" (Igoe, 2013,p.96)." Her thesis which demonstrates representative translation of the cognitive processes of textile designers in practice contributes to an emerging feminist discourse in design thinking that is perceived by Igoe to be missing from design research theory.

The role of the textile designer is invaluable across a wide range of industries, yet textile designing and thinking as an accepted form and process of knowledge generation struggles be acknowledged. Nigel Cross (1982) called for an "externalising" of the codes embedded in "designerly ways of knowing". The tacit knowledge and intuition embedded in the thinking and making of textile practice methodologies have rarely been documented; it cannot be coherently put into words. Rebecca Earley et al. (2016) and others (Kane and Philpott, 2013, 2016; Valentine et al., 2017) note that an in-depth knowledge of the thinking process in textile design leads to a lack of clarity about the differences in disciplinary practice, for example, in architecture or product design when they are grouped together as 'design thinking'. Exploring the tacit knowledge and understanding within individual textile design practices can reveal ways that these 'codes' provide insights to inform new ways of working which are valuable to other fields. Igoe describes textile practitioners using the term "textiley" within the field; however, that use of the diminutive illustrates the lack of knowledge and recognition given to the field, both from within and externally.

Despite its apparent universality and pervasiveness that is readily seen by those in the field, textile design methods and scope have traditionally been undermined and excluded within the domain of design research. Igoe proposes that including textiles as design discipline in development of design research theory would support stronger representation and recognition for the field. Her analysis of interviews with practising textile designers reports a prevailing feeling that textile design expertise has been perceived as lower down in the hierarchy of design disciplines. Igoe suggests that textiles' misrepresented position as a design discipline is a result of being tacked on to other design practices, therefore it performs a role which is not clear, and that can be misinterpreted by others. Igoe presents historical and current cultural context to support the suggestion that textile designers' practice has been suppressed and misrepresented. Igoe argues for the inclusion of textile design in the development of the design research discourse. This is approached using feminist qualitative research methods: for example, drawing on the lived experience of both her personal practice and her research subjects to establish theory. Igoe's study, which aims to reveal the embodied, tacit influence of textile thinking, argues for the intricate, enigmatic, non-linear textile design methods and their practitioners to be acknowledged within design research. The proposal is that textiles' inclusion within theories of design could impact on perceived hierarchies and misinterpretation by being positioned in relation to an established design research methodology. Igoe examines the textile design process and textile thinking, both tacit and explicit within the design thinking and design research agenda to explore areas of design research discourse that might be enhanced by the inclusion of textile design. For example, acknowledging Elizabeth Sanders and Pieter Jan Stappers' map of Design Research (2008), using textiles design as a lens could contribute to the understanding of design and emotion. Igoe suggests that although textile design aligns most closely with "design and emotion" it has the potential to expand across other design research fields. This expansion will determine the scope of textiles approaches which are included in development of design theory. Igoe proposes that taking a research approach will impact on both the textiles field and its external identity as a research discipline. In this thesis a key aspect is identifying ways in which textile design can be presented to other fields as a viable and useful research approach. Using examples of textile designers who collaborate with scientists, Igoe proposes that textiles which takes a research approach will expand across areas of design research, leading to definitions and an understanding of the value of textile design in these contexts. Drawing on Sanders and Stappers'

mapping approach, Figure 2.1 is used to explain the positioning of the textile research in this thesis, in particular for communicating disciplines outside of design as important for sharing with textile designers. The X axis describes the mindset – exploratory or applied, and the Y axis shows how the research approach leads to insights or innovation. This is used to represent where textiles research is used in ways that generate socio-cultural and ethnographic insights (as well as research which results in material innovation). Arrows from "Innovation" to "Insights" signify existing technology that has been used as a tool to gather findings and develop insights, and vice versa where these insights lead to development in innovation and design. The arrow leaving the frame signifies innovation which is "non-material", to express that textiles research can lead to innovation in other design research fields. This is helpful for explaining that textile design research does not necessarily result in physical materials, and can be used as a tool for investigation into other areas.
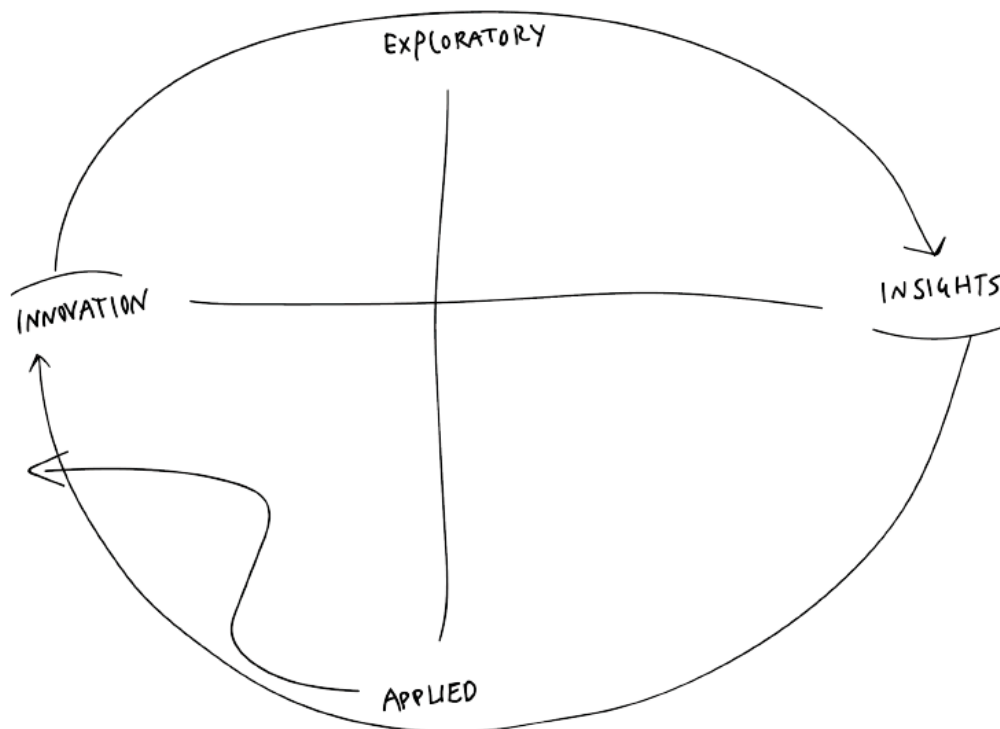
Figure 2. 1 Exploratory and Applied Textile Design Research

Criteria for Textile Thinking

Following Igoe's method of exploring the practice of others to develop criteria, the following is a review of textile thinking generated from the literature. This illustrates the valuable and varied approaches of textile researchers and practitioners. Key aspects of practice of contemporary textile design researchers in the context of this study are used to form criteria for applied textile thinking. The seven characteristics are: Tacit knowledge, affect and being in the synergies; Experimenting with materialities; Problem Setting; Engaging technology as a research tool; Inspiring New Practices; Building Relationships and Knowledge Exchange shown in Figure 2.2 and detailed in Table 2.2.
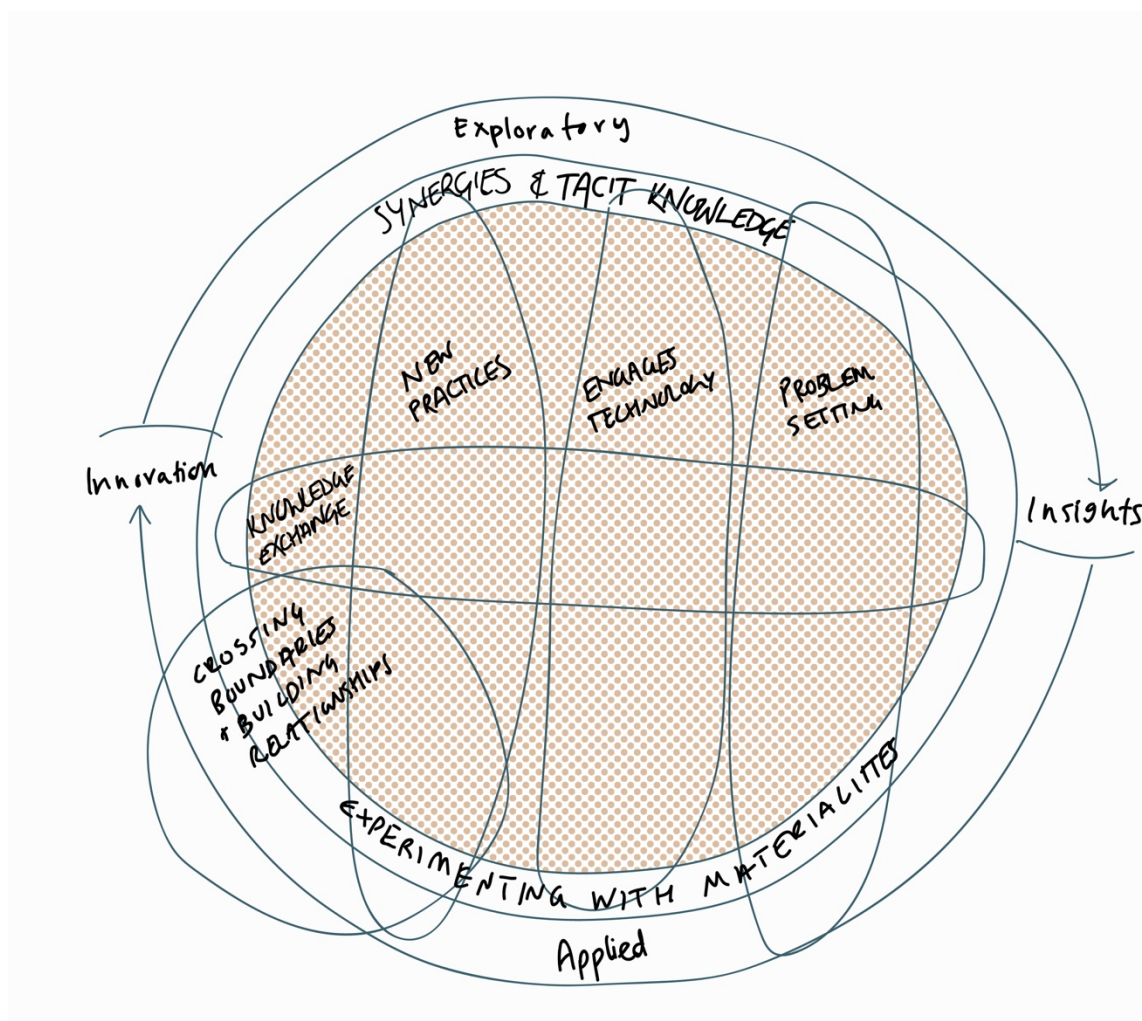
Figure 2. 2 Textile thinking characteristics on the map of textile design research

Table 2. 1 Criteria for Textile Thinking

Key Characteristics of textile thinking in this study	Examples from literature and practice reviewed
Works in the synergies, engaging with empathy and affect through tacit knowledge A role which is misinterpreted and often overlooked yet typically quiet in its nature can enable crafty observations, ideas and lateral thinking. "The unique intelligence of textile thinking and the material culture it informs are often overlooked due to the tacit nature of the knowledge involved" (Philpott and Kane, 2013, p.1)	Igoe, 2013 Corkhill et al., 2014 Harper, 2017 Millar and Kettle, 2018 Pajaczkowska,2014 Scott, 2012 Winters, 2016
Is concerned with **problem-setting** rather than problem-solving- a field which can offer suggestions for challenges in other fields through textile framing	Philpott and Kane, 2016 Farrer and Finn, 2010 McCann, 2016 Gwilt, 2015
Creates bridges- **inspires new practices** with other design disciplines and fields of research	Briggs-Goode et al., 2016 Castan, 2019 Kapsali, 2011
Shares experiences as **knowledge exchange** through a range of means and mediums. Establishes means to apply and "display the tacit knowledge of my [the textiles] discipline" in appropriate settings (Igoe, 2013, p21)	Earley, 2018 Earley, Forst and Wardropper (2018). E-Textile Summer Camp (2011-2017) E-Stitches (2020) Karana et al., 2015(a) Shercliff and Holroyd, 2019 Valentine et al., 2017 Walker and Piper, 2017
Crosses boundaries and builds relationships- engages and empathises with industry and academia, is flexible and can be found in alternative environments in different guises and locations: "forging relationships quickly and easily" (Igoe, 2013, p.44)	Cassim, Toomey and McNair, 2017 Hall and Earley, 2019 Hornbuckle, 2018
Experiments with materialities, especially **physical materials**, in making, metaphor and as probes, crossing physical-digital and other boundaries	Atkinson et al., 2013 Karana, Pedgley and Rognoli ,2015 Kapur, 2019
Engages with technology to address social and cultural scenarios, and to disrupt and question experiences offered by existing design	Ballie, 2013 Buechley, 2008 Menheere et al., 2018 Nevay,2017 Posche, 2017

The input of textiles is often shrouded by other disciplines or seen as decoration, or an addition, instead of the "designerly" contribution of textiles being seen as a whole. The practice of textile designers regularly working alongside other fields means that practitioners often work in non-linear ways, building sensitivities, and developing tacit knowledge through interdisciplinary working. Jen Ballie (2014) highlights that combined thinking and making processes in textile (and fashion) design are rarely well documented. Few publications cover this area of methodology. Ballie suggests that the tacit knowledge and intuition of the textile designer cannot coherently translate into words, since these processes are intuitive and rely on the individual's specialism and experience.

The external image of textiles is as a behind-the-scenes enabler for others; bound in the feminine; in a caring context; in home economics, in relation to motherhood. Igoe characterises textiles as female entities, embodied in the roles of the mother, the geisha and the spinster. Her research offers "textiles' role as agents of tactile and visual experience, specifically in decorative characteristics (Igoe, 2013). This is developed using interview insights collected from practitioners making textile designs – typically swatch samples ultimately used for interior design and fashion. The three feminine examples adequately and artfully cover the scope of decorative textile design practice. The image of the mother behind the scenes resonates with Igoe's interview findings with textile designers describing relationships with industry – for example, developing textile designs as products. Textile design roles typically engage with those in other fields, enabling insight into a range of disciplines, working in the synergies rather than at the forefront. Metaphor is used to communicate and decipher intangible or inherent understandings held by individuals. Using metaphor, illustrating these unseen, "intangible" sensitivities with personalities, Igoe's work aims to represent textiles by removing the craft and aesthetic "constraints" and permitting it into the discourse and toolbox of design research.

Considering the lack of knowledge about the lived experiences of textile designers described by Igoe (2013), Pajaczkowska (2015) suggests that the language of practice is a barrier. As a visual discipline, final outcomes, designs and products are evident but the individual activities, specific knowledge, skills and practices involved in these processes are unseen and therefore often unknown and difficult to explain. "Making

Known: Nine Types of Textile Thinking" (Pajaczkowska, 2015) textually presents understanding and values developed through practical textile practice. Pajaczkowska gives an overview of the actions and their implicit and explicit value for the maker, both in process and as outcomes: for example, the ego as material form, the stitch which acts as an action for contemplation and reflection and spinning. The line or thread represents the lifeline or umbilical cord. Kirsten Scott's (2012) exploration of Ugandan women pleating sleeping mats describes creation of "emotional threads", literally as well as metaphorically creating attachments to each other. These examples describe how knowledge gathered through tacit understanding of materials generates analogical and functional understandings. A lack of reporting on textile design activities can be by addressed by analysing meaning in the practical actions and their outcomes, rather than language-based understandings.

Textiles are used as physical connections and places for engagement with others and as a metaphor and a psychoanalytical reading of them as mind and the inner self in our engagements with others (worlds, peoples, self). Pajaczkowska (2018) posited that while design can be seen as planned, empathy is spontaneous. Drawing on affect and enabling empathy in textile-led research is described in textiles workshops in care homes by Pajaczkowska (2014), and Harper (2018) on memory and mourning in *The Erotic Cloth* (Millar and Kettle, 2018), and on wellbeing and knitting by Betsan Corkhill and Jill Riley: "Through knitting, lost emotions associated with anticipation, pride, excitement, and happiness are reawakened" (2014, p 39).

Louise Valentine et al. (2017) propose that authenticity for textile design lies in collaborative contexts and reiterate the theme of adaptability for practising and engaging with identified problems and through reflexivity for the textile designer herself.

> It is (also) argued that only through ambitious and inventive collaborative methodologies can cultural change become possible, which is deemed crucial when driving the agenda for sustainability as a key concern within the fashion industry. Yet what this does is to change the textile design process, and this often requires a personal journey, in the first instance, for textile designers to identify their own values through the process of making, which run parallel or are aligned to the needs of others. (Valentine et al., 2017, p.S966)

On acting in the synergies, Igoe (2018) supports textile designing in un-categorisable, fluid spaces, disguised by the zeitgeist, scanning with quiet preparedness for inevitable disruption and change. This is made possible using tacit knowledge, feeling and affect in engagement with new tools and dimensions made possible by engaging digital materials and modes of dissemination. Faith Kane and Ruth Philpott (2013) argue that a "purposeful deskilling" upon finding oneself in a new domain can lead to a reframing of context and problems. In textile thinking methodology, a "drawing together of multiple elements", both conceptually, learning from other fields and cultural concerns, and physically, by engaging with making and material knowledge, serves to reveal a new perspective. Thus, textile design in this way learns from and is inspired by other fields (including maths, chemistry, physics and aesthetics, as well as nature and history) to shed new light on different fields.

Problem Setting

In the introduction to *On Weaving* (1974, p.13), textile designer Anni Albers writes that she hopes her book will be of interest to those not only in the field of textiles but additionally to those in other fields which "encompass a textile problem". Albers is suggesting that those in other fields and disciplinary domains can learn from the book and from weaving, applying learning from textiles to their own field. It is established that the field of textiles has contributed practically to global health and well-being issues, including preventative healthcare. This is exemplified by the research of Joan Farrer and Angie Finn (2010), Jane McCann (2016) and Charmaine Childs et al. (2015). Specific research areas cover fashion and skin cancer prevention; sportswear for active ageing communities, and keeping warm at home. In the interests of realising the "ever extending relationships" of textiles (Albers, 1974, p.15) my thesis proposes to investigate the hunch that while digital and virtual representation moves us further away from ourselves, textiles has something to offer through "tactile sensibility". "No wonder a faculty that is so largely unemployed in our daily plodding and bustling is degenerating" (Albers,1974, p.62).

Tactile sensibility can offer ways of thinking and holistic experience that could be used for informing future design decisions for technology-supported interventions. Albers wrote using textiles to think, to illustrate and theorise about the state of the world, for example her commentary about decoration in the home and the lack of necessity to make, including clothing; food and the need for tools. Although writing in 1957 and 1965,

Albers acknowledged a perceived loss of tactile sensibility that owed much to the introduction of the ready-made. For example, in food, grains were already ground (also see a description of the influencing advent of Lycra on the role of the housewife (O'Connor, 2010)) and as early as Marcel Duchamp's *Fountain* (1917). Eliminating the need to work with our hands is also relevant today in a discussion of the loss of sensory engagement associated with digital experience (Pallasmaa, 2012). Albers suggests that a renewed sensitivity in tactile articulation would be to *"re*gain a faculty that once was so naturally ours" (Albers,1965). The human body in physical and material form loses meaning through such experiences. The risk of "growing lopsided" (Albers, 1974, p.62) through yet another offer of the means to remove form through digital data representation and experience finds itself as a textile problem. It is even suggested by Höök that humans *have* now become lopsided (2018, p.207).

In this thesis, the "textile problem" can be read as solutions and suggestions from textiles reading which can be adapted to challenges in other fields. This thesis aims to present ways in which other fields may learn and adapt methods from textile thinking. Sensory disconnect, now a *textile problem,* can be perceived as a lack of tactile sensibility within the context of digital experience. To address this problem, the issues arising and manifest in the representation of the physical body through screen-based and digital environments are introduced later within the case studies as a design challenge.

Textile design researchers Philpott and Kane (2016) argue that an important role for textile thinking exists in the "problem setting" rather than the problem-solving in interdisciplinary contexts. Philpott and Kane take advantage of the pervasive nature of textiles to explore ways to implement textile-thinking methodologies in interdisciplinary contexts, benefiting in particular from the practice of rationality and exploiting the "synergies between different elements". The approach uses "problem setting in which different perspectives have the freedom to entwine and overlap" (Philpott and Kane, 2016, p.237). These qualities are mentioned as being adapted by the architects Frei Otto and Lars Spuybroek (2006), reiterating a value in the practice of textile thinking for other disciplines previously overlooked (or dismissed) by Cross (2007). In this thesis, I employ an implementation of components of textile thinking to identify problems in other fields.

Textile designers working with other fields can inspire and transform new practices and working relationships. Section 6 of *Design Lifetimes: A Manifesto for Strategic Change*, a publication to support designers to create and improve sustainable design, is titled "Design that Looks at Models from Nature & History". This proposes using the evolutionary method of taking inspiration from a successful formula or process then translating this into a formula suitable for innovation in a different field (Earley and Politowicz, 2013). Taking models from nature, researcher Veronika Kapsali used biomimetic design drawing inspiration from the pine-cone to create INOTEK. This textile changes form in response to body moisture levels to increase airflow, for use, for example in clothing when playing sports. When the fibres become wet, they become more permeable to air, expanding and tightening the yarn and creating air pockets in the fabric (Kapsali, 2011).

ArchInTex ETN was an EU-funded project which aimed to strengthen the foundations of design for more sustainable forms of living by connecting architecture, interaction design and textiles. Two projects relevant to this study that can contribute to an understanding of the approaches and breadth of textile thinking across the contexts of the body, architecture and interaction are the work of researchers Jyoti Kapur and Marina Castan.

Castan (2019) used embodied design ideation to develop methods for creating textile architecture from digitally captured geometries of human bodies in movement. Kapur's research (2019) proposes tactile vocabularies and palettes of new materialities incorporating smell and audio, engaging in textile thinking as a lens to suggest new experiences for architecture and interior design practice. Combining a knowledge of architecture and spatial practice with the "invisible materials" of sound and smell, Kapur engaged in "sensory sensitive thinking", employing textiles as a material and a method to understand materiality in relation to smell. Kapur was inspired by the claim that vision and auditory senses are over-privileged in terms of communication, and the other senses are relatively unexplored, and used her textile design background to develop methods to propose alternative tactile, sensory attributes for spatial design.

The textile thinking examples discussed here illustrate developments of new practices and platforms for research.

Events, writing and networking within the field enables knowledge exchange for sharing methods, references and contributing to practice. In 2012, an EPSRC-funded project led by the Textiles Research Group at Loughborough University sought to find new ways to tackle issues around textiles and sustainability, including material development, design using recycled materials and energy-harvesting materials based on knowledge developed from engaging with textile thinking and practice. The approach included establishing a research network and identifying key areas of interest to pursue and took the form of an event at which thinking through making in an e-textiles workshop enabled discussion and knowledge exchange. "INTERSECTIONS" was a conference hosted by the Textiles Research Group in 2017 (and in 2019, as "TEXTILE INTESECTIONS"). These events featured the work of textile researchers tackling issues connected to wellbeing, smart materials, new technologies and sustainability that was carried out in collaborative contexts, often in unexpected interdisciplinary environments, which *"furthered the research in textiles and textile design"* through "applied textile thinking*"*. At the 2017 conference, researchers at Nottingham Trent University presented a "guide" for workshop facilitation to enable the engagement of participants with smart textiles. "The Textile Designer 2.0: A Workshop Guide for Future Workshop Facilitators in Smart Textiles" (Walker and Piper, 2017) was based on reflections on e-textiles workshops led by the authors in collaboration with textile engineers. The authors proposed that the transition from the role of practitioner to that of facilitator suggests that an additional role of researcher be added to record and share best practice for designing with new technologies for multidisciplinary contexts. The researchers also noted the importance of *"*facilitators becoming learners during the workshop to find equal congruent status and identity with the participants" (Walker and Piper, 2017). The approach benefits from flexibility and adaptability, and Philpott and Kane's 'purposeful deskilling' of textile thinking in practice in a new context. Established in 2019, the Stitching Together research network aims to connect and share best practices, insights and knowledge for researchers and practitioners using textiles workshops as a method (Shercliff and Holroyd, 2019). Supporting knowledge exchange for textile design researchers to develop as leaders, Earley expresses alternative forms of "leadership", for example through sharing an experience in writing. "The great potential here is for the next generation of textile designers to emerge as progressive and whole leaders, drawing on the discipline's rich past and the strong female roles that have emerged to date." (Earley, 2018,p.133*)*

Extending outside the academic setting is "S++ A Hybrid textile for Health and Wellbeing", a joint project with the Kyoto Design Lab (D-lab), the Department of Advanced Fibro-Science, Kyoto Institute of Technology (KIT) and the Textiles MA course at the RCA. The project presented practice-based research in which traditional *chirimen* (kimono silk) weaving took on a new form when combined with a thermoplastic polymer. The technique rendered the fabric hydrophilic and hydrophobic, suitable for wear in hospital settings. The weaver on the research team, John McNair, had to take on the new role of textile technologist to establish ways of working. In a similar approach, the D-lab facilitates workshops with design students and *chirimen* mill owners to ideate new strategies and market opportunities for their production. Engaging with the Kyotango weaving communities led the research team to identify key areas which might be explored to develop new processes. Through collaborative work with researchers in scientific fields, textile thinking here has adopted a novel approach by adapting new processes for traditional materials to empower and rejuvenate a declining industry while proposing a new direction for textiles in healthcare settings (Cassim, Toomey and McNair, 2017).

The focus of the Centre for Circular Design (CCD), at the University of the Arts London, is on addressing issues in the clothing and garment industry and establishing methods to engage stakeholders in circular design. Their research with partners in the fashion industry exemplifies textile thinking in industry settings. Their involvement in the Mistra Future Fashion project, working with the Swedish fashion industry, led to practical textile artefacts and processes that aimed to inspire both textile and fashion designers to innovate using sustainable design practice as well as tools for facilitating multidisciplinary communication in collaborative settings. This is documented in the report Circular Design Speeds: Prototyping fast and slow sustainable fashion concepts through interdisciplinary design research (2015-2018).

The Silence Shirt (Earley, 2017) was a garment produced as an outcome of a relationship-building exercise between scientists and stakeholders on the Trash-2-Cash project. The project report draws upon neuroscience, psychology and portraiture to inform textiles-based practical making exercises used as an "icebreaker" at the beginning of a three-year study that aimed to reveal subjective and personal elements

and create the basis for communication in the group setting. Research partners engaged in exercises that included meditation, looking at each other for extended periods of time and drawing each other. The drawings were collated and printed on a shirt which was used to strengthen relationships for collaborative working as a shared outcome in a cross-disciplinary setting. Acknowledging the challenges involved with working with diverse stakeholder groups Earley and Rosie Hornbuckle used textile design methods to instil trust and strengthen shared ambitions in a group consisting of scientists, designers and industry partners. On enhancing connections in multidisciplinary settings, Earley and Hornbuckle state: "Textile design approaches can nurture connections between people in ways that other disciplines cannot" (Earley and Hornbuckle, 2017, p.106). The events described were presented as platforms for dissemination and networking in textile design-led research to bring people together. Textile thinking performs a social function here, working towards engagement and empathy (Earley and Hornbuckle, 2017).

In 2019, CCD doctoral researchers explored routes for mechanical textile recycling and repurposing. In their article 'Divide, Switch, Blend. Exploring Two Hats for Industry Entrepreneurship and Academic Practice-based Textile Design Research', Cathryn Hall and Rebecca Earley presented methods for documenting and addressing impact and experience of formal and informal exchanges: for example, between manufacturers and researchers during site visits to learn about processes. They describe not only the nature of crossing disciplinary borders, but also those outside the academic context such as in an industry setting: for example, a factory, or even in the factory owner's car (Hall and Earley, 2019). CCD's work presents outward-facing and industry-focused positions for collaborative textile thinking.

Experimenting with Materialities and Modalities

The design researcher concerned with materials aims to test cultural, practical and ethical implications before production. In *The Material of Invention,* Ezio Manzini (1986) rigorously explored traditional as well as emerging new materials for design, presenting an extensive range of materials as inspiration and direction for new product functionality. He also offered wider implications for design based on conceptual and aesthetic responses from designers. This was an exercise to introduce designers to innovative developments that they could use in their design practice, as well as presenting and promoting new materials that were being developed in lab settings (Manzini, 1986). At this time, design researchers were focusing on materials that were typically involved in

product design, architecture and science, and were concerned with practical and functional factors in new material development and manufacturing processes. Later, designer and researcher Donald Norman introduced and advocated ways to consider experiential and emotional influences on the material of products (Norman, 1988).

Exploring new methods for researching with materials, Elvin Karana et al. (2015a) proposed the Material Driven Design (MDD) method, that facilitated design processes by making the material the 'driver'. In three case studies designers were invited to engage with i) familiar materials ii) unfamiliar materials iii) materials under development. Experience of working with the materials was mapped by participants, and this included the themes of sensorial and technical engagement, as well as that of uniqueness. These were then incorporated into a design phase, and prototype vessels were made from processed coffee grounds. This work explores new possibilities for designing with materials (Karana et al., 2015a).

Philpott and Kane (2013) identify sensitivity to materiality and whole-body thinking (thinking through making) as key factors embedded in textile thinking. Igoe (2018) draws upon the work of contemporary textile designers who are bridging the gap between physical and digital making to explore new meanings of materiality, including the concept of "agential material". This adaptability of the textile designer that enables them to enter new territories and adopt new ways of making – for example, using digital materials or "algorithmic crafting" (Igoe, 2018) – echoes Philpott and Kane's acknowledgement of the "soft logic" found in textile thinking.

Design research that explored an engagement with materials in digital space by Douglas Atkinson et al. (2013) adopted methods that included visual and touch-screen interactions with images of material which altered its appearance in response to physical touch. The Digital Sensoria project aimed to develop methods of communicating sensorial properties through digital means. Potential outcomes might be used to enhance the online textile sourcing and shopping experience. Prototypes to elicit emotion when the user interacts with the digital, visual and touch screen clothing experience were developed by investigating visceral responses to the physical touching of materials. Bruna Petreca et al. (2016) experimented with digital tools to explore the multisensory experiences of materials at trade fairs. The results of the dialogue generated by interacting with the tools demonstrated that attributes that went beyond the functional and technical, and experiential aspects were important for textile selection. Textile designer Amy Winters (2016) explored nuanced modes of expression in

interactive textile design in her doctoral study at the RCA. She suggests that a typical textile-technology collaboration is "technology led", with developments focusing on the miniaturisation of components, for example, rather than "textiles led", which might focus on the look, feel or experience. Other examples of work that combines material expression with the application of technology through responsive materials is shown in Lauren Bowker's project "THEUNSEEN" that explores colour-changing materials (https://seetheunseen.co.uk), Cute Circuit's garments with embedded circuitry (https://cutecircuit.com), fashion designer Ying Gao's socially responsive fashion concepts (http://yinggao.ca) and Pip Mothershill's garments with pneumatic chambers (MIT Tangible Media Group). In these examples, the research and investigation into materials led to consideration of potential applications for the physical material itself, whereas in textile thinking examples which engage with technology (described later in this section), materials and textile practice is used as a means to explore concepts and concerns beyond the designed artefact.

Winters (2016) found that the modes and platforms for the dissemination of material expression and technology research tend to be different from the typical outlets for textile design research. This reframes the style of approach. For example, Atkinson et al. and the MIT Tangible Media Group tend to publish their textile-focused research within the HCI and computing community publications. A "technology-led" rather than a "textiles-led" approach, as well as commercial constraints, may also emphasise this framing of the research as HCI. Textiles-led technology research and collaboration remains less established in these fields. Table 2.1 offers an interpretation of the differences between materials research and textile design research.

Table 2. 2 Materials and Textiles in research observations

Materials Research: commercially driven, materials as departure, focus on new and novel materials, product development, scientific, logic

Textile Design Research: aesthetic sensibilities**,** materials as information, exploratory, crossing disciplines, working in the synergies, enabling, intuitive, serendipity

Engaging with Technology

The known role of textile design in systems which support mechanisms such as biosensing and tracking for health and wellbeing have predominantly seen textiles as a

structure or container. Drawing on metaphor, Igoe described textile as an entity with the following characteristics: it "enables others into existence", "gives continuously"; is decorative, seductive, "provides alternative readings of the situation" and is "interesting but often overlooked" (Igoe, 2010, p.4). Textiles-technology collaborations have tended to focus on the physical and technical properties of the textile to host functionality, or, when implemented later, offer aesthetic potential for wearability and style. However, advanced technological developments and design-science collaboration now provide textiles with the agency to perform responsive and active roles (Collet, 2012, Footfalls and Heartbeats, 2013, Tibbits, 2014, Zhang et al., 2019).

Rather than textiles having a role that is merely supporting, combining the aesthetic sensibilities of textiles with technological accessories to create responsive fabrics and connected objects produces a wider range of characteristics: energy and agency for textiles to perform, to think and to lead. Of particular interest is the point at which engaging with technology enables insight into experience, social-cultural insights and ethnographic findings: "…textile design is being developed as a strategy for changing people's behaviour and is a concern for crafting new partnerships, relationships and alternative ideas" (Valentine et al, 2017, p.S968).

Now that smart textile developments have become more accessible, through the maker movement (Posche, 2017) and the availability of tools for crafting with electronics (Buechley, 2008), experimental approaches to the use of, and potential for, textiles-technology interventions are being explored in research settings. Sara Nevay found that textiles can mediate relationships with new technological applications, "enabling users to continue inhabiting and interact with the physical world whilst intuitively navigating the technological world" (2017, p.S4071). Martijn ten Bhömer's Tactile Dialogues used interactive textiles to assist communication in dementia care. Ballie used social media as a tool for a textile design intervention to research needs, desires and agendas to gather information about clothing habits and sustainable behaviours (Ballie, 2014). Others have used smart textiles in collaborative environments (Briggs-Goode et al., 2016); workshops and meet-ups for knowledge exchange (E-Textile Summer Camp, EStitches) and a smart bra for breast health monitoring (Menheere et al., 2018).

The examples discussed have been placed in categories in Table 2.2 to illustrate the types of activities and approaches which are relevant to each characteristic. However, the nature of textiles is that they are flexible and adaptable, and the researchers and practitioners included in this chapter tend to simultaneously employ multiple textile thinking characteristics in their approach hence the fluidity of the diagram in Figure 2.2.

I used this criterion of textile thinking as a basis to identify aspects of practice implemented in the case studies in this thesis. It is intended as an initial framework for textile thinking which will expand as textile design research itself grows and is recognised in the development of design theory.

Textile Problems

Through this thesis my aim is to give form to both data experiences and textile design research activities. The concept of the textile problem draws primarily on Albers' suggestion that issues outside the field of textile design can be re-addressed using techniques and perspectives derived from textile design approaches. The use of the word "problem" does not typically fit within the textiles domain but refers to the terminology which surrounds design research and design thinking processes. Textile designers have traditionally not responded to "problems" but to briefs for appealing samples and artefacts. In Igoe's interviews with textile designers (2013) she observed that their work does not fit or follow a linear process of problem solving, and this limited their own perceptions of the potential application of their work to the confines of their studio. In 2020, the processes carried out by textile designers encompass a wider range of industrial contexts and challenges, including "problem" identification. Acknowledging the breadth of this change supports the case for the stronger representation of, and recognition for, the field, including Igoe's proposed inclusion of textile thinking in development of design theory.

Textile Problems in Other Fields

The textile thinking programme in this thesis creates new textile problems in other fields, resolves a textile problem of identity within its own field and proposes meaning for textiles in theories of design. The development of appropriate design objectives and values to define and address textile problems in data experience is supported by a conceptual programmatic structure for design, as illustrated in Table 1.3 (Redström, 2017). In this thesis, my objective is to explore how issues associated with human interactions with data can be addressed by a textile designer. In doing this, I reveal aspects of textile designing which are useful to those in other fields. This approach offers alternative perspectives and new ways of working. Albers (1957) suggested that as textiles practice is a tactile activity it could be used to offer insights about issues related to a perceived move away from tactile engagement – for example, repair and making. Albers

contextualises the loss of tactility within the rise of the ready-made and the situation in which people no longer need to know about materials, thus losing those skills and sensibilities. In this study, I describe issues of data experience as immaterial, and I use textile design approaches to materialise and give form to aspects within this area. Resonating with Albers' suggestion that a loss of tactility could be an issue addressed through the tactile field of textiles, I address the intangible nature of data experience to explore how textile design approaches can lead to alternative readings and design suggestions.

I have established that the field of textile design research lacks well-documented reporting on how textile designers work. Igoe reported that when engaging in collaboration, textile designers have felt marginalised compared to other design disciplines. Undoing this "sociological wrapping" will contribute to the issue of authenticity of textile design for the individual as well as within the field (Igoe, 2013). Establishing modes of communicating textile design activities and their significance is valuable for developing personal and professional understandings, as well as in collaborative contexts. Positioning textile design within the design research discourse would support the acknowledgement of textiles by challenging hierarchical readings. Returning to Igoe, the notion of textiles as the mother behind the scenes and the geisha in disguise is disrupted by that of textiles as spinster. As an alternative suggestion, rather than performing for "suitors" and fitting into a map of design research, as seen, for example slotting into design and emotion on Sanders and Stappers' diagram (2008), in this thesis textiles as spinster, curious to test boundaries, contributes to a new map: an emerging topology of the textile design research field (Figure 2.2).

Generalising Textile Thinking

Design Thinking has transitioned from a design studio process denoting what designers do into a term which is now a recognised model of problem-solving using design tools and approaches. For example, in the management of businesses, policymakers and planners use the approach to solve social issues and develop more user-centred public services. Though this has raised the profile of designers, issues around the inclusivity of design thinking as a blanket toolbox for ideation and innovation are also raised (Kimbell, 2015).

A generalised "textile thinking" would also ignore the existence of diversity, so the characteristics compiled are relevant to this study, which follows the development of a practice for exploring the experience of data. I do not use textile thinking here as a set formula for "applying" literature and theory that is historically typical for textile design researchers and practitioners. Instead I report on the actual research activities of a textile design researcher, including the theories and concepts explored and the methods and outcomes of design, many of which are atypical, thus contributing to the understanding and scope of textile thinking as an approach for research through design. The identification of the characteristics which have been applied in case studies (Chapter 4) illustrate how textile thinking approaches can be used to develop critical perspectives on data experience.

The following chapter is a review of practice which engages tactile sensibility in design for digital experience and data representation.

Chapter 3: Data Experience

In this chapter I present the relevance of exploring human relationships with data and review the work of communities of practice who are addressing this. Focusing on representation, I report on issues which may be problematic for the layperson interacting with data experience, emotional responses and developing critical thinking on technology as concerns to be addressed through alternative manifestation. I present examples from art, design and human-computer interaction (HCI) that illustrate ways in which data representation is being designed to evoke emotional response and meaning. Data physicalisation is situated as a community set to benefit from the new approaches in data representation and experience explored in this study.

This review was led by the following question:

What roles can physical materials play in facilitating, generating and reporting on representation and experiences of digital data?

Representation and Experience

Use of the Terms Data and Experience in this study

Experience is acknowledged as the fourth economic dimension, following commodities, products and services (Pine II and Gilmore,1998). In the context of the experience economy consumer technologies – wearable fitness trackers, for example – can be described as experience products. Consumers pay for the intangible experience embodied in the product. In their study of experience products Richard Hull, Josephine Reid and Alison Kidd (2002) found that there are three "dimensions" that people engage with during experience:

- sensation/drama/ stimulation
- challenge/achievement and individual expression
- social bonding

Writing on experience products, Kidd (2003) observes that highly engaging experiences trigger all three dimensions simultaneously. Situated in the field of textile design, concerned with sensory engagement and physical making, the examples in my thesis engage stimulation in technology experiences. The case study experiences I designed (described in Chapter 5) invited personal identity, memory and meaning to be embodied in subjective representations of data. Data experiences designed with stimulation in mind enabled social bonding in group settings. Contextualised in textile design, the sensation

of touch and physicality of the material world inspired this research. However, during the case studies, I also considered the wider aspects of material engagement, including the senses of smell, hearing and taste, as well as the visual, for exploring data experience.

"Data" is used in this thesis to mean the visual and numerical representation of information, both personal (for example, generated by fitness trackers and other systems used to inform personal decision-making), unseen "general" digital data (as in the transfer of data for internet use and IoT products) and insights within the research context as "qualitative data collection". "Data" in this thesis implies the representation of information which is immaterial, and "inherently imperceptible" (Hogan and Hornecker, 2016); however, through the case studies the possibility of the material properties of 'digital goods' which exist in their felt interactions with the material world (Dourish, 2011) and the potential applications for "data sensification" – understanding which is gained through in the physical experiencing of data representations – are explored (Hogan, 2018).

Experiences and data in this thesis
- Personal data generated from knitted textile sensors
- Personal accounts of data-driven design and information experience offered by research participants
- Experience of, and insights into, living with high-speed internet-fibre broadband

Relevance of Exploring Human Relationships with Data

"[B]athroom scales have in fact not succeeded in "encouraging" people to lose weight, but more often simply add to the intense guilt, shame and anxiety people already have about their bodies" (Nafus, 2016).

As a counter-argument to the suggestion that we are becoming slaves to monitoring devices, digital ethnographer Dawn Nafus (2016) comments on the highly affective nature of even the simplest of health monitoring devices. Taking into account the emotions generated through the use of digital health devices can contribute to a wider understanding of how it *feels* to track your bodily functions. This could thus be used in the development of tools designed to explore the experience and impact of both wearable technology use and digital devices to monitor and encourage physical activity. An awareness of the ways that technologies function can also contribute to behaviour: knowing how a device is collecting information about us may alter the lived experience.

The experience of closely monitoring sensitive, often intimate, data can contribute to our wellbeing; "when the numbers look good" users tend to feel confident, whereas when the numbers are low this can lead to worry and anxiety (Lupton, 2017). Users of digital health technologies, including fitness trackers, rely on their devices emotionally – the presence of data, and the relationship with one's body data delivered through the use of digital devices, can affect the user mentally and ultimately physically through the actions they choose to undertake based on acceptance and interpretation of intimate information. Sociologist Deborah Lupton (2017, p.8) uses deliberate ambiguity to pose the question "How does digital health feel?" Her question implies both the sensory and affective responses, and how technologies, sensors and data contribute to these feelings.

The interest in the affective influence of data includes the experiencing of the body as users interact with the representation of human-data assemblage that then elicits the appropriate response. Lupton (2014) has used the term "data double" to illustrate the converging of a person's representation in data form, which is often made up of multiple data types: for example, from different tracking applications. This avatar, or image, may alter our self-perception of the fleshy body. Learning about the body's status using data expressed by screen display and wearable technology can have the effect of making the wearer feel relaxed or nervous. This is felt during everyday interactions that elicit guilt or pleasure brought about by presence of data. The visual display influences the felt experience of interactions with personal information. While it reduces the body, the digital-visual representation also objectifies the body (Lupton, 2014, p82). In discussing the user experience of prototype tools representing movement of emotional engagement Kristina Höök writes that the body becomes an object rather than an embodied subjectivity: "As the representation became available for scrutiny and comparison, with our user's inner experience of themselves, it sometimes enriched their view of themselves, but at other times it felt reductionist to them." (Höök, 2018, p.xxiv).

Data from biosensors and other digital trackers offer a new dimension to the understanding of the human body. Paying close attention to personal movements and subjective responses can reveal new understandings of who we are and how we feel. Through embodied ideation practices the subjective body can be incorporated into designs which produce mechanisms for altering the bodily lived experience. For example, Höök's practice of soma design introduces methods to connect with the body through movement during design ideation. Embodied approaches offer tangible means to explore a disconnect from the senses in digital displays of personal data. Systems and technologies designed to educate and reveal information about the body through data

display rarely express an aesthetic which is true or relevant to the human condition; rather they tend to "reduce" the body (Lupton, 2014). Representation, or the language we use in expressing the subjective experience, poses a problem recognised by Höök (2018), leading to display which tend towards a language-, logic- and reasoning-based portrayal. Focus on language-orientated, visually dominated design for data, rather than adopting an experimental, subjectively engaging, felt aesthetic, echoes architect Juhani Pallasmaa's concerns about the "ocular-centric" direction of design (Pallasmaa,2012). This can be extended to the challenge of representing data as embodied data experience.

Reporting on experience is noted as a challenge; however, affect, sensorial engagement and other threads of experience may be useful in facilitating insights. I reconsider how to express experiences which involve digital interactions and address the possibility of generating positive affective experiences using technology in this thesis. Affect has been described by Melissa Gregg and Gregory Seigworth (2010, pp.1-2) as follows: "other than conscious knowing, vital forces insisting beyond emotion – that can serve to drive us to movement, toward thought and extension..."

Affective atmospheres refer to the feelings created by entanglements of human and non-human actors within particular spaces and places. An example of these feelings is the way a person responds to an environment for example, whether it feels safe or risky. The study of affective atmospheres acknowledges the interactions with actors of a situation – for example objects, places and another humans' presence as contributing to a 'feeling'. Human geographer Anderson writes that atmospheres are ambiguous, and to explore the concept of affective atmosphere is to be affected by both objective and subjective experience *"...atmospheres are the shared ground from which subjective states and their attendant feelings and emotions emerge"*. (Anderson, 2009, p78) The physical experiences people have in a place including sensory encounters are key to their 'affective responses'.

Recognising the influence of affective atmospheres on subjective experience can be considered when exploring a digital interaction. The setting (location) and actors present during an encounter may also be joined by particular visual, audio and physical interactions generated by the use of digital devices to create a "feeling". Affective atmospheres can be considered for the design of experience products, for example wearable technologies, where the user interface, textures and fit of a product can all contribute to the "feeling" of its experience. Both Lupton (2017) and Chris Michels and

Christophe Steyaert (2017) note that when investigating affective atmospheres, embodied methods enable the collection of information about feeling and action, as well as language and discourse. I explore the influence of affect in this study to learn about how specific interactions with digitally represented data influences its users "off screen".

Designing for human interaction with data

Why are Data Visualisation and Experience Important?

Large datasets are analysed to reveal insights across all sectors concerning almost all professional and personal activities. Data representation aims to communicate insights in ways which are accessible and meaningful to wider audiences than those who collected the data. Data representation in casual contexts, for example in a museum setting is used not only to translate information but additionally to evoke a reaction, for example, to change someone's mind. To communicate meaning, data visualisation uses graphic imagery – for example, bar charts or a histogram – to show relationships, trends and patterns. Data physicalisations, for example, the thread display in 'What Made Me' (shown in Table 3.1) enable experience through touch and emotion: viewers can physically interact with and generate data and observe insights. 'What Made Me' invited exhibition visitors to answer questions using threads and labels, the variety of responses created a layered map of insights which was experientially interactive as well as informative and engaging through striking visuals.

In personal technology, user experience informed by individual preferences and perceptions is considered a key aspect of design, in addition to functionality, and is valuable, for example, in customer retention. Emotional engagement engendered through experience enables personal connotations and relationships. Researchers Yun Wang et al. (2019), who explored an expanded understanding for value in data representation found that physicalisation creates experiences which are more impactful than visualisation as a way of engaging with viewers on an emotional level. For example, it fosters reactions such as sadness or empathy, to encourage action. An example of emotional engagement in data physicalisation is seen in Exertion Games' 'SweatAtoms'. 3D-printed Fitbit data was designed as a reward to motivate people to carry out physical activity. Researchers in the area of 3D printed data objects, including Simon Stusak et al. ('Activity sculptures', 2014) and Exertion Games, claim that the printed physical

representation of data enables people to relate to, and more coherently interpret, their personal data through a sense of achievement.

Survey of Data Physicalisations relevant to this thesis

"Information exists whenever worldly things are 'informed', or 'put into form'".
(Galloway, 2012, p82)

My research proposes the employment of properties of physical materials as a means to represent data as a material for design by considering the potential of sensory and affective data interactions. Materials are also used to illustrate notions of materialising, or making real, revealing wider implications and concerns about data which often cannot be seen. The case studies in this thesis explore what physical and material representation used in data display can show and do in various settings. I review the types of experiences and interactions which are afforded by data representation, rather than observations of a scientific or commercial nature – for example, usability or market viability. I use material engagement to understand how sensory interactions can evoke emotional response and meaning in the design of data representations. Table 3.1 is a survey of data representation examples relevant to this study to show a breadth of forms used for displaying data. These inform the design and analysis of physical outcomes in case study activities. For the purpose of this study, physicalisation and materialisation are separated in the table, but there are many overlaps since each materialisation is first physical.

Table 3. 1 Examples of data representations relevant to this study

Example	1.Desciption and 2. Relevance in this thesis	Representation Type
Mesopotamian Bronze Age clay tokens	1.Used as currency to demonstrate data in physical form 2.Embedding value in physical objects is not a new concept and in fact something familiar, e.g. money	Data Physicalisation
Chronocyclegraph, Gilbreth, (1915)	1.Wire representations of the movement of factory workers adapted from photographs 2. An application beyond representation used to study and teach human motion	Data Physicalisation
IoT-Availabot Schulze and Web, *Berg London (*2007)	1.Physical representation of presence in Instant Messenger applications/USB puppet-small puppet stands up when a contact is online, and bends down when contact is unavailable. 2.Non screen-based depiction of an interaction which is specific to screen-based activity display.	Data Physicalisation
Blip, A Year of Travel, Güngör (2011)	1.Contrasting materials and treatments were captured in a transparent block to embody varying representations and evoke different feelings from the viewer. 2. Different materials were used to interact with the viewer however they were embedded (untouchable).	Data Physicalisation
Data Furniture, Segal, (2011)	1.Data furniture uses form and choice convey info about the data origin – natural and environmental events. 2.Simple representation of information without intended reaction or action for user/viewer.	Data Physicalisation
What made me? Grabkowska, (2012)	1.Interactive installation in museum context. Community members answered questions and used coloured thread to link up particular aspects. 2.Engages visitors through visual appearance and enjoyable activity.	Data Physicalisation
SweatAtoms, Khot et al (2014) Exertion Lab, RMIT	1.Prototype exploring material depiction of physical activity data (static outcome), researcher reports the objects are used to motivate further action. 2. Material choice is not particular to the motivation intentions of the design, a space where material choice could influence design and response	Data Physicalisation
Measuring the Universe Ondak (2014)	1.Exhibition visitors measured their height and marked it on a wall. 2.They were engaged physically, interacting with the information on the wall, ideally encouraging visitors to remember the occasion and feel connection to	Data Physicalisation

	their community but not necessary to remember the information	
Wearable Self-Personalized Data Jewellery Kang, (2016)	1.Daily step data used to make jewellery 2. A static representation as a reward rather than designed with interactive intentions	Data Physicalisation
Testing Textile Thinking, Lean (2018) (Appendix 1A)	1.Exhibition visitors responded to questions by drawing a spider diagram using coloured threads 2. The representation was attractive and engaging as a physical representation but not necessarily informative. Visitors likely to remember the interaction experience but not the data	Data Physicalisation
Hypertension Bowl, Barrass (2013)	1.Interact with the data by physically 'playing' the bowl. 2.The material interactions (feel, sound) create an experience of the data.	Data materialisation as method and experience of outcome
The Textile Mirror prototype Davis et al (2013)	1.The "mirror" used nitinol wire to alter fabric shapes so that a viewer would observe different textures intended to respond to their mood. 2. Emotional engagement with material (textures) used to inform data experience design	Data materialisation as method and experience of outcome
Ice Watch Eliasson (2014)	1.A large ice block was displayed for the public to interact with 2. People could connect with concepts of global warming by interacting with the ice as it physically changes form (melting)	Data materialisation as experience of outcome (the material interaction informs)
Perspire Potts (2018)	1.Crystals used to construct objects relative to the action through which the sweat was collected 2. The material characteristics of water and crystal contributes to the interpretation of data collection as a material for design	Data materialisation as method. It is possible that experiencing the product would also be a data materialisation as interpretation of the data source (sweat from physical activity) is presented as wearable, thus returning to the body context; however, this is not reported by the designer.

Data in physical form has existed ever since clay tokens were used as currency in the Mesopotamian Bronze Age (Schmandt-Besserat, 2014). More recently, examples of digital data enabling the design of artefacts, artworks and live, physical changes in interactive displays can be found in a collection of examples on the resource dataphys.org, collated by Yvonne Jansen, researcher at The French National Centre for Scientific Research. Other 'live' non-numerical physical data representations can be seen in examples of actuation. For example, Super Cilia Skin (Raffle, Joachim and Tichenor,2003) by researchers at the MIT Tangible Media Group, led by Professor Hiroshi Ishii, is a set of magnetically activated transducers covered in felt on an elastic background. They are computer controlled to move in a cilia-like way, creating a "physical-textural" display (see Figure 3.1). It also acts as a haptic input: when the user physically interacts with and touches the cilia this engagement is accurately recorded. It could display ambient information as well as acting as an interaction-feedback system.

Figure 3. 1 Super Cilia by Hayes Raffle and Tangible Media Group (2003)

Image available at https://www.hayesraffle.com/projects/super-cilia-skin reproduced courtesy of Hayes Raffle and Tangible Media Group, MIT Media Lab.

The use of the material felt and the alignment of the interaction with the functioning of bodily cilia evoke Vallgårda's use of "material expression" and suggest the potential application for focusing on material choice in data representation (Vallgårda, 2009). Vallgårda's thesis explored how functions of designed objects can be embedded in expression, demonstrating how aesthetic dimensions are found in computational technology. Ambient information systems align with my concern in this research to use materials to evoke reactions – for example, a specific action or thought, and understandings which do not require numeric or linguistic representation.

Addressing the issue of non- "language-based" communication, alternative outputs and the implication of qualitative interfaces (Lockton et al, 2017) and data physicalisation (Hogan and Hornecker 2016), Trevor Hogan et al. (2018) encourage an alternative approach to the representation of information. During a "Data Physicalisation" workshop, with Hogan et al., documented in 'Considering Physical Variables for Data Physicalization' (2018), cups containing varying quantities of small stones (chuckies) were used to represent "numbers of immigrants" from a given dataset. The workshop participants intended the mass of the stones be used to represent quantity. However, during discussion there emerged a darker, unintended meaning; the chosen material now represented roughness, weight, tension; a negative narrative. These affective interactions are a communication mechanism of engaging with materials. Orit Shaer and Eva Hornecker (2010) explored Tangible User Interfaces (TUIs), which "provide a means to interact with computational applications in ways that leverage users' knowledge and skills of interaction with the everyday, non-digital, world" (Shaer and Hornecker, 2009, p.4). Findings were themes and questions drawn from use of TUI in research, for example actuation as "a means to increase product expressiveness" (2010, p.111), Organic User Interfaces (such as fabric actuation) and TUIs in long-term studies: "Is the system still interesting after the first excitement has worn off (novelty effect)? Is it engaging over a longer time period? (Or is it, like a fancy all-bells-and-whistles toy thrown into the corner after a while?" (Shaer and Hornecker, 2010, p116).

Of particular interest to my research are "Tangible Resources for Action". "Tangibles support referential, social, and contextually oriented action, making it easy to make references by pointing, touching, or performing publicly visible actions." (Shaer and Hornecker, 2010, p115). For example, the "Body Bug" (Moen, 2007), designed to encourage movement-based interaction, is described as an "enabler of activity" (Shaer and Hornecker, 2009, p.113).

Considering that the ways we receive information might change our responses and behaviours, Marshall McLuhan and Quentin Fiore, in 1967, suggested that an overload of information forces us into a mode of pattern recognition rather than one of understanding. Supporting pattern recognition as a mode of communication, Bouchard (2014) writes that data can be used as if it is a raw material. In this way it is possible to develop tangible outputs intended as embodied experiences, which evoke reactions in its audience rather than a cognitive exchange or true understanding of the data. By interacting with this type of depiction, the aim is that the viewer can interpret using an alternative framing. In the following examples, collected data was given physical form to provide stimulating experience beyond the simple communication of information. They are designed to influence those who engage with it through the physicality of the representation.

Data Materialisation as a Subset of Data Physicalisation

Physicalisation is used to indicate situations in which data is made physical to communicate or observe a specific aspect (for example patterns of movement in Frank Gilbreth's (1915) Chronocyclegraph) or attract the attention of the viewer (for example in Dorota Grabkowska's "What Made Me?" thread display,(2012)). Data physicalisation enhances experience, and thus is used to communicate data by linking human emotion and the sense of touch, sensations which are associated with motivation and action. Data physicalisation has been identified by Yun Wang et al. (2019) as the representation of data which puts emotion at the forefront of the purpose and intended consequence. This differs from the value found in data visualisations, which are typically designed for efficiency: for example, for learning and performance. In my study, data materialisation as a subset of data physicalisation further engages emotion in the experiencing of the data through material choice. The aim then explored in case study activities is how specific material choice can be used in design of data experiences. The following examples by Roman Ondak and Stephen Barrass (also shown in Table 3.1) demonstrate the distinction between physicalisation and materialisation in data experiences.
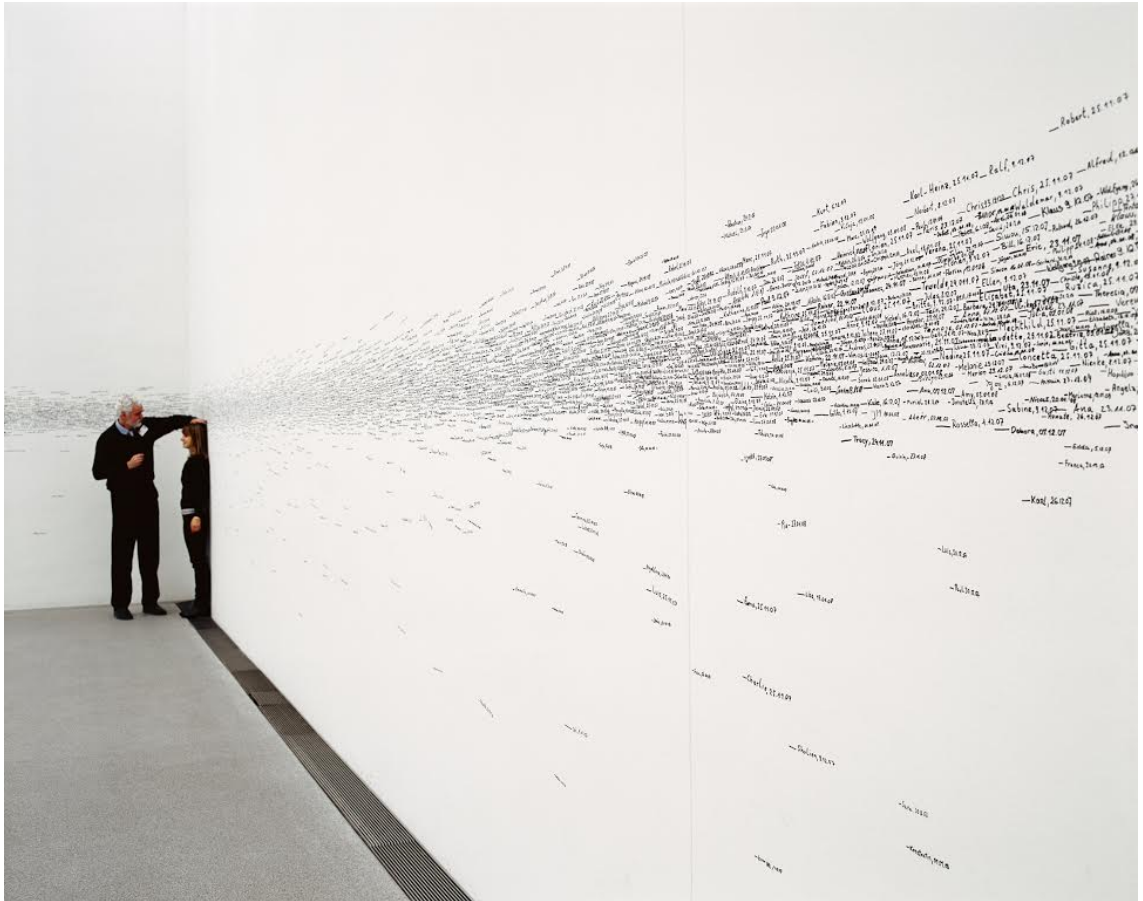
Figure 3. 2 Measuring the Universe by Roman Ondak (2012)

Available at
https://commons.wikimedia.org/wiki/File:Measuring_the_Universe_by_Roman_Ondak.j
pg licensed under Creative Commons CC-BY-SA-4.0

In *Measuring the Universe* (2012), Ondak invited visitors at an exhibition to be measured; their heights were marked on wall creating a shared knowledge as well as interesting statistical information for the neighbourhood (Figure 3.2). Ondak's data physicalisation engaged his audience by helping them to physically interact with the information on the wall, encouraging visitors to remember the occasion and feel a connection to their community.

Figure 3. 3 Hypertension Singing Bowl by Stephen Barrass (2013)

Image available at https://sonification.com/2013/07/10/hypertension/ reproduced courtesy of Stephen Barrass

Barrass used collected blood pressure data to create a unique shape for a musical instrument inspired by antique singing bowls. When played it is said to reduce stress and act as a reminder to the listener to consider their wellbeing (Figure 3.3). Barrass' data materialisation harnesses the characteristics of the specific materials used to create the object to evoke a response: it is the user who, by striking the metal bowl physically, generates sonic feedback.

Meaning in Materials

Physical materials and textiles used to create meaning in design contain and reveal character. In an architectural context, Gernot Böhme describes materials as "magically" creating atmosphere. The essence of materials is the affective ambience or aura which they permeate. The aura then, of materials is the product of their materiality, created in three parts that combine physiognomy, social and synesthetic characteristics. Designers such as architects, for example, work with the "raw" materials but apply characteristics to them to create aura and ambience. This can be seen, for example, in Böhme's (2014) description of two bookshops that offer the same product but a different experience. One has a musty smell, inviting nooks and exposed rough, wooden beams; the other has clear signage, bright lighting and chrome banisters.

When observing a piece of weave, say a tapestry, one can "feel" the texture of patterns and imagery created by its supportive underside. The tapestry takes its working with it: the data from which it was created is present. If knowledge of the input is removed, the tapestry, or data visualisation, remains beautiful; we can admire it. Cultural theorist Sadie Plant (1998) writes that a computer monitor is the flat, ordered surface concealing but supported by the very live, busy routing and rerouting of data behind the scenes. With some knowledge about the data – for example, how a tapestry is created – we can start to understand with a new depth how to interpret what the representation means. Meaning is embedded into material through the process, the data, manual actions, energy and ideas of the designer woven into the final outcome, interpreted by us, the viewer, the experiencer. Like Bhöme's description of designers embedding meaning into space by their choosing of materials, the meaning intended by the designer may be altered once in the hands of the audience, user or public. It is recognised by Karana et al. (2015, p.19) that materials "have the power to foster meaningful experiences".

In my study, materialisation transforms representation by using particular characteristics of material forms to create meaning and evoke reaction. The term "materialisation" refers to the use of materials in data representation which enables the viewer to grasp a concept by evoking an emotional response. To illustrate the term materialisation, as distinct from "physicalisation", the following example uses the characteristics of a specific material to engage with its audience. Rather than represent the abstract concept of global warming in a graph, or building blocks, Studio Olafur Eliasson delivered 45 blocks of Greenland ice to Tate Modern in London. Visitors to the exhibit engaged with meaning by experiencing material characteristics through personal physical sensations (cold, hard) and time-based degradation (melting).

"Data materialisation" in this study also refers to the method of data collection. Data collected from a personal technology such as a fitness tracker would need to be digitally processed before the data could be transformed into physical form, as seen in the SweatAtoms 3D-printed physical activity data. Data materialisation as data collection and representation is seen in Alice Potts' Sweat Crystals. Sweat collected from physical activity is transformed into crystals. Potts has used these crystals to construct objects relative to the action through which the sweat was collected: for example, ballet slippers. The data collection and representation are both physical forms. In this example of data materialisation, the materials of the representation directly connect to the action which produced the data –physical activity in dance in this case.

Materials perform a significant function in the personal experience of objects and spaces and in digital interactions. Hogan and Hornecker (2016), HCI researchers exploring data representation, suggest that the materials chosen to represent data can be used to direct both the sensory channel and metaphor used to interpret meaning. However, in their analysis of 154 physical data representations they found that the majority of samples were not designed using direct links between the material choices and the types of data but used for "interest and intrigue". Hogan and Sarah Hayes analysed materials used in tangible user interfaces in the "material choice database". In an observation relevant to this thesis, the authors found that common design materials were described in less detail than "unusual materials", such a human hair. This suggests that relationships with common design materials, for example wood or plastic, may be taken for granted. If more familiar materials are not described by designers it is less easy to understand the tacit decision-making that takes place in design (Hayes and Hogan, 2020). Though it is reported that no research has been done on the effects that multisensory data representation has on people, Hogan and Hornecker suggest that this technique is used by data artists to engage others through provocation. This gap in the understanding of the effects resonates with Fass (2017) who suggests that since studies on experience, typically in the field of HCI, focus on what can be measured and quantified, there is little literature which reports on feelings and qualitative reporting on experience of digital systems. This observation indicates the value in the development of practices used to express experience of data in both material and immaterial form through experiential encounters. Hogan and Hornecker (2016) note a renewed interest in the HCI field to explore "measuring non-analytical insight facilitated by data representations such as awareness, intrigue and curiosity".

Contemporary textile designers cross between digital and physical realms, pushing the boundaries of analogue material experience by combining digital tools. Igoe (2018) describes the post-digital as "moving away from the heroine of the digital", illustrating this in imagery, artefacts and behaviours that *"expose our networked lives"*. It is in the context of artistic practice and design which bridges physical, virtual, digital and analogue experiences – for example, Stella Speziali's Tangible Worlds (2017), Richard Vijgen's WIFI Tapestry (2017) and Memo Atken's Learning to See (2019) that Igoe positions the new, evolving position for the textile and material designer concerned with embedding affect and meaning in their practice. Igoe identifies hybrid forms of textiles – digitally animated fabrics, for example – as generating new forms of agency (Igoe, 2018). Redström and Ramia Mazé (2005) write that the intended functionality of technologies can hinder the potential for expressivity in application, yet materials as a raw resource can be explored and appropriated in form, expression and aesthetics. Engaging alternate dimensions – for example, data as "material" – through these assemblages, the textile thinker forms affective, meaningful experiences generating new formats and feelings for textile design. In their proposal for a design programme for textiles and computational technology, Lars Hallnäs, Linda Melin and Redström (2002) suggested that the two disciplinary domains could benefit from each other to explore new possibilities and applications, but equally that more general design research issues can be explored through these relationships.

The design of the Textile Mirror prototype (Davis et al., 2013) was informed by insights collected in an online survey about responses to different textures mapped to emotions. The "mirror" used nitinol wire to alter fabric shapes so that a viewer would observe different textures, intended to respond to their mood. The study's results demonstrate that specific textures can be associated with states of affect; this finding can inform design in many contexts. "My intent was for the user to observe the fabric changing in reaction to her stressful state, and then reflect on their emotional state in order to try to relax" (Felecia Davis Studio, 2013).

This example of materially expressed data demonstrates how material choice has been used to influence the experience with the data. My thesis proposes that due to their familiarity and our everyday experience of them, physical materials can be used as stimuli for emotion and meaning, and even when used in display with no or minimal

processing can elicit significant response, beyond representation. Another example of this is *Computer 1.0* by Victoria Manganiello and Julian Goldman working in collaboration under the name Soft Monitor (2018), shown in Figure 3.4. This installation artwork acts as a probe to engage its viewers in considering the value and impact of data in everyday life. The textile tapestry holds coloured liquid, which is pumped through the weft, which is made from hollow tubing, appearing like a live data feed: the textile piece is thus a proxy, or probe, for technology. Describing the work on film, Victoria Manganiello (2018) said: "Most of human history, textile has been the one thing that has connected us all. Technology now has become something that shares that equalising function. *Computer 1.0* is in part exploring this idea that both technology and textile have this overarching effect on people." (Manganiello,2018, 0:04). In *Computer 1.0*, by taking on a textile framing through its appearance, the concept of control by technology is raised, enabling the piece to perform as a probe for a dialogue on the experience of technology. In Igoe's thesis, the themes of "making it believable" and "making people understand" were included in topics associated with the role of textile designer (Igoe, 2013). *Computer 1.0* connects concepts from textile thinking approaches which draw on metaphor and meaning for social commentary and interpretation, using positioning in the synergies to gather information.
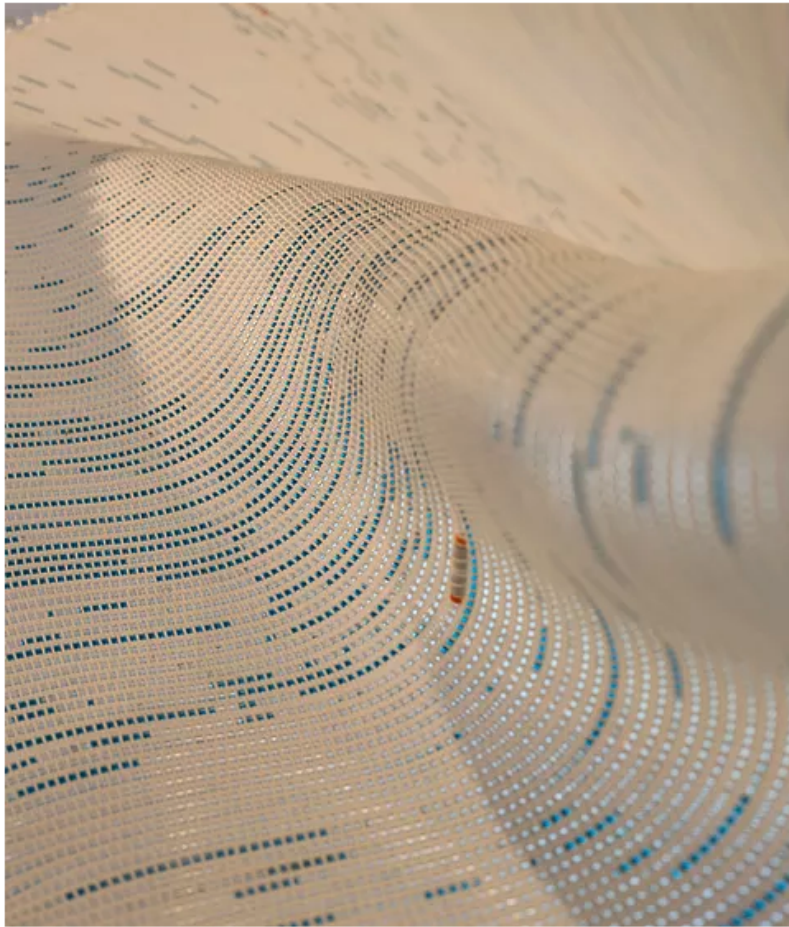
Figure 3. 4 Computer 1.0 by Soft Monitor (2018)

Learning from Personal Data Practices

Contexts for Improving Relationships with the Digital World through Design

In the design of intimate technological experiences – for example, fitness trackers – the rituals carried out between individuals and their data have mainly been based on rewards, incentivising and gamification. This assumes base levels of motivation and the mental state of its users (Lupton, 2014). For the most part, these designs, like the similarity in the technological function available (step count; sleep count; share with doctor; share with partner; bleep; flash; nudge) are intended to deliver and evoke similar reactions and experience in their users. There has been a recent trend for employers to

provide staff with health incentives and rewards relating to wearable technology use: for example, logging steps using fitness trackers. This means that an increasing number of people have access to these technologies, but what is not accessed is their experience of relationships with data beyond the corporate rewards. For example, the use of devices such as wearable technologies or logging systems in smartphone apps have recently led to concerns about privacy, as individuals can be personally identified using minimal data points (Haddadi and Brown, 2014). On the other hand, a move to "stop sharing", however, could also lead to poor performance in applications which rely on public data input – for example, on the Citymapper travel app, part of whose function relies on crowdsourced insights to inform its community of users.

Identity and Representation of self in digital display

Paula Gardner and Barbara Jenkins (2016) engaged in exploring ways to gather insights into the subjective experience of datafication of the self. Aiming to assess the ways that we interpret ourselves in data form, in the study "Bodily intra-action with biometric devices" by Gardner and Jenkins (2016), participants "experienced themselves" as data from Electrocardiogram (ECG) data. Using the term "entanglement" to refer to the lived experience of our physical and virtual interactions, the researchers note that flows of affect mediated the interpretation of data.

"We conclude that even when presented with artificial representations, individuals convert the representation into narratives inspired by their embodied experience and virtual parts of their own lives" (Gardner and Jenkins, 2016,p1). "Data wranglers" is a term used for heavy data collectors by researchers on the Qualified Selves project at Lancaster and Edinburgh Universities, led by Chris Speed. The project aims to establish how "personal sense-making" takes place in navigating mixed data types to identify what offers particular value to individuals, as opposed to responsive behaviour in commercially driven services devised for data capture (Speed, 2018).

McCarthy and Wright (2004) offer criteria to analyse an experience focusing on sensual, emotional, compositional, and spatio-temporal "threads". It is the combination of these threads that leads an individual to a state of "flourishing", recognising the felt experience and its framing, noting time and emotion. The "doings and undergoings" (Dewey,1934) which create an "experience" are recognised or remembered by the associated feeling. The feelings projected by the person experiencing, these threads can help us think more

clearly about an engagement with technology as an experience. Recognising that vocabulary is a challenge, in discussing embodied interactions in this thesis I used physical materials and representation to demonstrate sensations and stories associated with data experience.

Awareness of How Data Functions- Considering the Wider Lives of Data

Considering the wider lives of data beyond the spaces of the human body and devices raises questions and concerns about how data is used, including issues around security and reliability, due to feelings of technical uncertainty and ways in which technology plays a part in forming our own identities (Turkle, 2011). Personal data (small data) becomes part of the big data which is being continually collected, stored and shared. Data can be traded and profited from, raising concerns about control. Lupton uses the term "lively matter" to articulate the relationships between us and (our) data, and its wider consequences (outlined in Table 4): "..humans may find themselves asking to what extent their data speak for them, how they might betray them and how their data are different from other elements of their embodiment and selfhood" (Lupton, 2019, p17)

Table 3. 2 Descriptions of lively data adapted from Lupton (2015)

Lupton (2015) describes digitally generated personal data as "lively" referring to four aspects:
- The data is created by people's actual lives and their recording of it   - The data is "fluid" and open to/at risk of "repurposing" by others often without the owner's knowledge (has its own life)   - Since the data can be used as part of algorithmic decision-making it can have an effect on the "*conduct of life and life opportunities*" (beyond the individual)   - Owing to its value and commodification, data can have "*significant implications for livelihoods*"

"Lively data" implies the lives that people's data has outside of their knowledge, as described in Table 3.2. To be able to think critically about how an individual's personal data is used beyond their smartphones requires some knowledge of how data is generated, traded and commodified. I suggest that learning about people's experiences of interacting with data, including fears and awareness of how personal data is used, is

an area which can be explored by engaging with alternative representation formats. Engaging with data in an embodied way may reveal new understandings about how data, especially personal and bodily data, impacts on individual relationships and experiences with information. Although digital literacy provides opportunities to benefit from innovation, the hidden or unreachable technical details can make consumer use problematic. Robbins and Giaccardi (2019) worked with design researchers and industry partners to establish a "Manifesto for IoT", which proposes responsible design principles for connected devices to empower, rather than belittle, users. Commissioned from the Belgian design company beyond (beyond.io) as part of their study, Thingformation is a proposed packaging labelling system similar to nutrition labelling which would inform the consumer about how the device collected data and used it to enable efficient functioning of the product, creating a level of control for the user. The authors reiterate that consumer technologies are typically designed to communicate and appeal, separating the "ends of the technology (the outcome of the technology's use) from its means (the aspects of the technology responsible for the way it works) by masking their complexity from people*." (Robbins and Giaccardi, 2019, p.3).

What can be learned from personal data practices?
- Personal feeling about identity and representation of self through digital display
- Levels of digital literacy and technical know-how and what people understand and interpret about how particular technologies function
- People's awareness of how data is collected and used and to learn about privacy and control

Data Experience Summary

This chapter has introduced data representation as a key aspect of technology use which can influence personal experience, interactions and responses. I have considered data representation through multisensory and multimodality lenses: first, for technical and experiential functionality, and second, to enable dialogue and insights on experience through provocation. A survey of data representations which are non-linguistic, other than visual and non-screen-based representations of data have been presented as a) a proposed means of expressing information and b) to prompt critical responses about data experience: for example, reporting on personal practices. Issues surrounding the affective experience and interpretation of data resonates with my original desire in this study to explore embodied feelings drawing on (unmeasured) physical sensations of

ourselves and our surroundings – for example, feeling tired, feeling hungry or feeling anxious can inform interactive experiences. I have presented meaning in material experience as an element which may be adapted to explore ways to embed meaning in data representation. I have introduced challenges in reporting on experience and applications for material choice in physical data representations which could be explored. This revealed how materials are used to inform the design of interactions to influence experience in different ways. Specific examples demonstrate the value of engaging emotion and the senses using materials in data representation to initiate dialogue. Finally, I introduce issues around interpretation and representation of personal data, and the wider risks of the interactions and understanding of data-driven design systems. I propose these as a provocation for dialogues which can be initiated by exploring the experience of data in alternative formats.

The following questions arise from this review of data experience supported by the approaches outlined in Chapter 1:

In what ways can methods and materials from textile design research be used to facilitate, generate and report on embodied experiences of data?

What types of insights can be revealed about researching data experience by reframing challenges in data-driven design as a textile problem?

These questions are addressed using the emerging textile thinking methodology employed through case studies in the following chapters.

Chapter 4: Case Studies

The following case studies are research inquiries designed to explore the value and impact of embodied methods used to develop alternative data representation experiences. I present the findings, responses including individual insights on the comfort of interactions with technology to reveal the value and impact of designing novel data experiences. This contributes to the discussion on data representation which is multisensory (described in Chapter 3), and potential applications are presented within the final case study. This chapter concludes by reporting on the value of embodied methods (outlined in Chapter 1) and textile thinking (described in Chapter 2) used as research approaches to explore data experience (Chapter 4). I present the case studies here in response to the research question: What is the value in applying textile thinking to gather insights about human data practices?

Case Study 1: Physical activity and technology

In the following case study, the activities and their outcomes contribute to the aims of my research by offering an understanding of how relationships and interactions with physical materials can be used to research personal practices with data. In the particular context of physical activity and technology two approaches are described which present ways for developing speculative proposals for data experience to challenge the norm of typical data visualisation. The research in this study took place over a three-month period and was qualitative and exploratory, situated in a rugby clubhouse, an intelligent textiles company office, a public gallery space and the postgraduate study design studio at the Royal College of Art. The activities and findings in this case study are grouped in Table 4.1

Table 4. 1 CS 1 Activities aligned with textile thinking characteristics (Chapter 2)

Activity	Outcomes and Analyses	Textile thinking characteristics	Lessons learned
Expand knowledge : Intelligent Textiles Industry Placement to expand knowledge	Learning about functionality and applications of a product. Experiment with samples to develop workshop activities to find out what is possible. Contextualises research agenda	**Crossing boundaries** and building relationships	Being an outsider, I am in some ways a probe myself to initiate conversation- physically being there
Expand knowledge : Workshop with sports group Test activities	Personal anecdotes about experience and knowledge of wearable technology and tracking devices	**Crossing boundaries** and building relationships	Trying out technology can be used to engage research participants with their own experience of similar devices or applications
Data Collection: Test workshop activities with sports group	Insights into how the research activities – for example, material mapping – can be used to develop design outcomes and prompt discussion Alternative data feedback prototype based on the senses	Experimenting with materialities especially **physical materials**, Working in the **synergies** Sharing experience for **knowledge exchange** through a range of means and mediums	Workshop-like activities, trying something new/unusual together provides the opportunity for relationship building and trust as well as observations Engaging with physical mapping encourages subjective and personal reflection
Data Collection: Conversations held at public exhibition of installation	Provided space for insights about personal technology practices Conversations held at the Stretch Orchestra installation provided space for insights about lived experience of technology Conversations invited critical perspective (more than lived experience), questions, concerns and fears of technology	Sharing experience for **knowledge exchange** through a range of means and mediums	Technology as experience-people enjoy trying new things

	Potential application for data representation experience (prompts discussion and insights) Data physicalisation artefact acts as affective experience, an ethnographic probe, a prompt for critical perspective, a learning opportunity		
Data Representation and Analysis: Films of workshop and exhibition used to present research activities and participant commentary - insights	Collaborative film showing participants demonstrating prototypes and responses to the workshop Films used to show what happens in research workshops demonstrate an approach to capture embodied design methods and decision-making	Shares experiences as **knowledge exchange** through a range of means and mediums.	Experimenting to share evidence of values and ways of working in the programme

Stretch Orchestra workshop- Background and approach

The aim was to identify themes which arise in response to experiencing and interpreting physical activity data from sensor systems. The objective was to test an embodied approach to exploring data experience from technology which tracks aspects of the human body. A partnership with a sports team, the Haringey Rhinos Ladies Rugby Football Club (RFC) was established to contextualise the physical activity theme. A relationship-building exercise took place in which I introduced the research aims and held a discussion to learn about the group's current knowledge and experience of fitness tracking devices (including smartphone applications). The potential for worn textiles to track personal data during their game was of interest to the players and fitted well with the notion of non-screen-based or material feedback systems proposed in the research agenda. The title of this case study, Stretch Orchestra, stems from my interest in exploring communication of fitness information feedback that would engage the senses – for example, using sound.

I designed workshop activities as opportunities for observation and data collection, which included trying out sensors, critiquing and mapping materials and prototyping data feedback ideas. To explore how associated, emotional and sensory relationships with

materials could be used to consider alternative experience of data feedback, participants tried out sensors, took part in group workshop activities in reading and mapping materials and ideated prototype data feedback scenarios. This workshop took place at the rugby clubhouse after a training session and was documented on films and photographs.

Textiles Sensors in this study

A placement with an intelligent textile company, Footfalls and Heartbeats, provided the opportunity to learn about the technical aspects of knitted sensors, and enabled dialogue to consider novel applications. This case study used Footfalls and Heartbeats' knitted textile sensors to illustrate a means by which material could collect data. The company's key product is pressure sensor socks, currently used by athletes and diabetics; however, they also produce long lengths of knitted sensor fabric (made with conductive thread) as shown in Figure 4.3. Using the ready-made textile sensor fabric was effective for this workshop as it had a professional finish, was durable and had been tested for functionality. This allowed the study activities to focus on the data collection experience, representation and interpretation of this information. The socks and sensor fabric were introduced to give participants an understanding of how textile sensors could be incorporated into soft material. Participants physically engaged with the textile fabric by wearing the socks and playing with the textile. Most participants had not previously encountered this type of technology.

Figure 4. 1 Handling sensor fabric was represented by numerical data on screen

Stretch Orchestra Workshop Outline

Group activities were designed to introduce the "affective" nature of materials, break down and re-examine a single material, and finally explore how affective and sensorial properties of materials could be appropriated to explore physical activity datasets. Participants were provided with a booklet explaining the research aims and workshop tasks as well as offering contextual discussion (see Figure 4.1; also Appendix 2). Participants took part in material mapping activities before engaging in brainstorming, prototyping and discussion as a group. A selection of stationery and materials was provided. This included basic items such as writing tools, sticky notes, fabric and plastic swatches, simple electronics - for example battery operated LED lights – and low-tech responsive smart materials: for example, thermochromic paper and scent releasing ink.
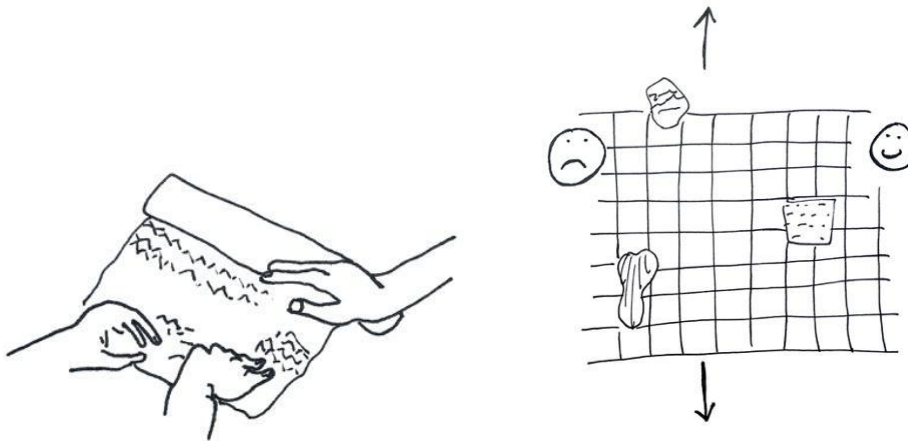
Figure 4. 2 Images from the information booklet provided to participants

Exploration of the interactive agency of materials was conducted with the aim of equipping participants for 'designing' in the final task. Physical material handling took place to explore how the tactile experience of materials might generate concepts and metaphors beyond functional or supportive qualities, to reveal potential communicative agency and enable the development of a mutual understanding in group settings by creating a language, or palette. The "Affect Grid" and "Defamiliarisation" activities were intended to provide participants with an alternative framing of, and way of using, materials for the third activity, "Data Materialisation". In the following section I discuss the background to each activity before describing the specific outcomes in the workshop environment.

Activity 1. Designing the Affective Material Palette

To explore the influence of affect on decision-making, the first task was to explore how materials could be considered "affective". I devised a novel mapping system based on James A. Russell, Anna Weiss and G.A. Mendelsohn's (1989) "Affect Grid: A Single-Item Scale of Pleasure and Arousal". Created for "assessing affect", this consists of a scale from unpleasant to pleasant on the horizontal axis and high levels of arousal to low levels of arousal on the vertical. Participants "mapped" their chosen materials, using the physical samples. The exercise was a quick-fire one, intended to stimulate fast reactions and provide inspiration and reference for the subsequent tasks. A wide selection of

material samples was provided and participants decided collectively where to position materials, often debating and changing the position. In some cases, they provided anecdotes from their own experience, both practical and personal, relating to why a certain sample 'belonged' where. The premise was to create an "affective material palette', similar to the idea of Robert Plutchik's Colour Emotion Wheel, but not limited to visual detail (Plutchik, 2001). This activity resonates with aspects of aesthetic tuning in which experiences are associated with familiar triggers to engage the senses. Given the subjectivity, the individual responsibility for personal choices and what participants were exposed to sensually the aim is less about actually artificially augmenting (as in aesthetic tuning) but focused more on encouraging people to be more aware of their senses. The aim was to afford people the power to engage with themselves through their own bodies.

Material mapping, or organising in "comparative scales", either in groups or individually, first shows that meaning in materials is found in both a subjective and an objective analysis. Second, exercises which give value to the subjective can encourage alternative perspectives and ways of thinking by empowering a less tangible, and more experiential, relationship with materials for design. Karen Marie Hasling and Anne-Louise Bang (2015) presented educational exercises which engage textile students with material meaning as methods for developing textile designs. The authors refer to materials' physical and social "worlds". The physical is concerned with performance and functions: for example, waterproofness and high-tensile strength. The social "world" refers to human experience and "social interaction" with materials. This may further be categorised as objective and subjective. A material's "compositional" and "technical" attributes contribute to the "sensorial' experience due to the fact that physical contact engages the sense of touch, as well as vision. Karana, Pedgley and Valentina Rognoli (2015) identified aesthetic, meaning and emotion as three experiential components for materials. Supporting a more "holistic" understanding of materials and their potential, Serena Camere and Karana (2018) explored affect in the development of a toolkit for categorising materials. The outcome is a catalogue of materials with sensorial, interpretive, affective and performative functions that are intended for use by design professionals and materials researchers in user studies, for physical product development. The concept of a 'toolkit" has inspired this research, as the material mapping activities in my research are delivered in pop-up workshop style.

Since the focus was not on the materials themselves but on the responses, associations and interpretations of the materials by workshop participants, this exercise was delivered using basic materials. At times the materials provided, which were intended for

crafting/prototyping, got caught up in the mapping. For example, the bicycle lights often found themselves in the "positive, high arousal" section of the Affect Grid. Sequin material also tended to be found here, whereas a parquet wood sample would be moved to "positive low arousal". The first workshop activity was designed to gently ease participants into the notion of material meaning, physically interacting and performing textile thinking (shown in Figure 4.2). Participants freely moved materials and initiated discussion, often claiming that a particular sample "belonged" in a certain section. Though it was the first time for most that they had mapped materials, strong opinions were expressed, illustrated by moving a fabric sample from one place on the grid to another.

Figure 4. 3 Material Mapping, White Hart Lane Clubhouse

Critique in design studies is used to improve a process or proposal by presenting work to others, to try to see "how others see it". In Jeffrey Bardzell's "How to do Design Critique" (2018), critique is used as a description which locates the design according to a framework. – for example, relating to style or genre, process and fit for purpose. An approach within a specific context may include creating a hypothesis or working with a dialogue to explore "generals and particulars", where aspects of design successfully represent or perform the perceived functionality. In "Making by Making Strange: Defamiliarization and the Design of Domestic Technologies", Genevieve Bell, Mark Blythe and Phoebe Sengers (2005) used the literary technique of defamiliarisation as a design critique to reveal hidden meaning and create opportunity for critical reflection. In their study, they explore the kitchen as a space of enquiry to rethink assumptions. Methods that included historical reading, collecting ethnographic accounts and comparative ethnography suggested challenges and strategies for design in the home technology space. Design critique through a process of estrangement was proposed by Norman (1988) who challenged the affordance of glass, suggesting that by asking simple questions of something familiar it becomes strange and we can begin to see through others' eyes. Wilde et al. (2017, p.2) write that in processes of embodied design ideation, estrangement is used to "enliven the ideation process and bring new ways of designing into being".

In this case study, the approach of defamiliarisation which *"compels the reader to examine their automated perceptions"* (Bell, Blyth and Sengers, 2005, p.151) was appropriated for the purpose of exploring hidden and explicit meaning in materials. It also supported learning about others' subjective interpretations. Participants were presented with a selection of materials and invited to describe them. Specific materials were provided (a fluffy ball; shiny embroidered paper; a piece of leather), and to enable them to start to see materials differently participants were asked to describe it as though speaking to an alien. Written responses ranged from an exact material description, potential applications, curious observations and guesses as though in a trivia game, like/dislikes and thoughts which had come about based on personal experience ("it makes me think of..."). Each participant was asked to keep their observations hidden, and reveal them later (without influence).
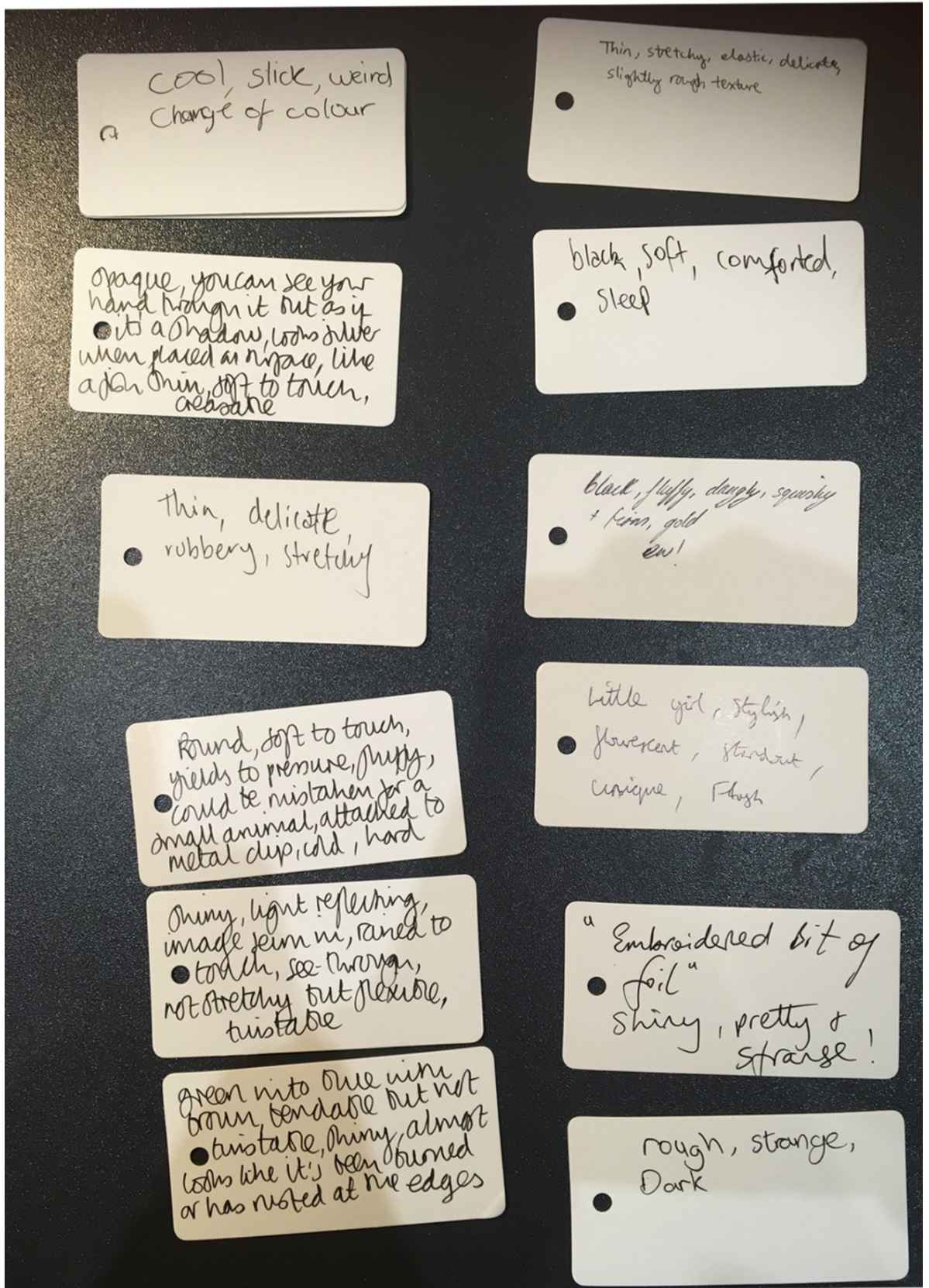
Figure 4. 4 Written Descriptions in Defamiliarisation Activity

Participants then shared their descriptions, some revealing disciplinary expertise (for example, having studied textiles at school), others revealing more personal stories or questions related to the material samples. The exercise presented alternative readings of the same material sample and created discussion about the potential for communicative properties in material. It became apparent which of the participants took a pragmatic approach in their analysis; which of them led more cultural un-pickings, and which offered metaphorical analysis which could be used as a creative tool.

During the mapping exercises participants identified personal stories, practical suggestions and affective associations with materials. The aim of the subjective exercises was to create a vocabulary, or material palette, which could be used to illustrate positive or negative emotion, memory and sensation. Considering personal, private interaction and tactile connections with a particular material also provided a potential design direction for ideas about personalised material feedback system in the final exercise. Using the textiles discourse as an example, subjective responses to materials rather than analytical approaches were shared to learn others' ways of seeing and broke the ground for dialogue in the group setting. An unintended outcome of this exercise showed that materials could be used as props that might be used to enable relationship-building in cross-disciplinary environments. A shared "way of seeing" or "material empathy" may help in a material liaison role, for example between designers and manufacturers where frustrations between different vocabulary and meaning can disrupt progress in both the design process and relationships (Hornbuckle, 2018).

Activity 3. Design Challenge: Brainstorming and Data Materialisation

Participants tried out Footfalls and Heartbeats' textile sensors (see Figure 4.3) to get a feel for textiles as sensors; the feedback (data representation) was shown on a screen. In the Data Materialisation challenge, participants considered non-screen-based feedback. In the final exercise, participants were shown a numerical dataset featuring graphs of physical activity. They were asked to "bring the data to life" by considering alternative ways that data could be communicated beyond the typical graphical visual. It was suggested that they consider the other senses and, if the data was collected from a material (for example, using the textile sensors tried in the session), then how material might also perform as an output. Comments from the group brainstorming exercise on alternative feedback using materials are shown in Table 4.1.

Suggestions collected from brainstorm by participants, Stretch Orchestra workshop, Haringey Rhinos Ladies RFC, August 2018

- Celebration [soap] bubbles with a lavender scent for post-exercise recovery
- Plasticky thing would be comfortable: you could put sensors in the lines and use them as shoulder pads [ribbed silicon sample]
- Bubble wrap makes me feel like I have achieved something
- Measuring contact through changes in colour [thermochromic paper samples]
- Lavender smells like sedentary [scented ink]
- Training headband-data collector

Table 4. 2 Comments from brainstorm on alternative feedback and responses

The initial exercises were aimed at drawing on subjective and personal experiences; this thinking could then be applied within the design challenge, shown in Figure 4.4. Without being prescriptive, it was assumed that the rugby field context would be considered, mainly because most players had never before tracked their play. Participants were eager to contribute ideas about how it might work to improve their game, and were encouraged to be playful and speculative, not to search for a 'right' answer. Participants prototyped a data collecting headband, shown in Figure 4.5.

Figure 4. 5 Speculative design suggestions in 'Data Materialisation' activity

Interacting with the textile sensors led to ideas about responsive materials in the context of the sports game. Speculative suggestions ranged from ideas based on the workshop materials provided – for example, scent release function on sports kit – to ideas using the technology sampled: for example, a soft insert for a skullcap that could record contact during play for trauma evidence. These design ideas represent themes and critical perspectives which arose during discussion and brainstorming in response to workshop activities. Engaging in senses other than the visual to communicate data called for alternative sensory engagement for non-screen-based data feedback. Participants were able to take on the idea of alternative sensory engagement for data experience and developed their own critiques of what would be 'appropriate'. Feedback from the participants described the session as "something different" and as something that they had not considered before. The participants enjoyed interacting with materials; some asked whether they had been doing the "right thing". Trialling the textile technologies was a new experience and created opportunities for further questions and discussion around the use of new technologies in sports.

The objective was to test an embodied approach using an associated, emotional and sensory relationship with materials to consider alternative experience of data feedback. Participants engaged with all areas of the workshop and together brainstormed ideas for alternative feedback. The intention and the order of the exercises was designed so that participants could move away from the idea of materials as functional in terms of physical support (for example, tensile strength, waterproofness, etc.) and find alternative communicative or interpretive properties through sensory reactions. The materials were used as starting points for design. Interacting with the textile sensor fabrics and observing the interactions as numerical data on screen was offered as an existing "data experience" to prompt ideas for potential alternative experiences. Textile-led approaches were used to engage others in their experience and design of data feedback, and the participants explored crossing digital-physical material boundaries to suggest material and sensory triggers for data experience.

Following the workshop, I further explored ideas about using the affective communicative properties of materials to explore data. This led to the development of a design which aimed to elicit positive affect by drawing on the subjective experience of materials.

Stretch Orchestra Installation

To explore how a textile thinking approach to data experience could initiate dialogue and critical perspectives, an interactive material experience of physical activity data was exhibited. The Stretch Orchestra installation was designed to encourage the consideration of alternative data feedback systems for bodily data collected from digital health products. The work was exhibited publicly and attracted visitors from diverse backgrounds to try out a textile sensor system which collected data and then fed back the real time data in a novel format. A connected pommel-horse cushion made with Footfalls & Heartbeats' textile sensors responded to interaction by inviting visitors to experience physical activity data in a playful way; a giant marble run was designed to elicit positive affect in a childlike feeling of wonder and satisfaction.

Design Methodology

The aim of the installation was to invite the public and groups in the wider community to reconsider ways in which the risks of a sedentary lifestyle are being tackled from the perspective of textiles and design. Visitors tried out the prototype material feedback system whilst learning about ways that design, new material applications and emerging technologies are being used to monitor and improve health.

The design followed an identified cycle: an individual's action would trigger a reaction which could then inform another and thus enable future action (behaviour). References ranged from Rube Goldberg-style machines, like the breakfast machine in *Chitty Chitty Bang Bang* (1968) and Tim Hawkinson's responsive kinetic sculptures (Figure 4.6) to Mona Hatoum's more subtle yet socially engaging sculptural installations, for example *Homebound* (2000), shown in Figure 4.7.

Figure 4. 6 Überorgan by Tim Hawkinson (2000)

Available at

https://commons.wikimedia.org/wiki/File:%C3%9Cberorgan_(2000)_by_Tim_Hawkinso
n_--_2-1,_Zoopsia,_Getty_Center_in_Los_Angeles,_2007.jpg licenced under Creative
Commons by SA 2.0
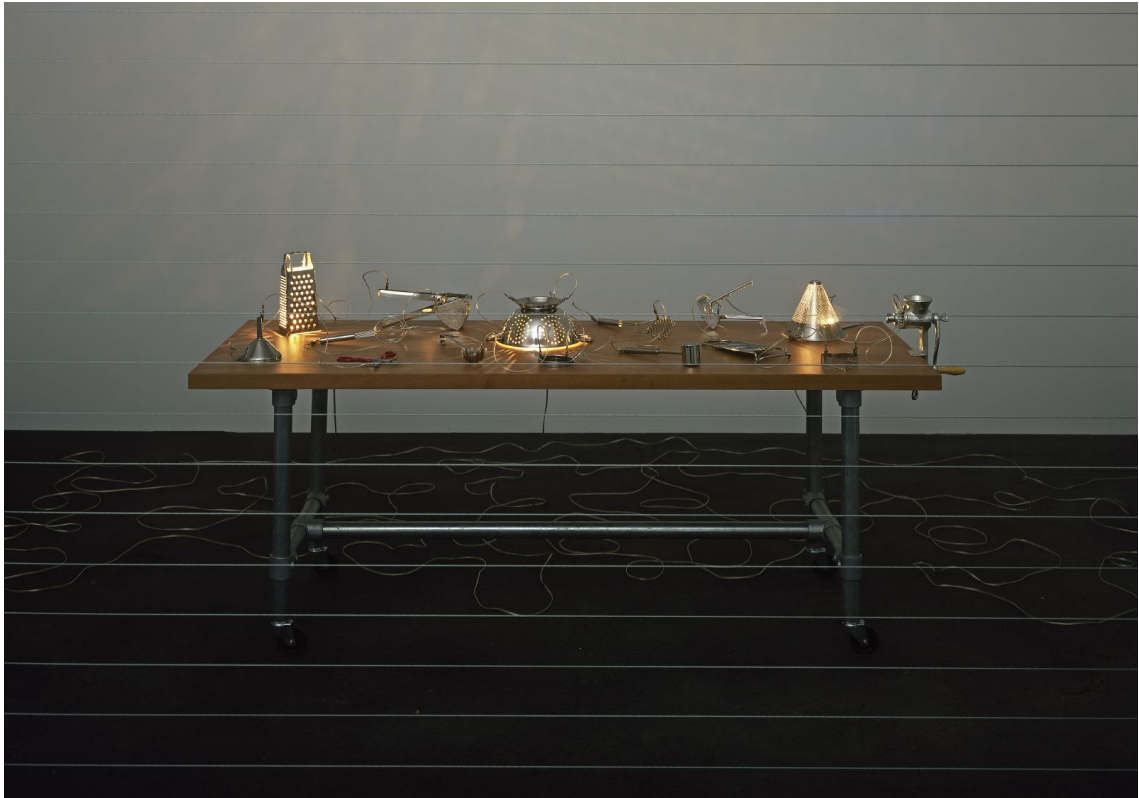
The concept further grew from exploration into the affective nature of materials, searching for ways that materials might trigger positive affect. This developed into a large-scale marble run. The sound and sensation of marbles moving down a run was selected due to its connection to childhood and the "will it/won't it?" sense of excitement and relief. Textile sensor fabric was embedded into the cushion of a customised pommel-horse (indicative of traditional gymnastics equipment) which aimed to materialise the context of childhood memory and physical activity. Engagement with the pommel-horse triggered the marbles to set off down the two runs. Knitted material with sections of conductive yarns which acted as sensors was programmed to send signals to an Arduino microcontroller according to the time spent and the pressure on the conductive sections when touched. There were 16 sensor sections in a 4x4 array. Combinations of sensors held down simultaneously were programmed to alert microcontrollers and trigger various different marble run activities. For example, using the forearms, fists and elbows, if (sensor 4, 6, 8) were stressed for (10 seconds) at (> 2000 mV) then (Marble Run A)

would turn once or (if sensor 9 + 12) are stressed for (15 seconds) then (Marble Run A and Marble Run B) would turn twice, etc. One turnstile rotation was equal to one marble rolling down the run. The run and the pommel-horse were built in light wood, with the emphasis on a low tech, "natural" feel, to juxtapose the technical processing required to enable the interaction. While the goal had been to create a fully wireless installation, configuring the Wi-Fi shields proved to be more of a challenge than expected; a computer monitor (and wires) was therefore required. While the presence of visible wires was at first disappointing, the presence of the numerical data on screen allowed visitors to first see their data as numbers before the marbles were activated to move down the run, creating a link between each section of the interaction. This relied less on the notion of technical magic, and moreover offered a clearer expectation of the functionality and potential need for a more impactful data display. An image from the installation is shown in Figure 4.8, and the film 'Stretch Orchestra installation" (Appendix 7) offers a deeper view of the experience.

Figure 4. 8 Exhibition visitor testing Stretch Orchestra Installation

In the gallery space, marbles tumbling down the run echoed round the white, calm space and tall ceilings. At the opening event, visitors gathered round the run, eager to try the system. They were instructed to hold a "plank" position; by leaning on the pommel-horse (elbows and fists applying pressure to the sensor sections), after a few seconds the marbles would be released. The installation was open for four days, I was present throughout in order to take visitors through a demonstration and collect feedback. Visitors from a range of sectors and social groups passed by. The installation created a space where I could engage in conversation and learn from observations of people interacting with the installation. Learning about visitors' own practices by helping them to try out the installation presented me with an opportunity for sensory ethnography and observation through the act of engaging in an activity together (Pink, 2015, p19). The collaborative film I made for this case study captures visitors to the exhibition engaging with the installation and presents the material, sound and scale of its appearance.

I used thematic analysis (described in Chapter 2) of the visitor comments to identify themes which can be used to consider applications and contexts for data physicalisations. The findings were analysed (shown in Table 4.2) to express meaning for the data physicalisation installation as a research object. This included:
a) as a design probe used for ethnographic inquiry and informal discussion
b) as a space for creative learning and development: demonstrating functionality – for example, design process using textile sensors and microcontrollers
c) as an experience – a novel interactive activity eliciting memory and emotion
d) as a space for critical reflection – discussing development ideas for innovation, provoking ideas and topical discussion on the current state of technology

Table 4. 3 Stretch Orchestra interactive installation feedback

Findings analysed according to themes to express meaning for the data physicalisation installation as a research object

Comments	Themes developed
● Childhood memories and stories related to both pommel-horse and marble runs ● Material associations Memory, emotion	Affective nature of the experience
● Personal stories about the use of digital products, time spent using phones, experience of apps and fitness trackers ● Though it was a non-medical setting it was possible to generate insights about body/health Informal discussion prompt	As a probe for ethnographic investigation and informal discussion prompt
● Suggestions for development and alternative use cases ● Ideation and brainstorming informed by interacting with the structure ● Thought-provoking, for example a father explaining to his child using video games that they are an example of something which is "digital"	Critical perspective
● Interest in the technical aspects ● Sharing recent material development ● Demonstrating functionality ● Inspiration and motivation to consider making and designing alternative representation Learning opportunity, finding out about the type of work going on in this area	Learning and Development
● Questions about target market/viability of functionality ● Introduction of the exhibit as a concept and not necessarily a "product" – more of a 'prop', provocation ● Design vs Design Research- expectations of visitors Exhibiting Research	Other

A gallery or exhibition is not a context in which one usually expects to engage with physical activity. This positioning enabled a range of feedback types. One exhibition visitor expressed that her interest in interacting with the experience as a whole meant she barely noticed the installation had "got her to exercise". As a public engagement opportunity to engage with the topic of health tracking, the exhibition was well placed to draw in an audience from a non-typical demographic. Some visitors were curious and questioned the technical and practical elements of the structure, including asking questions about the textile sensors and the installation mechanisms and the design process and concepts, including their inspiration and references. These conversations led organically to discussions around wider use contexts and the design potential for alternative interfaces. Others offered personal anecdotes about their experiences of data and tracking technologies, which led to dialogue on wellbeing and lifestyle issues ranging from cybersecurity concerns to fears about screen-time. Finally, visitors who were content to simply enjoy the experience often found the concept tricky to grasp, and thus required further explanations of the role of design research itself. The installation was multifarious in that its presence invited a range of response types which offered a perspective on the roles and positioning of the installation as a representation and the experience of the research itself. Figure 4.9 groups the main areas of commentary and themes elicited from the installation visually.
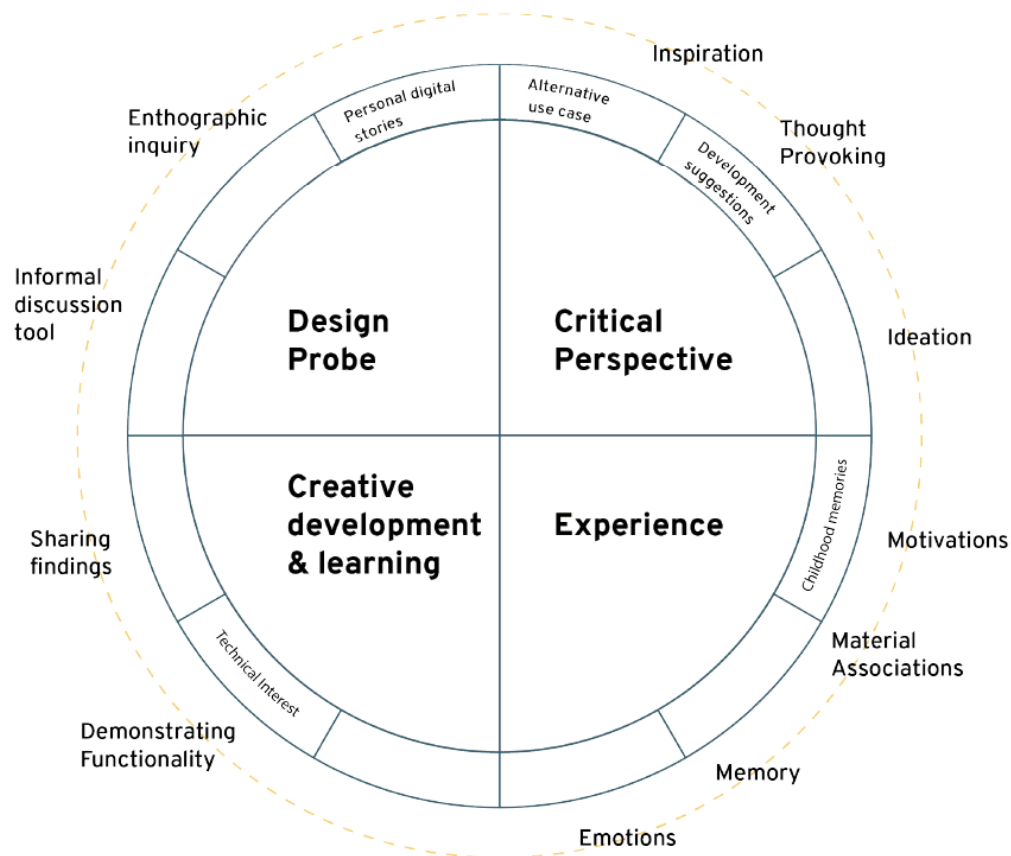
Figure 4. 9 Analysis of Stretch Orchestra feedback and discussion themes

Discussion on the Activities Described

The workshop and installation present novel approaches for exploring the experience of data from digital devices. Diverse research activities generated speculative proposals as an alternative to typical data visualisation. The role for textiles was as probe and provocation, and this allowed a "way of thinking" to be revealed.

Placing value on one's own experiences could offer a meaningful perspective for the design of interactions, which closely monitor personal data. In this case study, I introduced data materialisation as a means of bringing data to life by thinking beyond a physical data representation to consider how particular characteristics and relationships with materials can be used to meaningfully communicate data. Taking the concept of affect inherent to textile design practice, and using materials as an explicit representation of emotion, enabled a type of thinking using the subjective experience in a tool for design.

Learning about others' readings of the same materials invites an empathy, a shared way of seeing.

Informal responses to the interactive installation from visitors which raised questions about market viability allude to the typical objective of design and textile design as market-led practices. Igoe (2010) refers to the individual activities of the textile designer, mentioning that the user is normally at the end of manufacturing chains, with agents buying textile swatches. Group work and brainstorming in a team environment (the Stretch Orchestra workshop) created a dynamic which is distinct from the individual nature of traditional textile design practice. The role of the textile designer as facilitator requires taking on a support position, rather than offering critical perspective, for example on style or aesthetics (Hasling and Bang, 2015). As a facilitator for the design experience, in this project the role of textile designer was to bring together different elements into designed activities and experiences that allowed others to develop their own outcomes and perspectives in relation to the activities.

Textile thinking approaches in experimenting with materialities informed the design of an interactive system from my own perspective. And it was an opportunity to impart methods (material mapping; design critique; data materialisation) to generate ideas and develop others' own material experiences using new knowledge about material agency. At times during this case study there was a misunderstanding of the conceptual agenda – a personal trainer, for example, was highly sceptical that her clients would be installing marble runs at home. The scale (and sound) of the installation drew visitors straight into interacting and trying to achieve the marble goals (and disappointment/joy when a bug in the code stopped the marble turnstile releasing/ kept the turnstile opening and hundreds of marbles came clattering down at once). Communicating across different programming and technical languages often required some interpretation to understand the requirements a significant challenge for contemporary textile design researchers "transgressing boundaries". (Igoe, 2018, p.5). The installation acted as a prop for discussing the research and the installation prompted dialogue and response on a range of topics, as shown in Figure 4.9 and Table 4.2.

Conclusion

Through the practice of creating experiences through workshops and an exhibition, I demonstrated that materials evoke sensations and affective reactions, and that this

can be implemented to create meaningful experiences. Encouraging participants to talk about materials placed value on personal likes/dislikes, memory and associations. Engaging with physical data representation enabled a range of insights and themes to emerge about the value of alternative information experiences.

The studies showed both coherence and divergence in the ways people reflect on and relate to materials. Methods to collect and explore this were shared, suggesting a design application for exchanges that would otherwise be subjective and silent. The challenge of exploring specific concerns about data which is reductive, affective and objective was responded to through prototyping. This reveals how textile design approaches can be used to initiate dialogue and ideate in response to challenges within digital health and data experience, in informal settings with diverse communities. The design of activities, outcomes and feedback of the two experiments in this case study informed the overall design programme. This contributes to an understanding of textiles-led ways to explore the experience of data. The results revealed the themes that arose throughout the practical experiments and indicate the wider challenges which might be addressed through the textile thinking programme. This contributes to an understanding of the value in exploring data experience, in particular the affective and sensory dimensions of our interactions with the digital world.

Case Study 1 Film (1)

Stretch Orchestra Workshop Film https://www.youtube.com/watch?v=OFm9avpqW64

Case Study 1 Film (2)

Stretch Orchestra Installation https://www.youtube.com/watch?v=iwolrz5k_uU&t=4s

Case Study 2: Valuing Materials in Data Representation

The following case study sheds light on the research question: What is the value in applying textile thinking to gather insights about human data practices? The main objective of this case study was to explore how material engagement can enable designers to form and demonstrate critical perspective on the experience of technology and data. I also describe here approaches which were taken for capturing participant activities (log, outcomes and film) rather than documenting (taking photographs,

observations). This contributes to insights which are useful for communicating value in embodied design methods and to support designers to understand their process. Cal Swann proposes that engaging others in understanding design methodology is useful for recognition and respect: "It is through increased understanding of creativity – demystifying the process – that the community is likely to develop more respect for designers and their role in society" (Swann, 2002, p.57).

In the introduction to this thesis, I positioned the tacit knowledge of textile designers as a challenge which may contribute to the lack of acceptance and advancement of the textile design research field. The outcomes of this study contribute to the overall research aims by offering a means to capture design activities. Logbooks were used to record individual interpretations of the research activities and report on participants' own actions which were not necessarily clear in the design outcomes. The act of collecting data gives participants the opportunity to consider the complexity of deciding which aspect to log and how this will be communicated in a representation. First, the interactive prototypes are presented as a way of communicating how an object performs. Second, research participants verbally present their ideas. A key finding in this case study is the use of log-books and film to capture and communicate value in embodied design activities, while designed prototypes act as the documentation of process. The film "Material Led Feedback System" (Appendix 7) shows workshop participants discussing their processes and the outcomes of data materialisation in context. Table 4.6 shows the schedule and activities during the workshop.

Material Led Feedback System workshop outline

Day 1	The first day was an introduction to the research themes and included lectures from experts. Dr Gerard Briscoe, RCA, materiality (Dr Elaine Igoe, RCA), experience (Dr Kevin Walker, RCA) and agency (Kelly Spanou, RCA). Concepts presented included information experience, data and materiality in broad terms, with examples from the fields of textiles, HCI, communication and architecture as well as commercial and industry illustrations. During each lecture the speakers suggested points of departure for the workshop, proposing challenges as well as highlighting issues. For example, ideas about communication at a non-linguistic, deeper level; issues around cultures of big data – for example, the ethics of predictive analytics; Elaine Igoe introduced the concept of "agential material", describing an interface as a "meeting point" which could evoke response and expressed to participants that though textiles is the "closest thing to the body" it can often be overlooked. The talks were a way of introducing the wider themes of the project from scholars who could also answer questions related to the project rather than relying on external sources: for example, internet resources in a limited time frame. The second part of Day 1 comprised group workshop activities, as described in Case Study 1.
Day 2	The second day started with the exhibition visit: "The Future Starts Here", at the Victoria and Albert Museum. The exhibition featured a vast range of existing, emerging and speculative technologies, "from smart appliances to satellites, artificial intelligence to internet culture" (V&A, 2018) curated for creating a vision of the near future. The aim of the exhibition visit was to: a) encourage participants to consider technology experience and potential scenarios b) consider how technologies were displayed in the museum/gallery context and the ways visitors were invited to engage with the concepts Following the talks and exhibition visit, brainstorming and discussion took place, in which participants highlighted areas they had encountered which they had found troubling, or worthy of raising. Using the brainstorming generated the previous day, participants used dot voting to identify the areas which interested them the most.
Days 3-5	Group work (3-4 participants per group) responded to a brief which was delivered, outlining the themes and directions for the outcome to be displayed in an exhibition format on the final day. John Wild, artist and RCA mechatronics technician, gave a presentation and introduced sensors, microcontrollers and electric paint, which students could use in their projects.

Material-Led Feedback System was designed as a practical exploration which invited art and design students to reconsider their relationships with materials as conceptual tools for designing with data. I devised a workshop outline, based on the activities in CS1. The generative process was designed to enable others to enter into the research context, engage in new methods and identify issues, which could be addressed through prototype experiences. This demonstrates an understanding of the programme (Redström, 2017) and its agenda. It is hoped the methods introduced could benefit participants in their individual art and design practice in the future, as well as contributing to the current research. The groups generated data representations which created an opportunity to propose critical perspectives on particular themes of data engagement. Direction for design provocations derived from the feelings of experiences in certain aspects of digital/data-driven services: for example, the uncanny feeling that an advert is "following me around the internet" using AI, and materialising the concept of sustainability.

The themes of the designed physical outcomes, observations and participant feedback, as well as the practical outcomes, offer data which contributes to an understanding of the scope of the research. This contributes to the literature on data representation, textile thinking and embodied design methods. Students were provided with the definitions on Table 4.5 for data representation and encouraged to explore data materialisation as both method and outcome

Table 4. 5 Data representation terms (repeated from Chapter 1)

Data Visualisation	*"General term that describes any effort to help people to understand the significance of data by placing it in a visual context"* (Data Visualisation Summit, 2018)
Data Physicalisation	"*Traditional visualisation map data to pixels or ink, whereas physical visualization map data to physical form*" (Jansen, 2014)
Data Materialisation	Brings data to life by applying the affective and sensory dimensions and essence of our interactions with the material world as a way of meaningfully communicating and interpreting data (Lean, 2019)

The aim was to investigate how participants use materials to initiate dialogue on data experience. The objective was to test a platform which proposed the use of the communicative potential of materials to convey and interpret meaning and explore experience within the context of digital data representation.

Can information be communicated in ways that trigger sensations or emotional reactions so that the 'experience' of interpreting the information becomes as important as the information itself?

Can the materials of the experience provoke a desired response, creating a feeling through engagement with materials removing the need for raw information or numerical/textual symbols?

My goal was that participants would be able to take the concept of material meaning and the agency of materials created through narrative, association, and emotion into their choice of materials for their task, to materialise data. I gave participants the option of generating their own or using their chosen datasets rather than using the datasets provided. There were prompts as to what sorts of experiences could bring the data to life: for example, it could be educational, motivational or shareable. The challenge was to find ways to use specific materials, or material characteristics, to create data experiences where the role of the material is to trigger a response through its presence and those interacting with it. My interest in creating an "experience" for this exploration of data was to move beyond the creation of static data sculptures, algorithmically designed objects and artefacts produced from data. The focus instead was to consider the impact and potential of the interaction with the data once it was in a physical and material form. The experience of the data was intended to evoke the potential for emotions, knowledge and ideas that one might take away. Thus, the brief includes suggestions of experiences to educate, motivate or inspire creation and debate, as shown in Table 4.4.

Table 4. 6 Material Led Feedback System project brief

Material-Led Feedback System: design brief

Create a material-led feedback system; Material Experience; Alternative Sensory Engagement: Non-screen-based Feedback

Data may be collected personally; from a digital device; observed; from a big data source; in real time; delayed

Context should be connected to the body; health; wellbeing; exercise

Experience can include performance; interaction or workshops, and could be designed to educate; debate; motivate; share; expose

Materials should be chosen carefully to elicit meaning; through emotion; sensory interaction; felt experience. Consider what type of experience, or behaviours the data can create and how the material can support it

Show your completed projects on Friday afternoon at 4.30 for the inFORMation exhibition

Methods

I introduced activities for material engagement to the participants to develop the understanding for them to use materials beyond their functional properties. The aim was to find narrative, emotional and communicative possibilities (Hasling and Bang, 2015). I hoped that participants involved in the workshop would take away the "right" to assume and impose material meaning, and to use it (Bohme, 2013). The activities aimed to reiterate ideas about materials and communication. Putting these into practice in a design challenge was a means to validate these ideas.

The Masters level students at the Royal College of Art who took part were from a range of different programmes: Ceramics and Glass; Sculpture; Global Innovation Design; Textile Design; Information Experience Design and Digital Direction. The week-long course and workshop were titled "Material-Led Feedback System". The title aims to emphasise the notion that materials provide information. The workshop took place in a teaching room at the RCA's White City campus. During the prototyping stages, participants were encouraged to use the entire university campus and facilities and the wider city. Participants were given a logbook (see Appendices 4 and 5) to record their experiences in. The prototypes were exhibited in an open critique-exhibition format on the final day, which was also captured on video (see Appendix 7).

Outcomes

Prototype material experiences represented participants' feelings and responses to the topics addressed and created an opportunity to develop a critical perspective on particular themes of data engagement. This included novel ways to communicate and represent data, dialogue about types of data and data collection possibilities and creative responses to behaviours and attitudes associated with emerging technologies. The final presentations and discussion, along with the physical outcomes themselves, showed that participants were able to take elements from the areas presented by speakers and the material exercises and apply them rationally to create unique outcomes that demonstrated a critical perspective towards the topic of technology and data experience.

As facilitator, the process of delivering the methods and time spent working towards receiving results presented me with a level of anxiety about how participants would interpret and respond to the design challenge based on the particular perspective of the research. On the final day of presentation and prototypes, the three groups showed thoughtful responses to the brief. The responses presented a perspective which at first appeared as though the brief, which had been directed at engagement with *health* data, had been misinterpreted. Later, during discussion with the participants, video interviews and reading the logbook responses, I gained insight into the perceived challenge and the process of interpretation and response. These outcomes also reveal group dynamics and individual roles taken. On reflection, given the time frame (five days) the responses were carefully crafted and presented material provocations to open dialogue on issues associated with data experience. New opportunities were presented to extend the programme into other areas of interest, beyond heath-tracking data. The following descriptions describe the models developed by student groups; these are expanded on in Table 4.7.

Table 4. 7 Group outcomes and themes

Group	Theme/inspiration	Participant Comment (from participant logs)
The Uncanny	AI, robots, driverless cars	*"We chose this particular experience because we were fascinated by things we cannot understand, which are sometimes frightening."*
Making Sustainability visible	Making experiences showing how we can recycle materials, storing the "data" in a visible way that could be delivered to different places	*"Thanks to the value and context of the material, we can convey meaning. Depending on the properties of the materials, we can relate to feelings, emotions and our own experience. Therefore, I believe in the intangible and almost spiritual aspect of the matter, and how it can build a dialogue with our awareness."*
Data which encourages awareness of unintentional human behaviour/impact	Projects that remove the technology from the "technological world" through the use of more organic/everyday materials. For example, the exhibit featuring curtains opening and closing depending on an individual's use of their phone. (Miranda July: *I'm the President, Baby*, "The Future Starts Here", V&A Museum)	*"I was also wondering if by materialising data, one will never be able to precisely show the quantitative data, as can be done when visualising or physicalisation. However, materialisation has the potential to have a greater impact through experiencing the data."*

Uncanny Tea Set

Title: Uncanny Tea Set (Figure 4.10)

Theme addressed:

'Uncanny valley' is a term used to describe the way a viewer's comfort level drops when engaging with simulation technologies: for example, humanoid robots, in gaming and some 3D animation contexts. In 1970, the roboticist Masahiro Mori hypothesised a human reaction to robots, suggesting that this shift from empathy to revulsion, and the feeling of eeriness it evokes, may be a form of protection or self-preservation (Wang, Lillienfeld, and Rochat, 2015).

Material Experience:

The group explored the concept of the uncanny in a material experience using an object intended to evoke this unsettling feeling. The display consisted of a plate of sweets with a hidden underside. When someone reaches for a jellybean, the plate lifts up to reveal a metal plughole full of hair, recalling a cinematic horror scene mixed with the participant's own responses to a very familiar experience. The Uncanny Tea Set was further complemented by an experience which the designers created as a way of "measuring engagement with the uncanny". It explored the idea that the uncanny is an unpleasant, yet strangely familiar/pleasing experience, and presented a way of gauging how much the feeling would be willingly experienced by, and captivate exhibition visitors. A wire "head" structure with hair (a wig) sat on top of a bowl of fruit squash. During the final presentation, those brave enough to engage with the uncanny were given a paper straw placed through a hole in the top of the head. They were instructed to suck through the straw: drinking the liquid would result an on-screen visual to alter its appearance. A large circle, which reduced as the liquid was consumed, was designed to log and visualise the participant's engagement with the uncanny.
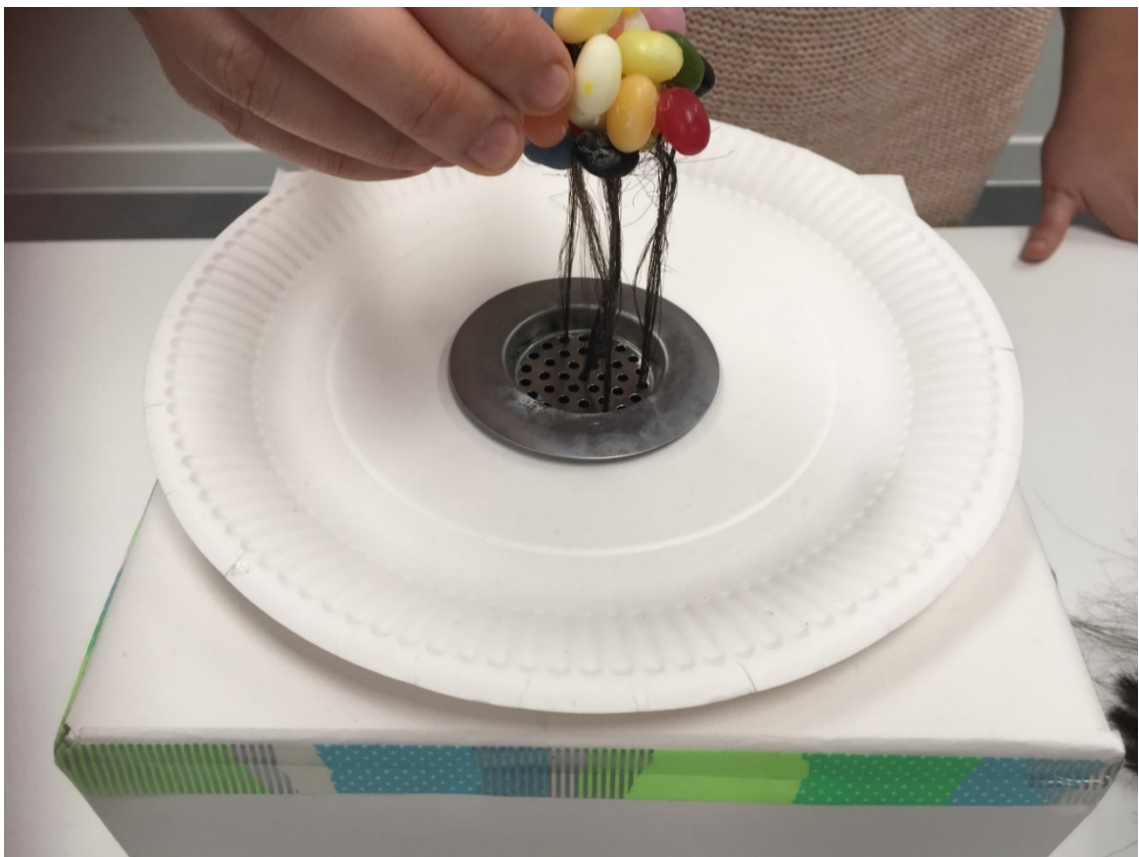
Figure 4. 10 Uncanny Tea Set

Making Sustainability Visible

Title: Making Sustainability Visible (Figure 4.11)

Theme addressed:

The project investigated ways of connecting people with the concept of sustainability. The group designed the experience to "build dialogue with our own awareness" to motivate, educate and encourage actions associated with recycling and sustainability.

Material Experience:

The group first created a "new" material consisting of recycled, broken-down, found materials (for example plastic packaging) and natural material, including sticks and leaves held together with a non-toxic glue to create a pliable surface. They proposed that this could be used in simple products. They then used recorded sounds, with electric paint as a proximity sensor to create a sensory experience designed as an interaction to link the new material with the materials that had been broken down to form it. Through the making process the group created an alternative format for data storage where the "information" (the concept of sustainability) was located in the physical engagement with the materials.

Arthur: *I found that linking data, experience and materiality to be an interesting way of seeing how we can speak a language with the only materiality.*

Arthur*: These are like "dead" objects - non-animated but we can kind of give them animation with the sounds that they usually make.*

(From the film "Material-Led Feedback System", [00:50] Appendix 8)

Figure 4. 11 Making Sustainability Visible

Unintentional Human Impact

Title: Unintentional Human Impact (Figures 4.12,4.13,4.14,4.15)

Theme addressed: This group explored ways to communicate that someone's presence might influence unseen factors around them. The experience created a dialogue on the transformation of data into information, questioning the stage at which meaning is created. Through their data materialisation process the unseen data took a form which enabled these considerations through discussion.

Material Experience:

An interactive system using a bubble machine and a motion sensor attached to a door was designed to signal to visitors that their presence in a room, in a city, on the planet, was noticed and recognised. It invited an awareness of one's "impact". This group executed their data in two forms, experimenting first with soap bubbles, and second by using air-filled balloons. Different coloured balloons were used to infer meaning about

the type of gas a person brings into a room, proposing that at some stage there could be a limit, and capacity could be reached. This illustrated, for example, capacity on the planet. A suggested application for this experience is in raising awareness, for example, about consumer habits or population growth.

Figure 4. 12 Hidden Data is Materialised

We have created a chute filled with balloons and designed an electronic mechanism which allows one balloon to be released each time someone enters the room. Thereby reducing the amount of space of the air in the room, gradually over the course of the day, as more people occupy the space. (From logbook 3b in Appendix 4)

Figure 4. 13 Unintentional Human Impact presentation slide (1)

Figure 4. 14 Unintentional Human Impact presentation slide (2)

Figure 4. 15 Unintentional Human Impact presentation slide (3)

Use of Logbooks to Capture the Design Process

I have positioned the tacit knowledge of textile designers as a challenge which may be hindering acceptance and advancement of the textile design research field. On capturing one's own actions in a design process, Pedgley (2007) notes that in the context of design process "only by eliciting an account of designing from the originator can the nature of design activity from the originator's perspective be revealed" (Pedgley, 2007, p.466). Diaries are included in his discussion of tools for "capturing" design activity as a data source.

Design process lecturer Julia MacLean (2018) found that logs that were intended to be used to communicate to those external to the individual design projects resulted in the students themselves learning more about their own processes. Her study "Examining Design Process Journals for Postgraduate Student Learning" showed that using the log enabled students to be more reflective by asking questions before making decisions: one explored alternative means to communicate visually instead of using words. Another used it to communicate with peers to develop ideas, and many said they would continue to use this as a technique in their future practice and careers. MacLean's reading of the journals, alongside interviews with the students, showed that students benefited from the physical log as an artefact of their efforts and changed the perspective of those who had previously focused on outcomes: they became more interested in process, able to

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critique their own approach (both in logging and in practice) as they learnt about their own creative steps.

Logbooks in this case study were designed to engage participants with the research activities and to record process but also revealed a method for identifying interpretations of the value of an individual's actions in design.

Logbooks in this case study

The main "log" and recorded demonstration of the knowledge and understanding of the programme's agenda was embodied in the final outcomes and artefacts. For participants, the aim of using logbooks was to offer an opportunity to take time to reflect on the activities. The limitations of using logbooks is that not every participant filled it in fully: some logbooks came back with missing pages. There could have been more emphasis on filling out a daily report, as many waited till the final day to write them. However, the logbook entries were an opportunity to invite individuals to share personal interpretations about how engaging with the research in the workshop provided:

      a) New Knowledge

      b) Prompts to reflect about own work /projects to reject

      c) Prompts for new projects and future practice

For the researcher, the logs provided insight into the interpretations and individual responses to tasks and the brief set (shown in Table 4.4). Each of the twenty participants were provided with a physical logbook containing questions in which to record their experience of the course. The logbooks were created as a method of:

      a) data collection including insight into the design processes and interpretation of the tasks delivered

      b) as a means of connecting participants to the concept of research through recording and reporting

Considering that the workshop theme focused on the concept of data collection, the use of logbooks would ideally link the concept of manual data collection as well collecting using digital technologies. The logbooks contained a section for each day, with questions related to the specific activities. Participants were encouraged to write or draw their responses. By the end of the week there were twelve participants and there were nine returned logbooks. On the final day, when participants were filling in logs, it was observed that one participant had Googled "data materialisation" and translated it into Chinese,

and was then translating it back to write in English in the log. The aim of the question "What does data materialisation mean to you? (Table 4.9) was not intended to elicit a right or wrong answer, but rather an interpretation of the concept. This observation suggests a feeling of formality and "testing" initiated by the logs that is not normally present in creative activities. In this study, along with the final artefacts and presentations, and reviewing the film created, the notes inside the logs created an opportunity to identify the ways in which each member of the team had brought specific aspects to the project, enabled by the programme.

Table 4. 8 Log entries (meaning)

What does data materialisation mean to you?
Use a visible and tangible method to bring information alive
Using materials to effectively convey stories that data can tell you. i.e. using materials to materialise data in the 3D experience the way we use colour/form to visualise data in 2D
Use the material itself to create function
To make data/number/feeling tangible and visible
Converting immaterial information to extract a physical outcome

Much of the design and making activity took place away from the main workshop space, making observations of the design processes hard to capture. The logbooks were reviewed to identify how participants interpreted the activities using their own words and on their own, as opposed to when they delivered group presentations where one member tends to lead. Through close reading, thematic analysis was used to develop an understanding of how engagement with research activities resulted in design outcomes. In this case, thematic analysis was deductive based on preconceived themes in line with the workshop objectives. These are the potential impacts which the workshop activities would provide: an opportunity for the participants to engage with new knowledge, to reflect on their practice and to develop considerations for future practice. In particular, coding in the analysis which supported the identification of these themes consists of words and descriptions related to personal and disciplinary knowledge, the practical application of tacit knowledge, understanding of the tasks and directions, understandings about data experience. The findings from participants' log entries contribute to an understanding of how the projects in the textile thinking programme led to typical examples. By reviewing the physical and material outcomes, as well as participants' own

words, it is possible to understand a tacit and embodied understanding of individual aspects of design prompted by the workshop activities. Through this, the approaches I used in this case study to capture participant activity (in the logs and film), contribute to insights which are useful for communicating value in embodied design methods and to support designers to understand their actions.

Log questions included "What was your role in the design team?" (Table 4.8) and "How might you take these concepts (for example, data materialisation) forward into your practice?" The cohort was made up of students from a range of backgrounds . Thus, the questions were responded to accordingly within the particular context of students embarking on a new course and developing their practices. Some, with more established disciplinary backgrounds, offered specific examples from past work in which they had touched on the concepts. This reflects their interest in enrolling on the workshop. Insights into specific learnings from the week-long workshop included comments such as "Learnt more about sensors, and electronics and physical computing and material" and "It was very exciting to actually make new things with useless and recycled materials. It opened various possibilities of how we can perpetually sense matter". These statements show where new knowledge has been achieved by interacting with the programme activities (statements in Appendix 4, log 6.c).

Table 4. 9 Log Entries (role)

My role in the design team:
Modelling, hand-sewing, coordinating
Providing the idea, building the structure
Making the objects by discussing ideas
Programmer/Mechanism designer
Tech Specialist (LOL), General Design Facilitator
Making, contributing ideas
Handcraft work and touch board testing
1. Organising /designing the project 2. Collecting different materials/devices for Arduino microcontroller 3. Making samples-cutting material into pieces

The film (Appendix 7) was reviewed alongside the log entries and physical outcomes. The ways that participants had interpreted the concept of "data materialisation" were particularly important as it was a new concept to the group (shown in Table 4.9). "Making Sustainability Visible" incorporated "material sounds" in recycled material objects. This demonstrated that they could embed or topic concepts and information into an object or experience, and created meaningful discussion around the theme of sustainability. Data as "meaning", and thus "meaning materialisation", took the form of objects which gave sounds, so the "meaning" which was in their previous "sounds" (for example, before they were broken down and recycled) took the form of experience, and meaning took the form of a material sensation.

The communicative potential of materials is explored through participants' responses in Table 4.10. The idea of "materiality as a language" had been explored through prototypes and in interviews, showing further scope for the research and an extension of the programme itself.

Table 4. 10 Log entries (communicate)

In what ways can material quality/properties/engagement be used to communicate data?
Material engagement is fundamental, as interacting with materials is the first thing we do as toddler as we're experiencing the world. Challenging the meaning of material provokes a new way of experiencing the world
Gas density. It affects the height of balloons floating in space
Raw digital data can be impossible for a human mind to comprehend naturally; therefore the translation of data through material is essential. The choice of material has a huge impact on how the data is communicated.
Materials are a way to create something tangible out of something intangible. How one engages with the material, can be how one engages with the data.
Look back to history, find the traditional methods, when people have no internet, how do they communicate by symbols, objects, etc.?
Store the data in a visible way that could be delivered to different places
Thanks to the value and context of the material, we can convey meaning. Depending on the properties of the materials, we can relate to feelings, emotions and our own experience. Therefore, I believe in the intangible and almost spiritual aspect of the matter, and how it can build a dialogue with our awareness.

Material handling and critique was used to invite participants to value their lived experiences and subjective responses, and to consider bodily/sensory engagement. Based on this, I designed the brief to enable workshop participants to interpret the challenges being addressed in the research with respect to their own practices with data. The outcomes (artefacts and logs) showed that students were able to use and explore ways that material properties could be used to express information and enhance the experience of data. Models acted as provocations on specific themes. Developing material experiences created a bridge between the research themes and challenges and physical prototyping, allowing the new perspective and ideas to relate to, and be understood, in the context of design. The processes that were applied and the roles that were assumed are examples within this context which led to physical outcomes, and contribute to the dialogue of the identification and applications of textile thinking in this study. A key impact from the experience of the workshop was the evidenced application of textile thinking principles in participants' own work. This supports perspectives on the potential of this way of working. The material experience (both designed workshop activities and outcomes) act as a provocation to engage in dialogue and offer a critical perspective on practices with data. Table 4.11 shows specific activities in the context of textile thinking (outlined in Chapter 2).

Activity	Outcomes and Analysis	Textile thinking characteristics *outlined in chapter 2*	Lessons learned
Expand knowledge: Workshop with MA students Guest Lectures Exhibition visit Design activities	Test activities and potential applications: a) Designing the Affective Material Palette b) Material Critique- Defamiliarisation c) Data materialisation d) Group brainstorming based on concepts of Experience, Data and Materiality Brainstorming following lectures on data, experience, materiality and agency Develop an understanding of landscape/context to be addressed and inspiration for design of interactive exhibits. Workshop and logs provide understandings of how others interpret research activities and themes	**Crossing boundaries** and building relationships to learn and gather knowledge and inspiration from other fields; formally through expert presentation and informally during an exhibition visit	Planning and engagement
Data Collection: Workshop Activities with student groups: material mapping and making alternative data representation Teamwork and prototyping Exhibit and demonstration	Engaging senses in embodied methods to explore subjective experience. Gathering information, linking insight bridging components Alternative data feedback prototype themes : The Uncanny, Making Sustainability visible, Data which encourages awareness of unintentional human behaviour/impact Data materialisation used to present alternative design proposals based on expert insight, shed new light on the landscape, consider altered perspective	Experimenting with materialities especially **physical materials** making as a way of generating knowledge and ideation, engaging with others and showing samples/prototypes to shed new light on the issue Working in the **synergies** finding links and playfully and metaphorically engaging material characteristics in a design process Sharing experience for **knowledge exchange** through a range of means and mediums.	Considering the bigger picture, including the sensory engagement in the experience of data provides the opportunity to form new readings and ways of reading the information (interpretation) Considering alternative communication experiences for data created space for meaningful dialogue on issues beyond the data itself

		Tacit knowledge was shared in material engagement through mapping and design critique exercises enabled other ways of seeing material (for example associating materials to emotion)	(for example data security
Data Collection: Workshop participant logs : used to learn about how participants engage with the topic and tasks	Own words and responses to tasks Individual interpretations of the research activities which were not necessarily clear in design outcomes. Addition of language and own words to describe aims. Logbooks can be used to capture and communicate embodied activities.	Is concerned with **problem-setting** rather than problem-solving- a field which can offer suggestions for challenges in other fields through textile framing	Logs and written experience can provide alternative insights and can be used to prompt conversation Insight from logs can be used to paint a bigger picture about research participants: e.g., background outside of conversation/ interview scope
Data Representation and Analysis : Film interviews Logbooks	Showed how participants had developed their own perspectives on the scope of the research Making physical models demonstrated an understanding of the brief and the concepts, using their own words and physically showing it on film enabled participants' interpretations and the potential applications of the research to be revealed Tacit knowledge was shared in material engagement through mapping and design critique exercises enabled other ways of seeing material (for example associating materials to emotion)	Sharing experience for **knowledge exchange** through a range of means and mediums.	Film interviews and written words used to engage participants

Physical outcomes, as well as information from the logbooks collected from participants during Material-Led Feedback System, highlighted new areas which the research framework had not previously been considered to belong to – for example, sustainability. My intention had been for the research to exist in the particular context of bio-sensing data and the body; however, through the embodied data experiences presented it was clear that participants had developed their own interpretation and function for the methodology. This reframing of the scope of the research contributes to the design programme agenda, establishing a further positioning and application for the textile thinking program.

The topic of sustainability as data came naturally to participants in the course during their short interaction with the research. This demonstrates the value in inviting others to engage with the research in different ways, as I had not engaged with the topic in the longitude of the study. It was a welcome development to consider wider potential avenues for the methodology, exposing potential applications. Additionally, this informs me as researcher-facilitator to consider ways that the practice informs the programme. The research (and I as researcher) was influenced by, and evolved in response to and alongside, the practice, readdressing notions of the scope and potential impact of the programme. This openness to unexpected happenings appears to be a success in these examples, and a lesson to enable organic development at certain stages within a design process In his work on reflective practice and learning, Donald Schön (1983) supports the notion of allowing agents of an encounter or situation to suggest its direction and outcome.

> In each instance the practitioner allows himself to experience surprise, puzzlement, or confusion in a situation which he finds uncertain or unique. He reflects on the phenomena before him, and on the prior understandings which have been implicit in his behaviour. He carries out an experiment which serves to generate both a new understanding of the phenomena and a change in the situation. (Schön, 1983, p.68)

By 'reflecting in action' the designer discovers new findings, practitioner becomes researcher. Is the design programme objective then generated through reflection on it,

rather than at the outset? By recording methods and sharing or adapting them for future interactions, facilitators and designers become researchers.

Material-Led Feedback System was an opportunity to share design methods and explore new applications and direction for data materialisation. Through the discussion, feedback and outcomes of the group work the scope of the research expanded. This broadened perspective led to design of activities and topics explored in the third case study.

Case Study 2 Film

Material Led Feedback System https://youtu.be/92lkpWalWIY

Case Study 3: Ethnographic Data Experience

"To reduce the risk of only producing more or less typical experiments, we need to seek the program's boundaries and breaking points, the push ourselves out of its comfort zones." (Redström, 2017, p.99)

The final case study examines the value of embodied research methods through the use of material practice in ethnographic study. The context challenges the boundaries of textile thinking approaches by entering into an applied research setting. In response to the key research question "What is the value in applying textile thinking to gather insights about human practices data practices?" this case study, the activities and their outcomes contribute an understanding of how data materialisation is used to reveal the tacit. Both people's personal experiences and my processes as a researcher are captured, in order to communicate and connect with stakeholders.

The Stretch Orchestra workshop and installation (CS 1) and the course Material Led Feedback System (CS 2) were exploratory encounters designed to:

> a) Facilitate alternative forms of designing data experience, including ideation and prototyping artefacts and experiences as provocations to initiate dialogue

> b) Generate insights into the experience of interacting with data generated from digital devices

The outcomes of these studies are designed artefacts and insights about data experiences collected from workshop participants and exhibition visitors. These are evidence of the ways that textile thinking can be used to engage people to learn about their practices with data. Learnings from CS1 and CS2 informed the design of activities for generating dialogue and insights and the use of designed artefacts to communicate and connect with others. The final study investigates how textile thinking is used to engage people in an applied research setting. Case Study 3 applies tested methods and employs artefacts (data materialisation) as outcomes in a research study set within Building Digital UK (BDUK), in the UK Government's Department of Digital Culture Media and Sport (DCMS). The results show that textile thinking approaches can be used to develop embodied methods for use in data collection. This case study contributes to the research agenda by revealing how data representations can be used as engagement opportunities to examine how people connect emotionally with information in an applied setting.

This setting provided the context for knowledge exchange using textile thinking approaches, which were used to engage people in research activities. The aim was to

learn about the experience of living with a high-speed internet connection. The outcomes are insights about the impact of gigabit-capable connectivity which were presented to stakeholders and will inform the development of future interventions to encourage the uptake of fibre internet connections. Novel research approaches led to a bank of personas and scenarios as an evidence base for the benefits of gigabit-cable connectivity. My study reports on the methods employed and the findings, followed a discussion of the ways that a textile thinking programme supported knowledge exchange in the context of the government's Gigabit Broadband Voucher Scheme.

Background

Providing public funds to boost digital infrastructure which supports the building of networks is a key proposal of the UK Government's White Paper *Industrial Strategy; Building a Britain Fit for the Future* (HM Government, 2017). This infrastructure is necessary to enable access to future internet technologies, including fibre-optic networks and 5G. Though the necessity for internet access is widely recognised, there is little formal evidence of the tangible benefits of gigabit-capable internet (1000Mbps). The aim in this case study was to create an evidence base for the benefits of fibre internet. This is based on interactions with recipients of a grant scheme which provides vouchers to support the build cost of new infrastructure. The Gigabit Broadband Voucher Scheme (GBVS), which ran from March 2018 to May 2020, was an intervention designed to increase the deployment of fibre, part of the Local Full Fibre Networks programme.

I reframed the challenge of learning about personal experiences with gigabit-capable internet as a textile problem. I defined this in Chapter 2 as problem areas outside the field of textile design that can be addressed using techniques and perspectives derived from textile thinking approaches. The approach is informed by the themes which arose from the exploratory case studies (CS1, CS2) based on personal experiences of interacting with technology and information. The textile thinking approaches (described in Chapter 2) which I tested in the previous case studies were applied in the design of activities used to engage research participants and deliver findings on the benefits of fibre internet. The results include ethnographic insights about lived experiences afforded by high-speed internet, a map of the research landscape and proposals for future schemes to encourage fibre internet uptake. The activities also provided experiential knowledge that was useful for developing future projects for government social research – for example, learnings useful for relationship-building. I explored this textile problem

by applying synergistic approaches which included calling upon both personal and professional networks to create to a more intricate picture and understanding of the experience of high-speed internet connectivity. A Theory of Change approach developed by BDUK in line with a benefits analysis framework outlined the potential impacts of gigabit connectivity. These forecast impacts were very high level and indicated significant influence in the areas of productivity, public value, closing the digital divide and wellbeing. Learning through lived experiences provided evidence which illustrated real-world examples in the impact areas on the benefits framework including revealing findings which deviated from the assumed impacts. The results show that by engaging in embodied research activities, it was possible to develop an understanding of, rather than theoretical assumptions about, what the changes brought about by faster broadband connections are, and what this reveals.

Methods

The approach I took was experimental and qualitative. Ethnographic research activities were carried out over a three-month period (March- May 2019). Based on initial desk-based research, insights from conversations with stakeholders (programme directors at BDUK) led to a research proposal which was submitted and approved by a steering group at BDUK. The first stage was relationship-building followed by fieldwork, data collection and finally synthesis and dissemination. Figure 4.17 shows an illustration of the research process and journey.
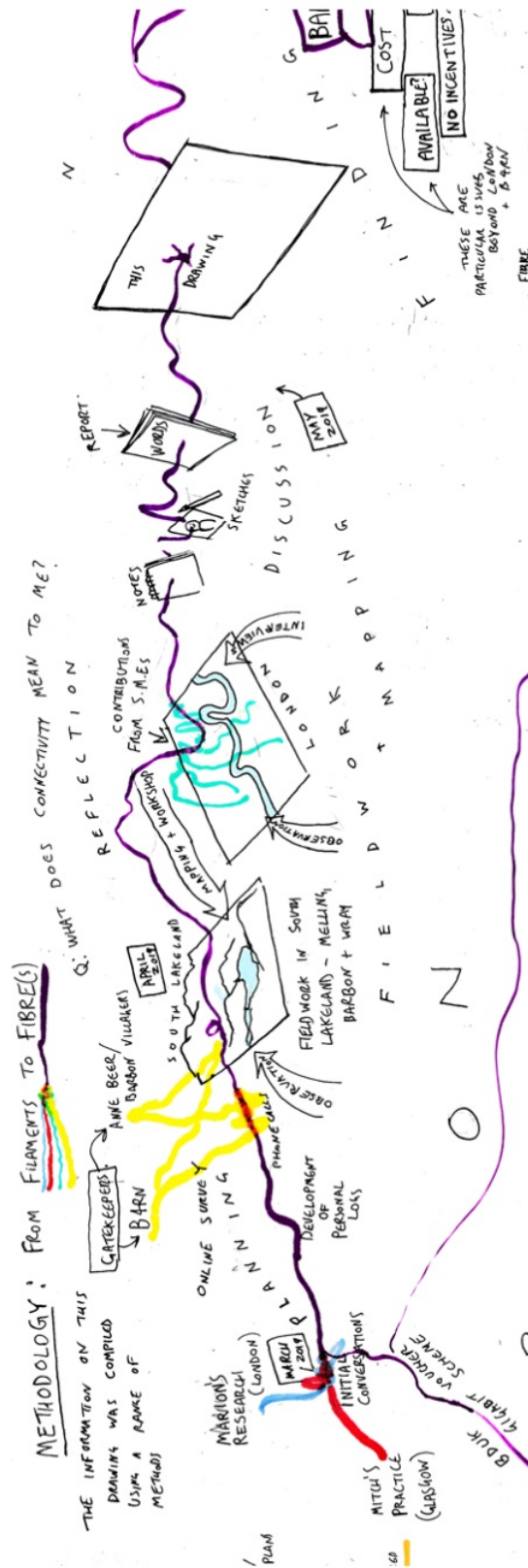
Figure 4. 16 Methodology Map (Mitch Miller, 2019)

The activities shown in Table 4.12 developed from the two exploratory case studies were encouraged yet unprecedented in the new setting (BDUK). These activities were facilitated in a range of encounters to reveal findings which contribute understandings of the potential changes brought about by faster broadband connections.

Table 4. 12 Case Study 3 Activities and Findings

Activity	Applied textile thinking embodied in outcomes and analysis	Textile thinking characteristics *outlined in chapter 2*
Expand knowledge : UKRI Policy **Placement** with Building Digital UK	Formal and informal learning opportunities, creating a new network and learning about people's experiences	**Problem setting**
Expand knowledge: Engagement with external parties and researcher's own networks, including informal encounters	Engaging with external parties and my own networks, including informal encounters Informal learning: engaging peers in conversation about home connections, informal discussion and settings with research subjects	**Working in the synergies**, identifying links and applying lateral thinking considering **emotion and affect** in responses
Data Collection: Probes to initiate dialogue (Technology demo, ethnographic logs and physical material mapping)	Introducing Kraydel (video streaming technology) Collecting ethnographies using gigabit connectivity as discussion probe	Experimenting with materialities, especially **physical materials** Engages with **technology**
Informal interviews; insights and experiences	Research participants' daily habits and lifestyles and emotional responses Shows the importance of broadband in specific communities – insights which were not previously available	Crossing boundaries and **building relationships**
Data Representation and Analysis: Practice-based research methods results in hand-drawn research landscape map **Knowledge Exchange:** Introducing ethnography and sensory ethnography approaches	Sharing findings with government stakeholders through report, presentation and dialectogram Inviting others in (tech company, illustrator, third sector) Depicting research landscape as a map enables actors, actions and findings to be simultaneously present	**Creates bridges-** inspires and transform new practices

The activities presented new ways of working, as well as meaningful findings for stakeholders of the study. Following the running of textiles workshops in the previous case studies to engage people from different communities, the approach incorporated

many different voices into the research in order to learn about their experiences. The focus was not solely on gigabit connectivity but also sought a more holistic understanding of the assemblages of internet and real-life experiences and interactions (Lupton, 2019). To support the study, I commissioned dialectographer Mitch Miller to join the various research encounters in order to give visual form to the findings as well as to support the analysis through mapping. Miller, who invented the dialectogram, describes it as "...a large, detailed documentary drawing of place, drawing upon multiple viewpoints and guided by the feelings, impressions and relationships of those who live there, or use it" (Miller, 2016, (dialectograms.com). This allowed me, as researcher, to perform the role of facilitator while Miller captured the insights from the research activities through drawings on paper. Data was recorded in sketchbooks and mapped onto a dialectogram, a detailed hand-drawn map. This provided an overview of the data, findings collected from the people and places visited. Imagery of the research process, activities and their outcomes drawn by Miller is shown in Figure 4.17 and in detailed in Appendix 11.
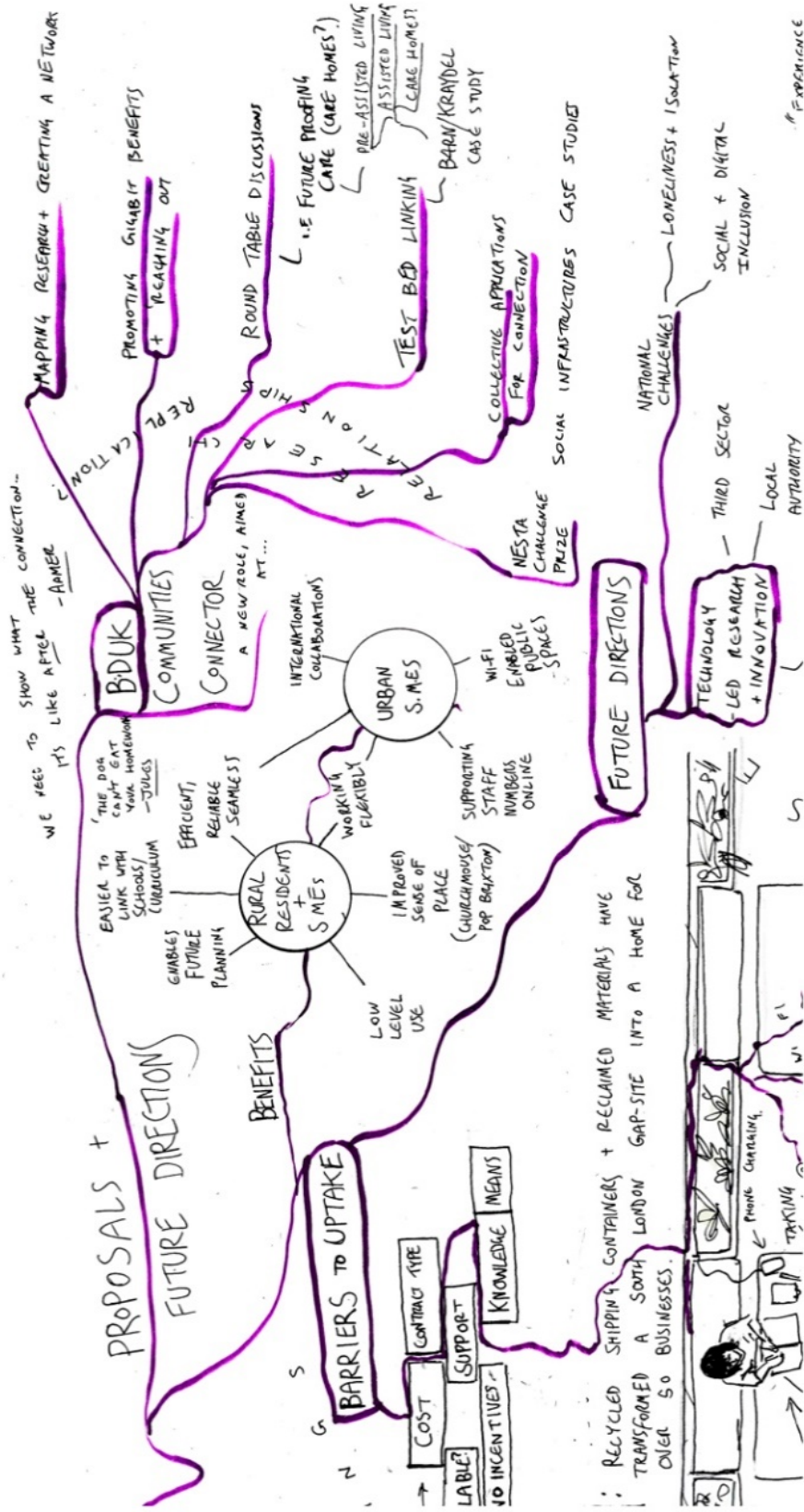
Figure 4. 17 Proposal and future research directions drawing (Mitch Miller, 2019)

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Relationship Building

The research design sought to engage real users in learning about personal experiences. This included insights from consumers, business owners, internet suppliers, local bodies, and government programme directors as stakeholders. To identify potential research participants, a dataset of beneficiaries of the GBVS was analysed to establish a range of potential participants based on their location and industrial context. From the data, two types of beneficiaries were identified. This was segmented as small businesses, in both rural settings and urban settings, and residents in a rural setting. I built relationships through a range of interactions in person and by telephone to identify the types of challenges which lay ahead, and to establish the broader implications of the study. The first stage was to make contact by telephone and email to introduce myself as the researcher and the project aims.

In the rural setting of Lancashire businesses and residents were connected to fibre internet on a connection from community broadband provider Broadband for the Rural North (B4RN). By engaging with volunteers at B4RN by telephone and email I was invited to meet members of the community at a computer club event. The computer club is a regular meet-up for older internet users at B4RN headquarters in Melling, Lancashire. Attending the event provided me with the opportunity to engage in conversation, share information about the research aims and to consider how to collect data in this community. In both settings (London and Lancashire) visits to businesses' workplaces were arranged. In most cases this meant having conversations with the company directors. This was useful for learning information which they could provide about particular activities and behind-the-scenes business activities. Where possible, spending time in physical spaces to observe staff, clients and customers gave a broader understanding of who else would be benefiting from internet connections in the workplace: for example, observations made in a co-working space and in a village shop.

Data Collection: Ethnography

The approach was to spend extended time with the GBVS beneficiaries in their own homes and workplaces, to learn who they were, what their lives were like and how their fibre internet connection played a part in this. By learning about who the beneficiaries were, it was possible to learn how specific benefits appeared, rather than trying to fit evidence into preconceptions outlined in the Theory of Change. Due to the constraints of time and location, I devised opportunities for sensory ethnography which would afford

concentrated exposure to research subjects' environments. Pink (2009) describes sensory ethnography as a developing field which is not intended to replace traditional ethnographic practice, where researchers spend time in participants' homes, but is more appropriate for studies with constraints, including the ethnographer's working hours. The approach does not seek to prescribe methods; instead it supports the generation and sharing of approaches which are designed to enable access to people's lives which transcend traditional ethnographic observations. These approaches include creating new ways to engage with the way others live through shared experiences and considering alternative ways of establishing meaning and expression (Pink, 2009, p6).

During relationship-building activities by telephone and in person, I arranged opportunities for interviews and observations . These interviews were semi-structured and recorded in drawings and notes. For businesses, my approach was to ask questions to prompt conversation but invite the research participant to be open and comfortable about sharing stories about their brands and services. This approach enabled a broad understanding of the participant's company and their network which could benefit from fibre internet connections. Being in their physical spaces offered me as researcher a different sense of the companies – personal items and local dialogues illustrate livelihoods and meaning beyond client numbers, for instance.

For residents, the approach was more structured. I used probes and mapping activities to engage research participants in conversations. To prompt dialogue about using the internet for communication the first probe was to use a new piece of video technology. I used probes in the form of diary pages to glean information about the participants outside their online habits. This was useful as a conversation aid and to identify background information in the short time available to learn about people's lives. A mapping activity provided insights about where the participants came from, but also provided a point of reference as each could then offer insights about their homes and villages as a starting point. I recorded observations by note-taking, made drawings and took photographs in research settings (see Appendix 9).

Synthesis and Representation

Sensory ethnography affords representation that goes beyond written accounts, as it acknowledges alternative forms of expression in research activities. Involving Miller in the data collection phase enabled him to gain first-hand experience of the complexity of the research landscape and the intricacies of the individuals and their insights. Thus,

when developing the final data experience (dialectogram in Appendix 9), the translation and representation was delivered from those who were involved in the data collection, instead of inviting a designer to give meaning to an abstract dataset at the end of a project, for example. This decision resulted in the collection of anecdotal insights, from Miller, me as researcher and from the case study subjects, which led to reactionary responses and actionable deliverables from stakeholders.

Miller joined me to draw observations while the discussions, interviews and activities took place. I invited Miller as a collaborator to join the conversations, and by presenting previous work (showing drawings presented in a physical portfolio case) engaged the research participants and generated interest in being involved with the project. Those who encountered our researcher-illustrator duo were very interested in the drawings which Miller was making: this was effective in breaking down barriers and prompting conversation. From sketches and written anecdotes, my notes and the physical experiences of being in the various locations, Miller created the dialectogram in response to my brief to create a single map showing the places visited, the findings and the proposals which emerged. Following the data collection phase, Miller created the dialectogram in his Glasgow studio and sent it by mail to BDUK in Westminster, where it was presented physically to stakeholders.

Embodied in the final outcome are both my actions, as the researcher, and the outcomes. The insights were collated in a hand-drawn paper data materialisation "somewhere between a map, an architectural plan, comic strip and diagram", which offered an overview and analysis of the people visited and their experiences (Miller, 2013, p.2). From the drawing, both the evidence bank for the benefits of fibre internet and the proposals for future strategies to encourage fibre internet uptake were identified. This information is useful for design of future interventions, such as, for example, a new type of grant for demand stimulation, or a grant delivered in a new format.

Analysis

After each ethnographic encounter, where possible I shared with Miller the types of conversation which had emerged and particular topics mapped to draw out themes. This analytical exercise was carried out in a physical way, using sticky notes and sketches to identify particular patterns, commonalities and differences. In order to analyse the qualitative findings over short, intense timespans I used an analysis structure based on potential benefits outlined in the BDUK Theory of Change to efficiently categorise

conversation topics and insights, as shown in Figure 4.18. These benefit areas include productivity, public value, closing the digital divide and wellbeing. I created the structure to appropriately record and locate discussion points and observations from the research encounters in the context of the BDUK benefits analysis framework. I analysed the dialogue from the interviews and conversations with all the research participants to identify the ways that fibre internet connections were supporting individuals and businesses, and where it was contributing to a wider community. The structure helped to classify the range of topics and insights from the rich and in-depth communications with participants. Cyclical analysis made it possible to quickly identify themes which emerged and present these coherently to colleagues and stakeholders as the research continued.
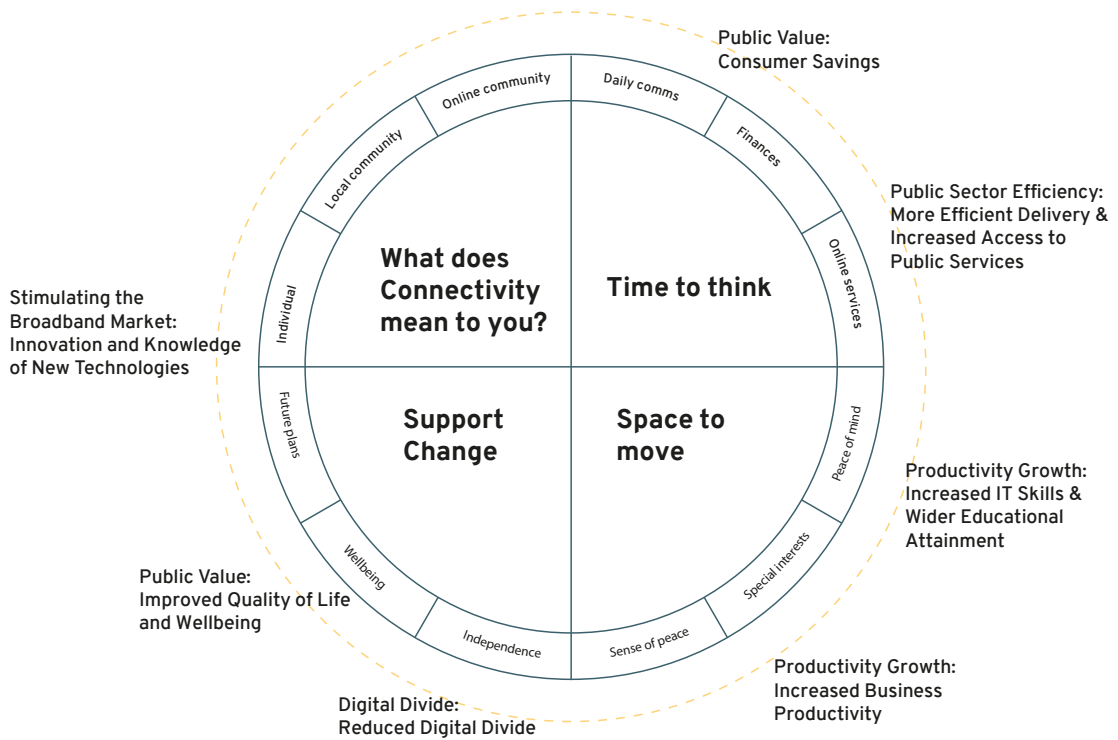
Figure 4. 18 Framework developed to assist analysis

Participants

The individuals and groups chosen to be part of the study had been connected to the internet through funding from the GBVS scheme. These groups were best placed to offer insights into the experience before and after the gigabit-capable connection. Users of

the community broadband scheme Broadband for the Rural North (B4RN) offered useful insights as a community who had had a gigabit-capable connection for a substantial time period (most of them for over a year), as well as insights into the experience of an ageing population, their families and communities and their health and social care. I carried out interviews in person over six weeks in rural Lancashire and central London, and by telephone with GBVS recipients in Manchester, Bristol, Yorkshire and London.

The themes identified for the SME (small and medium-sized enterprises) representatives were based on information from the GBVS portal data, such as the company's size, location, and type of industry. The aim was to analyse a range of creative, technical, community-based and business-focused companies.

The time frame (three months), my capacity as a lone researcher, rural transport options and fitting into others' schedules contributed to the design of the research, which included identifying appropriate GBVS beneficiaries as recipients. Given the constraints, in order to gather as wide a range of insights possible the selected participants represented both rural and urban residents, and also small businesses who have access to gigabit-capable connections. It was important to be flexible and exploratory, but also to stay true to the brief for BDUK to identify and build an evidence bank for the benefits of gigabit-capable connectivity.

Research Activities

Activities in this case study were informed by reflections on responses and interactions during the previous case studies. To accommodate new settings, participants and objectives, the approaches I developed for data collection were adaptable and flexible, learning from the "pop-up" nature of textile workshops. I used an ethnographic approach to collect data in order to learn about lived experiences and to generate qualitative data findings to inform the study objectives.

I broke down assumptions from the BDUK benefits framework to form a set of questions designed to direct my enquiry and my conversations during research activities:

"How does connectivity support you by creating time to think and space to move, and how does it support change?"

"What does connectivity mean to you?"

My awareness that findings from sensory ethnography do not need to be, and often cannot be, expressed in words resonated with my desire to address the "non-technical", affective responses and personal narratives behind the speed and efficiency associated with gigabit-capable internet. This presented a novel alternative perspective for stakeholders whose existing criterion for success has been based on download and upload speeds. Spending time with broadband users with gigabit-capable connections and learning about their actual experiences exposed an unexpected alternative finding. I observed that many "beneficiaries" were not benefiting according to the assumptions outlined by BDUK. This was made apparent when I engaged with research participants whose regular needs relied on activities which could reasonably be accessed on lower speed internet connections. This is in contrast to those using their connections for very high-level activities – for example, a voucher recipient working in the video games industry who requires high-speed connectivity for their daily activities. The observation here is that even the most efficient internet provision will not enable people to benefit if there is a lack of understanding, or support, of how to make the most of high-speed connections. Engaging with personal narratives moved the focus away from the theories of perceived benefits that might be collected by a survey, for example, and instead created the opportunity to learn about the impacts of high-speed connectivity based on collection observations and insights.

The rural participants engaged in interactive sessions (technology demonstration, informal interview, logbook entries and a mapping session) at a computer club for elders and home interviews. Urban participants were engaged through semi-structured interviews at workplace visits.

Technology Demonstration

To prompt discussion about the experience of online communication tools which rely on connectivity, I developed a working relationship with Kraydel, a company developing video-streaming technology for older people. A prototype demonstration of the device by a Kraydel representative at the B4RN computer club helped to contextualise my purpose as a researcher in being there, and provided the space to initiate dialogue and gather findings. Feedback about the device which had been presented, and personal experiences, were shared informally over cups of tea. Opportunities for insights included the following:

- Helping an older club member to log into her iCloud-enabled conversation, offering insight into ability and familiarity with technology

- Discussion about a rural train station which had become a community hub and a homework spot due its high-speed connection

- An invitation to visit a member of the computer club's home that initiated a relationship and enabled a set of interviews in a remote location

- Learning from Kraydel as a digital business enabled further insights into their needs in relation to digital product-based businesses use internet connectivity, and ways in which they use it

Using the gigabit connection itself as a topic to prompt conversation enabled informal interviews. These insights exposed findings which informed the design of probes (logbooks), and the experience contributed to the design of an interactive workshop. I used insights from these activities to suggest alternative proposals for engaging the public and encouraging uptake of gigabit connectivity through voucher schemes: for example, using communication channels from companies with digital products which could be better experienced using high-speed connections.

Log Entries and Physical Mapping Activity

Physical mapping acted as a probe to initiate dialogue and reflect on the discussions. Illustrated log pages designed by Miller (Appendix 7.2) invited participants to share some background about their living situations and family or work routines. A paper map of the local area was laid out and participants placed their log responses on the map connected by fibre cable shown in Figure 4.19. This was a way of collecting information that could be used as starting points for discussion, and to develop a clearer picture of the participants' communities. This activity also served to stall for time, as there were various points at which participants wanted to share their stories simultaneously. I interviewed the participant while Mitch talked another through the exercise. The results from these activities was not intended to be analysed, but the experiences and conversations which they enabled are reflected in both the final visual outcome and the proposed interventions.

Figure 4. 19 Results of mapping exercise with B4RN computer club

Based on understandings on the value of using logbooks for recording activities in Case Study 2, the aim was to invite research participants to share their personal practices. For most participants were surprised by the logbooks and questions. Some asked why I had travelled all the way to remote and rural locations rather than conducting an online survey, for example. The experience of travelling to and being embedded in the research context created opportunities for exchange by developing a sense of trust. Initiating a novel approach invited questions, and this too enabled conversation. I carried out the interviews in an informal and easy manner whilst learning about other aspects of the participants' lives by being part of them, albeit for a short time. The logs included the question "What does connectivity mean to you?" which resulted in a bank of personal and affective responses (Appendix 7.3) These collectively summarise experiences of gigabit connectivity. The descriptions of gigabit-capable connectivity as "a lifeline" (by a rural resident) and "seamless" (by an urban business owner) reflect the value and lived experience of the connection. These findings show that for many in remote locations the

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connection was a necessity, highlighting the importance of GBVS and fibre connectivity. Describing an internet connection as "seamless" was not the response I elicited from my peer network, who reported frustrations with lower-speed connections. This observation reveals the personal meaning and value in good connectivity. The role of fibre connectivity to support individuals, family and community by keeping in touch, for general access to knowledge and for wellbeing can be considered to address the issue of loneliness. Individuals who are socially excluded and may not consider themselves part of their local community can thrive online using connectivity to engage with groups, community forums and relevant special interest groups.

Outcomes

The aim was to identify and detail the benefits of high-speed connectivity from recipients of the GBVS in order to improve to improve BDUK benefit assumptions. Key findings from the research activities outcomes which were valuable to BDUK include:

- Anecdotal and visual evidence of the ways in which gigabit-capable connections are being used; the activities that are supported by the connection.
- Insights into why the connection was taken up, barriers to uptake and insights into its impact on business and personal lifestyles and productivity.
- The prompting of suggestions for further research in this area by the findings, such as a framework with proposed activities and a case study example of a testbed partnership between Kraydel and a community connected to fibre supplied by B4RN. Kraydel are testing their product with a group of fibre broadband users, and this relationship was formed as a result of the computer club event.
- Mapping of the landscape, including stakeholders who support people to benefit from fibre connectivity, as shown in Figure 4.17.
- The 'benefits' are not always clear, especially considering those who don't know how to 'make the most' of a high-speed connection potentially will not 'benefit' in the way expected/intended by the BDUK.

The findings consist of a range of responses, including feelings and insights into activities before being connected, practices with the current connection and discussion about future plans relating to participants' experiences of gigabit-capable connections. These are detailed in Appendix 12. Specific findings focused on participants' daily routines, insights about cost and savings, as well as time, and a bank of responses

which reveal the meaningful impacts of the connections. Through this, understandings about further uptake of gigabit connectivity could be promoted to other users in other communities. Within an A1-size detailed drawing, specific locations, including rural villages, homes and a farm and a central London urban retail and entertainment hub, were positioned as linking people and places. The drawing's deliberately interwoven design expresses the reach, influence and varied needs of those with gigabit-capable connections supported by the GBVS across the country while separating anecdotal descriptions and quotes from individuals to retain the richness of the findings.

The dialectogram is a data materialisation which presents a critical analysis of the benefits of gigabit-capable internet. The outcome shows how people are, or are not, benefiting. It also shows the activities undertaken which were used to reveal these findings and the locations visited to develop these understandings. This demonstrates a key insight, the process, activities and actors which provided an opportunity to learn about the lived experiences of faster internet connections. These parts of the representation capture the activities which I undertook to embody the research, shown in the stakeholder map, methodology and proposals in the upper section of the dialectogram (shown in Figures 4.17 and 4.18, 4.20). A written report documents the research project, but the dialectogram captures the essence of the study as well as acting as the outcome. It is a data experience. The main body of the drawing contains insights collected from individuals and their communities. For the viewer, interpretation is enabled by a visual presentation of the data collection methodology alongside the findings. For example, showing the limitations of who was involved and where the research took place illustrates that the responses came from a segment of the beneficiaries, rather than reflecting the experiences of everyone on the GBVS or indeed everyone with gigabit-capable internet connections.

Conclusion

By physically being in research participants' offices, village halls and living rooms it was possible for me to form a sense of the types of specific community activities and needs. Deeper observations and insights developed through conversation provided an understanding of how broadband supports lifestyles, including wellbeing and business productivity. The findings of this research form an evidence base for benefits of fibre broadband, which includes high- and low-level use cases, personal and community impacts and personal feelings about, and emotional responses to, broadband connectivity. This is captured in a large-scale hand-drawn map of the research

landscape portraying stakeholder relationships (Figure 4.20) geographical areas and individual anecdotes and insights. This information is useful for stakeholders in developing new programmes and understanding patterns in existing schemes. At BDUK the role of my case study research involved establishing opportunities for knowledge exchange using insight and experience in practice-based methods which could offer direction for government social research. Of particular interest were methods which led to findings and insight which were not solely linguistic – for example, actions, objects and expression. The challenge then was to analyse and present such findings in ways which are meaningful and productive for stakeholders, and to create a research model for future research in this area.
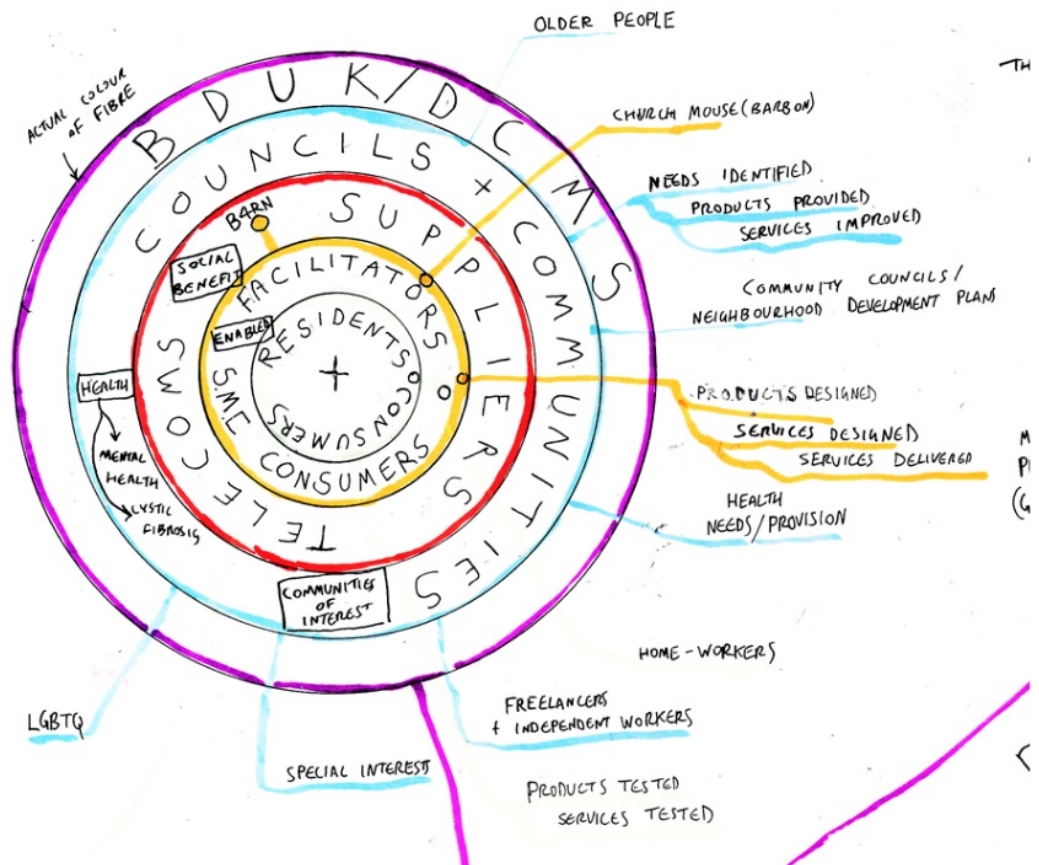
Figure 4. 20 Stakeholders and Community map (Mitch Miller, 2019)

The feedback from the research project and the means of data representation ranged from terms such as "novelty", from one civil servant who wasn't sure how to accept the unusual delivery format, and another who was "surprised" that this had been funded, to positive feedback from the DCMS Permanent Secretary. who welcomed the approach as a methodology the department could learn from. The insights from research participants, the proposals to stakeholders for new means of delivering the scheme and the methods themselves presented a new way of working for DCMS. Though the methods and delivery were somewhat unusual for this environment, the impact and reach of the work has engaged many people. Imagery from the dialectogram has been used to illustrate BDUK projects in both internal and external events, for example in a presentation at the Connected Britain conference in 2019 and the 2019 Social Research Association conference gallery. The dialectogram is now displayed on the wall at the Building Digital UK's London office. Due to its scale and novel appearance, the dialectogram attracts passers-by to have a closer look. Viewers (BDUK staff) can witness

the range of people their work is affecting, read the anecdotes and see how their work in broadband infrastructure is supporting many communities in different dynamic, tangible and overlapping ways. Physically bringing the paper drawing to the steering group meetings caught the attention of the stakeholders with its unusual appearance. The voices of the people who are being connected to fibre as a result of the voucher scheme were materialised. By rolling out the large map and physically bringing them into the room, those who are affected by the interventions could now contribute to designing the programmes. In this way it is possible to challenge assumptions and generate change by offering alternative perspectives based on the real people who took part in the study, through the experiences captured on paper.

Creating Opportunities for Knowledge Exchange

Engaging novel approaches for data collection raises concerns about validity, especially when experimental methods are employed. The approach taken in this case study relied on the ability to communicate some of the tacit knowledge of textile design in ways which aimed to avoid confusion and dismantle barriers. This required a level of trust between me and the stakeholders at BDUK in the application of particular methods in the study. For example, the notion of an ethnography workshop was more easily communicated than that of a textile workshop. Textile thinking as knowledge exchange through a range of means and mediums was presented to DCMS Government Social Research, the BDUK Commercial and Analyst Team and to the DCMS Permanent Secretary, Sarah Healey, who subsequently requested a blog report and a film. In response to the film created for the DCMS intranet to showcase the project within another new environment, the department noted that "It shows how different perspectives and ways of working can shine a light on policy issues we may otherwise miss". The dialectogram was subsequently translated into a digital format to be hosted on the Gov.UK website.

The sight of a bearded man with a sketch book and a researcher in an anorak is a far cry from the visual depictions of textile designers in Igoe's 2013 study. Recalling Philpott and Kane's "purposeful deskilling" (2013) and Winters' advocacy for the embracing of new and varied guises for the textile designer (2016) I myself became the research probe. I embodied the research by striving to fit in; dressing smartly and keeping abreast of the terminology, conforming to the civil service context. Anderson and Wilde (2012, p.65) offer the suggestion of designing temporary safe spaces where the researcher can "become", and take risks. The government telecoms department setting and its industrial

strategy were the given space, and by being embedded I was able to identify how learnings from the exploratory studies could inform the research agenda. This disguise created the opportunity to form an understanding of the bigger picture. Under my own hat (Hall and Earley, 2019), what would be permitted as acceptable in this environment was explored by quietly observing and developing trust to deliver a meaningful and engaging outcome.

Capturing experience and developing data representations which offer tangible understandings of the methodology are useful for communicating the process and findings relevant to the research context. Demonstrating value in the steps taken as well as outcomes support experimental design research by communicating the approach through which insights and findings materialise. Alongside communicating to participants and stakeholders in the case studies, both the films and the dialectogram also provided me with the opportunity to review my own emerging research process and to consider how it is that I learn by doing. The films offered a close observation of the activities and my own role and performance within the programme. However, the scale and format of dialectogram, not as a finished artefact but as working diagram helped me to consider how as a design experiment it facilitated knowledge production by
 a) gathering theory – understandings and insights useful to the research context (BDUK, data experience)
b) visually demonstrating how my designerly actions led to those results

While I contextually analysed ethnographic findings to inform the research questions for BDUK, Miller's dialectogram acts as an aid to communicate where knowledge emerged from the activities described. In particular, Miller's methodology map (Figure 4.17) moves in a linear fashion from idea to outcome, translating my not-so-linear navigation of a complex research context into a coherent methodology. Eva Brandt and Thomas Binder (2007) explored how aspects of experimental design research facilitate knowledge production using the terms "genealogy", "intervention" and "argument" to map research projects. They used dynamic sketching to identify how to generate new knowledge as presented by another practice-based researcher. Inviting Miller to capture and contextualise the methodology offered an interpretation of the value of my actions by demonstrating a "flow" in how knowledge emerged through the experimental approach (Brand and Binder 2007). Miller's interpretation of my methodology acts as a sketch of the relationship between the research context, the questions and the experiments. His approach differs from dynamic research sketching performed by the

design researcher themselves as the research context is acknowledged but wider programmatic context is omitted (Brandt, Redström, Erikson and Binder, 2011). In his depiction of the relationships between my actions, the research participants, their knowledge and the outcomes and proposals Miller's materialisation of the project helped me to consider means to formally demonstrate the value of my experimental approach in a framework.

Full Dialectogram image: Appendix 7

Case Study 3 Film

Exploring Benefits of Gigabit-capable Internet

https://www.youtube.com/watch?v=M0JBeGBJ8XE&t=15s

Case Studies Discussion

The case studies described here in Chapter 4 are presented in response to the research question: What is the value in applying textile thinking to gather insights about human data practices?

In Case Studies 1 and 2, textile thinking approaches revealed themes and identified methods which can be used to initiate dialogue around data experience in designed encounters. Participants included a sports team, exhibition visitors and Masters level Art and Design students. Conceptual design outcomes generated dialogue and direction for the research. In the third, I explored data experience within the context of gigabit connectivity, which resulted in valuable findings and proposals contributing to the UK's industrial strategy and informed governmental social research practice. By the time the final case study with BDUK was carried out, the scope and approaches were more established and were performed in an applied, yet still relatively exploratory, manner.

I mapped the case studies onto the mindset and approach map of textile design research (shown in Figure 4.21), including identifying where each case study can contribute. My aim is to illustrate where each was positioned in developing insights both for textile design researchers and for other fields engaged in the case study activities.

Figure 4. 21 Case studies mapped to Textile Design Research Map

The outcomes of the practice revealed wider implications of the challenge posed to address the affective and sensory dimensions of data. This supports the observation by critical designer Matt Malpass, who suggested that conceptual design can expose, rather than "solve", problems (Malpass, 2017). Through the various settings and communities in which my study took place it presented alternative applications of the research agenda and the potential of designing in research as a means of provocation and reflection. The conceptual encounters in this study opened discussion about the services and products we are served by offering alternatives and suggesting different ways of assessing these, by identifying our habits, needs and rights – for example, privacy or data security.

The process, which was originally conceived to expose a lack of sensory engagement in data experience, revealed:

a) there *can* be sensory engagement with data and technology experience, seen in the example of the Uncanny Tea Set; we can use material engagement to talk about and discuss phenomena and experience revealed through engagement with new technologies

b) the recognition of new types of sensations and experiences from engaging with technologies that can be used as a catalyst for design ideation

c) a critical perspective on the knowledge of, and response to, systems and technology designed to contribute to behaviour change which has been derived from practical encounters

The critical design approach I took in the early stages of the research, seen in the "(A)Dressing Stigma" reflective jacket evokes what design researchers Blythe et al. (2016) describe as practice based on satire and irony, and was dangerously close to Gamman's "posh boy design" (2017). The examples developed in the case study experiences, though still positioned as critique of technology support design, aimed to go beyond this by developing artefacts and prototypes which cannot be described as "slick solutions" and which participants could actually use to report on personal experiences and ideate, as well as to "help articulate and explore problem spaces" (Blythe et al., 2016, p.4977). The scope and the agenda of the research was formed through each of the encounters. Textile thinking approaches led to the outcomes and findings relevant to the context of data experience. Collectively, the encounters were original, and in fields in which it was unusual to find a textile design researcher. However, through the application of textile thinking based on the characteristics in Chapter 2, including the reframing of data experience as a space which could be a "textile problem", the spaces, topics and mode of enquiry appear appropriate, and have now been shared and recognised as research practice for exploring the experience of data. The knowledge gained through the case studies I explore in this thesis was accumulated to inform the design and understandings of aspects of each subsequent activity. The outline of methods (Table 1.4 on page 42) is updated in Table 4.13 to show the learnings, express the lessons learnt and the contributions to the research agenda derived from each case study activity. Insights described as "new knowledge" communicate the types of observations at each phase which enabled me to begin to untie the knots that technology puts us in.

Table 4. 13 How each experiment contributed a piece of new knowledge

Objective	Activity		
	Case Study 1	**Case Study 2**	**Case Study 3**
Expand knowledge	a) Intelligent Textiles Industry Placement: *(Footfalls and Heartbeats, Nottingham)* **New Knowledge:** Learning about functionality and applications of the product by trying it and holding conversations with the engineers and technologies. Experimenting with samples to develop workshop activities to find out show people examples of sensor fabric.	a) Cross-disciplinary design workshop with MA students at RCA: test activities and potential applications for data materialisation **New Knowledge:** Material handling led to students sharing personal experiences of interacting materials in home and educational settings. Understandings of how art and design students engage with experimental research activities and themes raised.	a) UKRI Policy Placement with Building Digital UK **New Knowledge:** Understandings about the topic of broadband through formal and informal learning opportunities by engaging in conversation with external parties and peers.
Data Collection	b) Workshop Activities with sports group (i): Trying out technology used to engage research participants with their own experience of similar devices or applications **New Knowledge:** Personal anecdotes about the experience and knowledge of wearable technology and tracking devices for example if they have tried a Fitbit in the past. c)Workshop Activities with sports group (ii): testing activities and potential applications **New Knowledge:** Insights into how the research activities can be used to develop design outcomes and prompt discussion. For example, during material mapping people showed pleasure or disgust when handling certain samples, people were drawn to more 'technological' materials for prototyping d) Conversations held at public exhibition of installation provided space for insights about personal technology practices	b) Workshop activities with student groups: material mapping and making alternative data representations **New Knowledge:** understandings of how art and design students develop ideas based on research themes into physical models/data representations: for example, which materials are chosen	b) Material practice in ethnography: Illustrated log entry and mapping exercise at B4RN Computer club (probes) **New Knowledge:** Research participants' daily habits and lifestyles and emotional responses which show the importance of broadband in specific communities – insights which were not previously available

	New Knowledge: Responses– from being curious to being open about habit and physical interaction with data materialisation presents potential application for data representation experience (prompting discussion and insights)		
Data Representation and Analysis	e) Analysing insights: considering the bigger picture of data provides the opportunity to form new interpretations of value in data representation **New Knowledge:** Value in data representation found in material choice f) Films of workshop and exhibition used to present research activities and participant commentary – insights **New Knowledge:** Films used to show what happens in research workshops demonstrate an approach to capture embodied design methods	c)Workshop participant logs: written experience provides individual insights and can be used to prompt conversation **New Knowledge:** Logbooks can be used to capture and communicate embodied activities. Individual interpretations of the research activities which were not necessarily clear in design outcomes. Addition of language and own words to describe aims. d)Filmed interviews showed how participants had developed their own perspectives on the scope of the research **New Knowledge:** Making physical models demonstrated and understanding of the brief and the concepts, using own words and physically showing the outcomes enabled participants' interpretations and the potential applications of the research to be revealed	c)Findings in the results of embodied data collection with research participants in hand-drawn research landscape map **New Knowledge:** Depicting the research landscape as a map enables actors, actions and findings to be simultaneously present and the value in the experimental approach to be communicated d)Sharing findings with stakeholders and steering group: Government Social Research and BDUK analyst team through a report, presentation and dialectogram **New Knowledge:** Data represented visually can be used to demonstrate complex relationships and express meaning of intangible digital infrastructure

In this study I define data materialisation as a way of meaningfully communicating (or interpreting) data by applying/engaging the affective and sensory dimensions and essence of our interactions with the material world. This is the way we draw upon our knowledge of the material world through subjective embodied experience to make sense of the information about a situation. Referring to the ways we make sense using recognised symbols and observations, Lockton (2017) writes "Much of our experience of – and meaning-making in – the real world is qualitative rather than quantitative" (Lockton,2017, p.2). Data materialisation took form at various points in the research as information which is delivered in a way that engage our bodily experience of the material world – for example, through sensations or memory, in order to enhance the conveying of information. The Stretch Orchestra installation (CS1) was an embodied experience evoking memory through its affective impact. Quantitative numerical data, along with a high level of processing, created a data materialisation to present physical activity data in a meaningful and pleasurable way. Data materialisation is an applied method to inform physical material choice or the design of material experience (sensations etc.), *to make sense* of data. This evokes Hogan's (2018) suggestion of a new form of data representation, "data sensification", which proposes that in the experiencing of (for example the kinaesthetic response to) the representational object the intent of the data is expressed, as seen in *My Life Don't Mean A Thing If It Ain't Got That Swing* (Pockson, Shenai and OFlynn, 2013). In data materialisation, the design emphasis is on the experiencing of materials – tactile-sensory engagement and associations – and intent is found in the context and delivery of experience: for example, in a textile workshop or civil service meeting room.

Data materialisation can be part of a design process. During Material Led Feedback System (CS 2), the group that incorporated 'material sounds' demonstrated that they could embed qualitative or conceptual data/information 'into' an object or experience to create meaningful discussion around the theme of sustainability.

Data experience which engages materiality moves beyond representation to enable dialogue, discussion and action in response to broader topics surrounding a particular data topic. Various modalities were used for representing and exploring data experience in the case study examples. In the exploratory studies, the type of materials used in data representation were important in particular in relating to physical sensation, social and personal connotations and experiential affordance. Speculative ideas and physical

prototypes offered "embodied information experience" where interacting with the materials engendered the data insights.

Hogan and Hornecker's (2016) survey of data representations showed that beyond a small selection of artistic pieces where material has been used to metaphorically represent data, specific material choice is not considered beyond its structural and functional properties in physical data representation. As seen in Uncanny Tea Set (CS2), workshop participants demonstrated that through their choice of materials they could report on an experience of data-driven design. In this example, and in the other prototypes in this study, it is significant to note that the introduction of the very simple textile and material samples provided to participants led to discussion and ideation about feelings and sensations of immaterial data experience.

For data materialisation in Case Study 3, What does Connectivity Mean to You? the material choice (paper) did not play a part so much as the specific choice of modality (physical). Visiting the GBVS recipients in person, recording dialogue and experiences on paper, interacting with people in physical settings to discuss their experiences of technology and data which is essentially immaterial, enabled discussion and representation. The physical representation of the research and findings reports on insights into ways to research about ineffable digital technology but also materialises the lives and voices of the people who provided the "data". Table 4.14 outlines the materials used in this thesis and their implications and functions.

Table 4. 14 Material choices in Data Experiences in this Study

Case Study Experience outcomes	Materials and Modality	Role of Materials (based on Hogan's themes of multimodality data representation, 2016)	Data materialisation application
(CS1) Stretch Orchestra Workshop	Scent release ink, LED lights, thermochromic paper, drawings, low-tech prototypes	Sensory Modality, Data insight through experience	Ideation, point of inquiry, probe, research tool
(CS1) Stretch Orchestra Installation	Marbles in movement, wood, pommel-horse, textile sensors	Sensory Modality, Data insight through experience	Revealed data insights, provocation, probe
(CS2) Material-Led Feedback System	Hair, sweets, balloons, recycled materials, "new" material	Sensory Modality, Data insight through experience	Report on data experience, provocation, probe
(CS3) What does Connectivity mean to you?	Paper, notecards, illustrated log pages, map	Representation modality	Engaging participants and stakeholders in physical settings, Report on experience, social engagement, gathering and delivering insights

The results show that a focus on material choice (even when limited or low-tech) can be used to generate meaningful, impactful representations beyond metaphor. Additionally, a further application of making and prototyping with data and materials outside the communication aspect is in the design research phase. Materials can be used to support ideation and enquiry, and have the potential to report on experience using non-linguistic means.

Films as Research Products

As part of three case studies, I made four collaborative films. The purposes of the films include:

- Communicating research objectives
- Capturing the essence of designed experiential encounters

- Functioning as a tool for reflection to support analysis of the research methods and their findings.

The following is a review of the films in this thesis. The aim is to identify ways that films can contribute to the programme as research products. The objective is to illustrate how particular aspects of the films created and delivered meaning within the scope of the research. Using this format enables the films to be viewed as a design product rather than as documentation of activities. Appendix 8 contains references to specific aspects of films discussed in this section.

Use of Films to Communicate Research Objectives

During the course of the study the films were used to present to stakeholders the type of work being carried out (including participant feedback). The descriptions of the overall research aim and the individual activities and outcomes in spoken word, supported by evocative imagery, sound and spatial contexts, contribute to this communication.

The research has been explorative and through the films a form of 'order' appeared, as wider components of the studies were brought together. The whole study was dynamic and shaped by those who encountered it through events/workshops etc., changing and influencing both the research direction and scope and myself as the researcher. For example, in an interview with rugby player Emma (CS1), she talks through the workshop activity in her own words. Philpott touches on this theme, saying "New meanings are created by our innate drive to make sense form non-coherence but these meanings are liable to shift over time. Contexts change, perceptions of both maker and users of the collection are liable to alter as different connections and juxtapositions emerge" (Philpott, 2007, p.59). Being able to re-watch the films and share them with others became a space for analysis as particular elements were extracted and explored within the thesis. A phrase from the film of CS2, where a participant talks about engaging with the "language of materiality" demonstrates an individual interpretation of the project, but can also be used to describe the wider research agenda – reiterating the importance of the material and immaterial differences between the digital and physical realms in design.

"How can we speak a language with only materiality?" [Material-Led Feedback System, 00:50]

This shows how the films played a part in the wider analysis of the case studies by viewing the films, including participant interviews, after the event once the excitement (anxiety) and energy of facilitation was removed.

The CS1 films were commissioned by the Get a Move On Network with the intention of showing the types of work that were being supported by the scheme. As the first case study project of the PhD, I then used the film of the workshop in CS1 as a tool for explaining to others what kinds of contexts and issues were being explored in the research. The imagery of the women in their sports clothes immediately established the theme of physical activity/sports. When the film has been shown (for example at London Design Festival and on the Get a Move On website) this contextualises the concept of wellbeing, also materialised by the pommel-horse as part of the Stretch Orchestra Installation. For CS1, the intended viewer is a public audience that includes academics, technologists and researchers interested in health/physical activity studies and critical design. By showing the film in a public space (the London Design Festival exhibition) the reach was expanded to include the general public, with the intention of inviting others to consider data experience.

The Use of Films to Capture the Essence of Designed Experiential Encounters

The films are used to show context, such as the physical activity setting or students in a university. The activities carried out and materials used are revealed. **The films demonstrate playful and explorative approaches to research.** In particular the films in CS1 illustrate the concept of using workshops which are informal and playful in research to learn about people. This is in contrast to a formal academic research setting, which would appear restricted, closed and controlled and less likely to be shared. [Stretch Orchestra Part 1, 00:27]. On arrival at the workshop venue to set up the space, the team captain warned of the possibility that the group "might not have the full space" and that "the guys might join" (the Haringey Rhinos Men's Rugby Football Club share the clubhouse). The clubhouse was transformed from a social bar area into a textiles workshop scenario. This type of concern is not easily captured in words, but the film acts as an experiential reminder of the workshop experience: not just outcomes but also process. I discuss aspects such as relationship building, a key activity in research which involves encountering a new group, in CS3 (Chapter 4) in this thesis.

In CS1 a digital camera was provided on the group table for workshop participants to use, and an iPhone positioned for voice recording; the video recording turned out to be more successful in capturing the session. The iPhone voice recordings were not clear, and, given the number of activity stations and number of participants (20) in a small space (the rugby clubhouse), the short interviews were useful to collect sounds and specific insights. The images on the camera were mainly fuzzy and not usable though if anything, do express the energy and movement present. The film footage of the space in action presented the array of activities as well as the buzz of activity. In the case of Stretch Orchestra workshop, (CS1) this was materialised in observations of the lids coming off pens, laughter and comments being written onto big sheets of paper. In Material-Led Feedback System (CS2) the project was longer, so there were periods of where there was no one in the room, causing slight panic for me, as the facilitator. This feeling was alleviated and rewarded when the nervous excitement of participants in the final stages of tweaking prototypes was heard as they decided who would be the lucky one to present to the group.

For the installation (CS1 part 2), filming took place during the exhibition in the gallery and in the pop-up workshop space; the film shows exhibition visitors trying out the experience. As part of this film three visitors talk through their experiences and responses to the piece. The films in CS1 and CS2 include comments and feedback workshop participants and exhibition visitors. Using film to capture the activities has become a way of showing "what happens" inside the experiences that took place. The films, which were produced at different stages of the research study, demonstrate the thinking and ideas which are manifest through the experiences and making.

The CS1 and CS2 films show various stages and associated feelings during the encounters – for example, the background noise of chattering signifies the energy and sound levels in the room; the informality and candid humour from exhibition visitors in CS1 (part 2) illustrate true responses and feelings from visitors who had not previously encountered the research.

At the Stretch Orchestra installation, Gunn invited exhibition visitors were invited to take part in a filmed interview. This revealed ethnographic insights; for example, "I don't think I track my data, it's more to do with how I feel" [Stretch Orchestra 2, 01:27] and responses to the installation such as: "it was exciting to see the marble do what it was set up to do" [Stretch Orchestra 2, 01:49] and "..it's a distraction from the physical activity to actually enjoy the performance" [Stretch Orchestra 2, 02:15]. Details such as personal introductions aimed to create a meaningful connection for viewers to show that this was

not "experts" presenting finished results. There is a sense of energy in the films which communicates the feeling of something brewing, similar to feelings which occur during a creative process.

The Use of Films as a Tool for Reflection on Methods and Findings

Aspects of the films which captured both researcher and participant activity are beneficial for design of future facilitation and to reflect on methods and their findings.

The first CS1 film was edited by Fairnie Productions with my directions; it was presented as a "mini documentary" and the research background, aims and activities are explained in four minutes. The film has been useful to be able to re-watch, to consider how the participants felt about the workshop.

During the CS1 workshop, film-maker Jake Fairnie set up a tripod at the side of the room and invited participants (and me as researcher) to talk about their experience at the workshop. He also filmed people interacting with materials, and each other as they took part in each activity. Prior to the event I discussed the workshop schedule with Fairnie, and the type of activities which might be useful to film. At the beginning of the workshop, I introduced Fairnie and his camera, and participants were able to opt out of being filmed. Though many of the participants were not initially keen to take part in film interviews, the set-up of the tripod at the side of the room became an extra activity after the brainstorming/prototype session. Jake asked participants to introduce themselves, talk about what they had done in the workshop, learned and whether they had done anything like this before. Since this workshop was the first one that involved external participants (rather than students or other academics) it was reassuring and important to hear their enthusiasm and specific anecdotes which illustrate others' interpretations of the encounter. This exercise was also informative from an ethical position as one of the participants later (after a few weeks) asked to be removed from the footage for any public display of the film.

When facilitating any type of group activity there is a period of exchange where the facilitator delivers information, explains tasks, sets briefs, and the participants accept the information, digest, then come together – often timidly (depending on the familiarity in the group), to confer and share what they can. This is the time when sound levels appear quieter, as introductions and assurances are made. There is a noticeable period where participants interpret, accept the challenge and the dynamic flow is felt to grow and

expand, noise levels rising. Of the workshops and events designed during the research, the affective atmosphere felt in the spaces was the main feeling that I as facilitator experienced. The films support a desire to communicate the senses present in the room. The films have played a part in being able to communicate the essence of the events back to myself and to others. From my own notes, "considering and responding to the dynamic in the room, feeling 'pleased' when the room was noisy and worried if there was silence" highlights the senses of anxiety and achievement in facilitation.

The film for Material-Led Feedback System (CS2) was shot by James Gunn, and took place on the final day of the workshop. The film shows participant teams presenting their work to the groups. The films, in this case, asked the participants to think carefully about how to present this in an interview/presentation format. The groups tended to choose the person in leader position to present the work, so being able to understand the concepts and processes alongside the accompanying logbooks provided insight into the "quieter" team members' roles and approaches.

The outcomes produced in CS2 were interactive: the films allowed the actions and feedback systems of the artefacts to be shown, but also the descriptions delivered by the participants themselves in their own words. The artefacts alone do not communicate broadly without a verbal or written description, since they are "live" (interactive). The films show both the objects performing and the interviewees' interpretations of the overall brief. The films were required for long-term documentation of the experiential outcomes in the case studies. Many of the physical outcomes were dismantled at the end of the events. This includes the prototypes in CS1 made from craft materials; The Uncanny Tea Set (CS2) was time restricted, as it was made from real jelly beans, and others included specific components, such as microcontrollers, which were removed from the artefacts and returned after the end of the project.

The film for "What does Connectivity mean to you?" (CS3) was recorded after the research had ended and the findings delivered. The style of the film, including my appearance and performance, is a more formal presentation, again alluding to the applied context of the case study. The film presents the final outcome and the process; however, it appears more polished than the real events which took place, which were 'pop-up' in style and in unusual locations – for example, a rural 'computer club'. In this film, the dialectogram, designed as a metaphorical representation of the research encounters, better represents the layers of research and feelings of the project and places visited. Findings are shown in the context of the research participant locations

(materialised on the dialectogram) and in the physical context of the DCMS shown on film ["What does Connectivity Mean to You?" 02:29]. The dialectogram and accompanying sketches are portrayed as though on a mood board or studio desk, which successfully communicates the idea of layered and in-depth research.

Capturing Evolving Research on Film

Through the workshops and outcomes generated through case study activities, the application for the textile thinking programme in this thesis is materialised in the exchange from the programme with others, for example workshop participants. Designers can take aspects of the textile thinking programme into their own practice. Stakeholders, such as BDUK, are invited to consider human aspects of digital connectivity by learning about the process and outcomes of design research approaches. The textile thinking programme has developed by learning from the groups who engaged with it what their insights and experiences could offer in shaping typical themes and outcomes. During the process of writing up the research, I used the case study reports, outcomes, films and feedback by collectively representing the evolution of the thesis as a portfolio to materialise the programme.

Chapter 5: Critical Perspective on and through Textile Thinking

The process through which I have addressed data experience, an area not typically associated with textile designing, offers a new strand within the textile design research field. The process established value in developing a programme as a way of exploring new research spaces from within traditional design disciplines by showing relationships and routes for exploring parallel fields. Outcomes and new knowledge at each stage confirm the value of engaging textile design approaches in data experience settings. This final chapter presents the original contributions of knowledge to the field of textile design research, as well as the impact and importance of engaging textile design approaches outside of the field. In conclusion, I propose ideas for the development of the research and further work.

Research through textile design in this study has developed from an exploration investigating experience of sensor and tracking technologies into a critique of theories to define design, especially the practice of textile thinking and its applications. The investigation began with what Redström calls sequencing – where an existing theory informs or inspires practice. Theories and perspectives from Lupton's call to address the sensory experiences created by the presence of data from digital devices were my initial motivation and inspired embodied methods for research. Ideas and approaches from textile design research and practice inspired a reframing in order to address the newly identified "textile problem", a loss of tactile sensibility in data experience. It is through this reframing that the programme has evolved to generate new meaning for articulating what kind of designing we are doing *(*Redström, 2017). Through the design of encounters and the artefacts and outcomes produced, I present a fresh perspective on role and scope of textile design research. Redström writes that although theory can be used to generalise and describe actions taken in design, they are still interpretations and commentary. Thus, the physical design outcomes which are made are the true statements and outcomes of research. The practice in my thesis has informed the making of a definition for textile thinking which describes a mode of inquiry, a space to address issues and concerns through textile design approaches. Adopting Redström's proposal that theories are fluid and transitional, the outcomes (research products) of the activities are varied, presenting new theories of textile design and alternative perspectives on data experience. The outcomes provide insights into data experience gathered through embodied methods and form an analysis, a critical perspective on textile thinking.

In my personal and professional experience, the notion of textile design had been limited to ideas of carefully planned and executed material samples, involving a deep

understanding of fibre, pattern and colour. As I carried out practice within the context of the developing research programme it became apparent that this now *is* "doing textile design". My perception has shifted as my personal practices were enacted and others were empowered to make things in a wider field of textile design than the one I originally entered, expanding my own personal definitions of the field and its potential. The recognition, and subsequent acceptance, of the practice as an atypical form of textile design, yet still a form of textile design, suggests typical examples of a programme, which is specific to the "general" field of textile design but particular in its positioning and attributes.

Developing Design Objectives through the Program

I have used concepts from Redström's *Making Design Theory,* and in particular the programmatic structure for design research, to establish the relationships, exchange and purpose of each phase of the research. Redström suggests that the development of the "programme" often is not clear until long after the projects and typical products have been produced, which leads to the acknowledgement of the programme and its embedded values and key features. Articulating this doctoral study as a programme provided space to experiment and push the boundaries of perceived outcomes of textile design.

In the following example I employ the description of a study which uses experimental design approaches to illustrate the value in creating conceptual structures to support exploratory research. The focus of Wilde and Underwood's (2017) study was to understand how designers can prototype with unknown materials and unrefined technologies. This was in parallel with the challenge of how to "give people the feeling of being in someone else's body, someone with perhaps very different abilities and constraints" (2017, p.2). Their study takes an exploratory approach, and thus the research reports on ways of designing for openness and the unknown. It employs a range of theoretical frameworks, participants and contexts, and a range of methods, materials and objects to engage research participants in considering how relationships with materials and artefacts can enable dialogue about the body. The process relies on openness to maintain the focus on allowing and enabling outcomes to remain unknown, and "remaining unknown long enough that new discoveries become possible" (Wilde and Underwood, 2017, p.1). The Poetic Kinaesthetic Interface project is presented as a loom. The probes, projects, and design actions are the "warp"; the participants, contexts and

design researchers are the "weft". The warp and weft are non-humans and humans woven together into new becomings: "new understandings of new aesthetics in relation to new materials" (Ibid, p.10). Describing the project as "live and volatile", not a finished design but a process of becoming, the parts, the product, the weavers and the loom itself "define their own domain". The work suggests that by taking "things" seriously it supports the understanding of how the agency of different things (people, objects, materials and events) contributes to the consideration of technology as material, something familiar which we can use to engage the unknown in a design process. The loom described by Wilde and Underwood illustrates an approach supporting the evolving space for design to become and form itself through interaction with the beliefs and values represented and exemplified in the becoming of the programme. The metaphorical "cloths of gold" produced by the loom are not finished designs or formed solutions; the researchers use the "cloth" to see what gaps and learnings have materialised. Referring to them as "sample cloths" which capture the "process, actions and thinking" they are used as a guide to move the project forward. This cloth is the "research" in a research through design process – the methods and the thinking to inform future research and design. The loom here can be read, using Redström's programmatic structure, as the body. The threads are the other disciplines and theories (new materialism and feminist technoscience), the warp is the projects – probes, participants and actions; the weft is the participants and the researchers, and the loom produces the cloth, not finished outcomes but examples and learnings. This is the programme created through these interactions with the projects defined by the examples produced. Interpreting their loom structure as a design programme provided me with a basis for identifying aspects of the programme described in this thesis using the conceptual structure of a palette.

I developed the palette in the 'Designing the Affective Material Palette' workshop exercise (CS 1) in the first stages of what is now the programme: the term "palette" is used to imply a place for mixing new forms, blending a new set of concepts and ideas with which to design. Like the typical textile design process of putting together a mood board, or collecting samples, these are the design problems, situated with aligning research fields with artistic practices. Rather than a controlled or given set of materials, the palette is a set of concepts which the designer takes through their own explorations of data as design material and expression. The palette was a way of supporting others in, and to develop, projects which organically led to the typical examples. This ultimately supports the understanding of the programme itself as a research practice. I used the palette as a vehicle to enable my understanding of new concepts and a space to host questions and hypotheses. These were then used to design artefacts and encounters

used as probes to initiate dialogue, development and critical perspective on data experience.

In my research, forming the programme as part of a design process itself could not and did not prescribe the outcomes and responses, but developed retrospectively through the projects and products. The programme is informed by the paradigm of textile thinking to tackle issues from other disciplines. Inhabiting the paradigm, as the lens and also the tools with which to dip into and explore a new field, provided a "platform" which sparked my curiosity and enabled me to identify new areas to reframe and address. The programme is a result of interactions between the textile thinking paradigm and other disciplines.

Defining Design through the program

Research experiments in the sciences conjure up an image of the scientist in the lab coat seeking universal and accepted answers and results; however, Redström reminds us that "experimentation" encompasses the idea of pushing boundaries and seeking difference. "When we think of the Bauhaus or HfG ULM, we more or less simultaneously picture both an idea of what designing is all about and a series of images of what such design appears like" (Redström, 2017, p.107).

Redström refers to Anni Albers' account of her time at the Bauhaus to illustrate the way that our notion of "design" based on the elevated reputation of the school in fact began from the experimental and unprescribed experience of the students finding their way. The reputation and theory later ascribed to it become synonymous with our idea of design and designing. "If we only think of them as a kind of 'open' experiment, it is easy to forget that they also act as design definitions with distinct definitions and implications." (Redström, 2017, p.117).)

In my research, using a metaphorical palette to situate and carry the project forward served various purposes as the research progressed. Pilot workshops which took place carried the title "Designing the Affective Material Palette' in later encounters, Designing the Affective Material Palette became a stage in a longer process. In workshop settings participants were invited to engage with their own subjectivity to construct tools for designing. This resonates with design's associations with the human values forming the structure of the palette (Walker, 2012).

Stuart Walker (2011) suggests that the ways we design, in particular with the focus on 'problem solving', contribute to supporting a fragmented perception of the world. He instead proposes making theories of designing which are about expressing values and beliefs. Compartmentalising different parts of our lives disrupts our worldview, thus removing a sense of responsibility in our actions and their wider impacts. We can consider this "compartmentalising" in the quantifying and objectifying of our bodies through data representation as we follow advice from tracking data which may be very specific yet abstract in relation to the rest of our being. In the palette, participants engage in activities intended at embedding value through meaning to "disrupt" ways of designing for mass-produced and non-individual experiences of data. By engaging with the programme in the workshops, participants generated knowledge as tools for design based on their own feelings and experience. This illustrates Walker's "holistic" ways of knowing which allow us to "synthesise" the bigger picture rather than fragmenting our lives into segments and objective facts. Outcomes of this contribute to the dialogue on the ways we design experience in this space and these illustrate understandings of how designing "could be". "But to actually redefine design, we need to present new designs, new projects and new programs that as they come together offer a different understanding of what designing could be like". (Redström, 2017, p.42).

Establishing the textile thinking "programme" as a lens, or set of values, through which to ask questions and tackle issues echoes the ways that designer Kenya Hara, in the film *The Wisdom Behind the Creation* (2008) advocates: he suggests that "designers and artists should create their own fields by themselves", suggesting that our fluid lives will not accommodate designing things by previous examples, and instead must be ready to jump into whatever the world is becoming. He adds that creatives should be "..applying their own ideas and philosophies of design to a new situation so that they can run their own domain by themselves" (Hara, 2008, 40:56)

The process of textile thinking is a methodology I develop in this thesis which applies knowledge and practices from textile design to address challenges in other fields. My motivation was a desire to establish how embodied understandings from material practice can be used to inform interpretations of digital practices. The design experiments focus on experiences which engage people to consider their physical being, sensory awareness and felt interactions with digital products and services. I use the characteristics of textile thinking identified from the literature to inform research activities as a set of experiments which can be adapted for exploration and engagement in multidisciplinary settings.

The relationships between the programme, the research context and the design experiments developed through this thesis as the programme for Materialising Data Experience through Textile Thinking, are structured using Redström's notion of programmes as follows:

- The researcher positioned in textile design "the paradigm" challenges and gathers questions related to "Other disciplines" (HCI and Data Physicalisation, Government Social Research and Digital Infrastructure and Physical Activity and Technology)
- The other disciplines become the research context for "projects" as design experiments
- The experiments as a design practice are motivated by challenges and questions in the research context and embody the designer's concerns and interests in "the programmatic worldview" – placing value in embodied knowledge and tactile interactions
- The "products" as results of the experiments are new knowledge for the research context and for the design practice – found in both the processes and outcomes
- The experiments develop into a programme which generates activities and opportunities for using experimental design practice for knowledge production in research settings
- The programme is positioned as a methodology for textile designers to use design activities to generate new knowledge for research in other disciplines

Positioning Textile Thinking

Applied textile thinking as a practice for research is an evolving space. Within the programmatic structure, my research spans the textile design paradigm and other disciplines. I position the theories and practice of the paradigm together to engage with identified areas of other disciplines. My research contributes to scholarship as both an outcome of the research (development of the specific values and motivations) and the driver for further projects and products. This model addresses and influences the research, resulting in outcomes which inform and contribute to the space between the paradigm and other disciplines–the programme.

As my research has continually developed through the process of its undertaking, it is possible to look at the questions in different ways, to offer new interpretations and

connections. However, through the process of learning and making links it is also clear that the process does not have an end, and will continue to develop as new relations occur and new boundaries are reached. Also, in relation to "new" technologies, those addressed at the beginning of the thesis were chosen for their relevance to the study, but in time will no longer be recognised even as "emerging technology": perhaps not even as "technology", but simply integrated and understood as function, purpose or experience provided. This was particularly important in the delivery of Case Study 3, with Building Digital UK, where I drew upon my peer networks. For example, asking my peers what type of internet they had at home revealed one of the key findings: a significant barrier to uptake of fibre connectivity was the fact that people did not know what type of connection they currently had, their understandings were obstructed by dense technical depictions and terminology. The integration of "emerging" technologies into our everyday lives on one hand creates an ideal opportunity for research and observation. But on the other, it reminds us that many systems are in place without a full awareness of the ways they have an influence and impact beyond the scope of their design.

Scholarship is developed by learning from, and with the aim to contribute to, the field. This is why the programme cannot be defined from the outset and is formed through the practice and processes in research. Having established a programme, the elements of the research project – as well as the role of the researcher – become clearer. I disrupted the typical image of the textile designer alone in their studio endeavours (Igoe, 2013), or that of the doctoral researcher, in favour of engaging distinct groups to explore each new territory. My role as designer has been as facilitator, identifying areas where textile thinking could be tested and applied and leading the projects, gathering the necessary actors, designing methods, generating resources and building trust to activate experiments.

I have used textile thinking as a phenomenon, and as a framework for reflection, like Redström's application of transitional object theory (he suggests the analogy of a child's security blanket that tides it over until it is no longer necessary), to formalise the "value systems". In this example, the notion of textile thinking has been at various times a target of the research as a concept to find, to seek within the work of others and as a topic to demystify and deliver to others. Revealing designerly approaches can contribute to a fuller understanding of theoretical frameworks by the way it affords disciplinary values to be put into practice. Textile thinking is the grounding one has based on one's disciplinary background and values which form the paradigm (and constraints) for research: the methodology. "Unlike a product that needs to function on its own out there, the research

prototype is typically not meant to live an independent life outside its programmatic context" (Redström, 2017, p.123). I established this study by searching for what textile thinking is and how it could be used: to protect it, but also to commodify it. My aim was to break it down and commandeer the methods, approaches and personalities of the textile design researcher in various contexts. In the approach, my hypothesis was to reveal an aspect that Igoe, Pajaczkowska, Philpott and Kane and others had missed. However, it is clear there is no secret process, whether linear or non-linear, but that the spectrum is dynamic and potential influence, of textile thinking is broad.

Conclusion

In this thesis I have elaborated on and discussed the positioning of textile design to address issues associated with data and digital technologies, and presented methods for disseminating and sharing textile approaches and ways of thinking in this context. I have shared new environments and references for textile design research, and through this I offer a reconsidered theory of textile design. I identified textile thinking approaches from the literature and practice in the field of contemporary textile design and materials research and applied this as part of an emerging research practice exploring data experience. I have developed the methods from within the textile domain, but have been influenced by encounters with other disciplines.

Establishing the research practice across an ambitious range of fields as well as the concerns of the everyday consumer introduced various concepts, including new vocabularies and ways of working. As tools to describe, present, and *do* the work, the terms "data", "materialisation" and "textile thinking" have been useful aids. Gauging responses has been an important part of the process, both within the academic spaces of textiles and design research, in communication with industry professionals and engaging with funding and impact requirements. A grounding based on the terms created a platform for study which could be both pliable and valuable for developing textile design research as a recognised mode of enquiry and for establishing novel ways to work with other disciplines outside of the fields of textile design.

Conducting textile design-led inquiries is a highly relevant, timely and novel research approach for exploring data experience. The findings showed that textile thinking can be used to develop methods to consider alternative experiences for data representation; to initiate the design of artefacts which generate dialogue about feelings and themes

related to interactions with information and to design ethnographic research encounters to gather information about the experience of high-speed internet connectivity.

By engaging with a range of fields in a role which is often misinterpreted and often overlooked (Igoe, 2013), the research design enabled me to develop my own personal scholarship, which guided the programme's boundaries. However, it is clear there are aspects of textile thinking which are transferable and adaptable. Examples here include others who have reframed textile problems (as seen in Material-Led Feedback System, CS 2) and those who have embraced knowledge exchange in new mediums (stakeholders at BDUK, CS 3). The range of people and places which have influenced and been impacted by the research, from textiles workshop practitioners to physical activity researchers and civil servants, implies both a curiosity towards and acceptance of textile thinking approaches which are transferable/flexible/pliable, and a discipline which should be considered for all areas of research. Researchers and designers can use the wider field of textiles as a grounding to enter into and address infinite possibilities and problems in contemporary life.

A summary of the main conclusions:
- Engaging textile thinking in the design of data physicalisations enabled meaningful engagements with ideas and positions regarding technology and information in diverse groups. I have used the facilitation of experimental design in artefacts and encounters to develop a research practice for exploring the experience of data. I used this to encourage a critical perspective by questioning and investigating systems and devices.
- Embodied understandings of technology, and of material and of design activities, have been expressed through a range of mediums, indicating that textile design theory and practice can support new understandings of everyday interactions.
- Illustrated by the designed objects and experiences in this thesis, I offer a new understanding, a theory of textile design as inspiration for future researchers interested in pushing disciplinary boundaries to create new modes of practice and inquiry.
- I have shown that design experiments can lead to valid and useful findings in a range of settings in their collective application that is unique to my research; however, they are transferable, revealing textile design research as a multifaceted domain and open-ended in its potential for application.

Contributions to knowledge

This investigation helps to expand the understanding of textile design as a medium for research. The outputs are primarily of interest to embodied design practitioners and the field of textile design research. They are also relevant to the areas of data physicalisation and information experience within human-computer interaction research.

Practical Research Contribution

Developing a research practice which focused on the experience of data required me to establish challenges from other fields which could be reframed as a textile problem – to observe issues in other fields which could be appropriately addressed using concepts from textile design research. Textile thinking as a concept has led me to develop the research programme, grounded in textile design with scope to engage outside of the field. Creating the conceptual space to become (Andersen and Wilde, 2012), and from which to experiment, and thus push boundaries, was key to identifying the types of issues that I could address within the scope of the study.

The approaches I have described enabled data collection and the dissemination of proposals that could be used to innovate for research and in design outcomes. Sanders and Stappers (2008) proposed that a move from designing for a product perspective to designing for a purpose perspective would result in the development of new and hybrid design disciplines. My research instead supports the design of spaces and practice situated within traditional design disciplines that can inform solutions and perspectives in a multitude of domains.

Through this thesis my aim is to give form to both data experiences and textile design research activities, and is relevant for designers engaging with scientific fields, such as data science, for example, which demand new tools and methodologies for inquiry and collaboration. I present a survey of the state of current textile design research, exploring methods and approaches, as a set of characteristics for textile thinking. This practical research contribution can be used as a tool to aid collaboration in multidisciplinary settings: for example, to communicate one's approach. However, it is also relevant to textile designers, who can use this as a framework to identify and find value for research in aspects of their own practices.

Theoretical Research Contributions

My study has reported on a range of encounters which involved actors from other fields who both contributed to the development of and benefited from the research programme: in particular, the impact of the research programme on the future implications of designing and evaluating grant schemes within BDUK. Ethnographic methods and the means of dissemination were both new approaches for the team, and a certain degree of risk was taken in accepting the research design I proposed. These methods were identified as being appropriate to the vast research landscape in a restricted time frame. My approach was validated by the affirmative and reactive stakeholder response to the findings and suggested interventions, as well as subsequent activity that included the commissioning of a film (Appendix 7) and exhibiting The Fibre Dialectogram at the 2019 Social Research Association conference gallery. This illustrates the evident potential for the meaningful application of textile thinking in fields outside of textiles and design to address dynamic challenges through flexible, pliable and adaptive approaches.

The theoretical contribution of my research is the paradigm of textile thinking as a design research methodology. The programme which has directed this thesis is grounded in textile design as a base but is driven by interest and challenges in other fields. An original contribution is the novel positioning for textile design research in addressing aspects of the human relationship with technology. I illustrate this using practical case study examples that present applications for textile thinking "not just for textiles' but as methodology for textile designers researching in other fields. Another area which can benefit from textile thinking in this study is data physicalisation in HCI (introduced in Chapter 3). Learnings about the ways particular material relationships and interactions can be incorporated into the design of information experiences are useful for others concerned with emotional responses in data display.

Research Methods Contribution

The positioning of the textile designer as leader in this study contributes to the literature which reveals the thinking of textile designers. This includes the types of issues and areas which the textile designer deems topical, timely and appropriate as a space of enquiry, and the themes which can be addressed (Igoe, 2013). This thesis has focused on the experience of technologies and related concerns, and is an original position for

textile design. It has not been about developing new textiles technology, for example designing soft sensors for new wearable technology applications. I have instead positioned myself as a textile design researcher in settings where methods and tacit knowledge from the field of textiles have been used to develop understandings through relationships and design. Consumer engagement and lived experiences enabled dialogue, critique and findings which are useful both for developments of future technology applications and for research, improving and investigating the impact of existing systems.

By drawing on the tacit knowledge and actions of the textile designer, an embodied approach to learning about people's technology practices has resulted in new understandings about how to capture experiences. I have collected people's intimate interactions with technology and reported on textile-design-like activities. New applications for textile design activities are revealed in materialisations of the tacit using the materials themselves for expression through a combination of media– in models, on paper and on film. The use of participants' own words and descriptions, for example in logbooks and as anecdotes on the dialectogram, provide valuable learnings about process and experience. This contextualises the outcomes of this thesis in the area of embodied methods with a particular contribution to the design of activities which enable and capture tacit engagement. I contribute to the research methods context by adding to exemplars of embodied design approaches and practice-based research through demonstrating these practical activities, their outcomes and value in research contexts.

Context and Future of this Research

This investigation opens up several opportunities to continue exploring with data. First, from the perspective of embodied explorations there is potential for further research to identify how data, and what kinds of data, could be explored through such methods. An invitation to lead a workshop at the Graphic Hunters "Emotions in Data Vis" event in Utrecht (April 2019) provided me with an opportunity to test this. Workshop participants created material palettes which were then used to materialise aspects of emotional labour in work and home life. The approach was to explore how responses to materials might be used to support dialogue on unseen but felt experiences with others in work environments. This suggests a context for data materialisation in mediation and representation in information experience which requires an alternative reading or empathy, for example sociocultural scenarios and engagement with environmental or political awareness.

My thesis examines practices and values in textile design that can inform future research studies for the design of services and systems which impact on human experience. Particular attention has been given to design which connects audiences by engaging affect, emotion and the senses, thus challenging the norm of visualisation in data experiences. As shown in this thesis, practices in the textile discipline engage the emotions and affect, and elicit tacit knowledge in both design process and outcome. Methodologies that are holistic and inclusive, place value on lived experiences and embrace design approaches and their outcomes which engage the whole body (not just the visual, for example) align with feminist thinking. **Textile design researchers sharing their work through academic and public channels, entering new domains and multidisciplinary relationships already challenge rather than perpetuate the status quo in the field of design research.** Continued study on the theme of textiles as a research discipline, drawing on Igoe's proposals for **feminist discourse in design thinking,** is important for the design research community. A framework for feminist textile thinking would be beneficial for identifying existing textile designers who engage with those in the margins, acknowledge intersections and empower others through their practices. These approaches could then be formally implemented to inform the design of future interventions, systems and policymaking based on the real and varied lived human experiences of those affected by their impact.

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Appendices

The following is review of programmatic design research, as proposed by Redström in *Making Design Theory*, in relation to the context of this thesis.

A program (sic) is the set of values and beliefs that form the basis for the design of the projects, that they are influenced by and that acknowledge the foundations of the paradigm. The creation of a worldview for design to be implemented for the purpose of design research provides a set of hypotheses and questions which continuously lead, reflect and are informed through experimental design to develop paths which shed light on poorly understood questions, creating starting points and a framework for research.

> [F]rom the inside, the design program is a call for action:
> "This is what designing is!" From the outside, the design program allows us
> to ask questions: Designing **could be** this; what would be its implications?"
> (Redström, p.97)

Johan Redström is a researcher with a focus on generating methodologies to explore design issues from new perspectives. His work, which engages computational technology as material for design, investigates agency for new technological textiles and the generation of novel aesthetics, experiences and creative relationships. Through practical design his approach examines new possibilities for the behaviours of textile materials afforded by the treatment of computational things and for novel technological experiences facilitated through textile treatment. In his book *Making Design Theory* (2017) Redström presents the design programme as a structure to accommodate design research in new and experimental settings.

> "A program is characterized by both **intent and unfolding**, an intertwining
> of projection and process." (Redström, 2017, p.88)

In the development of a design programme, the foundations of the discipline remain, while new practices for design join it. When design branches out and expands to new domains (for example, service design) our "foundations" become problematic and detached as we try to explain what we do. Redström (2017) offers a structural basis for the way we make definitions

of design, through design. Noting that the foundational grounding for design is situated in artistic practice, much of design today has strayed from its artistic foundations to incorporate new practice. For example, social design and service design. Today's products of design can be seen as very different from the notional understanding of design in its industrial context as form and prototypes for mass production (and even further from William Morris's 1882 call for design to produce objects and patterns of beauty). Thus we are regularly making new definitions for design in both the products we create and the activities and efforts involved in their making. A spectrum from the particular (a specific designed product) to the general (the concept of designing) describes the "span" between using an outcome to define what design is, and using the efforts or activities that result in the things to define what design(ing) is.

Based on Redström's written account of programmatic design research, a diagram was created as a tool to physically map the practice and findings (see Figures 1.1 and 2.2). The circular form is presented to denote the programme as fluid and reformulated as the experiments and design examples reach new boundaries towards an understanding of the design space. In Figure 1.1, cutting through each section (Other disciplines; Paradigm; Program; Project; Products) is the "Practice Wedge". The purpose of the wedge was to position where each element of practice had generated knowledge in which part of the overall process, and which activities were in place to learn about each section. For example, looking at the outer ring, the method "HCI Summer School" is an example of approaches with which to explore fields outside of textile design; "Other disciplines. Practice for researching within the paradigm (Textile Design)" and learning more about the field include public engagement and events – for example, hosting a symposium about the concept of affect with textile researchers.

Following Redström's structure for programmatic design research illustrated in Figure 1.1, this study takes the approach, described in Table 1.2. The research generates (Redström's) "Typical" examples, which shape the research practice, and in turn inform the research agenda and perspective. Robbins and Giaccardi (2019) suggest that value is represented not only in the new connections, therefore widening the impact of the research, but additionally in the way that the researchers themselves reflect on their own perceptions of the research itself and its wider contextual potential.

Using Redström's programmatic design research as a structure, my thesis evolved from my initial questions situated within textile design research and extended to identify the melange of influences and input from a range of players and fields. This expansion of knowledge contributed to a palette of resources from which emerged a research practice – a selection of

tested theories, tools and activities which I used to create a set of outcomes; events and artefacts which serve as the "typical examples" of this program of design research. Rather than fitting into one disciplinary practice (for example, textile design) the programme has engaged a range of "practices" to form the textile thinking palette as its means of delivery. Practice (practical doing) happens throughout the "discipline" but is not limited to the programme and engages with different practices and activities where appropriate.

Elements of *programmatic design research (*Redström, 2017)	Description	Elements of *programmatic design research* illustrated by examples in this study
Other Disciplines	• Areas of research which contextualise the problem area which is outside of the paradigm • Areas that have influenced and inspired development of the programme. • This is also the area where these outcomes of the research may contribute as a form of problem-solving or offering to address issues identified within those spaces.	For this study, these disciplines include digital health and human-computer interaction (HCI), and government social research
Paradigm	• The area of textile design research • Ideas and notions of textile thinking as an approach, discipline or method	• Practice and literature in textile design research • Characteristics of textile design research identified and grouped in Chapter 2 "Textile Thinking" and Table 2.2 "Characteristics of Textile Thinking"
Program	• The agenda which has directed the research, grounded in the paradigm as a base, or toolbox, but created from interest and challenges in other fields. • The programme expresses the values and the types of problems and challenges which are of interest and is supported with the typical examples as products of the programme. • The programme is formed in response to issues identified as problematic in the "other disciplines" as a prompt to approach and explore the relevant fields, identify problem areas and suggest a methodology to develop and adapt approaches which could lead to alternative solutions and contributions	• Textile Thinking Programme • This thesis embodies the Textile Thinking Programme by presenting objectives, processes, values and typical examples • In Figure 1.2 the programme is situated in the centre ring in the round diagram to represent its being embedded in the formation, and its relation to influences and insights
Projects	• Practical activities and experiments used to explore topics of interest • Activities in context – the particular environments in which the practical elements of the research were explored	• 3 Case studies in this thesis can be described as "projects"
Products or 'typical examples'	• Outcomes of the programme • Prototypes, objects and provocations • Feedback and findings from experiences • The designers who emerge or are changed as a result of engaging with the programme	• Design of activities carried out in case studies: *"Designing the Affective Material Palette"* *"Defamiliarisation"* *"Data materialisation"*

● Methodology as contribution to knowledge for the paradigm and other fields	● Outcomes of activities carried out in case studies: "*Stretch Orchestra installation*" "*Making Sustainability Visible*" "*Uncanny Tea Set*" "*Fibre Dialectogram*"

Table 1. 1 Redström's elements for programmatic design in the context of this study (repeated from Chapter 2)

Appendix 1 A Testing Textile Thinking at RCA Work in Progress, 2018
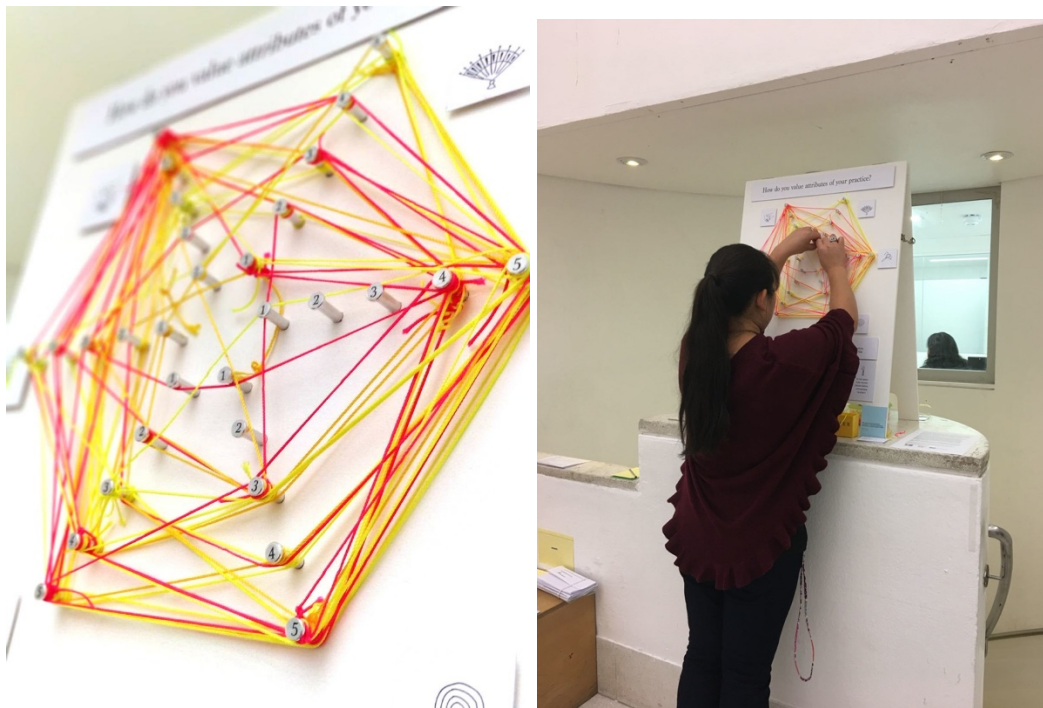
Testing Textile Thinking at the RCA 'Work in Progress' show, Hockney Gallery, Royal College of Art, January 2018.

I used aspects of Igoe's 2013 qualitative exploration to develop a hypothesis which might be tested, repeated and proven, in order to quantify the impact of textile thinking. Igoe's three entities for textile thinking were expanded to include three further entities deemed to be more appropriate for textile involvement in other fields engaging with technology and responsive applications. The three extra categories to further materialise textile thinking were based on decision-making, numerical ability and resilience.

During the RCA Work in Progress Show 2018, visitors were invited to map characteristics of their own practices to further explore the current understanding of textile thinking and contribute to a data physicalisation of the research. Here the characteristics became a criterion to identify aspects of textile thinking in others' practices.

The installation asked "How important is enabling, caring, revealing, seducing, decision making, logic (etc) in your practice?"

The results showed that of the 55 visitors who stopped to contribute over the duration of the show, most believed that each of the characteristics (illustrated and arranged in a numbered scale according to the relevance of each characteristic) was as important as the next. No one was willing to admit that they were any less of an enabler (mother), seducer (geisha) or pioneer

(spinster) than the next. Visitors enjoyed making patterns and interacting with an exhibition piece made of nails and string that could not suffer a technology fail. Data that was portrayed in a beautiful, tangible sociable way had a definite appeal; however, it revealed that further investigation was required to learn about the identification and applications of textile thinking.

Abstract and Workshop Agenda

Concerned with our relationship with materials, touch and physicality in a digital age, this workshop is part of a Practice led Design Research PhD which explores the role of materials in experiencing the immaterial concept of health using wearable technologies.

As the technology get smaller and the information collected more accurate, we barely notice sensors continually recording vital signs from clothing or skin, we somewhat seamlessly take another 100 steps, or skip dessert when our data gives us the guilt. Before human machine symbiosis takes hold and the seam disappears completely, this speculative platform aims to reveal what makes up the silent, magical forces in clothing, textile and material, and how we might distill it as designers to explore the ways we can connect with our bodies, ourselves and our environments in ways that can encourage healthy decision making using emerging technologies.

Moving away from the typical screen based interface of digital technologies the workshop aim is to consider alternative, material led feedback systems and their application potential.

This workshop is aimed at influencing design of interventions which disrupt behaviours around personal decision making in health and wellbeing. It tests a platform which explores the use of materials in design research; using the communicative dimension of materiality to explore experience of our bodily data collected by wearable sensor systems. Testing a material led design process, outcomes of the workshop are speculative material led interface systems for data feedback that explore the *experiencing and expression* of data.

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What's the matter, how do you feel?
Developing the Affective Material Palette

Harnessing the affective properties of materials to explore experience of bodily data

Tasks

Groups of 3-4, 20 minutes each)
1) Map materials onto 'affect grid'
2) 'Defamiliarise' a material
3) 'Materialise' a data set
4) Feedback

1. **Explore selection of materials and place onto affect grid**
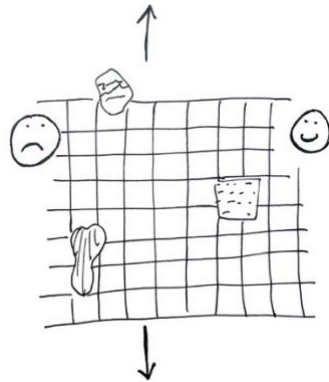
Feedback

1. Was mapping materials to affect easy? Have you considered this before?

2. What insights can be revealed through alternative readings of a material?
   How does hearing about individual readings/ways of seeing aid collaboration?

3. Can material qualities be used to communicate/experience data?

Thankyou!

3. Materialise Data

Need motivation?

- Choose one aspect of the Fitbit data (steps, minutes sedentary)
- Draw out and annotate, how might you feel in response to some of the information? (upset, motivated, satisfied?)
- Which materials might evoke high arousal (eg motivation)
- Using a combination of materials from first exercise, and new knowledge revealed about materials in second exercise to illustrate how one might feel according to data change/patterns
- Communicate data;materially, how might it be presented eg on clothing, on surface? Behind a screen?
- Can other group assess what is being represented?

Paola Buzz

A room for Art

Affect Grid
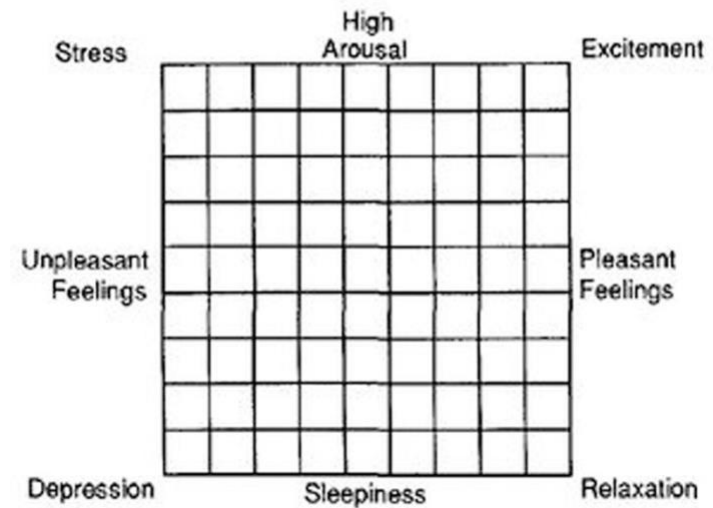
Russel et al, 1989

2. Choose one material to explore

- Each should write a short description of the material using whatever language or insights appeal (5 mins)

- Prompts for this part might be; physiognomic, synesthetic, sensorial, historical, social, cultural

- Share descriptions with the group (10 mins)
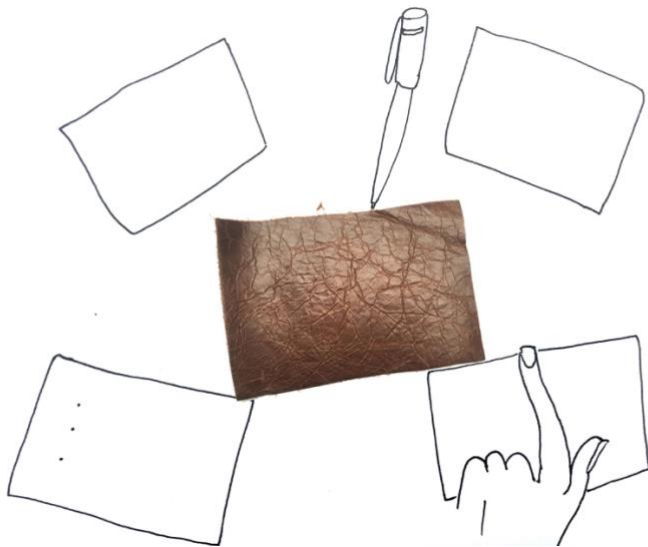
Sharing findings (5 mins)

How was the exercise?

What do you see?

How do others identify the material?

Are roles within the group revealed?

How do individual backgrounds influence?

The aim of this workshop was to explore ways the communicative dimension of materiality elicited through handling and interaction with physical materials might be used as a design tool to reconsider the ways we experience the immaterial concept of health using physical activity data.

Outcomes

Task 1. Explore selection of materials and place onto affect grid
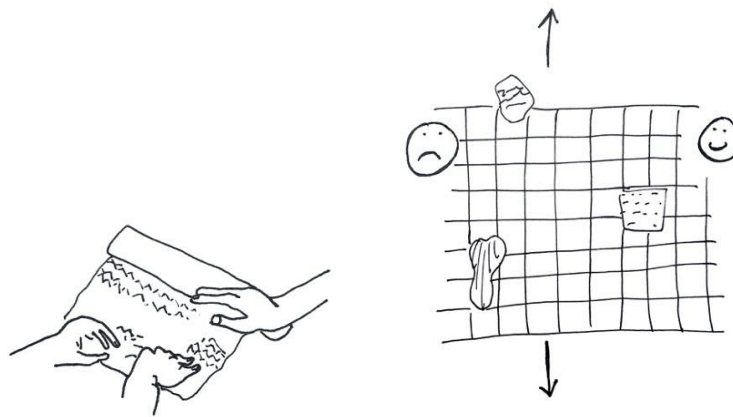
- Groups redrew version of the Affect Grid
- Placed materials
- Drew pictures of samples on to the grid

A hand-drawn chart with axes. Top center: "High arousal". Top left: "Stress". Top right: "Excitement". Left middle: "Unpleasant Feelings". Right middle: "Pleasant Feelings". Bottom left: "Depression". Bottom center: "Sleepiness". Bottom right: "Relaxation".
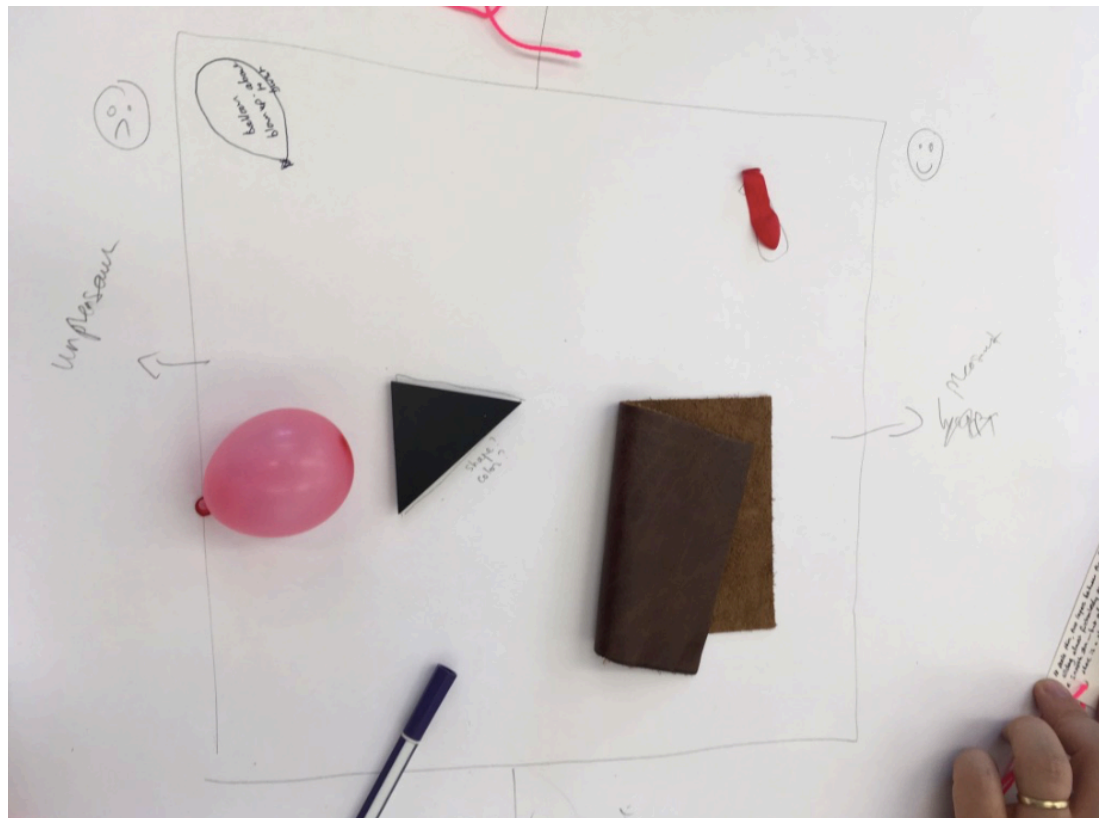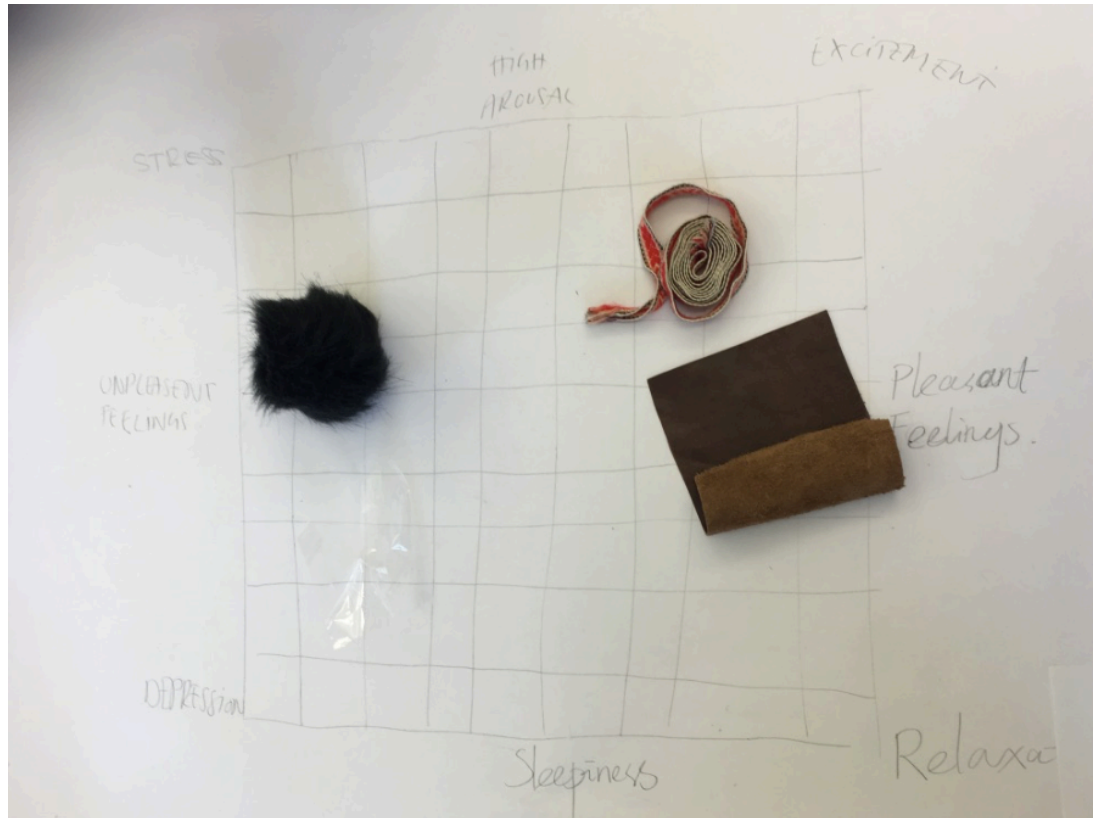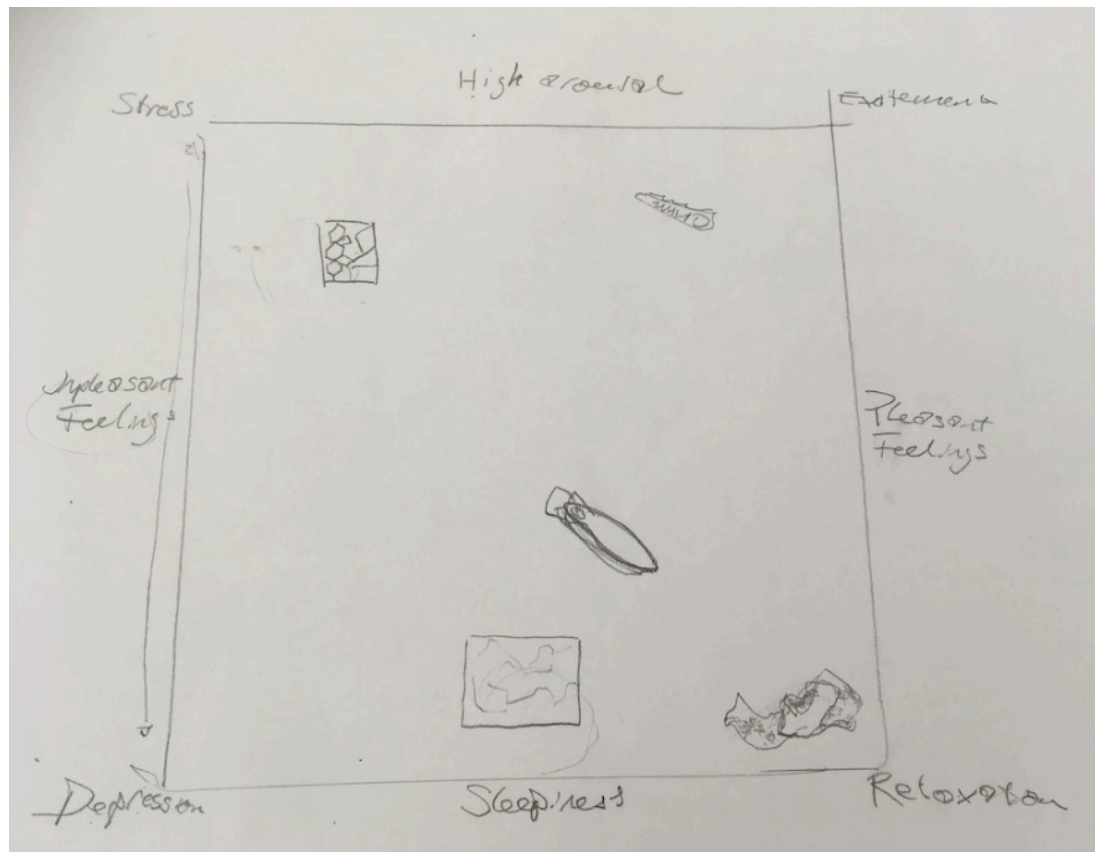
Task 2. Choose one material to explore

- Each should write a short description of the material using whatever language or insights appeal (5 mins)

- Prompts for this part might be; physiognomic, synesthetic, sensorial, historical, social, cultural

- Share descriptions with the group (10 mins)
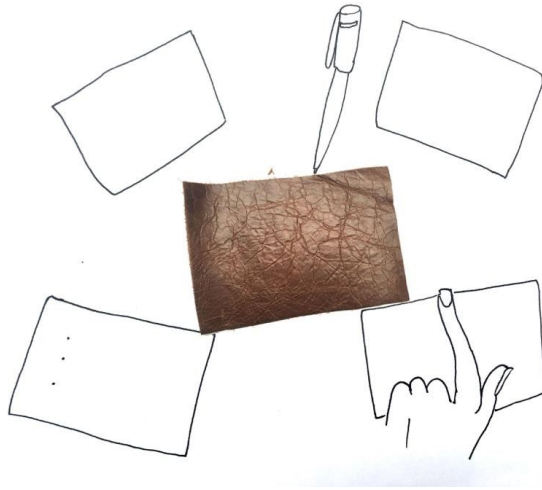
Material: interface

1. The material is: soft, rough, sparkly, rigid, non-elastic, shiny, matte, fibrous, **intriguing**, grey, wrinkled, almost rectangular, roughly cut, **contradictory**

2. Thick and fibrous on one side, catches the skin on fingertips. The other side is slippery, 'wet', the glue is probably made to attach as a back. Sort of thick and stiff bends back to original form, technical, structural. Dar and matte on one side, deep creases, fluffy/fibrous. Dark but reflects light on other side, almost looks clear, speckled, splattered pattern of glue, transparent/translucent

3. **This material has two personalities**. One side is smooth, shiny, slippery but still has roughness. The other side is warmer, more fluffy, **comforting**. The material is light you could easily tear is. If you can see it you will see a dark colour. It has no scent and is inedible.

4. Face 1-Black background with stars on it, shining and giving to the surface a rough feeling. Elastic and easy to split in two but resistant.
   Face 2- the light goes through, it is not useful for blind site. The texture, varies from face 1. **It's not rough nor smooth.** The fingers can feel every bit of the textile. Its manmade, can't define which materials are used and for what its used.
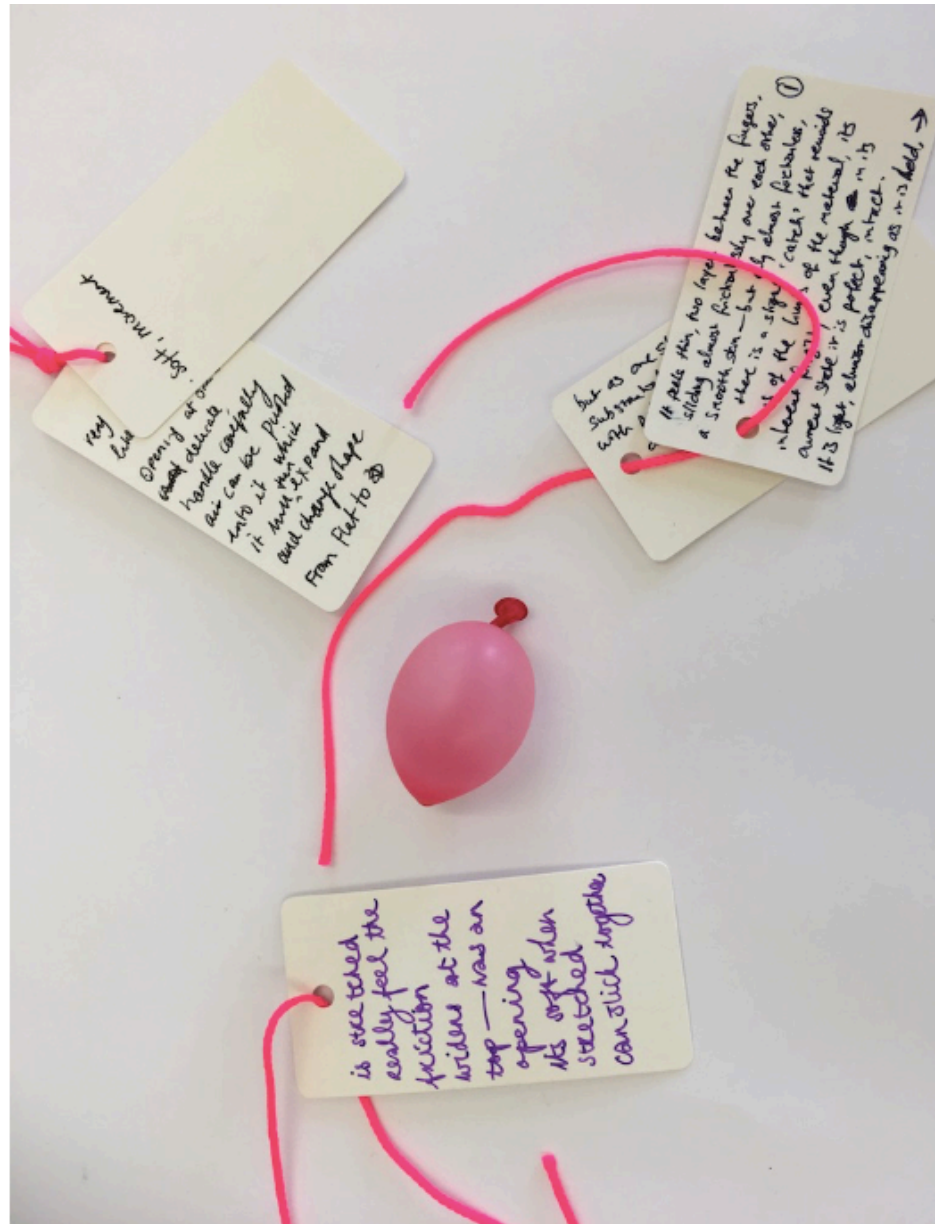
Material: waterballoons (empty)

1. It feels thin, two layers between the fingers, sliding almost frictionlessly over each other, a smooth skin-but only almost frictionless, there is a slight 'catch' that reminds use of the limits of the material, its inherent fragility even though in it's current state it is perfect, intact. It is light, almost disappearing as it is held but as one stretches it, it becomes more substantial, the tension **exciting with potential and promise of danger and surprise.**

2. Very fine, rubber like, elasticity, stretches. Opening at one end, delicate handle carefully air can be pushed into it which it will then expand and change shape from flat to 3D. Soft, movement.

3. Bright of the colour you feel the resistance/tension when you touch it its soft but also a bit frictional. Stretchy-

snaps/ hurts, becomes lighter when fabric is stretched
really feel the friction widens and the top- has an opening
its soft when stretched can stick together

Material: Fluffy keyring

1. Black, hairy, keyring, round, organic, soft, stiff to squeeze, nasty, warm, opaque, dry, gold, hard, smooth, cold. Open, roundish, shiney, **out of balance**, contrasting materials, moisture.
2. Fluffy, transportable. **Imagine a little black animal, delicate but weird**. Cocooning but **disturbing**. Contrast.
3. Unexpected haptic: soft but with this squishy inside. Curiosity: Would lie to know ow the squishy ball looks like. Contrast: soft-hairy Vs Metal. Prejudice : We have something in Germany that looks similar called "fox tail" that is at the antenna of an Opel.

Material: Reflective material sample with stitching

1.This material gives me the sense of 'Artificial Product', not sustainable. The components of it don't match very well, so… a feeling of **"conflict"**. Its very hard, not comfortable to wear on body. Itss cold, unfriendly. The pattern.. Or the way how its mafe is like sort of improvisation. Its not easy to fold, so not compatible or not flexible..not easy to break (unbreakable) not easy to depart or tear apart. High Tech.

2. Futuristic,shiny, reflective, pierced, hybrid, an orange stitch zig zags across the silvery surface. The silvery material is smooth to touch while the orange thread is rough and texturous. The stitch is chaotic, it pulls the foil up from one side and down from the other. This material, silver surface is translucent and reflective. Where the stitch is it is almost soft. But overall it is

very durable and hard to tear. There is a black thread over the orange.

3. Cold base material with **heartwarming** art on it (embroidery); glance Vs decent thin thread; many contrasts in many respects som transparency vs opaque parts; technical vs natural (ie sense of familiar) hybrid. Flat Vs linear; front and rear side different; embroidery adds a height in the otherwise flat material, shaping sub-surfaces that are convex/concave-malleable base material.

Task 3 Materialise Data
- Choose one aspect of the Fitbit data (steps, minutes sedentary)
- Draw out and annotate, how might you feel in response to some of the information? (upset, motivated, satisfied?)
- Which materials might evoke high arousal (eg motivation)
- Using a combination of materials from first exercise, and new knowledge revealed about materials in second exercise to illustrate how one might feel according to data change/patterns
- Communicate data;materially, how might it be presented eg on clothing, on surface? Behind a screen?
- Can other group assess what is being represented?

Group 1
Method: Considered alternative materials out with the given selection (water, time), incorporated material into a data control system, explored sensory functionality to communicate data, used water and altering its taste to influence actions in response to data. The idea that making the water more salty at different stages could alter taste promoting a sensory feedback system.
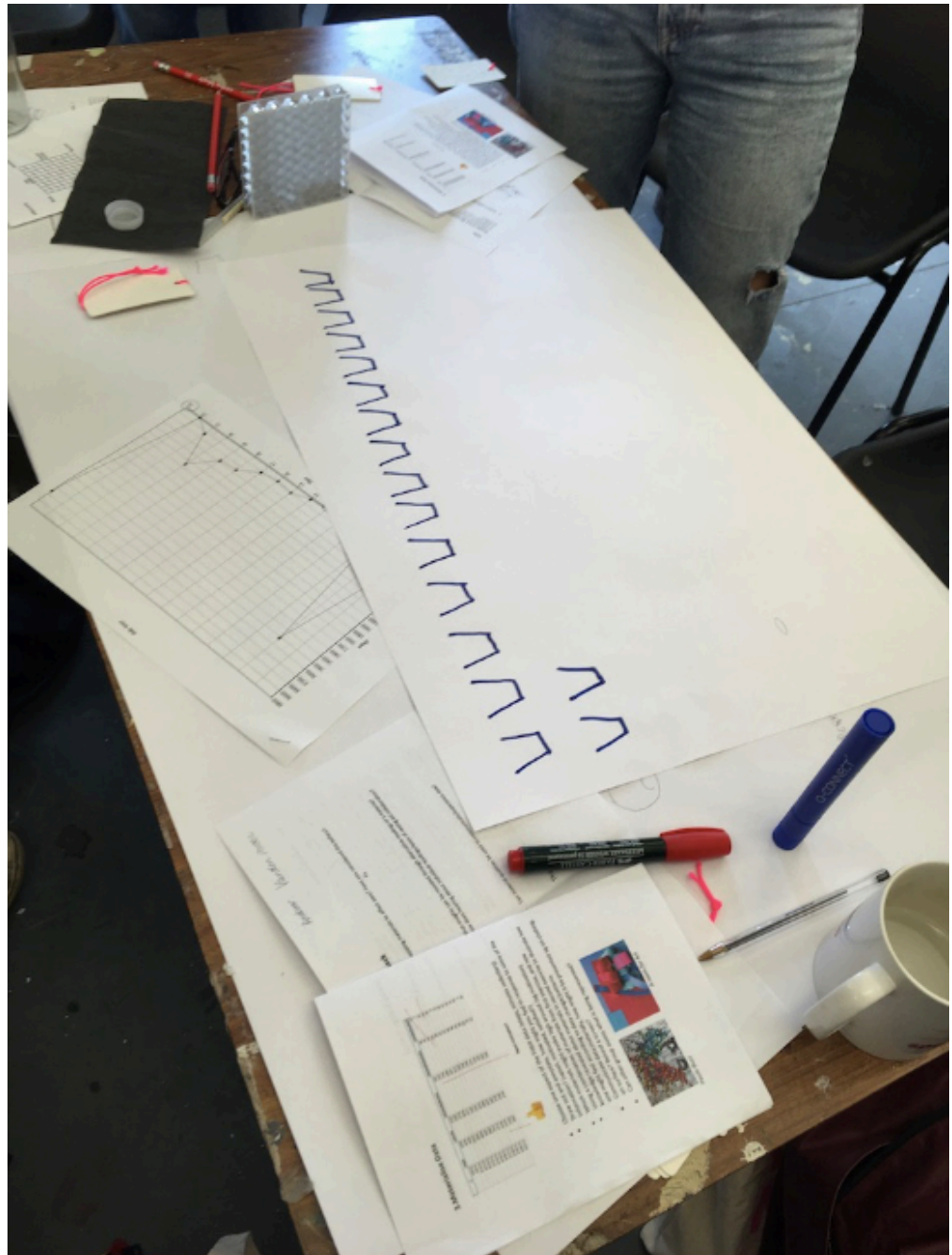
Group 2
Method: Considering personal, private interaction and tactile connection with a particular material provided a potential design direction for a material feedback system based on communicative agency found through close-intimate handling of a particular material.
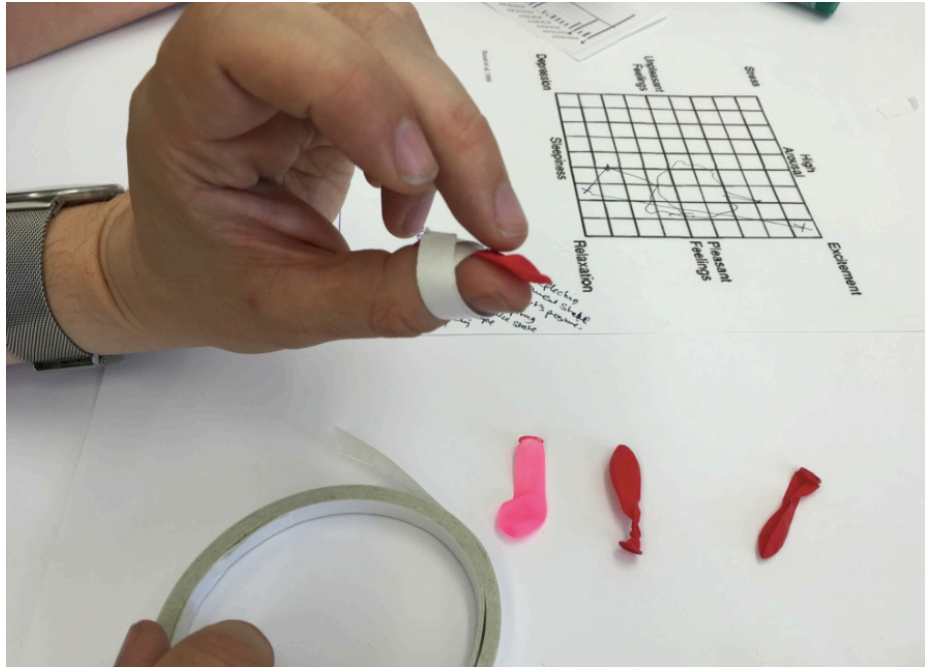
Group 3
Method: Story telling using material qualities
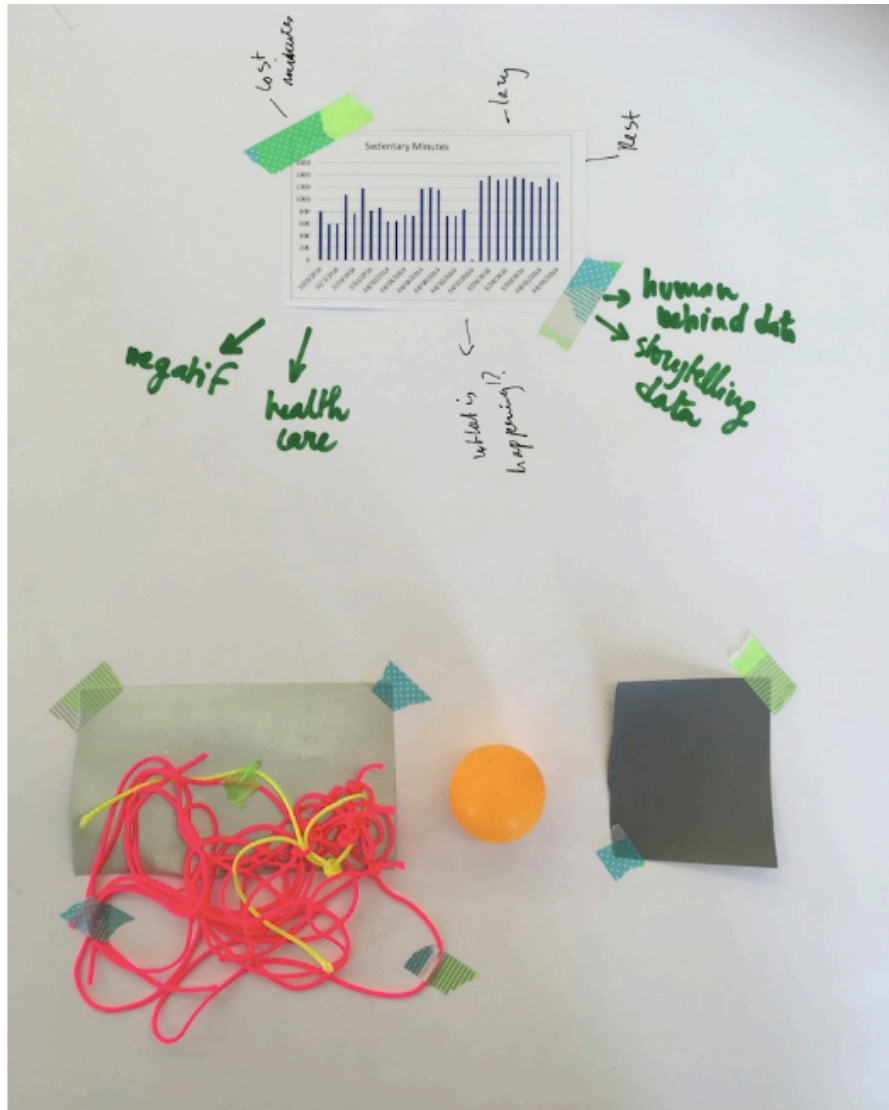
Group 4
Method: Materials aided in the translation of what is
happening in a dataset, illustrate the data set

"The exercise was very inspiring, I get to know various perspectives to feel/see/think about the materials; how does it feel, the way its made, the usage, scenarios, metaphorical meanings, (aesthetics), sustainability."

"It could have been better if we could use our own data- to set the context"

"I hadn't thought about using materials to communicate data before"

MATERIAL LED FEEDBACK SYSTEM

Exploring Data
Materialisation

ACROSS RCA OCT 2018

Name

Programme

WHY DID YOU CHOOSE THIS PROJECT ?

( ) New Knowledge   ( ) Ideas for Future Projects

( ) Reflect on Practice   ( ) Other:

SECTION 1.
INTRODUCTION TO CONCEPTS

TASK 1.
Please draw/describe a material/object that represents body-health-wellbeing

Keywords

TASK 2: MAPPING MATERIALS

How did you go about mapping materials?

How have you considered this before?

TASK 3: DEFAMILIARISATION

What insights can be revealed through alternative readings of materials?

How does sharing individual 'readings' contribute to the group dynamic?

Were any distinctive roles revealed?

What kind of "feedback" can you get from materials?

TASK 4: MATERIALISING DATA DISCUSSION

How did you use materials to explore data?

What data do you collect? (officially or unofficially)

How do you collect and share data? Apps, devices, signs?

What does data materialisation mean to you?

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 1

◯ New Knowledge   ◯ Ideas for Future Projects

◯ Reflect on Practice   ◯ Other:

COMMENTS ON

Experience _____
Data   _____
Materiality _____
Agency   _____

SECTION 2.
METHODS AND THE BRIEF

Observations

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 2

◯ New Knowledge   ◯ Ideas for Future Projects

◯ Reflect on Practice   ◯ Other:

COMMENTS ON

Methods _____

Materials _____

Metaphors _____

Group/dynamic _____

SECTION 3.
PROJECT DEVELOPMENT

The data my team is using is

The intention of the experience is

Materials and processes in the pallete

My role in the design team

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 3

◯ New Knowledge   ◯ Ideas for Future Projects

◯ Reflect on Practice   ◯ Other:

COMMENTS ON

Brief _____

Data _____

SECTION 3.
PROJECT DEVELOPMENT

Why did you choose the particular dataset?

Notes

SECTION 4.
PROJECT DELIVER

How have you created the data materialisation (draw/describe)

How important has the material choice/process/engagement been in the experience of the data?

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 3

◯ New Knowledge   ◯ Ideas for Future Projects

◯ Reflect on Practice   ◯ Other:

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 4

◯ New Knowledge   ◯ Ideas for Future Projects

◯ Reflect on Practice   ◯ Other:

COMMENTS ON

Brief _____

Data _____

SECTION 5.
REFLECTION

In what ways can material quality/properties/engagement be
used to communicate data?

How might you take this forward into your own practice?

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 5

( ) New Knowledge   ( ) Ideas for Future Projects

( ) Reflect on Practice   ( ) Other:

THANK YOU

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Name

Sogon Kim

Programme

Ceramics & Glass

WHY DID YOU CHOOSE THIS PROJECT ?

○ New Knowledge   ☑ Ideas for Future Projects

○ Reflect on Practice   ☑ Other: Meeting others.

SECTION 1.
INTRODUCTION TO CONCEPTS

TASK 1.
Please draw/describe a material/object that represents body-health-wellbeing

Keywords   Organization

anxiety (deal with stress)

TASK 2: MAPPING MATERIALS

How did you go about mapping materials?

We discussed each material and how it made us intuitively feel. There was some debate about certain materials and perceptions different people had. Also they could not all be judged equally because some of them were plain materials and some were objects which evoked different meanings & associations.

How have you considered this before?

No, it is very interesting however.
Might be interesting to just do one material as well & then get a group consensus as well. For eg. if public were all invited to place a piece of say, leather on the graph reach.

TASK 3: DEFAMILIARISATION

What insights can be revealed through alternative readings of materials?

. What emotions they evoke.
- How they are perceived in different cultural contexts.

How does sharing individual 'readings' contribute to the group dynamic?

- Unbiased opinions are shared.
- Keeps anonimity.

Were any distinctive roles revealed?

- Some formed deep emotional connections.

What kind of "feedback" can you get from materials?

- How they are handled, what data they carry in themselves eg. fingerprints, stories.

TASK 4: MATERIALISING DATA DISCUSSION

How did you use materials to explore data?

- Comfortable vs. uncomfortable materials to motivate an audience.

What data do you collect? (officially or unofficially)

- Movies I watch per year.
- what ~~kept me~~ made me happy each day } I have been actually recording these 2 all year long.
-

How do you collect and share data? Apps, devices, signs?

- Google Keep, Google sheets, Excel, IFTTT,
- Google Calender, Maps, Google docs/Emails.

What does data materialisation mean to you?

- Using materials to effectively convey stories that data can tell.
i.e. using materials to materialise data in 3D experience, the way we use colour/form to visualize data in 2D.

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 1

New Knowledge

Reflect on Practice

Ideas for Future Projects

Other:
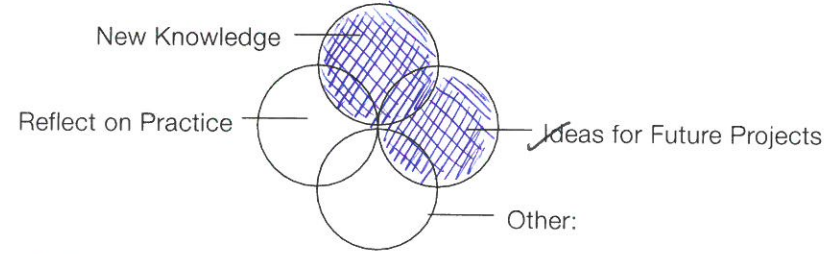
COMMENTS ON

Experience	Longer lasting - retained in memory, transcends language.
Data	Data is an untapped resource that has no value unless visualized/materialized.
Materiality	Medium, substrate, surface, interface
Agency	Materials sit within a context.

VIVEK MENON MURALIDHAR.

Name

MA DIGITAL DIRECTION.

Programme

WHY DID YOU CHOOSE THIS PROJECT ?

( ) New Knowledge   (●) Ideas for Future Projects

( ) Reflect on Practice   ( ) Other:

SECTION 1.
INTRODUCTION TO CONCEPTS

TASK 1.
Please draw/describe a material/object that represents body-health-wellbeing

DADDY   VIVEK

Keywords ____ THIRSTY

HYDRATED

HEALTHY.

SECTION 3.
PROJECT DEVELOPMENT

Why did you choose the particular dataset?

Notes

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 4
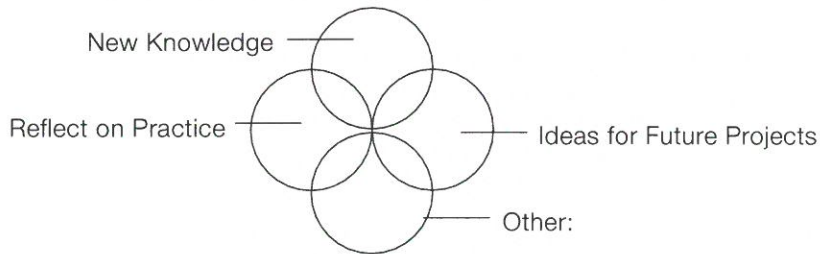
New Knowledge

Reflect on Practice ——— ——— Ideas for Future Projects

Other:

SECTION 4.
PROJECT DELIVER

How have you created the data materialisation (draw/describe)
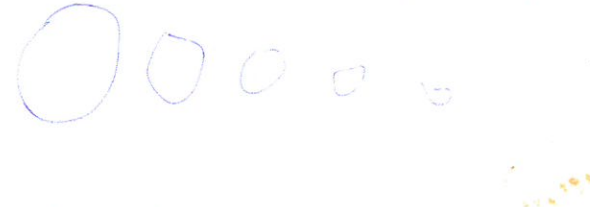
How important has the material choice/process/engagement been in the experience of the data?

Material touching and sense can create data. Data can also be inspired one visulize in textile way

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 5
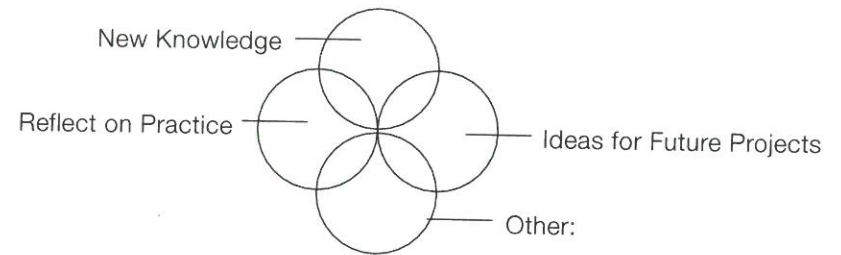
New Knowledge ———

Reflect on Practice ——— ——— Ideas for Future Projects

Other:

COMMENTS ON

Brief _____

Data _____

SECTION 5.
REFLECTION

In what ways can material quality/properties/engagement be
used to communicate data?

Look back to history, find
the tradition methods,
when people have no internet
how they communicate by symbols,
objects,

How might you take this forward into your own practice?

Use data to making textiles.
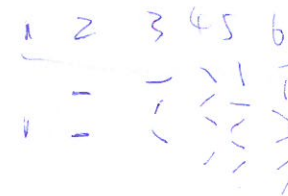
1 2 3 4 5 6

THANK YOU

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Ap 4.5e

SECTION 5.
REFLECTION

In what ways can material quality/properties/engagement be
used to communicate data?

How might you take this forward into your own practice?

Data → industrial
Phsicberism   • medical
               • manufactory

THANK YOU

SECTION 5.
REFLECTION

In what ways can material quality/properties/engagement be
used to communicate data?

How might you take this forward into your own practice?

I can choose what material to use
to deliver message better.

THANK YOU

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SECTION 2.
METHODS

Observations from exhibition

The exhibition created some turmoil in me as I found certain inventions to astray too much from Nature creating an anthropocentric world. Self driving cars and artificial intelligence seems fascinating but a future where robots populate the world as humans do is not an ideal for me. It also made me think about how much of our data is recorded and analysed. Are we manoured by bigger entities?

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 2
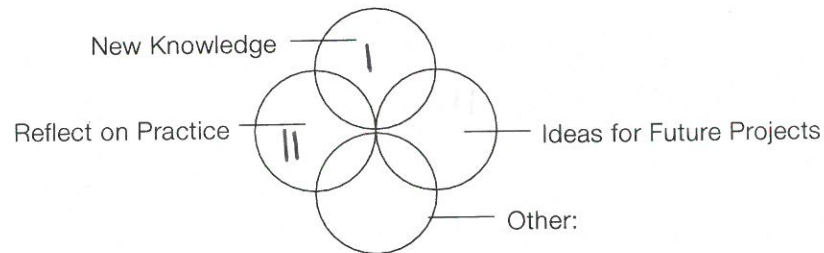
New Knowledge — I

Reflect on Practice — II

Ideas for Future Projects

Other:

COMMENTS ON

Methods _____

Materials _____

Metaphors _____

Group/dynamic _____

SECTION 3.
PROJECT DEVELOPMENT

The data my team is using is

We want to collect data to understand how much people interact with the uncanny.

The intention of the experience is   much

to measure how people engage with the uncanny

Materials and processes in the pallete

Wigs, candles, fake hair, wire, 3D modelling with wires, Arduino, pressure sensor

My role in the design team

modelling, hand sewing, coordinating

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 3
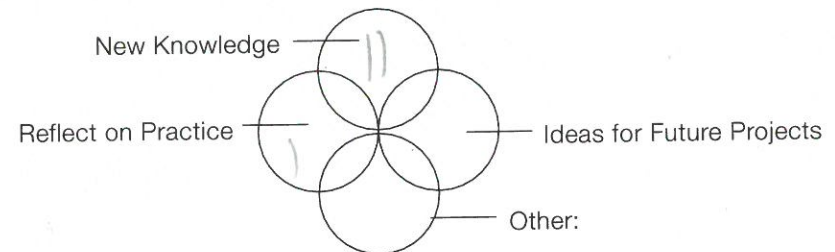
New Knowledge — II

Reflect on Practice — I

Ideas for Future Projects

Other:

COMMENTS ON

Brief _____

Data _____

SECTION 3.
PROJECT DEVELOPMENT

Why did you choose the particular dataset?

We chose this particular experience because we were fascinated by things we cannot understand which are sometimes frightening.

Notes

We aim to quantify how much people would engage with something they don't completely understand.

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 4
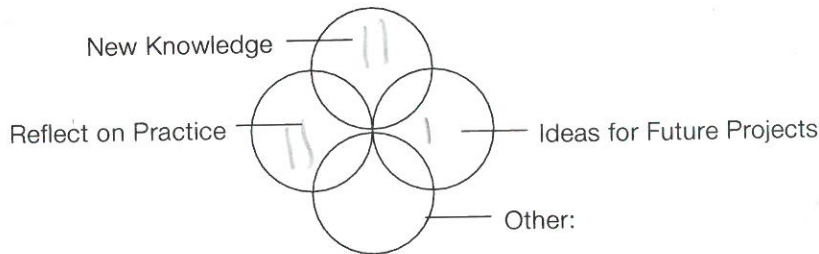
New Knowledge

Reflect on Practice — — Ideas for Future Projects

Other:

SECTION 4.
PROJECT DELIVER

How have you created the data materialisation (draw/describe)

Working with a pressure sensor we related it to the weight of a bowl and the liquid within it. this bowl is hidden by an uncanny object. Whenever someone drinks from it they interact with the uncanny.

How important has the material choice/process/engagement been in the experience of the data?

The materials were fundamental because they recreated that sense of uncanny (familiar materials that behave in a weird way) in a exhibition context

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 5
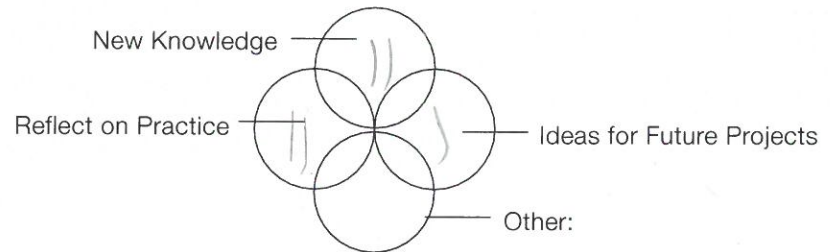
New Knowledge

Reflect on Practice — — Ideas for Future Projects

Other:

COMMENTS ON

Brief _____

Data _____

253   Ap 4.7d

SECTION 5.
REFLECTION

In what ways can material quality/properties/engagement be
used to communicate data?

Material engagement is
fundamental as interacting
with materials is the first
thing we do as toddlers as
we're experiencing the world.
Challenging the meaning of
materials provokes a new way
of experiencing the world

How might you take this forward into your own practice?

I'm currently working with
biomaterials, this workshop
made me realise how to
display & think of my work
so that it creates immersive
experiences.   + multi
                                 sensory

THANK YOU

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254   Ap 4.7e

<u>Xiyi. Wu</u>

Name

<u>Design Products.</u>

Programme

WHY DID YOU CHOOSE THIS PROJECT ?

○ New Knowledge   ☑ Ideas for Future Projects

○ Reflect on Practice   ○ Other:

SECTION 1.
INTRODUCTION TO CONCEPTS

TASK 1.
Please draw/describe a material/object that represents body-health-wellbeing

Keywords   TEXTURE

COLOUR.

SMOOTHINESS.

    Ap 4.8a

TASK 2: MAPPING MATERIALS

How did you go about mapping materials?

- Consider the level of experience, using the following factors.
  ① Colour ② Texture ③ Imagination.

How have you considered this before?

- Have not really considered before.
  Mainly looking at the texture & the textile function.

TASK 3: DEFAMILIARISATION

What insights can be revealed through alternative readings of materials?

- People tend to have similar views on the fundamental element / properties.
- There were differences on individual contextual & emotional feelings.

How does sharing individual 'readings' contribute to the group dynamic?

- Bring group together, in terms of some common views on the materials.

Were any distinctive roles revealed?

-

What kind of "feedback" can you get from materials?

- Experience
- Touch
- Vision

TASK 4: MATERIALISING DATA DISCUSSION

How did you use materials to explore data?

- 1. Decode the data to gain the insight.
  2. Apply the knowledge of mapping to find the connection between material, experience & insights.

What data do you collect? (officially or unofficially)

- 24h Steps

How do you collect and share data? Apps, devices, signs?

- Fitbit

What does data materialisation mean to you?

- Use a visual & tangible method to bring information alive.

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 1

New Knowledge ——— ₩₩
Reflect on Practice ——— + ₩ ——— Ideas for Future Projects
——— Other:

COMMENTS ON

Experience _____
Data _____
Materiality _____
Agency _____

256

Ap 4.8b
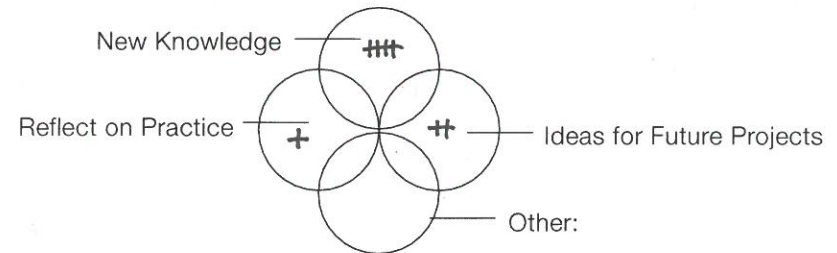
VALENTINA DIPIETRO

Name

MA TEXTILES

Programme

WHY DID YOU CHOOSE THIS PROJECT ?

◯ New Knowledge   ◯ Ideas for Future Projects

⊗ Reflect on Practice   ◯ Other:
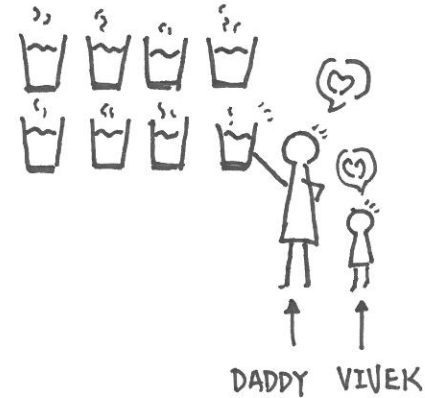
SECTION 1.
INTRODUCTION TO CONCEPTS

TASK 1.
Please draw/describe a material/object that represents body-health-wellbeing

Keywords Concentration - focus
feelings -

TASK 2: MAPPING MATERIALS

How did you go about mapping materials?

It was quite an instinctual process, led by the physical qualities of the materials but also to intrinsic memories and feelings related to them.

How have you considered this before?

I had never considered mapping materials and I've learnt quite a lot about myself and my instincts.

TASK 3: DEFAMILIARISATION

What insights can be revealed through alternative readings of materials?

This reading forced me to analyse materials I would probably neglect otherwise and be specific about certain details about them

How does sharing individual 'readings' contribute to the group dynamic?

Sharing the readings is useful as everyone's subjectivity comes to play and how every person notices a different detail.

Were any distinctive roles revealed?

I was the mediator + organiser of the group but I feel like everyone spoke out and participated

What kind of "feedback" can you get from materials?

you can get sensorial feedback but also some sort of chains of thoughts which connect the material to its social value or stereotype or memories that are subjective

TASK 4: MATERIALISING DATA DISCUSSION

How did you use materials to explore data?

What data do you collect? (officially or unofficially)

How do you collect and share data? Apps, devices, signs?

What does data materialisation mean to you?

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 1

New Knowledge — 11

Reflect on Practice — 1

Ideas for Future Projects

Other:
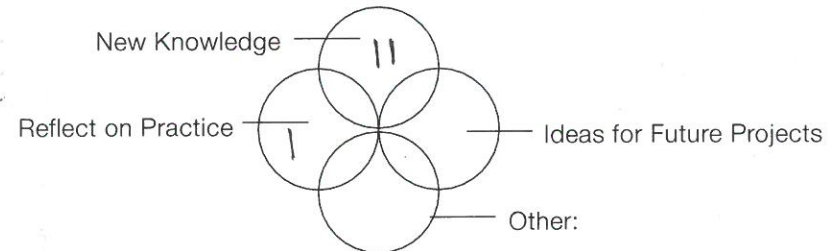
COMMENTS ON

Experience _____

Data _____

Materiality _____

Agency _____

258   Ap 4.7b

SECTION 2.
METHODS

Observations from exhibition

- Visualize the unintended information.
A project takes places in Catifonia, USA, to embedded. the fibre cable underneath the ground. It collects the vibration of the road ground, caused by surrounding transport & pedestrian.

The screen visualizes the frequency distribution, not only outline the boundaries of the building, But also reveal the interaction between citizens & urban dynamics.

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 2
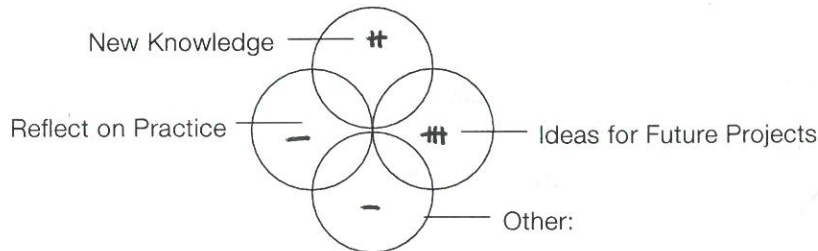
New Knowledge — ++

Reflect on Practice — — +++ Ideas for Future Projects

— Other:

COMMENTS ON

Methods _____
Materials _____
Metaphors _____
Group/dynamic _____

SECTION 3.
PROJECT DEVELOPMENT

The data my team is using is
- The presense of the people within the space.

The intention of the experience is
- To measure the air quality within the room.

Materials and processes in the pallete
- Kraft paper
- Wire
- Hang the apparatus on the ceiling.

My role in the design team
- PRovide the idea
- Build the structure

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 3
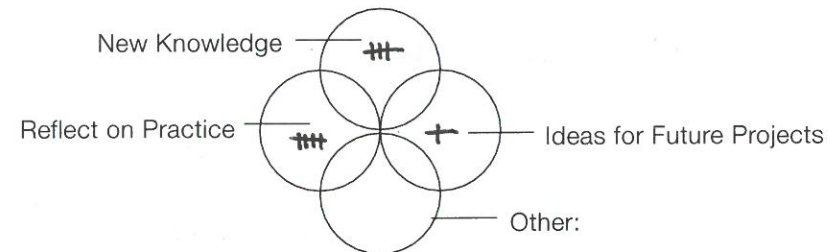
New Knowledge — +++

Reflect on Practice — +++ + Ideas for Future Projects

— Other:

COMMENTS ON

Brief _____
Data _____

Ap 4.8c

SECTION 3.
PROJECT DEVELOPMENT

Why did you choose the particular dataset?

- Air is consisted of different gas with various density.

- Visualise the difference & the changing in air composition.

Notes

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 4
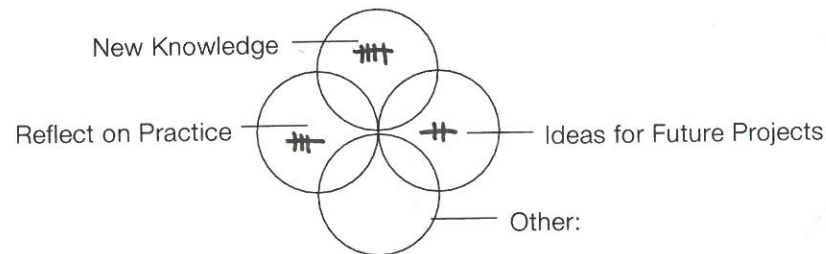
New Knowledge — ||||

Reflect on Practice — ||||

|| — Ideas for Future Projects

Other:

SECTION 4.
PROJECT DELIVER

How have you created the data materialisation (draw/describe)

$= O_2$ $= CO_2$ $: = $ Air quality.

How important has the material choice/process/engagement been in the experience of the data?

- The balloon is a good container for having gas

- Different colours on the balloons shows the different air component.

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 5

New Knowledge — ||

Reflect on Practice — |||| |||| — Ideas for Future Projects
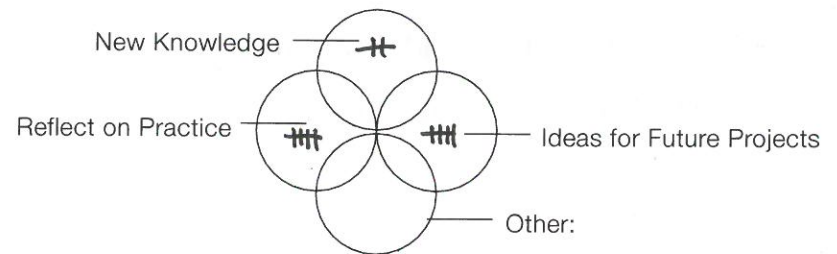
Other:

COMMENTS ON

Brief _____

Data _____

Yujia Huang

Name

Design Products

Programme

WHY DID YOU CHOOSE THIS PROJECT ?

(✓) New Knowledge   (✓) Ideas for Future Projects

( ) Reflect on Practice   ( ) Other:

SECTION 1.
INTRODUCTION TO CONCEPTS

TASK 1.
Please draw/describe a material/object that represents body-health-wellbeing

HUAWEI electric watch

It can record steps I walk everyday.
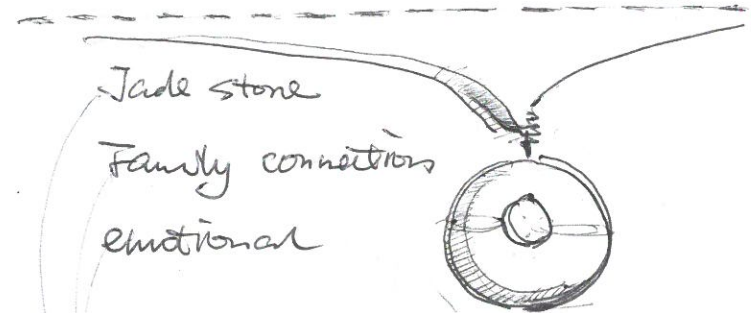
Jade stone

Family connections

emotional

Keywords

TASK 2: MAPPING MATERIALS

How did you go about mapping materials?

We used cross map and cataloged the materials by visual, touch, haptic and strength.

How have you considered this before?

We used the map gived to us. I think the map relates to our emotion.

TASK 3: DEFAMILIARISATION

What insights can be revealed through alternative readings of materials?

Material could be showed to public in different ways.

How does sharing individual 'readings' contribute to the group dynamic?

We used variety words to describe the material and knew these things in different perspectives.

Were any distinctive roles revealed?

I started to think about the surroneling area of material, ex. What will left after I touch this hair ball in my hand?

What kind of "feedback" can you get from materials?

To provoke us to imagine future and recall some mamery as well.

TASK 4: MATERIALISING DATA DISCUSSION

How did you use materials to explore data?

I would like to use material into products and do some user tests.

What data do you collect? (officially or unofficially)

We talked about temperature, smell and the meaning and emotion of specilty materials.

How do you collect and share data? Apps, devices, signs?

Test with timer and electric devices. Sometime use body to measure the data and share on apps and social media.

What does data materialisation mean to you?

To make data / number / feeling tangiable and visible.

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 1

FULL
New Knowledge

Reflect on Practice — — Ideas for Future Projects

— Other: New experience
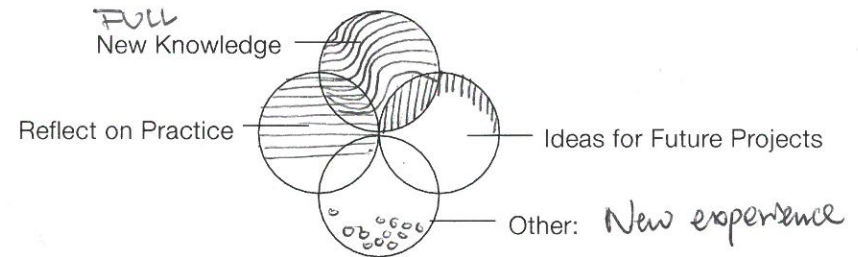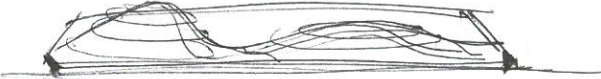
COMMENTS ON

Experience	First time to take part in a workshop in RCA.
Data	Don't have a specifric data to do test.
Materiality	Interesting.
Agency	Have no idea about this.

SECTION 2.
METHODS

Observations from exhibition

large sand box ⊕ project.
physical ⊕ visual / abstract.

It can be used in different data context
by using the same physical mode. It's
a combination form to show the
data and audience's feedback.

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 2

New Knowledge

Reflect on Practice

Ideas for Future Projects

Other:
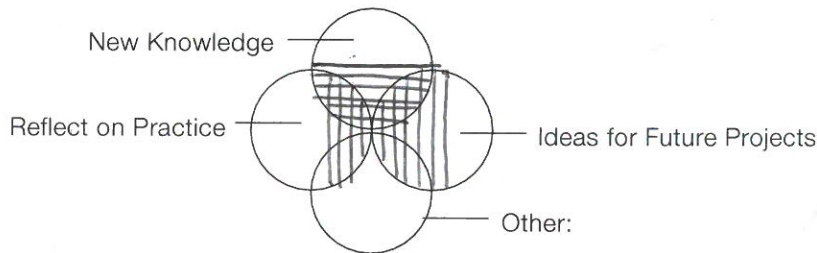
COMMENTS ON

Methods	Show data in physical form
Materials	touched a lot of things. novel and fresh.
Metaphors	not quiet make sense
Group/dynamic	good conversation

SECTION 3.
PROJECT DEVELOPMENT

The data my team is using is
Sustainable materials
(food packing. food waste.
dead leaf. branch)

The intention of the experience is
Collect the autumn's feeling

Materials and processes in the pallete
To find a sustainable glue
non toxic glue (PVA). white → transparency

My role in the design team
Handcraft work and touch board test

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 3

New Knowledge

Reflect on Practice

Ideas for Future Projects

Other:
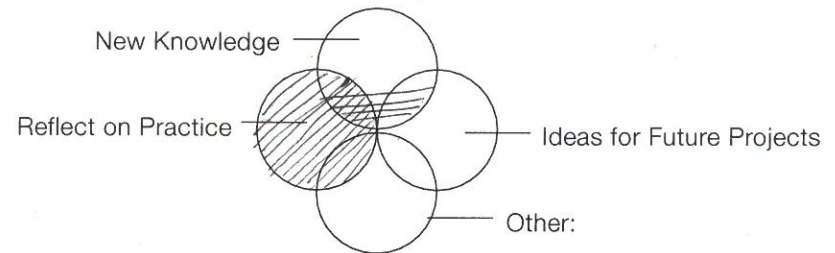
COMMENTS ON

Brief	not related to body data any more.
Data	it could be abstract data.

SECTION 3.
PROJECT DEVELOPMENT

Why did you choose the particular dataset?

Interested in the mixed material.
and handcraft as well.
To think about the sustainable material.
and which way it could be reused.

Notes

different from what I thought before.
More difficult to do tests.

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 4
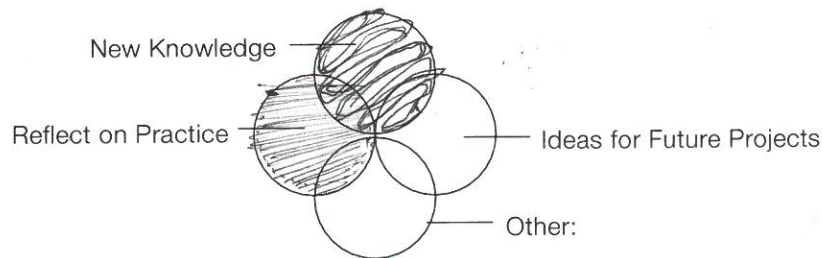
New Knowledge

Reflect on Practice

Ideas for Future Projects

Other:

SECTION 4.
PROJECT DELIVER

How have you created the data materialisation (draw/describe)

waste things

glue

block piece

How important has the material choice/process/engagement been
in the experience of the data?

To consider the making process. It's important
to choose the glue and sustainable material.
Because too much failures.

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 5

New Knowledge

Reflect on Practice

Ideas for Future Projects
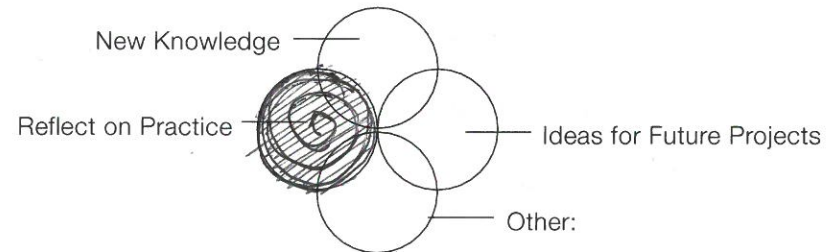
Other:

COMMENTS ON

Brief   almost change into another direction.
Data   to solided the data.

264   Ap 4.9d

SECTION 5.
REFLECTION

In what ways can material quality/properties/engagement be used to communicate data?

Store the data in a visible way. that could be delivered to different places.

How might you take this forward into your own practice?

1. to creat a new material by myself. use this material to product Design.

2. natural material related a more close feeling to users.

THANK YOU

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PhD Candidate,
Design Research Royal College of Art
marion.lean@network.rca.ac.uk

Ap 4.9e

SECTION 5.
REFLECTION

In what ways can material quality/properties/engagement be
used to communicate data?

- Gas density

- It affects the height of balloons floating in
the space

How might you take this forward into your own practice?

- Improve the efficiency of the mechanism

- Improve the numbers of different gases to
show more layers of gas balloons

THANK YOU

Marion Lean, 2018
PhD Candidate,
Design Research Royal College of Art
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TASK 2: MAPPING MATERIALS

How did you go about mapping materials?

Diffrent views from Man & woman

How have you considered this before?

Take it for granted.

TASK 3: DEFAMILIARISATION

What insights can be revealed through alternative readings of materials?

Multi sensory experience

How does sharing individual 'readings' contribute to the group dynamic?

diversity. inspiring

Were any distinctive roles revealed?

yes, machanism, construction

What kind of "feedback" can you get from materials?

data. / feeling

SECTION 4.
PROJECT DELIVER

How have you created the data materialisation (draw/describe)

Ballons
→ environment impact

How important has the material choice/process/engagement been in the experience of the data?

how and what convey a meaning

we should explore more

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 5

New Knowledge

Reflect on Practice

Ideas for Future Projects

Other:

COMMENTS ON

Brief _____

Data _____

267   Ap 4.2b
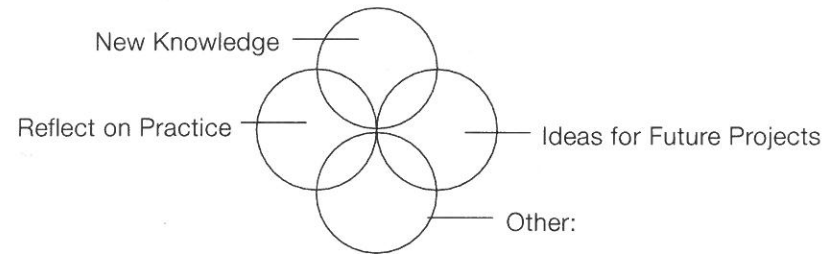
TASK 2: MAPPING MATERIALS

How did you go about mapping materials?

- Created debates around the material and its content.
- very straight forward analysis of the material.

How have you considered this before?

- Usefull
- simple / playfull

TASK 3: DEFAMILIARISATION

What insights can be revealed through alternative readings of materials?

It reveals the diverse approaches of each people and how the perceive the matter.

How does sharing individual 'readings' contribute to the group dynamic?

- Challenges

Were any distinctive roles revealed?

- Some more:
  - rational / scientific approach
  - sustainable / ecological approach
  - litteral approach

What kind of "feedback" can you get from materials?

- The value that each material contains conditions our perception of it.

TASK 4: MATERIALISING DATA DISCUSSION

How did you use materials to explore data?

- In a descriptive way, attaching a potential narrative to each materials.

What data do you collect? (officially or unofficially)

- According to the diagrams, we tried to build a potential narrative of the life of the person's schedule and daily routine.

How do you collect and share data? Apps, devices, signs?

- signs and symbols
- devices -

What does data materialisation mean to you?

- Converting immaterial information to extract a physical outcome.

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 1

New Knowledge

Reflect on Practice

Ideas for Future Projects

Other:
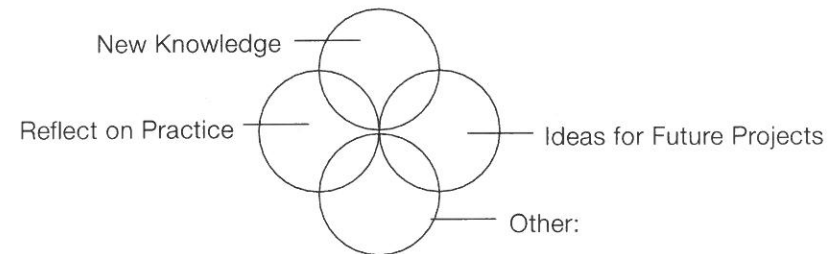
COMMENTS ON

Experience Intuitive, interactive, time and space

Data flux, information, tool, virtual, speed, sustainability?

Materiality senses, physical / virtual, substance, perception, influence

Agency

Arthur Cohen

Name

Information Experience Design

Programme

WHY DID YOU CHOOSE THIS PROJECT ?

◯ New Knowledge   ◯ Ideas for Future Projects

⊗ Reflect on Practice   ◯ Other:

SECTION 1.
INTRODUCTION TO CONCEPTS

TASK 1.
Please draw/describe a material/object that represents body-health-wellbeing
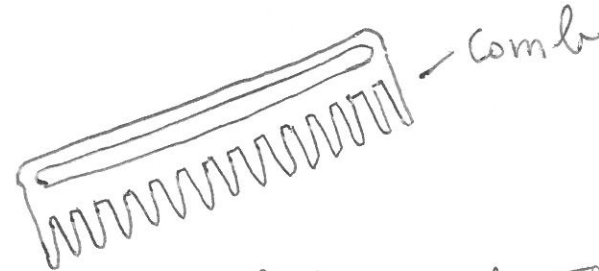
— Comb

→ it is a plastic comb. This object is usually used for hairs, but I use it to weave - It helps me to tamp the weaved threads and gradually building the tapistery, which is very satisfying for me, condensing the weaving and make it appear.

Keywords — Weaving, tool, thread, comb, acheivement, building layers -

SECTION 2.
METHODS

Observations from exhibition

- Innovative approaches on universal themes: environment, politics, language...
- Interactive experiences.
- Technological installations.

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 2

New Knowledge

Reflect on Practice

Ideas for Future Projects

Other:
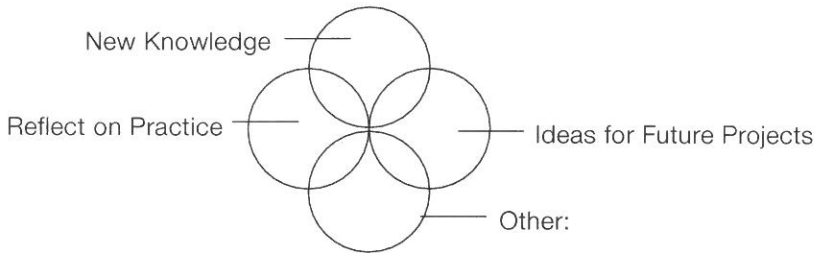
COMMENTS ON

Methods   experimental, interactive, sensorial
Materials   very diverse, tech. devices, press release
Metaphors
Group/dynamic   analysing the potential future
of the planet through multiple core
aspects

270

SECTION 3.
PROJECT DEVELOPMENT

The data my team is using is
- sustainability made visible.
- experience
- materials, packaging, plastic, natural elements

The intention of the experience is
- making experiences showing how
we can recycle materials

Materials and processes in the pallete
1. sustainable glue and small pieces of diverse recycled materials.
2. sounding recycled materials.

My role in the design team
1. Organising / designing the project
2. Collecting different materials / devices for arduino
3. making samples - cutting material in pieces

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 3

New Knowledge

Reflect on Practice

Ideas for Future Projects

Other:
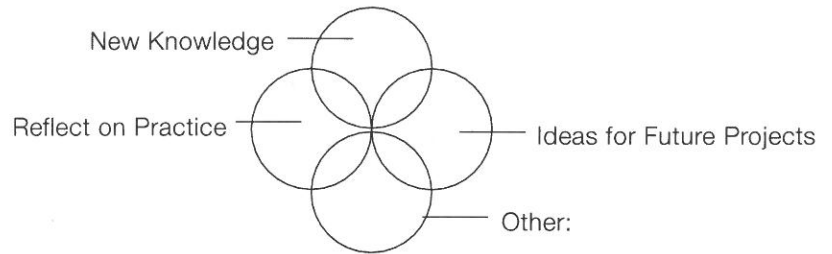
COMMENTS ON

Brief   Making sustainability visible through experimenting with recycled
Data   natural elements, sustainability, materials
eco-friendly, sharing   - Ap 4.6c

SECTION 3.
PROJECT DEVELOPMENT

Why did you choose the particular dataset?

Sustainability is very linked to recycling. Therefore, engaging people to participate to some ways of recycling some waste or natural elements seems to be an efficient way to make sustainability visible.

Notes

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 4

New Knowledge

Reflect on Practice — — Ideas for Future Projects

Other:

SECTION 4.
PROJECT DELIVER

How have you created the data materialisation (draw/describe)

Samples: plastic packaging, natural elements, mold, materials, peanuts waste → sound, wood sticks → sound

① recycling materials with sustainable glue.
② sounding objects
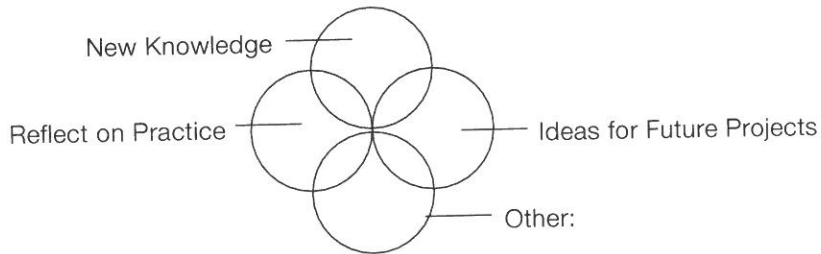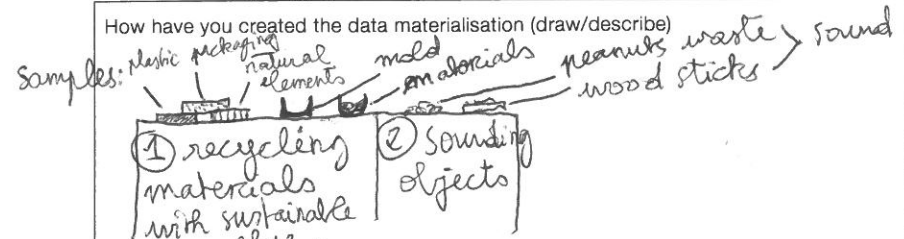
How important has the material choice/process/engagement been in the experience of the data?

It was very exciting to actually make new things with useless and recycled materials. It opened various possibilities of how we can perpetually reuse matter.

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 5

New Knowledge

Reflect on Practice — — Ideas for Future Projects

Other:
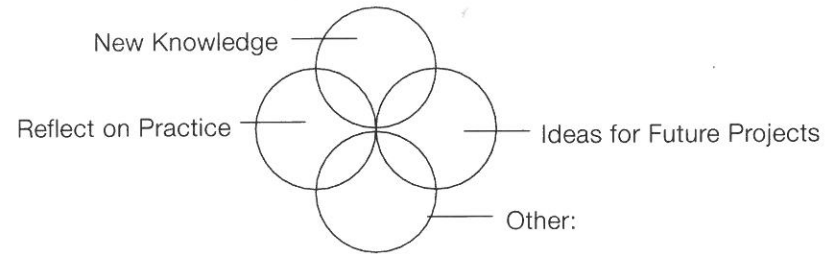
COMMENTS ON

Brief   Make a simple experience of sustainability
Data   Arduino — sound, PVA glue — waste, recycle.

TASK 2: MAPPING MATERIALS

How did you go about mapping materials?

Bring more connection between me and the object. Different gender have opposite view about same thing, for example, a guy from my group put the bra pad into "excitement" but I think it's belongs to "unpleasant"

How have you considered this before?

Not really, but I do seprate materials by what function they might have.

TASK 3: DEFAMILIARISATION

What insights can be revealed through alternative readings of materials?

How does sharing individual 'readings' contribute to the group dynamic?

people have different view but sometime similar, people from same discipline more likely to have similar view.

Were any distinctive roles revealed?

What kind of "feedback" can you get from materials?

Weight, smell, surface, waterproof, strechable

TASK 4: MATERIALISING DATA DISCUSSION

How did you use materials to explore data?

What data do you collect? (officially or unofficially)

exercises calendar via applewatch

How do you collect and share data? Apps, devices, signs?

Instagram /wechat /FB
Apple watch

What does data materialisation mean to you?

Use the material itself to create function.

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 1

New Knowledge

Reflect on Practice

Ideas for Future Projects

Other:
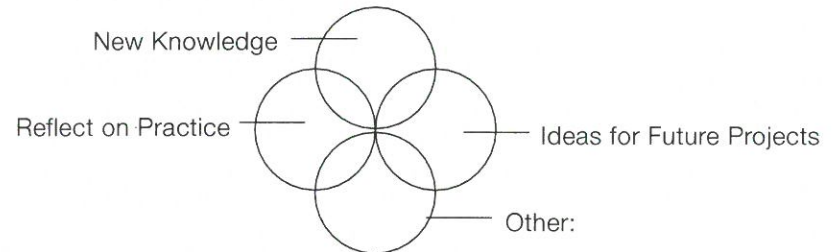
COMMENTS ON

Experience _____
Data _____
Materiality _____
Agency _____

Ap 4.5b

SECTION 2.
METHODS

Observations from exhibition

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 2
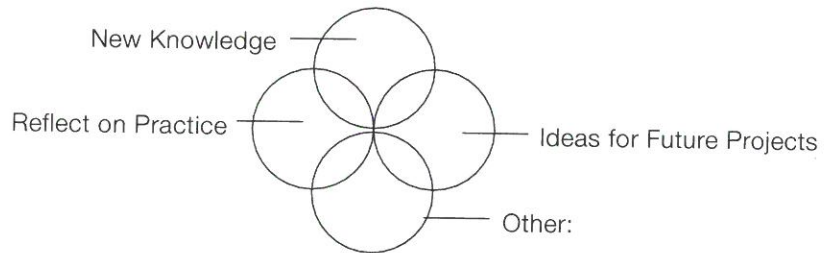
New Knowledge

Reflect on Practice

Ideas for Future Projects

Other:

COMMENTS ON

Methods _____

Materials _____

Metaphors _____

Group/dynamic _____

SECTION 3.
PROJECT DEVELOPMENT

The data my team is using is

How much people engage in the project.

The intention of the experience is

Materials and processes in the pallete

My role in the design team

making, contribute idea.
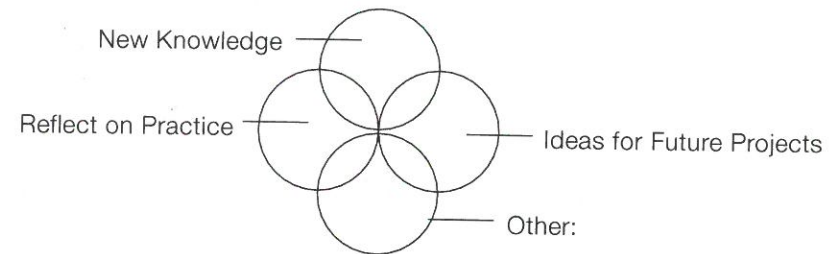
PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 3

New Knowledge

Reflect on Practice

Ideas for Future Projects

Other:

COMMENTS ON

Brief _____

Data _____

Ap 4.5c

SECTION 3.
PROJECT DEVELOPMENT

Why did you choose the particular dataset?

Because it was a quick way to make
an impactful experience.

Notes

We struggled to find the perfect brief information
to materialise and spent a whole day
figuring it out. I was also wondering if
by materialising data, one will never be able to precisely
show the quantitative data, as can be done when
visualising or physicalisation. However materialisation has
the potential to have greater impacts through experiencing
the data.

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 4

New Knowledge

Reflect on Practice

Ideas for Future Projects

Other:
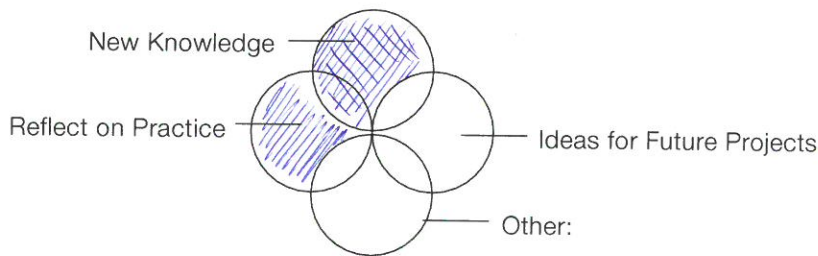
SECTION 4.
PROJECT DELIVER

How have you created the data materialisation (draw/describe)

We have created a chute filled with balloons and
designed an electronic mechanism which allows
one balloon to be released each time someone enters the
room. Thereby reducing the amount of space or air
in the room gradually over the course of the day, as
more people occupy the space.

How important has the material choice/process/engagement been
in the experience of the data?

Balloons were a good way to "capture/visualize air" -
or give a form to something that doesn't generally
have a form, so that material definitely relates to
the data.

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 5
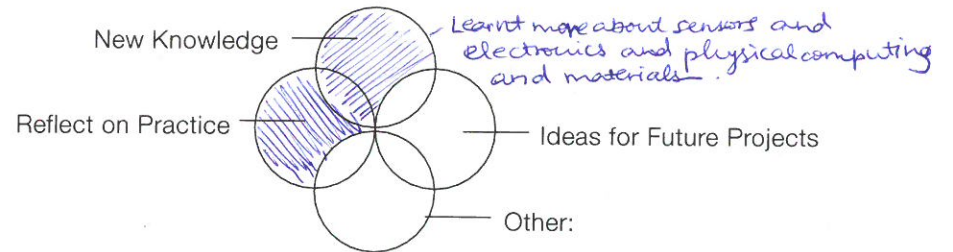
New Knowledge — Learnt more about sensors and
electronics and physical computing
and materials.

Reflect on Practice — Ideas for Future Projects

Other:

COMMENTS ON

Brief _____

Data _____

SECTION 5.
REFLECTION

In what ways can material quality/properties/engagement be
used to communicate data?

Materials are a way to create something tangible
out of something intangible.

How one engages with the material, can be how
one engages with the data.

How might you take this forward into your own practice?

I came to do my masters with the intention of
becoming an Information Designer and working
with data. While my work so far as a Graphic
designer doing 2D data vizualisations, this
week has allowed me to get out of my comfort
zone, work with space/interaction/electronics and
materials and further explore the potential of
creating 3D experiences out of data. I believe,
and this course has helped reinforce, what an
important field it is going to be in the upcoming
decade.   Thank you Marion! :)
            I really had fun this week.

THANK YOU

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PhD Candidate,
Design Research Royal College of Art
marion.lean@network.rca.ac.uk

Juncheng Wen

Name

G ZD

Programme

WHY DID YOU CHOOSE THIS PROJECT ?

(✓) New Knowledge   (✓) Ideas for Future Projects

(✓) Reflect on Practice   ( ) Other:

SECTION 1.
INTRODUCTION TO CONCEPTS

TASK 1.
Please draw/describe a material/object that represents body-health-wellbeing

pain relief

Keywords ubiquitous , security,
swallowing

Ap 4.2a

SECTION 5.
REFLECTION

In what ways can material quality/properties/engagement be used to communicate data?

RAW DIGITAL DATA CAN BE IMPOSSIBLE FOR A HUMAN MIND TO COMPREHEND NATURALLY, THEREFORE TRANSLATION OF DATA THROUGH

How might you take this forward into your own practice?

MATERIAL IS ESSENTIAL. THE CHOICE OF MATERIAL HAS A HUGE IMPACT ON HOW THE DATA IS COMMUNICATED.

I WILL CONTINUE WITH MY THOUGHTS ON 'ENVIRONMENT AS INTERFACE', USING THE AFFORDANCES OF THE NATURAL WORLD/ MATERIALS TO PLAY WITH DATA COLLECTION/DELIVERY, SPECIFICALLY WITHIN THE FIELD OF WILDLIFE CONSERVATION AND HUMAN-ANIMAL-MACHINE INTERACTION.

THANK YOU

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Design Research Royal College of Art
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SECTION 2.
METHODS AND THE BRIEF

> **Observations**
>
> I REALLY ENJOYED THE EXHIBITION. FOR ME, THE MOST INTERESTING PROJECTS REMOVE THE TECHNOLOGY FROM THE 'TECHNILOGICAL WORLD' THROUGH USE OF MORE ORGANIC / EVERYDAY MATERIALS. FOR EXAMPLE THE CURTAINS OPENING AND CLOSING DEPENDING ON AN INDIVIDUALS USE OF HIS PHONE.
>
> ('SMART CURTAINS THAT TRACK HUMAN EMOTIONS', MARANDA JULY, WITH ONMARON IDRISSA)

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 2

New Knowledge

Reflect on Practice

Ideas for Future Projects

Other:
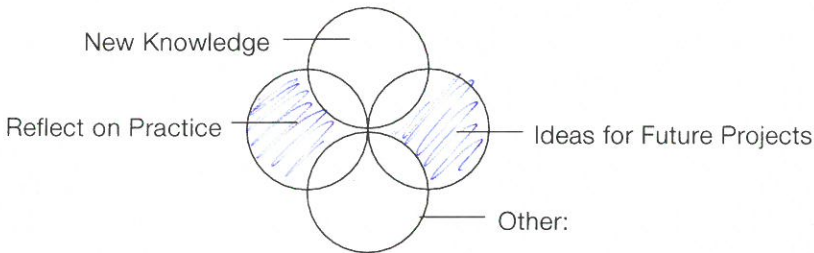
COMMENTS ON

Methods   'HUMAN' MATERIALS, ENVIRONMENT AS INTERFACE
Materials _____
Metaphors _____
Group/dynamic   NOT WOOD!

SECTION 3.
PROJECT DEVELOPMENT

> **The data my team is using is**
>
> CO_2 / HUMAN IMPACT ON THE ENVIRONMENT
> UNINTENTIONAL, HIDDEN, HARD TO VISUALISE
>
> **The intention of the experience is**
>
> TO MAKE THE VISITOR MORE AWARE OF THEIR PRESENCE IN A ROOM THROUGH AN ACTION THAT THEY CANNOT CONTROL BUT IS
>
> **Materials and processes in the pallete**   TRIGGERED BY THEM ENTERING.
>
> ETHERIAL MATERIALS. SOMETHING TO BOMBARD THE VISITOR (WITHOUT CAUSING THEM ANY HARM). SOMETHING TO
>
> **My role in the design team**   HIGHLIGHT THE INVISIBLE (I.E. THE AIR IN THE ROOM)
>
> PROGRAMMER / MECHANISM DESIGN

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 3

New Knowledge

Reflect on Practice

Ideas for Future Projects

Other:
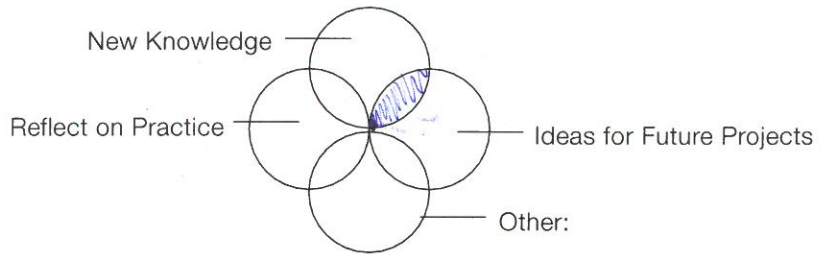
COMMENTS ON

Brief   VERY INTERESTING BRIEF – EXACTLY WHAT I WANTED
Data   UNINTENTIONAL HUMAN BEHAVIOUR / IMPACT DATA V. INTERESTING TO ME.   TO BE WORKING ON.

SECTION 3.
PROJECT DEVELOPMENT

Why did you choose the particular dataset?

INTERESTED IN EXPLORING UNINTENTIONAL/
HIDDEN/HARD-TO-VISUALISE HUMAN
DATA, CROWD BEHAVIOURS ETC.

Notes

MATERIAL SHOULD BE ETHEREAL,
INITIAL THOUGHT: BALLOONS, VISUALISING
AIR IN THE ROOM IN A SOLID FORM.

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 4

New Knowledge

Reflect on Practice

Ideas for Future Projects
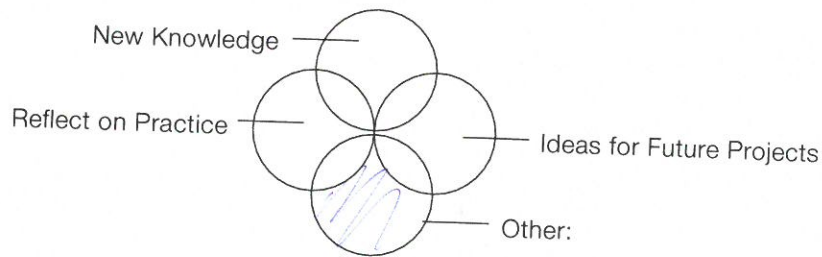
Other:

SECTION 4.
PROJECT DELIVER

How have you created the data materialisation (draw/describe)

DATA OF PEOPLE ENTERING THE ROOM IS
VISUALISED THROUGH THE RELEASE OF
BUBBLES INTO THE ROOM/ON TO THE VISITOR

How important has the material choice/process/engagement been
in the experience of the data?   ON REFLECTION,
VERY IMPORTANT. IT WOULD HAVE BEEN
GOOD TO CONSIDER MORE MATERIALS/
MAKE MATERIAL CHOICE MORE
PROMINENT IN THE BRAINSTORMING
PROCESS.

PLEASE LOG YOUR EXPERIENCE EACH DAY: DAY 5

New Knowledge

Reflect on Practice

Ideas for Future Projects

Other:
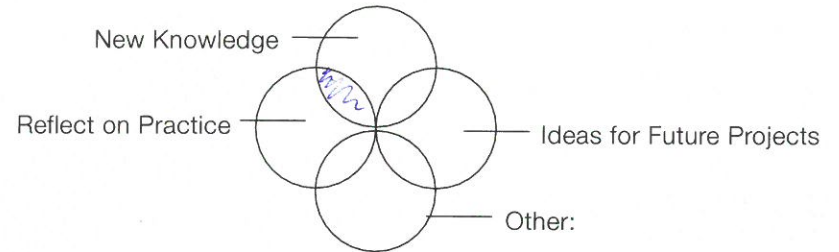
COMMENTS ON

Brief   I FEEL LIKE THE PROJECT WAS VERY
Data   INTERRUPTED BY GROUP DYNAMICS

The following are typed version of the hand written logbooks which are scanned in Appendix 4. The label on the right signifies scanned log book page number. E.g 'Ap 4.2 a' is Appendix 4, scanned page 2a.

Material Led Feedback System :Masters level Art and Design Students
Which course?

Ceramics and Glass:✔	**Design Products:** ✔✔
Global Innovation Design:✔	**Textile Design:**✔✔
Information Experience Design:✔✔	**Digital Direction:**✔

Why did you choose this project?

New Knowledge:✔✔✔✔	**Ideas for future projects:**✔✔✔✔✔
Reflect on Practice: ✔✔✔✔	**Other:**✔ Meeting others To play with materials and make things

Section 1.
Introduction to Concepts

Task 1: Please Draw/describe a material/object that represents body-health-wellbeing

Keywords:	Log Scan
Concentration, focus, feelings	Ap.4 2a
Texture, colour, smoothness	Ap.4 8a
Organisation, anxiety (deal with stress)	Ap.4 4a
Ubiquitous, security, swallowing	Ap.4 2a
Thirsty, hydrated, healthy	Ap.4 3a
Memory, touch, experience	(scanned page missing)
Jade stone, family connections, emotional	Ap. 4 9a
Weaving, tool, thread, comb, achievement, building layers	Ap.4 6a

Task 2: Mapping Materials

How did you go about mapping materials?	Log Scan
It was quite an instinctual process led by the physical qualities of the materials but also to intrinsic memories and feelings related to them	Ap.4 2b
Consider the level of experience, using the following factors 1) colour, 2) texture 3) imagination	Ap.4 8b
I found it interesting that some people have a different idea with the same material	Ap.4 4b
Different views between man and women	Ap. 4 2b
We discussed each material and how it made us intuitively feel. There was some debate about certain materials and perceptions different people had. Also they could not all be judged equally because some of them were plain materials and some were objects which evoked different meanings and associations	Ap.4 3a
Bring more connection between me and the object. Different gender have opposite view about same thing, for example, a guy from my group put the bra pad into excitement but i think it belongs to unpleasant	Ap.4 5b
We used cross map and catalogued materials by visual. Touch/haptic and strength	Ap.4 9b
Created debates around the material and its context. Very straightforward analysis of the material	Ap.4 6b

How have you considered this before?	Log Scan
I had never considered mapping materials and Ive learnt quite alot about myself and my instincts	Ap.4 7b
Have not really considered before. Mainly looking at the texture and the textile function	Ap.4 8b
I used some of them for making my models or as materials for tools	Ap.4 4b
Take it for granted	Ap.4 2b
No, it is very interesting however. Might be interesting to just to one material as well and then get a group consensus as well. For eg. If the public were all invite to a place a piece of say leather on the grid each.	Ap.4 3a
No really, but I do separate materials by what function they might have	Ap.4 5b
We used the map given to us. I think the map related to our emotion	Ap.4 9b
Useful, simple, playful	Ap.4 6b

Task 3: Defamiliarisation

What insights can be revealed through alternative readings of materials?	Log Scan
This reading forced me to analyse materials I would probably neglect otherwise and be specific about certain details of them	Ap.4 7b
People tend to have similar views on the fundamental element/properties. There were differences in individual contextual and emotional feelings	Ap.4 8b
A different view of each person	Ap.4 4b
Multisensory Experience	Ap.4 2b
What emotions they evoke. How they are perceived in different cultural contexts	Ap.4 3a
Materials could be showed to the public in different ways	Ap.4 9b
It reveals the diverse approaches of each people and how they perceive the matter	Ap.4 6b

How does sharing individual 'readings' contribute to the group dynamic?	Log scan
Sharing the readings is useful as everyone's subjectivity comes to play and how everyone notices a different detail	Ap.4 7b
Bring group together, in terms of some common views on the materials	Ap.4 8
It broadens our perspective	Ap.4 4b
Diversity, inspiring	Ap.4 2b
Unbiased opinions are shared. Keeps anonymity	Ap.4 3a
People have different view but somehow similar, people from same discipline more likely to have a similar view	Ap.4 5b
We used various words to describe the materials and knew these things in different perspectives	Ap.4 9b
Challenges	Ap.4 6b

Were any distinctive roles revealed?	Log Scan
I was the mediator and organiser of the group but I feel like everyone spoke out a participated	Ap.4 7b
Valentina led the whole task	Ap.4 4b
Yes, mechanism, construction	Ap.4 2b
Some formed deep emotional connections	Ap.4 3a
I started to think about the surrounding area of materials, eg, what will be left after I touch this hairball with my hand?	Ap.4 9b
Some more: rational/scientific approach, sustainable/ecological approach, literal approach	Ap.4 6b

What kind of 'feedback' can you get from materials?	Log Scan
You can get sensorial feedback but also some sort of chains of thoughts which connect the material to its social value or stereotype or memories that are subjective	Ap.4 7b
Experience, touch, vision	Ap.4 8b
The materiality of materials itself	Ap.4 4b
Data, feeling	Ap.4 2b
How they are handled, what data they carry in themselves eg fingerprints, stories	Ap.4 3a
Weight, smell, surface, waterproof, stretchable	Ap.4 5b
To provoke us to imagine future and recall some memory as well	Ap.4 9b
The value that each material contains conditions our perception of it	4 Ap.4 6b

Task 4: Materialising Data Discussion

How did you use materials to explore data?	Log Scan
1. Decode the data to gain the insight 2) Apply the knowledge of mapping to find the connection between material, experience and insight	Ap.4 8b
Comfortable Vs uncomfortable, materials to motivate an audience	Ap.4 3a
I would like to use material products and do some user testing	Ap.4 9b
In a descriptive way attached a potential narrative to each material	Ap.4 6b

What data do you collect? (officially or unofficially?)	Log Scan
24hour steps	Ap.4 8b
Movies I watch per year. What made me happy each day- I have actually been recording these two all year	Ap.4 4a
Exercises-calendar via apple notes	Ap.4 5b
We talked about temperature, smell and the meaning and emotion of special materials	Ap.4 9b
According to the diagrams we tried to build a potential narrative of the life of the person's schedule and daily routine	Ap.4 6b

How do you collect and share data? Apps, devices, signs?	Log Scan
Fitbit	Ap.4 8b
Google Keep. Google sheets, excel, IFTTT. Google Calendar, Maps, Google Docs, emails	Ap.4 4a
Instagram/wechat/FB/Applewatch	Ap.4 5b
Test with timer and electric devices. Sometimes use the body to measure the data and share on apps and social media	Ap.4 9b
Signs and symbols, devices	Ap.4 6b

What does data materialisation mean to you?	Log Scan
Use a visible and tangible method to bring information alive	Ap.4 8b
Using materials to effectively convey stories that data can tell you. ie using materials to materialise data in the 3D experience the way we use colour/form to visualise data in 2D	Ap.4 4b
Use the material itself to create function	Ap.4 5b
To make data/number/feeling tangible and visible	Ap.4 9b
Converting immaterial information to extract a physical outcome	Ap.4 6b

Log Experience Day 1:

New Knowledge: ✓✓✓✓✓✓	Ideas for future projects:✓✓✓
Reflect on Practice: ✓✓✓	Other: New Experience

Comments:

Comment	Log Scan
Experience: Longer lasting-retained in memory, transcends language First time to take part in a workshop at RCA. Intuitive, interactive, time and space.	Ap.4 3b, Ap.4 6b, Ap.4 9b
Data: Data is an untapped resource that has no value unless visualised/materialised. Don't have a specific data to do test. Flux, information, tool, virtual, speed, sustainability (?)	Ap.4 3b, Ap.4 6b, Ap.4 9b
Materiality: Medium, substrate, surface, interface Interesting. Sense, physical/virtual,substance, perception, influence	Ap.4 3b, Ap.4 6b, Ap.4 9b
Agency: Materials sit within a context Have no idea about this (lecture postponed till day 2)	Ap.4 3b , Ap.4 9b

Section 2.
Methods

Observations from exhibition	Scanned Log
The exhibition created some turmoil in me as I found certain inventions to stray too much from natures creating an anthropocentric world. Self-driving cars and artificial intelligence seem fascinating but a future where robots populate the world as humans do is not ideal for me. I also made me think about how much of our data is recorded and analysed. Are we managed by bigger entities?	Ap.4 7b
Visualise the unintended information. A project takes place in California, USA to embed the fibre cable underneath the ground, caused by surrounding transport and pedestrian. The screen visualises the frequency distribution, not only outline the boundaries of the buildings, but also reveals the interaction between cities and urban dynamics	Ap.4 8c
Uncanny, robot-scary, Volkswagen Car	Ap.4 4b
I really enjoyed the exhibition for me the most interesting projects remove the technology from the 'technological world' through use of more organics/everyday materials. For example the curtains opening and closing depending on an individuals use of his phone. (Smart curtains that track human emotions', Maranda July with Ohmaron Idrissa)	Ap.4 1b
Certainly very interesting. I felt like there could have been a bit more structure to where and why things were placed where they were. All of the stuff displayed didn't necessarily evoke 'future' for me. But still lots of cool projects! (in this exhibition) I found out that I'm quite optimistic about the future.	Ap.4 3c
Large sandbox Project. Physical. Visual/abstract. It can be used in different data context by using the same physical mode. It's a combination form to show the data and audience's feedback.	Ap.4 9c
Innovative approaches on universal themes; environment, politics, language. Interactive experiences Technological Installations	Ap.4 6c

Log Experience Day 2:

New Knowledge:✔✔✔	Ideas for future projects:✔✔✔✔✔
Reflect on Practice: ✔✔✔✔	Other:

   Comments:

Comment	Log Scan
Methods: Show data in physical form. Experimental, interactive, sensorial.	Ap.4 9c, Ap.4 6c,
Materials: 'Human' materials, environment as interface. Touched a lot of things, novel and fresh Very diverse, tech, devices, press release	Ap.4 1b, Ap.4 6c, Ap.4 9c
Metaphors: Not quite made sense.	Ap 4.2.9c
Group/Dynamic: Not good, Good Conversation. Analysing the potential future of the planet through multiple core aspects	Ap.4 6c, Ap.4 9b

Section 3.Project Development

The data my team is using:	Log
We want to collect data to understand how much people interact with the uncanny	Ap.4 7b
The presence of people within the space	Ap.4 8c
Uncanny, body, senses	Ap.4 4b
How much people engage in the project	Ap.4 5c
CO_2/unintentional human impact on the environment, hidden, hard to visualise	Ap.4 1b
Qualitative data about how much space one occupies/ones' carbon footprint	Ap.4 3c
Sustainable materials, food packaging, food waste, dead leaf, branches	Ap.4 9c
Sustainability made visible, experience, materials, packaging, plastic, natural elements	Ap.4 6c

The intention of the experience is:	Log
To measure how much people engage with the uncanny	Ap.4 7b
To measure the air quality within the room	Ap.4 8c
Make people feel uncanny	Ap.4 4b
To make the visitors more aware of their presence in a room through an action that they cannot control but it is triggered by them entering	Ap.4 1b
To visualise how one person unintentionally has an impact on a space	Ap.4 3c

Collect Autumn's 'feeling'	Ap.4 9c
Making experiences showing how we can recycle materials	Ap.4 6c

Materials and processes in the palette:	Log
Wigs, candies, fake hair, wire, 3d modelling with wires, Arduino	Ap.4 7b
Kraft paper, wire, hang apparatus from the ceiling	Ap.4 8c
Hair, sweets, wig>sense of taste, and see	Ap.4 10b
Ethereal materials. Something to bombard the visitor (without causing them any harm, Something to highlight the invisible (ie the air in the room))	Ap.4 1b
Balloons, electronics, (Arduino and photocell sensor, wires etc), Paper, cardboard theremo col	(page missing from scans)
To find a sustainable glue- non toxic (PVA). White at first, turns transparency	Ap.4 9c
1. Sustainable glue and small pieces of diverse recycled materials 2) sounding recycled materials	Ap.4.6c

My role in the design team:	Log`
Modelling, hand sewing, coordinating	Ap.4 7b
Provide the idea, build the structure	Ap.4 8c
Making the objects by discussing ideas	Ap.4 4b
Programmer/Mechanism design	Ap.4 1b
Tech Specialist (LOL), General Design Facilitator	(page missing from scans)
Making, contribute ideas	Ap.4 5c
Handcraft work and touch board testing	Ap.4 9c
1. organising /designing the project 2)collecting different materials/devices for arduino 3)making samples-cutting material into pieces	Ap.4.6c

Log Experience Day 3:

New Knowledge:✓✓✓✓✓ ✓ How to not just physicalise data but materialise it	**Ideas for future projects:**✓✓✓✓
Reflect on Practice: ✓✓✓✓✓✓✓	**Other:**✓ Get familiar with others

Comments:	
Brief: Very interesting brief-exactly what I wanted to be working on. I feel like the project was very disrupted due to group dynamics Not related to body data any more. Making sustainability visible through experimenting with recycled materials	Ap.4 1b, Ap.4 1c, Ap.4, Ap.4 9c
Data: Unintentional, human behaviour/impact data is V. interesting to me. It could be abstract data. Natural elements, sustainability, eco-friendly, sharing	Ap.4 1b, Ap.4 6c, Ap.4 9c

Section 3.
Project Development

Why did you choose the particular dataset?	
We chose this particular experience because we were fascinated by things we cannot understand which are sometimes frightening	Ap.4 7b
Air consists of different gas with various density. Visualise the difference and the changing in air composition	Ap.4 8d
We were looking for the most hated material which was hair	Ap.4 4b
Interested in exploring unintentional/hidden/hard-to-visualise human data, around behaviours etc	Ap.4 1c, Ap.4 9d
Because it is a quick way to make an impactful experience	Ap.4 3d
Interested in the mixed material and handcraft as well. To think about the sustainable material and which way it could be reused.	Ap.4 9d
Sustainability is very linked to recycled. Therefore, to some ways of recycling some waste or natural elements seems to be an efficient way to make sustainability visible.	Ap.4.6c

Notes:	
We aim to quantify how much people would engage with something they don't completely understand	Ap.4 7d
Hair, wet hair, drain	Ap.4.4b

Material should be ethereal, initial thought: balloons, visualising air in the room should be a solid form	Ap.4 1c
We struggled to find the perfect information to materialise and spent a whole day figuring it out. I was also wondering if by materialising data, one will never be able to precisely show the quantitative data, as can be done when visualising or physicalisation. However, materialisation has the potential to have a greater impact through experiencing the data.	Ap.4 3d
Different from what I thought before. More difficult to do tests.	Ap.4 9d

Log Experience Day 4:

New Knowledge:✔✔✔✔✔✔✔	**Ideas for future projects:**✔✔✔✔
Reflect on Practice: ✔✔✔✔✔✔	**Other:**✔

Section 4.
Project Delivery

How have you created the data materialisation (draw/describe):	
Working with a pressure sensor we related it to the weight of a bowl and the liquid within it. This bowl is hidden within an uncanny object. Whenever someone drinks from it they interact with the uncanny.	Ap.4 7b
(Image)White balloon= O2 Coloured balloon= CO2 One = to the other is air quality	Ap.4 8d
Take a candy, pile of candies lifts and hair coming out of a drain is revealed	Ap.4 4b
Balloons, environment, impact	Ap.4 2b
Data of people entering the room is visualised through the release of bubbles in to the room/on to the visitor	Ap.4 1c
We have created a chute filled with balloons and designed an electronic mechanism which allows one balloon to be released each time someone enters the room. Thereby reducing the amount of space on air in the room, gradually over the course of the day, as more people occupy the space.	Ap.4 3d
1) Recycling materials with sustainable glue 2) sounding object	Ap.4 6c

How important has the material choice/process/engagement been in the experience of data?	

The materials were fundamental because they recreated that sense of uncanny (familiar materials that behave in a weird way) in an exhibition context	Ap.4 7b
The balloon is a good container for having gas. Different colours on the balloons shows the different air component	Ap.4 8d
It was the most important part-to deliver the feeling of uncanny	Ap.4 4b
We should explore more, how and what conveys meaning	Ap.4 2b
Very important. On reflection, it would have been good to consider more materials/make the material choice more prominent in the brainstorming process	Ap.4 1c
Balloons were a good way to "capture/visualise air"- or give a form to something that doesn't generally have a form, so that material definitely relates to data	Ap.4 3d
Material touching and sense can create data. Data can also be visualise in Textile way	Ap.4 5d
To consider the making process. It's important to choose the glue and sustainable material. Because of too much failures	Ap.4 9d
It was very exciting to actually make new things with useless and recycled materials. I opened various possibilities of how we can perpetually sense matter	Ap.4 6c

Log Experience Day 5:

New Knowledge:✓✓✓✓✓✓	**Ideas for future projects:**✓✓✓✓✓✓ Learnt more about sensors and electronics, physical computing and materials
Reflect on Practice: ✓✓✓✓✓✓✓✓	**Other:** (no entries)

Comments:	
Brief:I feel like the project was very interrupted by the group dynamic Almost change to another direction. Make a simple experience of sustainability.	Ap.4 6c, Ap.4 9d
Data:to make the data solid. Arduino-sounds, PVA glue-waste recycle	Ap.4 9d, Ap.4 6c

**Section 5.
Reflection**

In what ways can material quality/properties/engagement be used to communicate data?	
Material engagement is fundamental as interacting with materials is the first thing we do as toddler as we're experiencing the world. Challenging the meaning of material provokes a new way of experiencing the world	Ap.4 7b
Gas density. It affects the height of balloons floating in space	Ap.4 8e
Raw digital data can be impossible for a human mind to comprehend naturally, therefore translation of data through material is essential. The choice of material has a huge impact on how the data is communicated.	Ap.4 1e
Materials are a way to create something tangible out of something intangible. How one engages with the material, can be how one engages with the data.	Ap.4 3e
Look back to history, find the traditional methods, when people have no internet how they communicate by symbols,objects etc.	Ap.4.5e
Store the data in a visible way that could be delivered to different places	Ap.4 9e
Thanks to the value and context of the material, we can convey meaning. Depending on the properties of the materials, we can relate to feelings, emotions and our own experience. Therefore, I believe in the intangible and almost spiritual aspect of the matter, and how it can build a dialogue with our awareness.	Ap.4 6e

How might you take this forward into your own practice?	
I'm currently working with biomaterials, this workshop made me realise and think of my work so that it creates immersive and multisensory experiences.	Ap.4 7b
Improve the efficiency of the mechanism. Improve the numbers of different gases to show more layers of balloons	Ap.4 8d
I can choose what material to use to deliver message better	Ap.4 4e
Data physicalisation-> industry, medical, manufacturing	Ap.4 2e
I will continue with my thoughts on the environment as an interface using the affordances of the natural world/materials to play with data collection/delivery, specifically within the field of wildlife conservation and human-animal-machine interaction	Ap.4 1d
I came to do my Masters with the intention of becoming an information Designer and working with data. While my work so far	Ap.4 3e

as a graphic designer doing 2D data is visualisations, this week has allowed me to get out of my comfort zone, work with space/interaction/electronics and materials and further explore the potential of creating 3D experiences out of data. I believe and this course has helped reinforce what an important field it is going to be in the upcoming decade. Thankyou Marion :-) I really had fun this week.	
Use data to making textiles 1 2 3 4 5 6 _/-/_--/-/// --_//_--//	Ap.4 5e
1. To create a new material by myself use this material in product design 2) Natural material related a more close feeling to users	Ap.4.9d
The materials that we made may be useful in my future work. Either integrating these materials in weavings or building volumes, casting the mixture.	Ap.4 6e

Designing the Affective Material Palette. Using materials to explore the experience of systems and technologies designed to aid behaviour change

Marion Lean

Designing the Affective Material Palette.

Using materials to explore the experience of systems and technologies designed to aid behaviour change

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Abstract: The ways that some data is communicated has been said to *"stigmatise, marginalise and trivialise disempowered social groups",* which in turn may alter the way is received, understood and acted upon by the recipient. There is a call for counter mapping to challenge the one size fits all style (Lupton, D 2017).

Drawing on the affective potential of both data representation and materials, embodied methods are implemented to inform a design process resulting in 'data materialisation' as a response to identified issues from fields of digital health and behaviour change. Engaging with theory and practice from textile design as a framework for the speculative design of digital health technology experiences, creatives in a week-long workshop programme tackled issues and responded through making; prototype 'material experiences' and 'data materialisations' designed to elicit affective response.

Keywords: data, textiles, design, experience, sensory design, materials, affect

Designing the
Affective Material Palette

Using materials to explore the experience of systems and technologies designed to aid behaviour change.

The concept of Data Materialisation is introduced as a means of bringing data to life by applying the affective and sensory dimensions and essence of our interactions with the material world as a way of meaningfully communicating and interpreting data. A workshop methodology explores ways that the communicative dimension of materiality (Lupton, 2016) elicited through handling and interaction with physical materials, might be used as a design tool to explore an alternative representation and experience for data initially from digital health products.

Motivations

Aspects of methods from the field of Human Computer Interaction Design (HCI) including Somaesthetic Design and Defamiliarisation (Hook, 2018; Bell, 2005) inspired Textile Design led material mapping activities which aimed to encourage a subjective embodied approach to design. Considering the proposal that our 'fleshy attributes are reduced to flat 2D imagery' (Lupton, 2016) and the objectification of the body by data (Hook, 2018) and (Brouer, 2003) it is hoped we can harness value from the sensory and affective dimensions of our material world experiences to explore particular areas of data experience.

Methods

Exercises are designed to introduce the affective nature of materials; reexamine a single material, and re-appropriate affective properties of materials in experiences which 'bring data to life'.

Findings

· Physical material handling enabled dialogue on emotion, memory and sensory pleasure/displeasure.

· Concepts brought into discussion from textiles including Affect led to prototyping about data experience eg driverless cars or the 'Uncanny' feeling of AI 'following you around'

· Placing value in one's own 'felt' experiences could offer meaningful perspective for the design of interactions which closely monitor personal data.

Discussion

Redstrom et al (2005) encouraged the use of technology beyond 'mere implementation of function' through processes of appropriation and interpretation, challenging the convergence asking *what it would mean to approach technology design on the basis of traditions that exist in the area of textiles, or vice versa.'*

A dialogue between HCI design research community and Textile Design researchers can create the opportunity for informed implementation of textile technology collaboration and synthesis beyond product aesthetic, to consider the experience and impact.

Running with Scissors

With technologies at home and online developing at a faster rate than ever before, we often encounter a new or unfamiliar experience. As we hurtle into unknown and uncertain futures, take a moment to stop and really consider how it is something makes us feel, from that silky fabric we all snuggled as kids, dislodging a pile of your sister/flatmate/airbnb-er's hair from the plughole, to the way you feel seeing the message flash on your screen telling you how many steps you haven't done. This workshop outline introduces developing methods to extract secrets from the tacit wisdom and ways of thinking from the age-old craft of textiles that might lead us to ideas and insight to aid as we tackle a seemingly unbounded horizon of data-driven experiences.
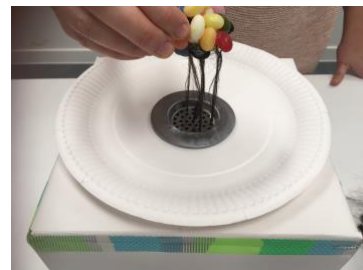
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1. Stretch Orchestra Workshop https://www.youtube.com/watch?v=OFm9avpqW64

2. Stretch Orchestra Installation https://www.youtube.com/watch?v=iwolrz5k_uU&t=4s

3. Material Led Feedback System https://youtu.be/92lkpWalWIY

4. Exploring Benefits of Gigabit-capable Internet

https://www.youtube.com/watch?v=M0JBeGBJ8XE&t=15s

Film CS 1 Stretch Orchestra (part 1)

- Situates the context (purpose)
- Shows the activities and materials used
- Explains the concept of textile design workshop in research: informal, playful (e.g. as opposed to a psychology research setting which would be restricted, closed and controlled) [00:27]
- Shows the activities and inviting others to take part [00:42] Useful for showing others the approach.
- Shows people trying out the textile sensors (touching, squeezing, pinching, scratching) [02:01]
- Shows participants carrying out the material mapping, choosing where to put materials, making decisions before placing
- Shows participants carrying out a defamiliarisation exercise and the interactions that took place with materials, for example touching the thermochromic paper to see the reaction and dropping the fluffy ball
- Explains textile sensors in an accessible way [00:59]
- Shows participants' interpretation of how sensor socks work: "I was a bit apprehensive that I would feel the electrical sensors" [02:17] "it was really good to see how the pressure goes through the fit, different intensities in different places" [02:40]
- Shows participants' interest in the context and learning more about these type of technology [03:41]

Film CS1 Stretch Orchestra (part 2)

- Explains project background and motivation shown in the visual and physical context of the research
- Shows the design and function of the installation
- Shows the scale and materials, as well as sound [00:12]
- The spoken words describing the work and the themes are shown with imagery of hands interacting with materials, helping to communicate the project agenda: for example, "evoke emotion and memory" [03:09]
- Visually demonstrates using voice and hands more than text (for example in the thesis) shows

- Words accompanied by film encourage an understanding of the research themes: for example, "savour real world experience" – evocative words accompanied by the physical object and people on film

- Ethnographic insights: "I don't think I track my data, its' more to do with how I feel" [01:27]

- Responses to the installation: "it was exciting to see the marble do what it was set up to do" [01:49] and "...it's a distraction from the physical activity to actually enjoy the performance" [02:15]

- Material sounds are played on the film, engaging the viewer more than is possible in the text

- Use of technology and process, such as Arduino, is explained; shows ways that a collaborative approach has supported individual expertise [01:07]

- Informal/playful introduction to the outcome proposals but with formal descriptions of design processes and objective [01:20]

- Offers insights into individual interpretations of the project; for example: "how can we speak a language with only materiality?" [00:50]

Film CS3 What does Connectivity mean to you?

- Explains the aim, methods and outcome clearly [00:42]

- Explains the personal research (PhD) agenda clearly: "what's missing is the personal and emotional interaction with this technology" [00:22]

- Shows the layers of the research; for example, the types of information collected and from whom [01:30]

- Shows the depth achieved through the process undertaken [01:50]

- Mapping outcome and findings of the study explained [02:19]

- Explains and expresses the value of the ethnographic approach visually

- Shows the findings in the context of the research participant locations (materialised on the dialectogram) and in the physical context of DCMS shown on film [02:29]

- The style of the film, including the researcher's appearance and performance, presents the subject formally, again alluding to the applied context

Appendix 9 Benefits of High-Speed Internet Fact sheet

Fact sheet developed from Dialectogram findings.

Department for Digital, Culture, Media & Sport

BUILDING DIGITAL UK

Benefits of High Speed Internet

Fact Sheet

Rural residents and Urban SMEs took part in research looking at the benefits of fibre internet

- Spending time within communities as research means direction less framed by pre conceived concepts and frameworks - learning rather than validating knowns

- Findings of research with Gigabit Broadband Voucher Scheme recipients revealed value in taking explorative approaches to learning about experiences of enhanced internet speeds

- Gigabit Broadband Voucher Scheme recipients reported positive experience, describing fibre connections as 'Lifeline', 'Efficiency, 'Reliability'

- Barriers to uptake include cost, contracts and perceived lack of 'need', not knowing 'what type of internet connection you currently have', lack of technical knowledge and terminology

- Most recipients using connection for low level activities, however SMEs using at high level eg entertainment industry describing connections as 'Seamless' and 'an invisible layer'

- Findings reveal that greater potential of fibre connectivity including 'preparing for future and assisted technologies at home' could be realised by engaging with emerging technologies and digital service suppliers as facilitators

- Gigabit test bed set up as a case study for user testing internet technologies in 'gigabit communities'

- Findings point to a space for BDUK to engage with wider DCMS initiative eg OCS loneliness agenda and Nesta Challenge fund to support further impact research

Department for
Digital, Culture,
Media & Sport

Case Study research I May 2019

Illustrated log page (blank) and word cloud of responses.

Log pages drawn by Mitch Miller were used as probes to prompt dialogues during research sessions with rural participants. The information collected on these logs is held by BDUK in line with research ethics and GDPR conditions. The final question on the log asked 'What does connectivity mean to me?' these results of this are shown in a word cloud below.
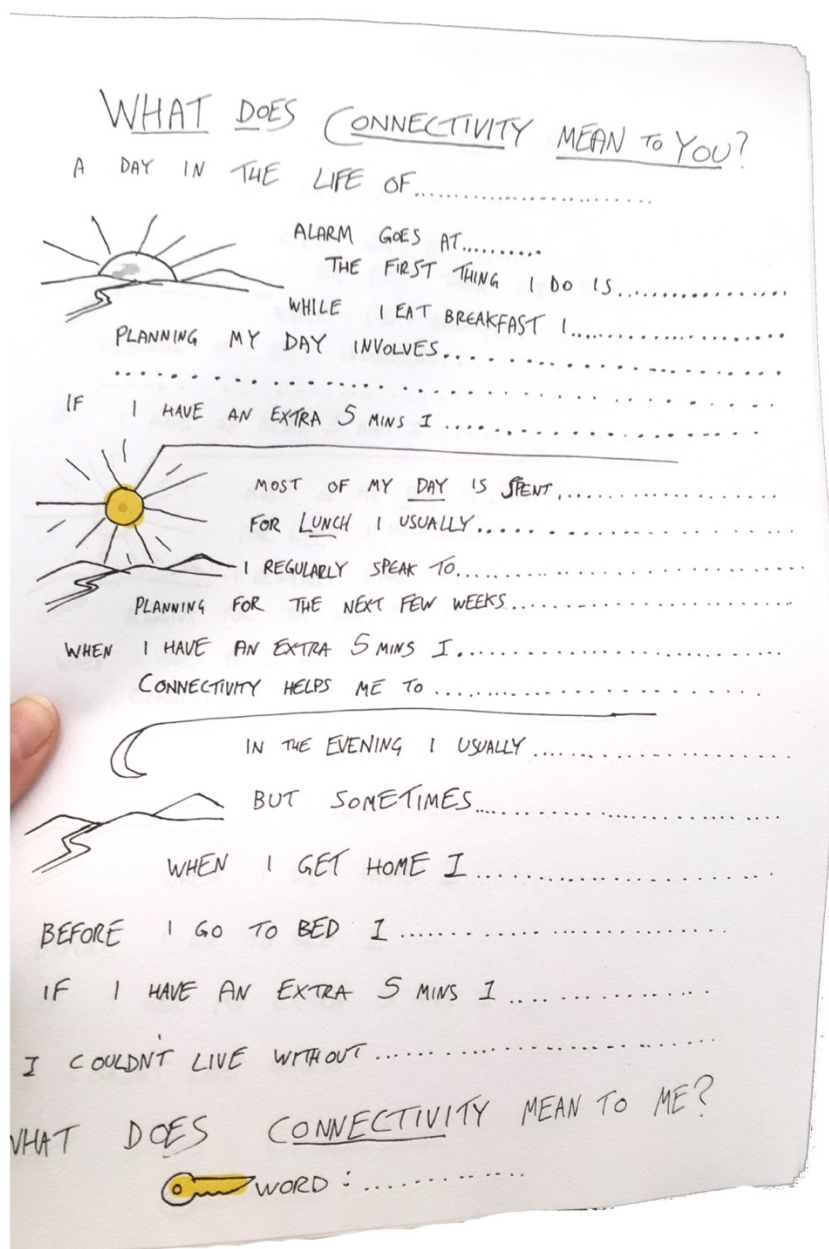
Being-Aware

Easier

Reliability

Communication

Access

A-Voice Quick Job Efficiency

Research

Embedded Community

Love Convenience

Connectivity

Invisible-Layer

Lifeline Seamless

Keeping-Informed

FIBRE: A DIALECTOGRAM SKETCH

METHODOLOGY: FROM FILAMENTS TO FIBRE(S)

THE INFORMATION ON THIS DRAWING WAS COMPILED USING A RANGE OF METHODS

Q. WHAT DOES CONNECTIVITY MEAN TO ME?

REFLECTION

GATEKEEPERS — ANNE BEER / BARBON VILLAGERS

ONLINE SURVEY

MARION'S RESEARCH (LONDON)

MITCH'S PRACTICE (GLASGOW)

INITIAL CONVERSATIONS

PHONE CALLS

DEVELOPMENT OF PERSONAL LENS

FIELDWORK IN SOUTH LAKELAND — MELLING, BARBON + WRAY

SOUTH LAKELAND

PLANNING

FIELDWORK + MAPPING

CONTRIBUTION FROM S.M.Es

MAPPING + WORKSHOP

NOTES

WORDS

SKETCHES

REPORT

THIS DRAWING

MAY 2019

REFLECTION + DISCUSSION

PROPOSALS + FUTURE DIRECTIONS

BENEFITS

BARRIERS TO UPTAKE

COST — CONTRACT TYPE
AVAILABLE? — SUPPORT
NO INCENTIVES? — KNOWLEDGE / MEANS

THESE ARE PARTICULARLY ISSUES BEYOND LONDON + B4RN

BDUK — COMMUNITIES CONNECTOR — A NEW ROLE, AIMED AT...

WE AIM TO SHOW WHAT IT'S LIKE AFTER THE CONNECTION — AAMER

MAPPING RESEARCH + CREATING A NETWORK

PROMOTING GIGABIT BENEFITS + REACHING OUT

ROUND TABLE DISCUSSIONS

I.E. FUTURE PROOFING CARE (CARE HOMES)
PRE-ASSISTED LIVING
ASSISTED LIVING
CARE HOMES?

TEST BED LINKINGS

B4RN / KRAYDEL CASE STUDY

COLLECTIVE APPLICATIONS FOR CONNECTION

NESTA CHALLENGE PRIZE

SOCIAL INFRASTRUCTURES CASE STUDIES

RURAL RESIDENTS + SMEs

URBAN SMEs

BENEFITS: EASIER TO LINK WITH SCHOOLS / CURRICULUM, ENABLES FUTURE PLANNING, EFFICIENT, RELIABLE, SEAMLESS, LOW LEVEL USE, IMPROVED SENSE OF PLACE (CHURCHMOUSE / POP BRIXTON), WORKING FLEXIBLY, INTERNATIONAL COLLABORATIONS, SUPPORTING STAFF NUMBERS ONLINE, WI-FI ENABLED PUBLIC SPACES

FUTURE DIRECTIONS

TECHNOLOGY LED RESEARCH + INNOVATION — THIRD SECTOR — LOCAL AUTHORITY COLLABORATIONS — CONNECTING TO EXISTING INFRASTRUCTURE

NATIONAL CHALLENGES — LONELINESS + ISOLATION — SOCIAL + DIGITAL INCLUSION

POP BRIXTON: RECYCLED SHIPPING CONTAINERS + RECLAIMED MATERIALS HAVE TRANSFORMED A SOUTH LONDON GAP-SITE INTO A HOME FOR OVER 50 BUSINESSES

CONNECTED

BDUK / DCMS COUNCILS + COMMUNITIES

SUPPLIERS
FACILITATORS
RESIDENTS
CONSUMERS
SME
TELECOMS

OLDER PEOPLE

CHURCH MOUSE (BARBON)

NEEDS IDENTIFIED — PRODUCTS PROVIDED — SERVICES IMPROVED

COMMUNITY COUNCILS / NEIGHBOURHOOD DEVELOPMENT PLAN

PRODUCTS DESIGNED — SERVICES DESIGNED — SERVICES DELIVERED

HEALTH NEEDS / PROVISION

LGBTQ

SPECIAL INTEREST

PRODUCTS TESTED — SERVICES TESTED

FREELANCERS + INDEPENDENT WORKERS

HOME-WORKERS

SUPPORT FOR OLDER PEOPLE

(PART OF) THE B4RN AREA (B4RNLAND)

KENDAL — KIRBY LONSDALE — BARBON — MELLING — WENNINGTON — WRAY — SOUTH LAKELAND

AUBREY + HELEN'S FARM WAS CONNECTED TO FIBRE BY B4RN IN LATE APRIL 2019. THEY HAD PREVIOUSLY BEEN USING THEIR PHONE HOTSPOT OR THEIR NEIGHBOUR'S CONNECTION.

APRIL 2019: FARMERS REPORTS NOW HAVE TO BE SUBMITTED ONLINE

MANY FARMERS CAN NOW SELL LIVESTOCK DIRECTLY TO EACH OTHER, BY-PASSING CATTLE AUCTION

HELEN REARS RAREBREED CATTLE — THEY ARE NOW CONSIDERING SELLING MEAT DIRECTLY TO CUSTOMERS

THE FARM IS BOTH A RESIDENTIAL CONSUMER — BUT ALSO AN S.M.E.

B4RN: IS A COMMUNITY BENEFIT COMPANY, BASED IN MELLING. IT EMPLOYS OVER 30 STAFF + 100s VOLUNTEERS + HAS CONNECTED 5000± PROPERTIES. IT CONNECTS TO FIBRE + HAS RETAINED c.55% OF THESE PROPERTIES ONCE CONNECTED.

BROADBAND 4 THE RURAL NORTH

CORE STAFF: THEY RUN + ADMINISTER B4RN

VOLUNTEERS: ESSENTIAL FOR INFORMATION, PROMOTION, LABOUR!

BUSINESSES / SCHOOLS / RESIDENTS / COMMUNITY FACILITIES / CARE HOMES

PHYSICAL BUSINESS — VIRTUAL BUSINESS

THE CHURCHMOUSE @ BARBON

THE CHURCHMOUSE IS EVERYWHERE... IS...

(APRIL 24TH-25TH 2019)

THE WHOLE CAFÉ IS LIKE FACEBOOK IN STONE...

IT'S ABOUT CREATING WORK OPPORTUNITIES IN RURAL COMMUNITIES — JULES

STAFF CAN BE HARD TO GET + RETAIN IN ISOLATED COMMUNITIES

MENU — COFFEE MACHINE — KITCHEN

WORK OPPORTUNITIES IN RURAL COMMUNITIES IS A MAJOR BENEFIT — JULES

JULES + HER FAMILY LIVE, WORK, PLAY + CREATE ON THE SAME SITE

CHEESE IS AN IMPORTANT ASPECT OF CHURCH MOUSE. JULES IS A CHEESEMAKER + IT IS A MAJOR U.S.P.

CARD MACHINE

CHEESE — DELI

ICE CREAM — SCONES

CAKES (HOME-MADE)

DRINKS CABINET

LOCAL PRODUCE — PUNNETS OF EGGS — REALLY NICE FRUIT W. VEG — GROCERIES

PRINT OF A CHEESE WEDDING CAKE — CHURCH TAKE ORDERS FROM ALL OVER THE U.K. + ARE ON SOCIAL MEDIA

WE TAKE IT FOR GRANTED NOW — IAIN

THE P.C. DOCTOR: A LOCAL COMPUTING CONSULTANT WHO HOLDS REGULAR FREE DROP-IN SUPPORT SERVICE

IT HOLDS OUT SALES + PROMOTES HIS TRADE — JULES

MARION

JULES FOR JULES' PET QUARTET

THERE'S NO PHYSICAL GAP BETWEEN WORK + HOME

AGE UK SOUTH LAKELAND

WE SPOKE WITH PAULINE, AGE UK, WHO DELIVER IT DIGITAL INCLUSION SCHEME

PAULINE, AGE UK DEMONSTRATING A TABLET TO A CLIENT

3 MONTH LOAN WITH TRAINING

DIGITAL CHAMPIONS

LONELINESS + ISOLATION IS AN ISSUE THAT NEEDS ADDRESSED IN RURAL COMMUNITIES

WHAT HAPPENS TO OLDER PEOPLE WHO DON'T HAVE CHILDREN / GRANDCHILDREN TO WORK THE TECHNOLOGY FOR THEM? — PAULINE

AN APP THAT TRACKS CAN PLAY MULTIPLE TRACKS IN DIFFERENT PARTS OF THE BUILDING

JULES' MOTHER, READING THE PAPER — JULES

STACKS OF THE LOCAL PAPER

CEREAL

FRUIT BOWL

LANDOWNERS: A CRUCIAL COMPONENT, A PERMISSION TO LAY FIBRE IS CRUCIAL...

BARBON INN — ADVERTISES ITS WI-FI

THE IMPLEMENTATION PROCESS REALLY IMPROVED INTERACTION — PETER

KRAYDEL TRIAL

KRAYDEL IS A DEVICE WHICH OFFERS VIDEO STREAMING THROUGH A TV — USEFUL FOR OLDER PEOPLE WHO ARE NOT CONFIDENT / COMFORTABLE WITH NEW TECHNOLOGIES. A TRIAL IS NOW BEING PLANNED WITH BARBON RESIDENTS + MAY INVOLVE AGE UK SOUTH LAKELAND

BARBON IS TINY — ABOUT 200 PEOPLE — BUT VERY WELL CONNECTED. THE WHOLE VILLAGE COLLABORATED TO DIG TRENCHES SO THAT B4RN COULD LAY THE CABLE.

VILLAGE HALL

ANNE BEER'S HOUSE — WAS OUR RESEARCH BASE + WHERE MOST BARBON INTERVIEWS TOOK PLACE. (THERE WAS AN 'ESCAPE ROPE' IN EVENT OF A FIRE...)

COMMUNITIES OF INTEREST

CARE HOMES

SINGLE OLD PEOPLE

VIDEO CONSULTATION BY GP.s?

THE TRUCK IS TO CLOSE THE CHASM BETWEEN THE EARLY ADOPTERS + MORE CONSERVATIVE CUSTOMERS — AAMER

SMALL MAIL BOX

AS A RURAL BUSINESS, THERE'S NO PASSING TRADE — YOU HAVE TO BE A DESTINATION — JULES

THE DOOR IS COVERED IN PARISH NOTICES + BROCHURES

A PHYSICAL FACEBOOK STATUS UPDATE...

THE CHURCHMOUSE AT BARBON

www.churchmousecheeses.com

THE CHURCHMOUSE AT BARBON: A ONCE DYING LOCAL SHOP / CAFÉ HAS BEEN TRANSFORMED (BY THE FORMIDABLE JULES) INTO A VIBRANT COMMUNITY HUB — BISTRO, DELI, MEETING PLACE, VENUE, CAFÉ, COMMUNITY NOTICE BOARD, CORNER SHOP + EXCELLENT WI-FI.

MOST OF IT'S SOCIAL ENGINEERING — PETER

POP FARM

A CITY-BASED 'GROW YOUR OWN' INITIATIVE THAT PROMISES GREENERY. IT HAS A # + INSTAGRAM

CHALKBOARD REQUESTING / ADVISING: POURING ICE OR HOT DRINKS ONTO THE BEDS WILL SHOCK THE PLANTS + CAN KILL ROOTS, LEAVING YOUR LEMONS + LIMES ON THE SOIL WILL ALTER THE pH + AFFECT PLANT GROWTH. @URBANGROWTH.LC #POPFARM

MARION STARTS TO COLLATE FINDINGS + POTENTIAL PROPOSALS

TAKING STOCK @ THE END OF FIELDWORK...

I LIVE JUST ACROSS THE ROAD FROM HERE — DAN, MAKESHIFT

PLANS FOR FINAL DIALECTOGRAM

SKETCHING IS A USEFUL WAY OF ENGAGING PARTICIPANT + RECORDING IMPRESSIONS + RELATIONSHIPS

THE WI-FI ENABLES THE RESIDENT BUSINESSES + CUSTOMERS TO WORK IN THIS SPACE — 2 LEVELS OF ENABLEMENT (LITERALLY...)?

BRIGHTLY PAINTED SIDE

I HEAR A LOT OF BRIXTON ACCENTS HERE — IT'S WELL-USED BY LOCALS — MARION

ONE OF MY BEST TEACHERS IS IN SHEFFIELD — + IT REALLY DOESN'T MAKE A DIFFERENCE — SONIA

POP BRIXTON

THE GREENHOUSE

WE USED TO RELY ON A SHARED CONNECTION, IT CUT OUT A LOT — SONIA

TO ENABLE AN ENTIRE BUSINESS ON 90 QUID A MONTH IS INCREDIBLE — SONIA

E-COMMERCE SOFTWARE

LONDON CRAFT CLUB

VIDEO-CALLS WITH COLLABORATORS

CRAFT TEACHERS (NETWORK)

SALES + MARKETING

"EXPERIENCE ECONOMY" (SEE ALSO... HOOP)

THERE WAS THIS TIME I WAS A FEW HUNDRED SHORT OF MY MONTHLY TARGET — I MADE SOMETHING, UPLOADED + SOLD IT — SONIA

THE DRAWING SHOWS JUST A SMALL PART OF A WHOLE COMPLEX OF CONVERTED CONTAINERS IN BRIXTON

WE TRY AT MUCH AS POSSIBLE TO OFFER OUR SPACE TO LOCAL BUSINESSES — SHANNON, MAKESHIFT

YOU CAN BUY FOOD + DRINK FROM THE VENDORS BELOW THEN TAKE IT UPSTAIRS

YOU DON'T GET THE SPINNING WHEEL OF DEATH ANYMORE...

WHAT MAKESHIFT OFFER: HIGH SPEED INTERNET IS PART OF A RANGE OF FACILITIES POP BRIXTON IS ABLE TO OFFER BUSINESSES + GROUPS — IT IS AN OFFLINE + ONLINE PACKAGE.
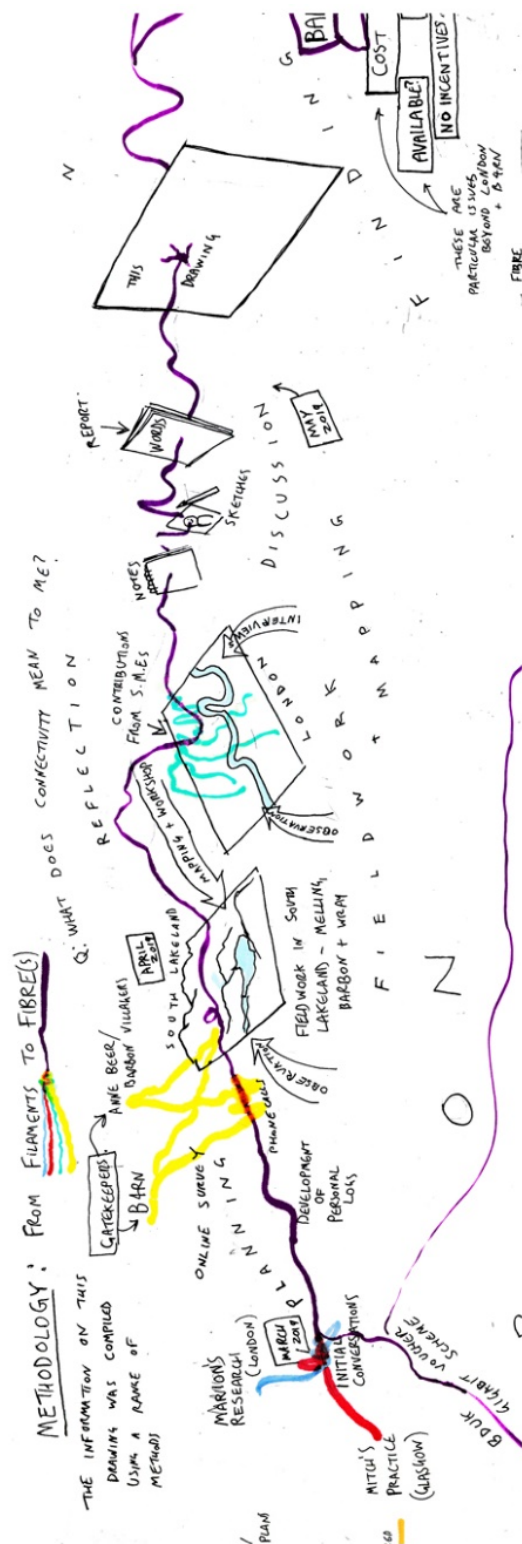
MOST OF US HAD JOBS + BUSINESSES ELSEWHERE CAME HERE TO DO THINGS DIFFERENTLY — SHANNON

TO DO GOOD WE ALSO HAVE TO MAKE MONEY — SHANNON, MAKESHIFT

BELOW THE RAISED SEATING IS A SELECT OF FOOD + DRINK VENDORS

LIKE THE CHURCHMOUSE, POP BRIXTON PERFORMS AN IMPORTANT ROLE AS A COMMUNITY HUB, MEETING POINT + PLATFORM, PHYSICALLY + VIRTUALLY

UPHOLSTERED IN RECLAIMED SACKING

VERY SMALL CHAIR

POP BRIXTON

RAMP

THE SPEED DOES MAKE A DIFFERENCE — MAX

THERE IS A SISTER-SITE TO THIS IN PECKHAM

I'VE ALMOST FORGOTTEN THE PAIN OF BAD INTERNET — SONIA

SMOKE & SALT (RESTAURANT)
ROE (RESTAURANT)
LANDINGS LEADING TO RESTAURANTS

MAKESHIFT'S OFFICES ARE A SHORT WALK AWAY

LONDON CRAFT CLUB (SONIA) OFFERS CLASSES + ACTIVITIES TO VARIOUS CLIENTS + FUNCTIONS AS A PLATFORM FOR CRAFT SPECIALISTS + TEACHERS, AS WELL AS ONLINE SALES

HOOP (MAX JENNINGS) — WE SPOKE TO MAX JENNINGS, ONE OF THE FOUNDERS OF THIS APP, WHICH MATCHES PARENTS TO CHILDREN'S ACTIVITIES

ABOUT ⅔ OF OUR WORKFORCE ARE PARENTS WORKING @ HOME — MAX

ALMOST ALL OF OUR OFFICE TOOLS ARE WEB-BASED — MAX

KRAYDEL (ARMORI)

WE SPOKE TO DAN + AAMER TO DISCUSS VARIOUS APPLICATIONS OF KRAYDEL TECHNOLOGY

HOME TO BDUK + THE GIGABIT VOUCHER PROGRAMME.

DEPT. OF MEDIA, CULTURE + SPORT

THE LONDON RESEARCH WAS CARRIED OUT IN A SERIES OF ON-SITE VISITS ACCORDING TO AVAILABILITY + OPPORTUNITY — A "DRIVE-BY" ETHNOGRAPHY

RESEARCH SITES IN LONDON

MAKESHIFT (DAN + SHANNON) WORKING OUT OF BRIXTON, THIS COMPANY TRANSFORMS GAP-SITES + EMPTY BUILDINGS INTO NEW COMMUNAL SPACES FOR SMALL BUSINESSES + LOCAL GROUPS

LIKE THE CHURCHMOUSE, POP BRIXTON ENABLES PEOPLE TO CONNECT + SUPPORTS A RANGE OF SOCIO-ECONOMIC ACTIVITY

CLERKENWELL — WESTMINSTER — SOUTH — THE THAMES — BRIXTON

(2ND MAY 2019)

B R I X T O N

303

FIBRE: A DIALECTOGRAM SKETCH

BASED ON FIELDWORK IN SOUTH LAKELAND + LONDON, SHOWING THE CHURCHMOUSE + THE GREENHOUSE

Full drawing and zoomed in sections with descriptions to view the dialectogram and zoom in it is also available at http://marionlean.co.uk/Design-Research-Methods-Ethnography

This drawing, found along the top of the hand drawn map is a depiction of the methods and activities which were used. This includes relation building (for example, using phone calls),
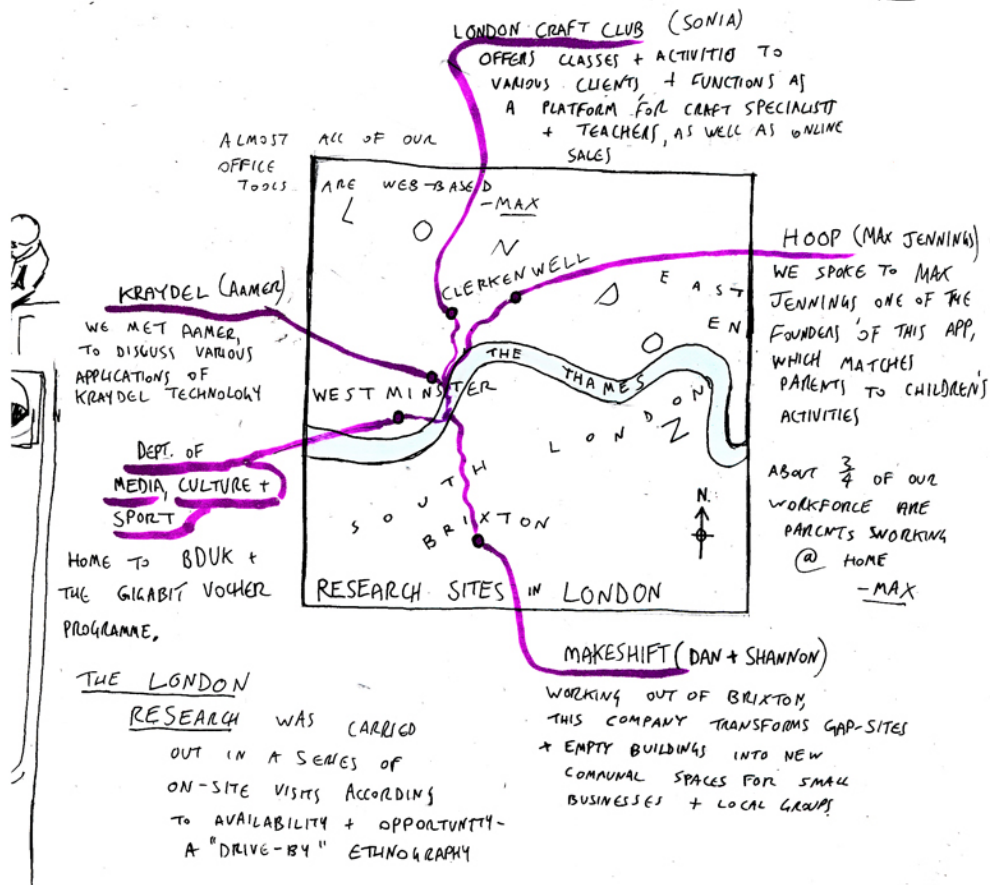
visiting potential sites of interest and places which ethnographic research took place. The process of interviewing, note taking and finally developing into 'this drawing' are shown.
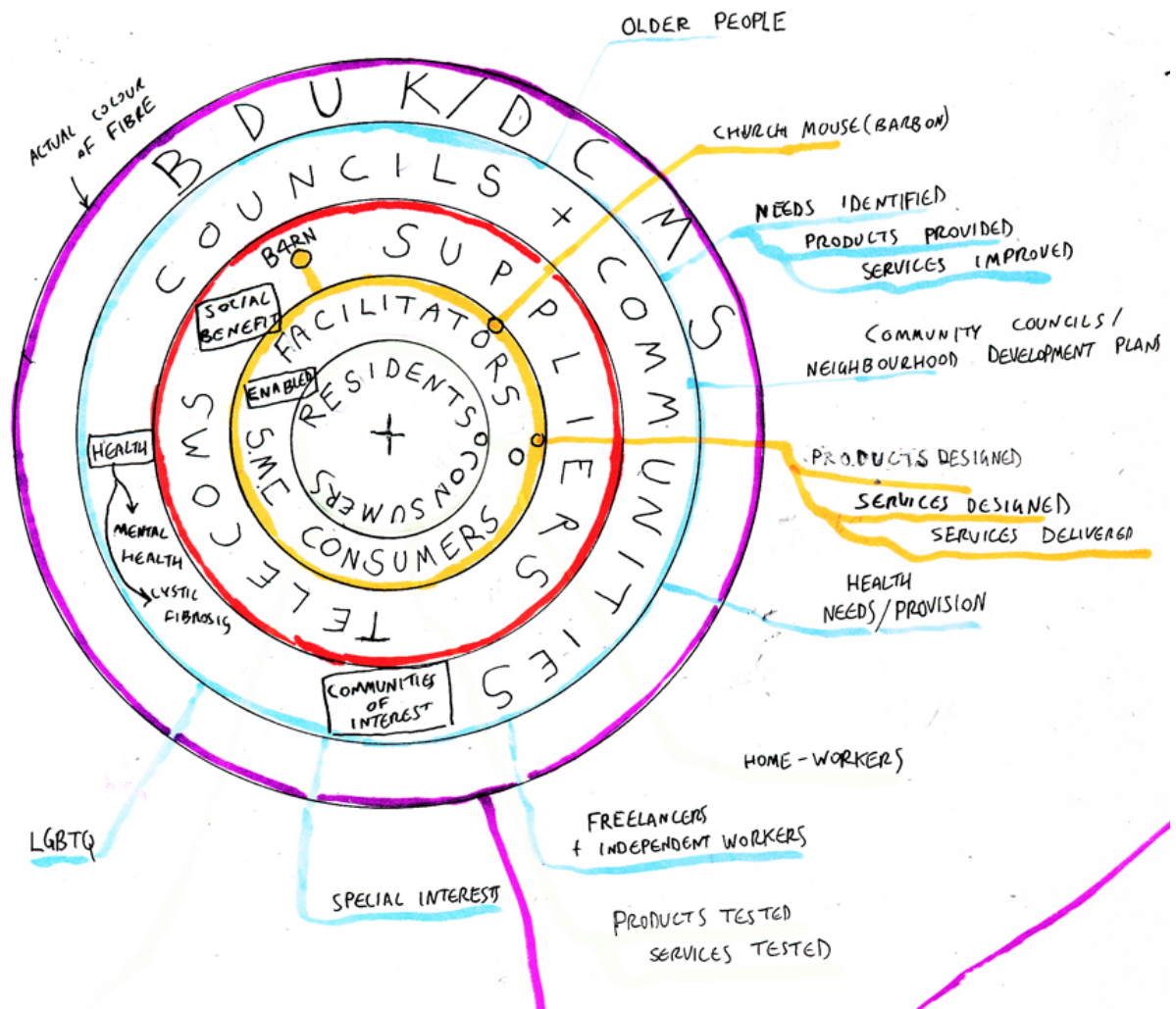

A detail from the hand drawn map of the research. This wheel shows different stakeholders who provide and benefit from fibre connections.

I'VE ALMOST FORGOTTEN THE PAIN OF BAD INTERNET
— SONIA

LONDON CRAFT CLUB (SONIA)
OFFERS CLASSES + ACTIVITIES TO VARIOUS CLIENTS + FUNCTIONS AS A PLATFORM FOR CRAFT SPECIALISTS + TEACHERS, AS WELL AS ONLINE SALES

ALMOST ALL OF OUR OFFICE TOOLS ARE WEB-BASED
—MAX

CLERKENWELL

HOOP (MAX JENNINGS)
WE SPOKE TO MAX JENNINGS ONE OF THE FOUNDERS OF THIS APP, WHICH MATCHES PARENTS TO CHILDREN'S ACTIVITIES

KRAYDEL (AAMER)
WE MET AAMER, TO DISCUSS VARIOUS APPLICATIONS OF KRAYDEL TECHNOLOGY

WEST MINSTER

THE THAMES

EAST END

LONDON

ABOUT $\frac{3}{4}$ OF OUR WORKFORCE ARE PARENTS WORKING @ HOME
—MAX

DEPT. OF MEDIA CULTURE + SPORT

SOUTH

BRIXTON

N.

HOME TO BDUK + THE GIGABIT VOUCHER PROGRAMME.

RESEARCH SITES IN LONDON

MAKESHIFT (DAN + SHANNON)
WORKING OUT OF BRIXTON, THIS COMPANY TRANSFORMS GAP-SITES + EMPTY BUILDINGS INTO NEW COMMUNAL SPACES FOR SMALL BUSINESSES + LOCAL GROUPS

THE LONDON RESEARCH WAS CARRIED OUT IN A SERIES OF ON-SITE VISITS ACCORDING TO AVAILABILITY + OPPORTUNITY - A "DRIVE-BY" ETHNOGRAPHY

This drawing depicts businesses which were visited in the urban location. The map and the anecdotes are used to briefly identify who and where the research took place.
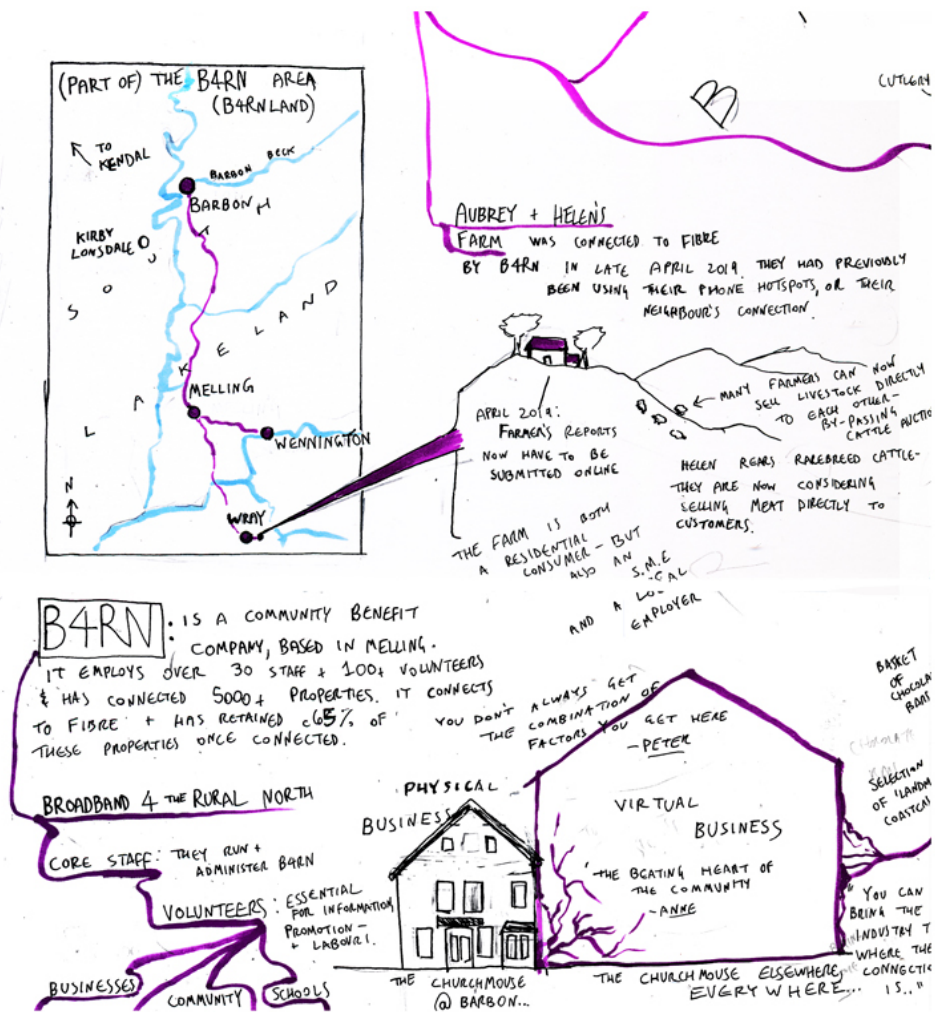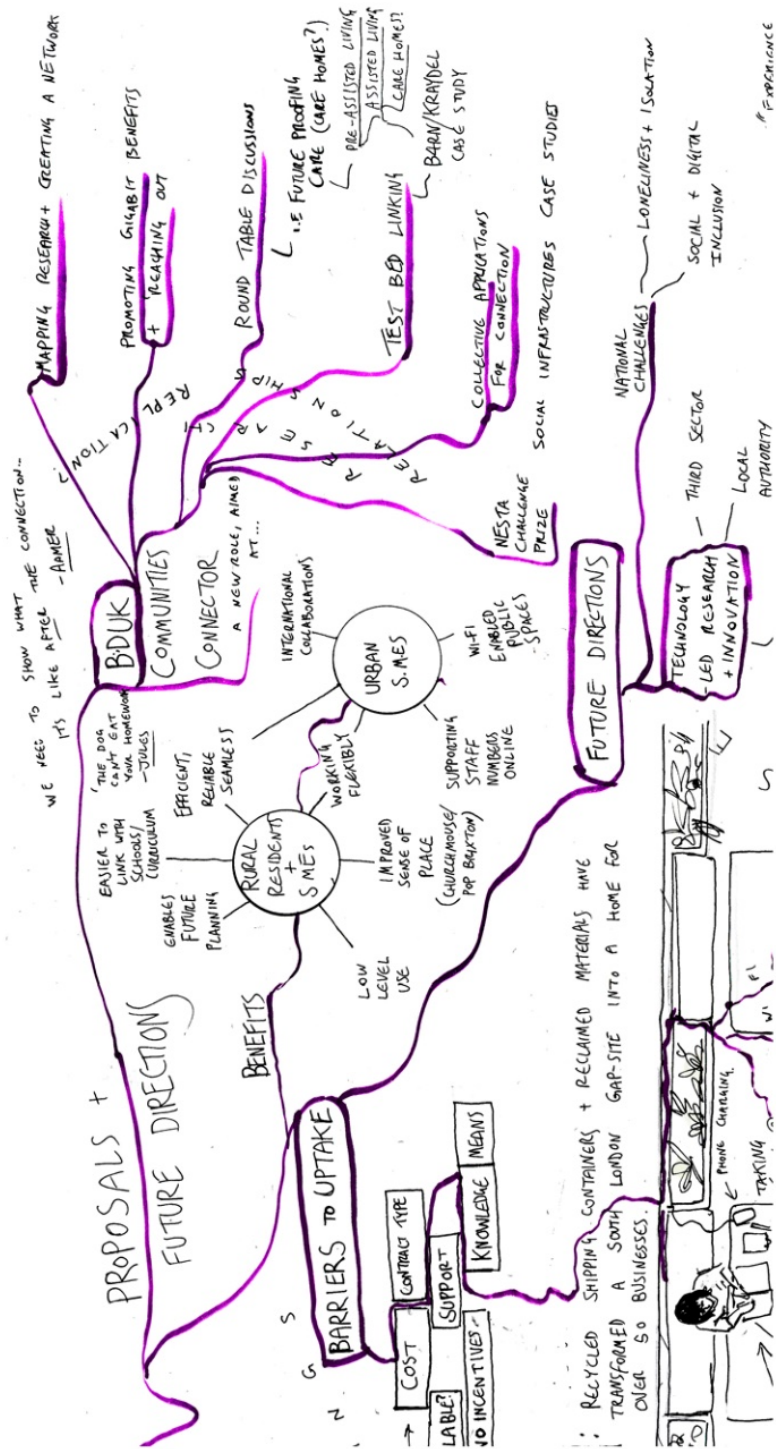
This drawing shows some of the sites visited and names some of the stakeholders who shared insights which informed the study. For example, the charity Age UK told us about their 'Tablet loan scheme' where older people are given a digital device to try out and learn about the internet. The drawing shows the geographical location of a research setting. On the left is a 'zoomed-out' map of the area, on the right shows a rural farm on a hill which previously had never been connected was now enabled through the help of a community broadband connection. Having a connection affords the farmers new perspectives in terms of commercial possibilities, for example selling speciality meat online as 'chop boxes'.
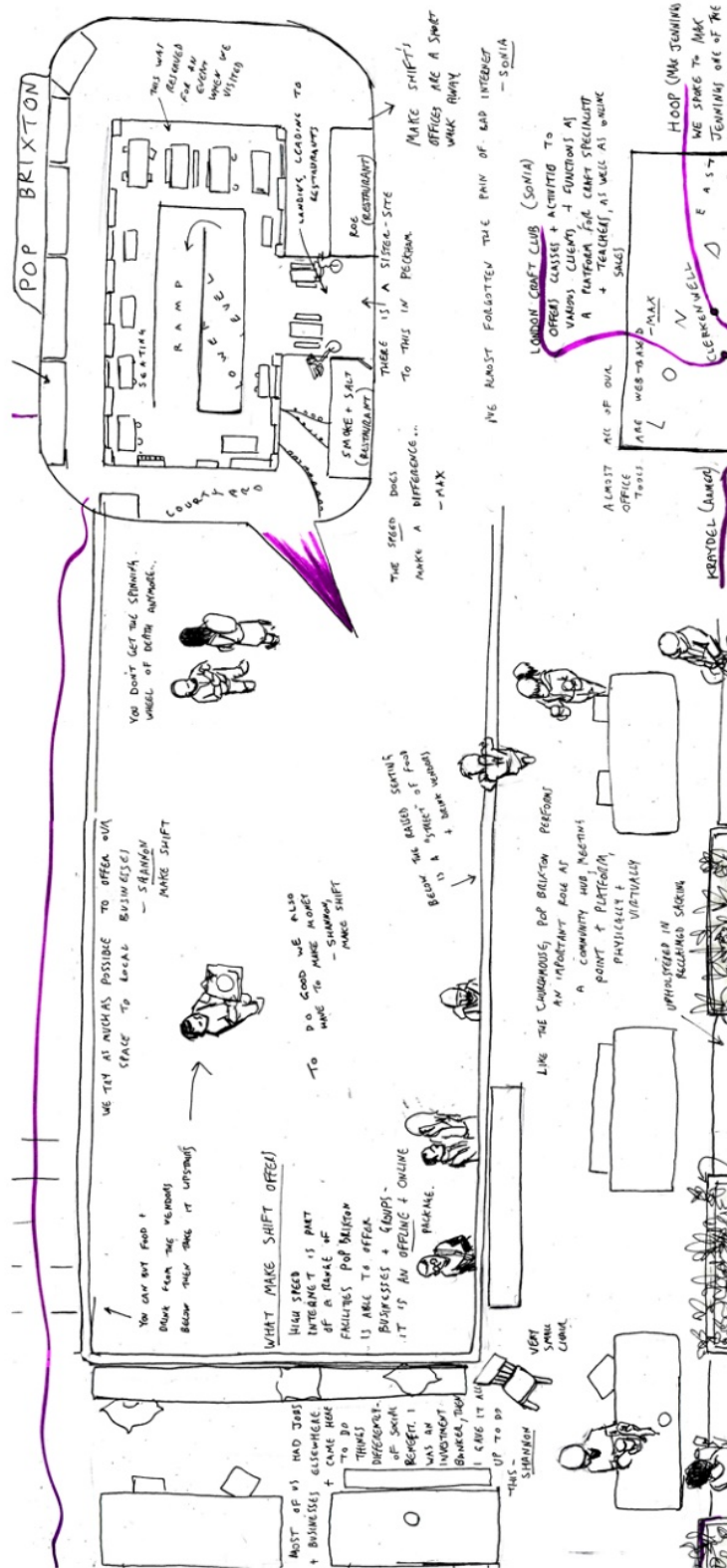
This drawing shows the layout of a co working space where the author and Miller spent time learning about users of the space are using and benefiting from high speed internet connections.

This part of the drawing features one of the locations where research took place. This is a small coffee shop in a small rural village. The drawing shows the layout of the venue but also anecdotes about the types of people who live there and their use of fibre connections.

This drawing portrays some of the potential partnerships and interventions which could be developed based on the data findings. Outcomes of this research includes anecdotal evidence for the ways gigabit-capable connections are being used; the activities that are supported by the connection, insights into why the connection was taken up, barriers to uptake and insights into impact on business and personal lifestyles and productivity.

Selected Case Studies

The following case studies participants agreed to their data being used in a report about gigabit connectivity. This is a sample of GBVS recipients experiences and is not intended to be reflective of everyone's practices with gigabit-capable connections.

Findings

- Gigabit Voucher Recipients were generally positive about their fibre connection, using words such as 'lifeline,' 'efficiency, and 'reliability.'
- Rural residents reported 'low level' use, such as daily communications, entertainment, and online finance services.
- Some residents reported that the connection did not make much difference while others suggested it provides confidence in considering future plans, for example assisted technologies for later life.
- SMEs used words such as 'seamless' and 'invisible layer' to talk about fibre connections.
- SMEs using connections at a high-level including industries such as gaming, TV and film, and digital content likely to make greater potential use of connection.
- SMEs are also using their new connection at a lower level, for instance general admin in care homes, online retail and event management organisations. One specific example included providing connections for attendees to an outdoor cinema event.
- Barriers to uptake include cost, contracts and perceived 'lack of need.'
- Not knowing 'what you currently have,' lack of technical knowledge and terminology hinders interest in switching to fibre.
- The 'benefits' are not always clear, especially considering those who don't know how to 'make the most' of a high-speed connection potentially will not 'benefit' in the way expected/intended by the BDUK.

Recommendations

- Potential for knowledge transfer and innovation incentives to realise potential. For example, using One Digital and Age UK's model of helping people to see value in connectivity by offering tablet-loan scheme to older people.
- Gigabit Community Testbed for internet connected technologies and services.
- Proposed Community Connector role within a research group linking BDUK communities from DCMS to suppliers, facilitators and consumers, and academic communities to establish a dynamic network for research and impact.

Computer Club at Broadband for the Rural North

Members of B4RN computer club took part in conversation and research workshop activities at the Broadband for the Rural North office (B4RN). The computer club is a regular meet up for older internet users run by volunteers at B4RN headquarters in Melling, Lancashire. Nearby local residents use it as an opportunity for social engagements. The group members have a mix of jobs and backgrounds, many are retired.

The research activities included:
- Informal discussion
- Technology demonstration with [Kraydel](#), a company who produce video streaming devices for older people. This provided opportunities to learn about people's use of connectivity for communication purposes.
- Interviews and mapping workshop activities with computer club members and village champions

The findings were firstly understanding about the value of the connection to those communities personally. Due to their remote locations, being connected is really important to the people living there. Fibre connections are the only possible ways to get online in many of these areas, most of the local residents also contributed by volunteering to physically dig the trenches for fibre.

A local 'village champion' told us that demand for broadband *"as high as demand for fixing potholes and that says something!"*

The use cases in this community were generally 'low level' for example using online governments services, online banking, and communication for example, local campaigning and promoting events. The computer club is positioned as a social opportunity to meet others and learn how to use technology. Most members brought along their own devices, for example a tablet however this is also an event to learn about new technologies and services. Adam from Kraydel showed the group how their video streaming technology worked and received many questions. From this experience at the club, the company has set up trials to test their product with a rural community. The computer club is a place where people could learn more about how to make the most of their fibre connections.

The computer club as a social space is important for rural communities- a member of this community shared that before everyone had home connections people would go to a school to get online, for example for their online shopping orders. A potential disbenefit

of connections at home mean that people living remotely could miss out on face to face interaction.
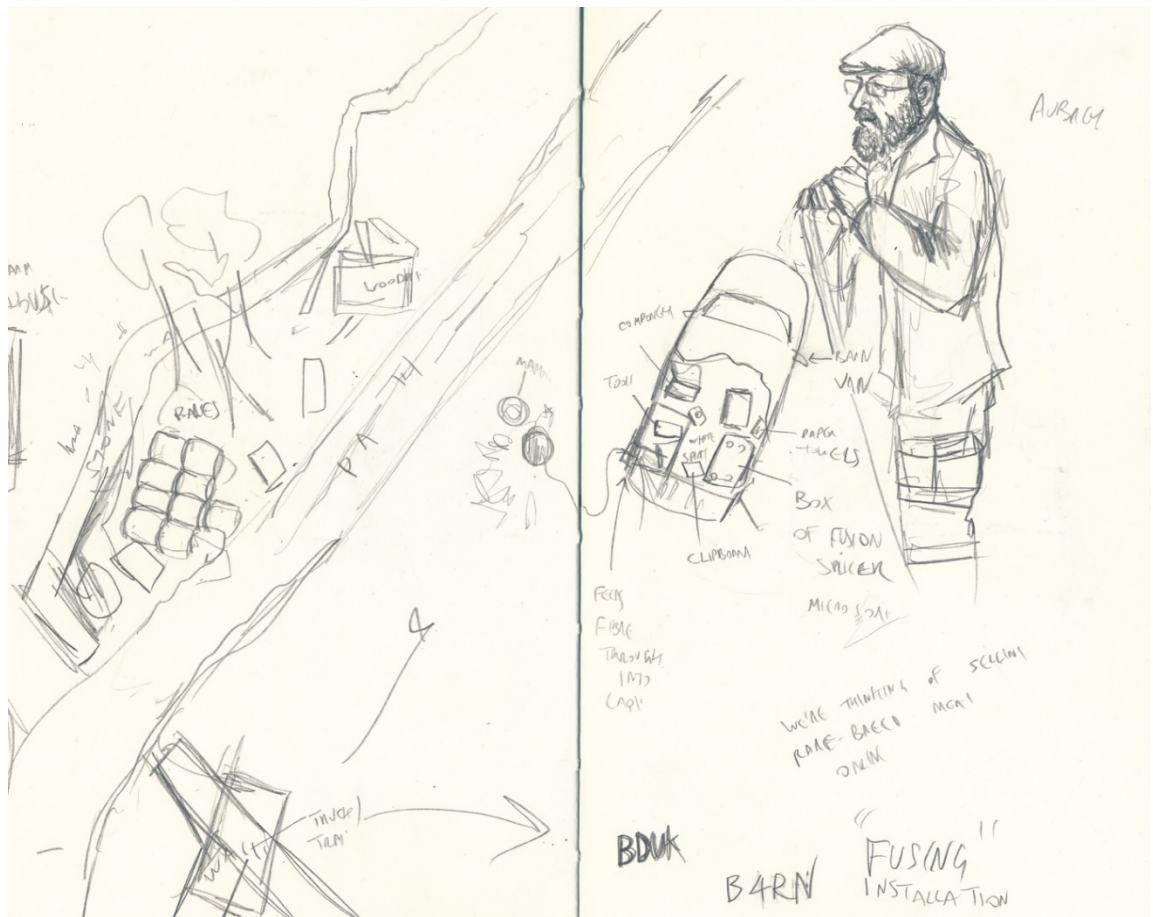
Aubrey and Helen's Farm, Roeburndale

This is a cattle farm in a very remote location at the top of a hill. The farmers are simultaneously residents, broadband consumers and an SME who employ local staff- we met a blacksmith attending to a horse. The research activity carried out to learn more about the value of connectivity at this location included:

- Observing a fusing with B4RN at the remote farmhouse.
- *Fusing refers to splicing together optical fibres ensuring light passes through evenly and is not scattered. This allows the connection to enter the premises.*
- This afforded informal discussion and observations with farmers in their own home and on the farm including staff members.

We learned that the farmers had previously been using their mobile phone hot spots, or going to neighbours to use their connections. Since all farm reporting, for example information on animal movement/ meat/milk parlour production must be done on line since April 2019 (as per Department for Environment, Food and Rural Affairs) the

farmers felt they had to get a connection. Though the connection was now essential for business reporting it also offers potential opportunities for future plans and development. Helen explained that they breed rare cattle and would now be looking to do direct sales online both for meat and to bypass cattle auctions by trading online.

Marion interviewing a resident in the village of Barbon

Barbon is a small village with about 200 residents. It has a village shop and cafe, a pub and the village hall. I met with 8 residents at one of our participant's home. The research activities included:

- Engaging participants, who were mainly retired couples and people living alone, ages ranging from 60-90 in individual and group discussion.
- A 'log book' page was filled out participants to learn more about their positions and backgrounds beyond their internet habits as a way of understanding the value of connectivity in this group.

This group shared insights about low level use, and was mix of those technically able and interested in fibre connection and technology and those who were not. The use cases in this group were mainly for communication. For example, Facebook, the news, entertainment, language learning and assessing historical and academic resources. One participant did not have a fibre connection, was not interested and still on a copper connection. She expressed that she couldn't see the value in changing. Another couple said that they had taken the connection as it came past the door but they "don't notice a difference". Another participant showed how the connection meant she was able to carry

on working, and feeling connected to her professional and personal communities using online tools, even after retirement. Showing that she was able to live remotely but feel part of her community which is elsewhere-online provides a mutual space. We heard how the connection enabled families to connect physically as well as helping people to connect virtually- "my daughter can work from home online while I help with the children".
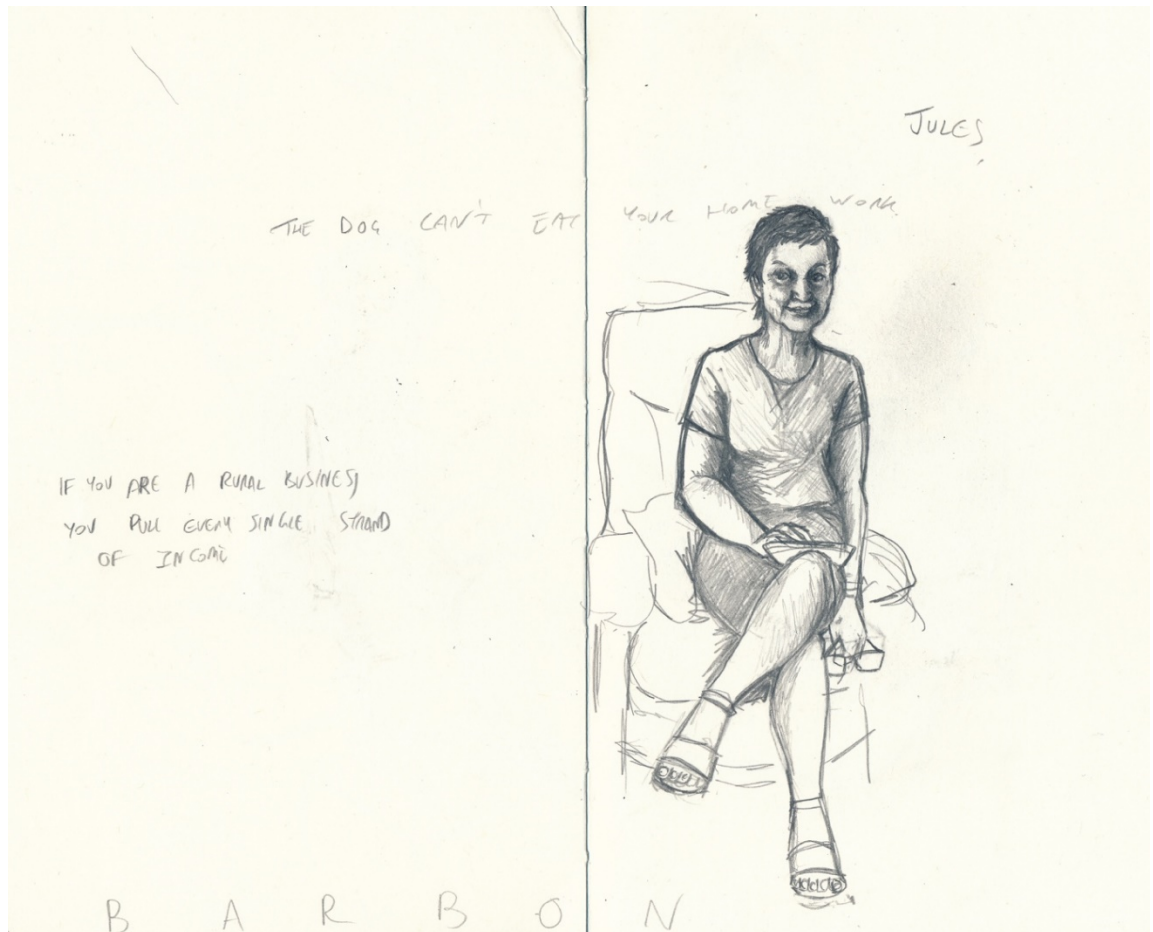
Church Mouse, village cafe, shop and meeting hub, Barbon

Church Mouse, once a dying local shop has been transformed by the owner Jules into a space which is at once a village store, cafe and deli and hosts events. For example, PC Doctor sets up once a week to offer tech help. It's a place to meet up and supper clubs are held in the summer evenings with groups travelling from as far as Kendall to attend. To learn about value of connectivity for Church Mouse research activities included:

- Interview with village shop and cafe; local 'hub' owner
- Visit to the cafe and shop,
- Observations and conversations with staff

We learned about the challenges of running a rural business. Jules told us "As a rural business there's no passing trade, you have to be the destination" , "it's about creating work opportunities in rural communities" and "staff can be hard to retain in isolated communities". She explained that hosting events like the PC doctor "helps our sale and promotes his trade", activities which enable people living remotely to also stay independent. Alongside the shop and cafe, Jules and her husband have an online business selling cheese wedding cakes. They rely on the internet and social media for this as they sell and send the cakes across the UK. The connection at Churchmouse allows its owners to be flexible and versatile and enabled future planning. As a potential dis-benefit Jules expressed that the connection makes it possible to work anywhere at home "there's no physical gap between work and home" so they make a point of switching off after work and spend time with family. Jules explained that the connection is also used for their children's homework and it makes it easier to link with the school's curriculum "The dog can't eat your homework".

 A plus side of their connection is being able to use multi-room audio which enables different sorts of music to be played in different rooms at the same time (their house is attached to the shop).

One Digital and Age UK South Lakeland-Kendall

Age UK are working with Citizens Online, Clarion Futures, Scottish Council for Voluntary Organisations and Digital Unite as [One Digital.](#) The aim is to tackle digital exclusion with a particular focus on enabling people using digital technology. Pauline Mort from Age UK in South Lakeland met us to talk through the Tablet Loan Scheme.

"What happens to older people who don't have children or grandchildren to work the technology?"
This is a program where older people are loaned tablets, given training and learn to use the device for example, to look at photos and communicate with family members. I inquired about how the people who borrow the tablets get online and heard that they are usually provided with a 4G dongle to connect. After the 3-month loan, digital champions help them to make choices around getting devices and connections. This is a trigger point to encourage uptake of high-speed connections. The approach of providing people with a reason to connect helps people to find value for themselves by getting online.

Suddenly Frogs (Milo Brent Carpenter), Bristol

Milo is a game reviewer and online influencer in the games/entertainment industry living in Bristol. His brand had 1.3M YouTube Channel subscribers at the time of the study. To learn about the value of connectivity for Milo I undertook the following the research activity :

- Semi-structured interview and telephone discussion

Milo reported high level use uploading, downloading streaming in gaming, film and TV. His connection means that he can collaborate internationally. For example, starting new professional relationships working with film editors. He mentioned the feeling of a sense of place with Bristol hosting more creative entrepreneurs due to high internet speeds which are available however he mentioned lack of price choices compared to what bigger cities, for example, London can offer.

Title Role, Manchester

Title Role is a film and tv production company based in Manchester. They are independent, their work is broadcast to more than 200 countries. To learn about the value of connectivity for Title Role I undertook the following the research activity :

- Semi-structured interview and telephone discussion

The director reported high level use including sending large files internationally and expressed that they "couldn't work without" their connection.

Care Homes Owner

I spoke to a Yorkshire care home owner who runs two premises. To learn about the value of connectivity for this care home I undertook the following the research activity :

- Semi-structured interview and telephone discussion

Low level use was reported including staff rotas, scanning QR code on resident's beds and expressed no plans to upgrade technology in the homes.
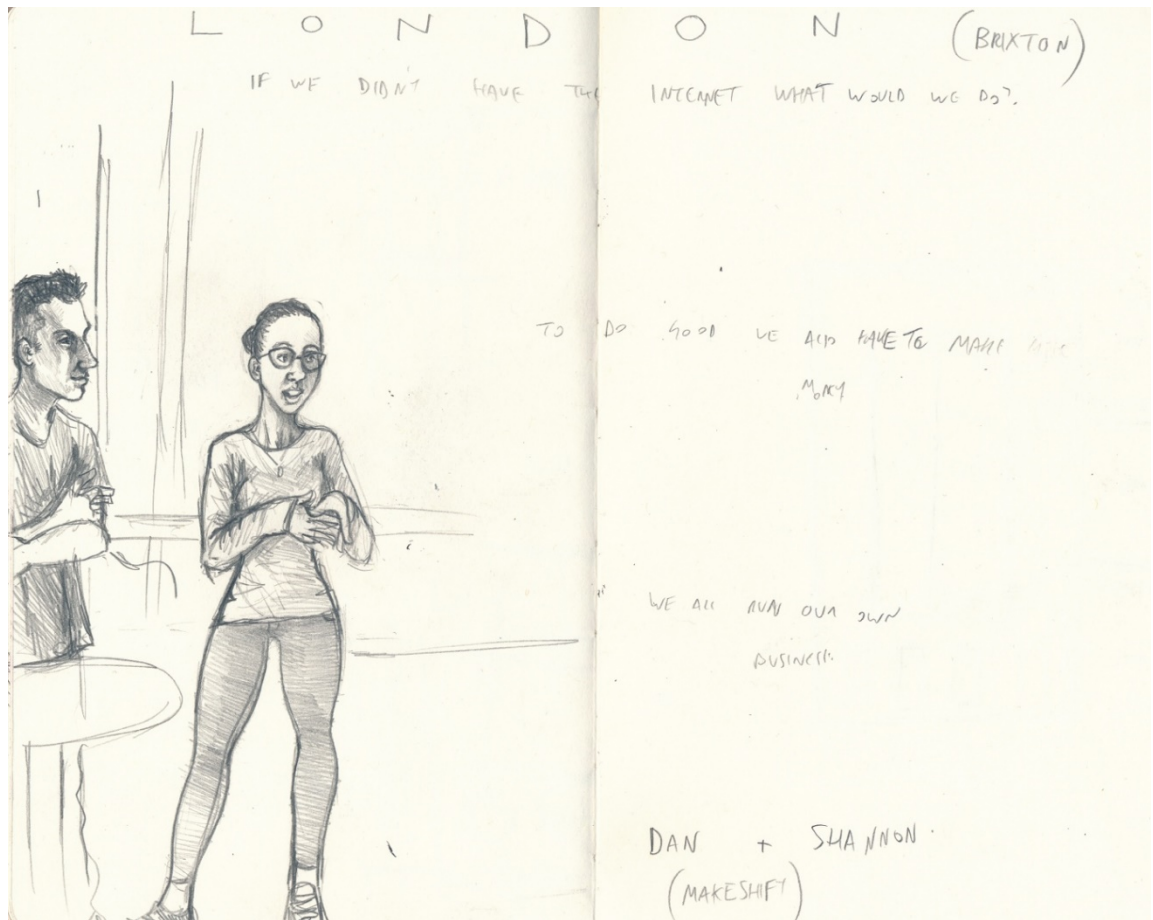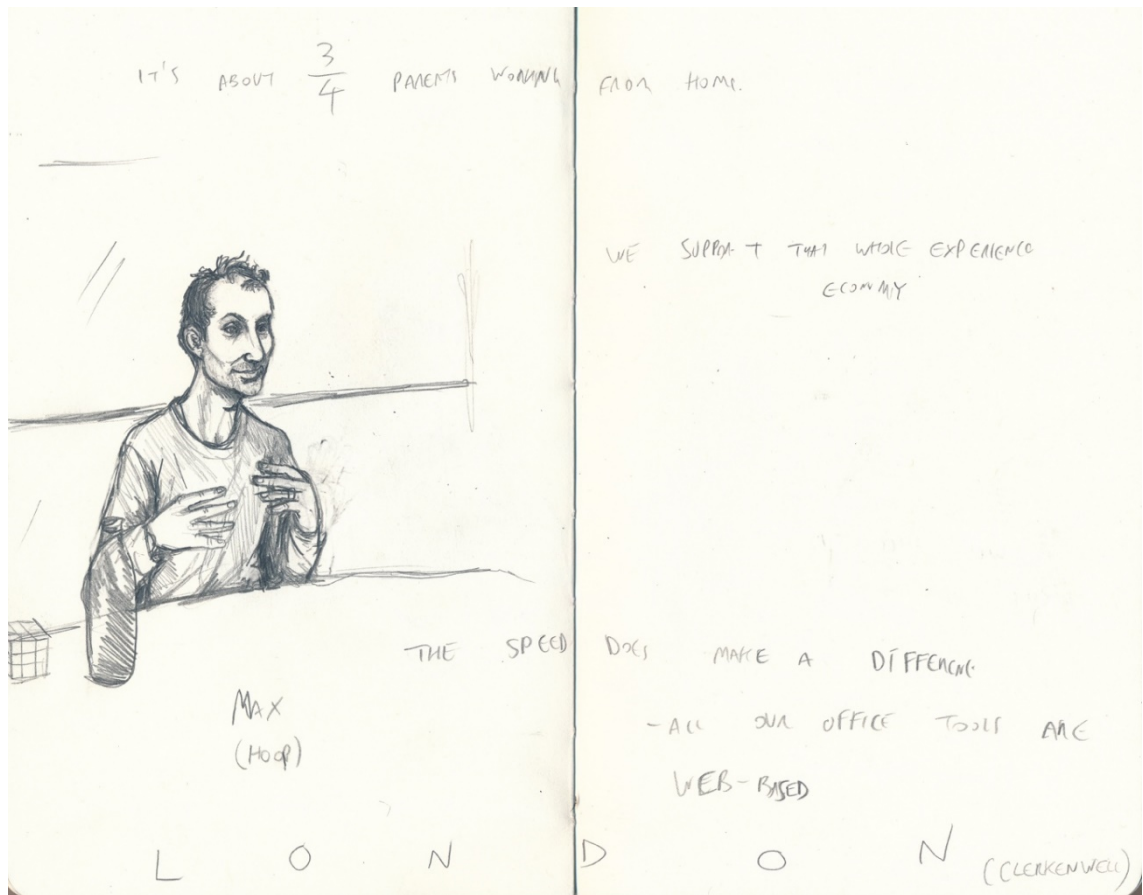
Make Shift, London

With local communities Make Shift transform derelict buildings into coworking and events spaces. Insights were collected in the following research activity:

- In person interview in office and site visit (Pop Brixton, London)

We visited their first site Pop Brixton. This is a coworking, retail and entertainment venue. Pop offers online and physical facilities to potential clients and vendors who use the space. found that their connection is supporting a number of communities within the event and co-working spaces as well as daily running of office for staff at Make Shift office. They emphasised the community focus of their business for example, working with local entrepreneurs. Pop Brixton serves its community by providing physical meeting space.
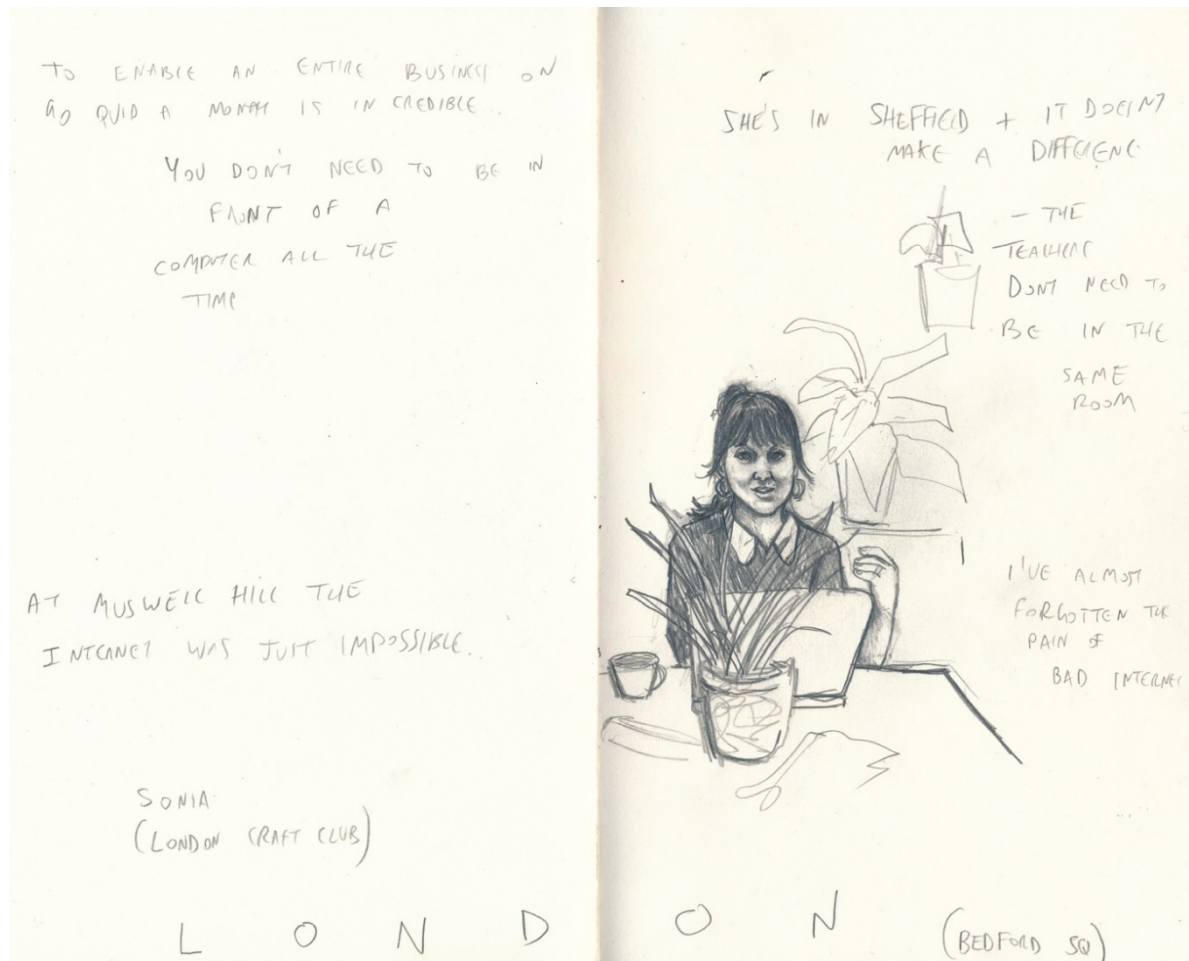
IT'S ABOUT 3/4 PARENTS WORKING FROM HOME.

WE SUPPORT THAT WHOLE EXPERIENCE ECONOMY

THE SPEED DOES MAKE A DIFFERENCE.

- ALL OUR OFFICE TOOLS ARE WEB-BASED

MAX (HOOP)

L O N D O N (CLERKENWELL)

Hoop

Hoop is an activity planning app for children with families. They currently have a London office and the app focuses on London based event but is expanding across UK. They have a large team and in-house creatives and data specialists. To learn about Hoop the following research activity took place:

- In person interview in office (Clerkenwell, London)

Their connection is used for daily operations such as reaching out to customers, emails and finance. Product maintenance-regular in app updates. The owner described the connection as 'seamless'.

TO ENABLE AN ENTIRE BUSINESS ON 40 QUID A MONTH IS INCREDIBLE..

YOU DON'T NEED TO BE IN FRONT OF A COMPUTER ALL THE TIME

AT MUSWELL HILL THE INTERNET WAS JUST IMPOSSIBLE.

SONIA
(LONDON CRAFT CLUB)

SHE'S IN SHEFFIELD + IT DOESN'T MAKE A DIFFERENC

- THE TEACHING DON'T NEED TO BE IN THE SAME ROOM

I'VE ALMOST FORGOTTEN THE PAIN OF BAD INTERNET

L O N D O N (BEDFORD SQ)

Craftwork,   *London*

This is a Not for Profit supporting craft businesses and start-ups. The Craft Club is a physical making and events space. Sonia, the owner hosts making session for example for hen party groups and other learning activities. The following research activities enabled findings:

- Semi-structured interview and telephone discussion, visit to creative/event space and further discussion

The fibre connection is used to support digital engagement. For example, events promotions, uploading imagery to website for e-commerce and social media. Sonia connects with other makers and crafts professionals nationally "one of my best makers is in Sheffield and it really doesn't make a difference". Sonia left a corporate career to set up this business and the scheme has helped to support that.

Publications

- Inbodied Interaction Design Example :Fat Tapestry in Interactions Magazine. XXVII.2 March-April 2020, p46. http://interactions.acm.org/archive/view/march-april-2020/inbodied-interaction-design-example1
- Taking on textile thinking'; chapter contribution in Textile Design Theory in the Making (Igoe, in press, Bloomsbury)
- Designing the Affective Material Palette. Using materials to explore the experience of systems and technologies designed to aid behaviour change at the European Academy of Design Conference, Dundee (2019) published in The Design Journal, Vol 22: pp. 2177–2178

Exhibitions

- Stretch Orchestra films exhibited at Futurescan 4,Valuing Practice, Association of Fashion Textiles Courses, University of Bolton (2019)
- Exhibition and presentation at Lloyd's Register Foundation Design for Safety symposium, RCA (2018)
- Exhibited at the Royal College of Art 'Work in Progress' exhibitions (2017,18,19)
- Stretch Orchestra Installation at Evolution in Design Research, at London Design Festival, RCA, (2018)
- '(A)dressing Stigma' garment exhibited Intelligent Textiles and Mass Customisation Conference exhibited in Smart Textiles Salon, Ghent (2017)

Workshops

- What does Connectivity mean to you? Broadband for the Rural North computer club, Lancashire (2019)
- Data Materialisation workshop at Emotions in Data Vis, Graphic Hunters conference, Utrecht (2019)
- Exploring Data workshop at Stitching Together Network retreat, Clayhills Arts, (2019)
- Design Research Society Conference, delivered the workshop 'Designing the Affective Material Palette' at PhD by Design, Limerick (2018)
- Material Mapping for Affect, Cognitive Science Seminar Series, Queen Mary University of London (2018)

- Stretch Orchestra workshop with Haringey Rhinos Ladies rugby team, New River Sport Centre, London (2018)