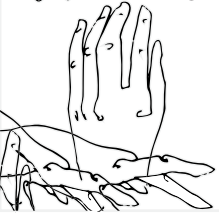
An understanding of embodied textile selection processes & a toolkit to support them

Bruna Beatriz Petreca

Supervised by:
Professor Sharon Baurley and Professor Nadia Bianchi-Berthouze



Thesis submitted in partial fulfilment of the requirements for
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Declaration

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

I, Bruna Beatriz Petreca, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Signature: Bruna Beatriz Petreca

Date: 4th November 2016

Copyright statement

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Abstract

The textile selection is a crucial part of the design process, for which there is no systematic understanding and no support in place from the designer experience perspective. In the selection, designers need to synthesise technical information, their sensory and affective experience around textiles, and its related meanings. However, currently the textile industry just provides methods to describe, measure, or predict the properties of textiles perceptible to hand manipulation: methods that only partially support the designer. Hence, designers' selection still relies heavily on experiential knowledge, that is, through processes that remain implicit or inaccessible to conscious articulation. The thesis addresses this gap by contributing new understanding of when and how the textile selection happens in the design process, uncovering tacit processes and embodied aspects integral to it, and secondly, by developing a toolkit to support the designer experience when selecting. The Design Research Methodology (Blessing and Chakrabarti, 2009) was taken as the overarching methodological approach, and was enriched by a further selection of methods. This approach enabled the description of the textile selection in the design process by investigating diverse sectors (fashion, interior and vehicle design), and led to the development of a support for this activity reflecting the reality of designers' practice. To understand the textiles selection processes, four qualitative exploratory studies were conducted. Study one investigated the textiles selection by designers, taking a Grounded Theory approach, which revealed when (in the design process) and how textiles selection happens (through four emerging themes - 'Collection', 'Interrogation', 'Projection', and 'Transformation'). These processes were articulated to propose the 'Quad-core Textile Selection Model'. Study two investigated a facsimile design process, of sports shoes customisation in a retail setting. Through this study the tacit processes were confirmed and better understood, and 'Projection' was further elaborated as a phenomenon. Study three investigated an intense moment of selection in the context of a textile fair to understand what sensorial information underpins the textile selection processes. This study revealed the importance of the multisensory experience to textile selection, and the complexity of remembering and communicating such experiences in the design process. Study four explored the embodied aspects of textiles selection emerging as significant through the tactile experience in more depth, using the 'Elicitation Interview' (Petitmengin, 2006) method to obtain a first-person verbal description of experiential processes. The latter revealed 3 types of touch behaviour and 3 tactile-based phases of the textile selection process, and their dynamics. These findings enrich the proposed model including experiential and embodied components of the textiles selection that go well beyond 'textile hand' (AATCC Test Method 202-2012), and highlight the dynamics and interactions between the textile, the body and the product to be, which emerged as crucial for these processes. Finally, these findings were used as input for designing 'The sCrIPT Toolkit', comprised of instructions that facilitate focus and elaboration of the textile experience in the textiles selection. To conclude, a reflection on the pedagogical potential of this tool is presented, based on explorations within various sectors in academia.

Acknowledgements

Throughout this PhD I learned that my experiences are only relevant for this bodily existence, in relation to people, things and spaces. From this embodied perspective, I would like to thank all of those who have supported me through this (trans)formation.

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Further out into COSMOS, there are so many dear people I want to thank, that I thought about an action word to synthesise what each of you have inspired me throughout this journey:

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Rachel Arduin (enjoy)
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Katia Aprile (familiarise)
Fernando Garrido (accompany)
Stephanie Degreas (share)
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Clarissa Lorenz (fight)
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Grit Hartung (reflect)
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Main publications (accomplished through this research program)

Publication Type	Description	Based on
Paper in preparation	Petreca, B., Furniss, D., Bianchi-Berthouze, N., Baurley, S. Textile Selection for Design: A Grounded Theory Study to Make Tacit Process Tangible. *To be submitted to the journal Design Issues.*	Chapter 4
Paper in preparation	Petreca, B., Furniss, D., Bianchi-Berthouze, N., Baurley, S. From Coordination to Projection: Using Distributed & Embodied Cognition to Explore How Consumers Use Tools When Customising Products. *To be submitted to the journal TOCHI.*	Chapter 5
Paper in preparation	Petreca, B., Bianchi-Berthouze, N., Baurley, S. Feeling Textiles Like an Expert: Articulating Designers Tactile Experience in Textile Selection for Design. *To be submitted to Journal of Design and Science (MIT Press).*	Chapter 7
Paper in preparation	Petreca, B., Saito, C.; Bianchi-Berthouze, N., Baurley, S. The sCrIPT Toolkit: Designing a Support to Embodied Textile Selection Processes. *To be submitted to the journal Design Issues.*	Chapter 8
Book chapter	Petreca, B., *in review*. **'**Giving body to digital fashion tools.' In: *Digital Bodies*. London: Palgrave Macmillan.	Chapter 2
Journal	Petreca, B., *in press*. Können wir digitale Textilien fühlen? Designforschung, Körpererfahrung und ein Ausblick auf zukünftige Technologien", in: Jana Herwig, Alexandra Seibel (Hrsg.), Texture Matters: Der Tastsinn in den Medien – haptisch/optisch 2 (Maske und Kothurn. Internationale Beiträge zur Theater-, Film und Medienwissenschaft, vol. 61/1), Wien: Böhlau	Chapter 2
Journal	Atkinson, D.; Baurley, S.; Petreca, B.; Watkins, P.; Bianchi-Berthouze, N., 2016. The tactile triangle: a design research framework demonstrated through tactile comparisons of textile materials. *Journal of Design Research.*	Chapter 2
Conference proceedings	Petreca, B., Bianchi-Berthouze, N., Baurley, S., 2015. How Do Designers Feel Textiles? In: *Proceedings ACII'15*. IEEE.	Chapter 7
Conference proceedings	Petreca, B., Atkinson, D., Bianchi-Berthouze, N., Furniss, D., Baurley, S., 2014. The future of textiles sourcing: exploring the potential for digital tools. In: *Proceedings of the 9th Design and Emotion International Conference*. Colombia, 8-10 October, 2014.	Chapter 6
Conference proceedings	Petreca, B., Bianchi-Berthouze, N., Baurley, S., Watkins, P. A., Atkinson, D., 2013. An embodiment perspective of affective touch behaviour in experiencing digital textiles. In: *Workshop on Mediated Touch and Affect (MeTA) in conjunction with ACII'13, Geneva.*	Chapter 2
Conference proceedings	Atkinson, D.; Orzechowski, P.; Petreca, B.; Bianchi-Berthouze, N.; Watkins, P.; Baurley, S.; Padilla, S. and Chantler, M., 2013. Tactile perceptions of digital textiles: Design research approach. In: *Proceedings of 2013 ACM SIGCHI Conference on Human Factors in Computing Systems.*	Chapter 2

Awards

Type	Award
Funding	**(2015)** RCA – Student-led fund – granted by the Research Methods Course to organise workshops *'Relational Materials: From Material to Experience & From Experience to Material'*
Funding	**(2014)** RCA – Student-led fund – granted by the Research Methods Course to organise the seminar and workshop *'Super-feelers: materials and design sense making'*
Prize	**(2013)** Best concept or narrative in Human Centred Design, on the annual Human Centred Design Institutes PhD research prize competition, Human Centred Design Institute.
Prize	**(2013)** Best poster presentation, IV ABEP-UK Conference.

Invited Talks

Participation	EVENT
Seminar	**(2016)** Petreca, B. "Flash on, Flesh on, Fashion: moving on with fashion and technology". Talk to MA Fashion and Service Design students within the project Living Technologies. 16th February 2016.
Seminar and workshop	**(2016)** Petreca, B. "The Plasticity of Materials Experience". Talk at the event "Designing with Plastics", followed by a workshop using the 'sCrIPT Toolkit', organized by the Museum of Design in Plastics (MoDiP) and the Knowledge Transfer Network (KTN UK). Art University Bournemouth, 11th February 2016.
Workshop	**(2015)** Petreca, B. ***"Relational Materials".*** Workshop "From Material to Experience" conducted at the Delft University of Technology, NL. 4th December 2015.
Presentation	**(2015)** Petreca, B. "Feeling Like an Expert". Talk at the event "Inflating Curiosity" organized by MIT and IDE at the RCA. London, 14th October 2015. Event website: http://www.inflating-curiosity.com
Seminar and workshop	**(2015)** Petreca, B. ***"Relational Materials".*** Workshop "From Material to Experience" conducted at the University of the Arts Bremen, funded through the scheme ERASMUS+, with the collaboration of their MA student Carmem Saito. 9-10 June 2015.
Seminar	**(2015) Petreca, B.** ***"Articulating Our Tactile Experience With Textiles".*** Seminar presented at the Fashion and Textiles Research Group at RCA on the 28th May 2015.
Presented	**(2015)** Petreca, B. **"*In our pockets: investigations of tactile experiences through touch behaviour during textiles selection.*"** Poster presented at the First International Affective Touch Congress, 20-22 March 2015, at UCL in London.
Presented	**(2015)** Petreca, B. ***"Articulating Our Tactile Experience With Textiles: Undisciplined Conversations On The Unspoken."*** Paper presented at the 'Erotic Cloth' Symposium, 20 March 2015 – at the Art Workers Guild in London.
Presented	**(2015)** Petreca, B. **"*How designers feel fabrics: Investigations towards articulating tacit dimensions in the process of selection*."** Paper presented at the 'Enacting Modalities of Feeling' workshop held by the Anthropology Department at the University of Vienna. 25-27 Feb 2015.
Presented	**(2014)** Petreca, B. ***"The sensory experience of textiles".*** Seminar presented to the MA Fashion Futures at LCF. 20th November 2014.
Presented	**(2014)** Presented at the MIDAS (Methodological Innovation in Digital Arts and Social Sciences – Digital Technology and Embodiment) Event: "The Body in Digital Fashion" in 19th September 2014 – seminar entitled: ***"Embodied cognition in textile selection."***
Presented	**(2014)** Seminar at the Karolinska Instituet in Stockholm at the Centre for Social Sustainability. Seminar title: ***"Design research towards experiencing textiles".*** 20th August 2014.
Presented	**(2014)** Textile Innovation Workshop organised by an AHRC funded research network 'From Invention to Consumption: electronic textiles', which took place on the 14th July at the Institute of Making – UCL. Presented in a panel on "Design method/praxis" and talked about sensory perception and textiles.
Presented	**(2014)** Petreca, B. "***Towards Experiencing Digital Textiles: Design Research, Embodied Experience, and a Glimpse of Future Technologies"***. In: TEXTURE MATTERSThe Haptical and Optical in Media International Conference organised in collaboration by Universität Wien, The Tisch School of the Arts at New York University and the MAK Vienna. 2nd and 3rd June 2014 at MAK – Vienna.

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1. Introduction

1.1. Context of research

"The challenge when working with the senses is to not presuppose that we already know what it means to sense."
(Manning, 2007)

The textile selection is a crucial part of the design process, to which there is no systematic understanding and no support in place from the designer experience perspective. This is both an inspiring and a critical task in the design process, and designers need to be imaginative as well as fulfil technical requirements, while achieving a desired experiential effect. The textile options are numerous and make this an overwhelming process[1], so it is important that designers are prepared to make decisions, which demands adequate support and training. In the selection, designers need to synthesise technical information and their sensory and affective experience around textiles, and also its related meanings. However, currently the textile industry provides methods to describe, measure, or predict the properties of textiles perceptible to hand manipulation (i.e. the 'textile hand'), which only partially support the designer. Hence, most of their selection still relies on experiential knowledge, through processes that remain implicit or inaccessible to conscious articulation.

This has been an ongoing issue in the industry, which was recently highlighted in the fashion realm, as the visionary trend consultant Li Edelkoort asserted that "fashion designers [are] being trained who are not familiar with fabric, who do not know how textiles work or how fibers react." (2015 cited in Dewintre, 2015). Even though this topic may be surfacing, so far the reality of the industry is that the existing support is mostly focused on providing information about the textile physical characteristics, e.g. in technical specifications. The latter are provided through objective (used for measurement of textile properties) or subjective (explicitation of textile properties

[1] In this process numbers (e.g. time, volume, costs and technical specifications) pressurize designers' decisions. This can be highlighted through the example of the fashion industry, where designers usually need to travel to source fabrics. At Première Vision, the largest textile sourcing show, 1,725 exhibitors from 52 countries present collections that are developed closely with industry (Première Vision, 2016). Additionally, fairs are spread across the globe and happen at close periods in the year, and designers travel to source on these occasions and encounter masses of information to absorb and make sense of.

through verbal descriptors) methods that are used to assess and characterise the physical properties of textiles, and numbers or verbal descriptors related to its characteristics and performance are abstracted.

This disconnection between experiential knowledge and the explicit knowledge around textiles experience, the latter currently provided through this measurement-based lenses of textile engineering field, is also at odds with evidence in literature that technical information is mostly useful at the later stages of the design process (which will be discussed in Chapter 2). Additionally, literature centred on designers' practice gives the impression that the selection occurs from early stages of the design process, and that at this moment the experience of materials is critical for defining the success of a product (Karana et al., 2015). Indeed, the selection of materials in the early design stages is not only based on technical concerns, but also on the experience that they can provide, which designers experiment with when interacting with textiles, as will be highlighted in Chapter 6. The latter has a strong influence on the creation of design concepts. To address this gap, this thesis investigates how textile selection sits, how it is performed in the design process, and how it can be facilitated.

This thesis contributes to knowledge by: (i) understanding when and how the textile selection happens in the design process (i.e. how it accompanies the design process), (ii) uncovering tacit processes and embodied aspects integral to it, which show that the selection is not only based on physical properties of textiles, and (iii) developing a support for the designer experience when selecting, specifically the embodied processes, that facilitates focus and elaboration of the textile experience.

Such contributions emerged through an iterative process where, by investigating the 'experiential'[2] aspects of textiles selection in a more general manner, the 'embodied'[3]

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[2] At the start this research followed John Dewey's (1980) positioning, for whom experiences emerge from continuous interactions that are "involved in the very process of living" (Dewey, 1980, p. 36). Experience is about relating, and "every experience is the result of interaction between a live creature and some aspect of the world in which he lives" (Dewey, 1980, p. 45).

[3] Here the embodied experience is considered taking the body as "the subject of perception" (Merleau-Ponty, 2012, p. 239), i.e. the body as a source of experience (Bianchi-Berthouze, 2013). The term 'embodied' highlights the corporal basis of experiences (Petitmengin, 2006; Thompson and Varela, 2001), particularly sensorimotor (Dewey, 1980). As Merleau-Ponty (2004) suggests, "Indeed our experience contains numerous qualities that would be almost devoid of meaning if considered separately

processes emerged as crucial for experiencing textiles, particularly in knowledge creation, affective states, and for the creative process flow. Indeed, the manner in which we generate knowledge and organise information is always related to the body[4]. Hence, this required a more focused approach to investigate such embodied processes of the experience, particularly as the connection between embodied (sensorimotor) and affective experience emerged as relevant in this research (mainly in Chapter 7, and which was noted previously in research by Savva et al. (2012) and Bianchi-Berthouze (2013) in the context of games and human-computer interaction), and also in relation to experiential knowledge[5] of designers. This positioning emerges throughout the thesis, following the research progress, and will be reflected upon in the concluding summary.

This research is an offshoot from the research project *Digital Sensoria*[6] (Professor Sharon Baurley, PI – grant no. EP/H007083/2), whose main aim was to enable people to communicate about their tactile perceptions around textiles. This thesis builds on the knowledge acquired from Digital Sensoria, and responds to the gap identified through the literature review and to insight from industry, both of which show that currently there is a disconnect in supporting the designer in textiles selection processes.

1.2. Background

Textiles selection is a critical process in the design industry, to which there is no systematic understanding and no support in place from the designer experience perspective. This is both an inspiring and a crucial part of the design process, and

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from the reactions they provoke in our bodies. (…) The only definition of this quality is a human definition" (pp. 46-47).

[4] An important contribution to knowledge that exemplifies how human cognition works is the concept of 'embodied metaphors', proposed by Lakoff and Johnson (1980, 1999), which demonstrated that language metaphors are rooted on dynamic patterns of recurrent bodily experience (Lakoff and Johnson, 1980). These are fired by the sensorimotor system and are crucial for cognition (e.g. conceptualising, reasoning and visualising experience).

[5] This will be discussed throughout the thesis in terms of implicit, tacit knowledge (Dormer, 1994; Veja, 2015), where the knowledge is personal and embodied (Goodwin, 1994; Petitmengin, 2006), develops in action (Schön, 1991), increases with expertise (Goodwin, 1994), and hence is difficult to make explicit and "transmittable in the form of concepts and rules" (Petitmengin, 2006; p. 234).

[6] This research was focused on facilitating people's understanding of products by creating means to communicate their sensory perceptions using rich multi-modal digital interfaces.

designers need to be imaginative as well as fulfil technical requirements while achieving a desired experience.

Currently research on textiles provides well-defined, systematic methods and is mostly interested in measuring objectively, replicating and controlling the feel of textiles for manufacturing and quality control. These are related to what the industry defines as 'textile hand', which refers to "the tactile sensations or impressions that occur when fabrics are touched, squeezed, rubbed or otherwise manipulated" (AATCC Test Method 202-2012). To understand 'textile hand', this field relies mostly in objective and subjective approaches, according to the definitions that follow. Subjective analysis has been employed for characterisation of the tactile properties of textiles (Bensaid et al., 2006), to assess consumer preferences (Philippe et al., 2003), to verify quality and suitability of new fibres, material structures and finishing, and for fibre blend characteristics of handle analysis (Howorth and Oliver, 1958). Diverse methods have been applied in subjectively assessing fabrics considering the many variables involved (Laughlin, 1991; Guest and Spence, 2003; Philippe et al., 2003, Behery, 2005). In pursuit of more tangible information, objective measurements serve to complement subjective analysis (Howorth and Oliver, 1958, Cho et al., 2002). In objective evaluation (Behery, 2005; Kawabata, 1980) properties of a textile are assigned numerical values, which can then be interpreted to indicate how it is expected to feel (e.g. a fabric with a high bending rigidity measurement is expected to feel stiff). The results obtained through such objective systems require specialist technical knowledge for interpretation and use. These are produced through systematic analysis focused on the textiles, and which are lab based. *Both subjective and objective approaches are focused on characterising the textile based on its physical properties*. This focus on the textiles is the first aspect that supports the problematic that this thesis will interrogate, which is related to the type of support currently in place to aid textiles selection, as is provided by the textile-engineering field. Here we see that even when the field introduces subjective approaches, mainly what they mean is an explicitation of textiles properties, through verbal description. *Hence, what we see is a predominance of explicit, most times quantifiable, knowledge centred on the textiles only*.

Since not only numbers determine the designer selection, non-measurable *experiences* through the textiles are also investigated in this thesis. This is considering that information around textiles properties and performance has limited use for designers,

whose selections are also based on their sensibilities and experience acquired through training and practice (Bang, 2011). This is highlighted by reports of great designers who claim to explore this relation through 'conversations' with the textiles. As an example, in famous statements by the designer Yohji Yamamoto, he argues, *"Fabric is the skin"* and considers it a living and responsive thing, that should be listened to as *"The fabric has much to teach us"* (Yamamoto, in Salter, 2014). But the ways in which such conversations happen is still very little understood and poorly articulated. Hence, this experiential knowledge remains difficult to grasp.

Observing literature on designers' practice in order to gain insights into their knowledge and experience, it becomes clear that designers are familiar with the physical characteristics and aesthetics of textiles, besides its suitable applications and contexts of use. They rely on multiple resources for inspiration and research – personal, cultural, market and trend related (Bang, 2009a), which they skilfully articulate in design proposals and communicate to design teams and stakeholders, to guarantee their concepts are translated through manufacture and use. Such knowledge is innate (reliant on designers' sensibility and intuition) and tacit (acquired through training and experience) (Dormer, 1997). Designers communication in the design process is usually verbal, visual or through samples, and frequently is multimodal. This recalls Dormer's definition of distributed knowledge (1997) that designers rely on the environment they work within – the social, organisation and the physical environment – to form their knowledge basis, test concepts and support decision-making processes. They use, for example, mood boards, samples and prototypes[7] to progress their thinking (Cross, 2011),

[7] Experiences with materials, such as prototyping, are crucial for thinking with things. Recently, embodied cognition studies (Kirsh, 2013), have described how things are used in thinking through the concepts of 'anchoring' (where things are used to externalise thought) and 'projection' (where things are used to support thinking about things that do not yet exist). However, this is not a novel theme in the fields of art and design. In art, the relation between perception and production is highlighted as it always involves a "process of doing or making" (Dewey, 1980, p. 48), where 'material engagement' is seen as crucial for thought and reflection processes (Karana et al., 2015). In crafts, the craftsperson is seen to engage in conversations "with" materials (Ingold, 2013), and this direct experience of materials is related to learning processes (Schön, 1991). In the intersection between art, crafts and design, the Bauhaus (Moholy-Nagy, 1929; Albers, 1934) made a strong contribution by proposing pedagogical approaches for relating with materials, and deriving knowledge from subjective experience. In product design, 'designerly' ways (Manzini, 1986) of exploring possibilities of materials application and use, through tinkering and making, as well as the impact that this deeper engagement has on the end user experience have been acknowledged (Manzini, 1986; Ashby & Johnson, 2002; Karana et al., 2014, Karana et al., 2015). More recently, as design increasingly engages with technology, we see products that reveal opportunities for engaging with materials (Bergström et al., 2010), introducing new blends between the physical and digital (Strong and Gaver, 1996; Dodge, 1997; Tollmar et al., 2000; Zimmerman et al.,

they literally "think with things" (Kirsh, 2013, p. 26), and communicate or explicit their thoughts through. To support their thinking with things, designers have access to physical material libraries and trade fairs that offer a wide range of materials, and are curated to showcase the most innovative ones, allowing designers and product developers to be updated in terms of future trends (Mani et al., 2013). There are also instances in which they interact directly with suppliers and agents, and also get to receive physical samples in this way.

However, irrespective of the acknowledgement of the importance of 'thinking with things' as a means to inform making, these processes are still not described in the textile field. Indeed, *currently there is no systematic understanding of the textile selection in the design process, and of when and how such activities and methods support it*. The latter is the second aspect of the problematic addressed through this thesis: *the lack of understanding and support to experiential aspects*. What we do not know is: what are the processes supporting this experiential approach? Through this thesis we try to understand *how* such processes occur and affect designers practice, so that they can then be supported.

The two aspects highlighted above form the basis to state the problematic that this thesis will address. This is related to a disconnection between design and engineering approaches, when it comes to support textiles selection, and which revolves around the spectrum: *objective – subjective – experience*. As was defined above, the objective side is where there is more understanding available, which is centred on knowledge about the textile; the subjective is considered here in the terms of the textile-engineering field, which is also concerned with understanding the textile; the experience is the least understood, but here is where the designer lacks support.

2007; Sundström et al., 2010; Giles and van der Linden, 2014). Here tinkering with materials is crucial for prototyping artefacts and interactions that facilitate bringing "material considerations into the design process" (Giaccardi & Karana, 2015, p. 2448). Common to the above examples is the consideration that physical engagement with materials enables understanding that supports decision-making. This is also seen in literature on the application of textiles to products, where making is seen as crucial to the selection cycle, and physical experimentation is considered fundamental for production, aesthetic, and financial definitions (Jones, 2005). In the textiles area, the role of making within the selection cycle has been noted from traditional weaving (Albers, 1982) to e-textiles design (Veja, 2015). The most acknowledged advocate remains the Bauhaus tutor Anni Albers (Danilowitz, 2000), who considered materials selection crucially related to the process of making, and that the choice emerged from conversations with materials, "in a dialogue with our medium" (Albers, 1982). Veja (2015) demonstrated how prototyping is a crucial means to "select ideas to take forward" (p. 71), both in terms of materials and processes.

There is currently not much more than samples and technical specifications in place to support the textiles selection, hence research into general materials selection is considered here to expand our understanding and better frame this problematic. Research into materials selection is increasingly exploring experiential aspects to support designers beyond providing technical specifications. These meet the previously identified need to support a better balance between technical and experiential information, as noted in materials and design research (Ashby and Johnson, 2010; Karana et al., 2008, 2010, 2013, 2015; Miodownik, 2007; Rognoli, 2010; Van Kesteren, 2010). This stream of research is more experience-related and often subject to culture, market, time, place and context diversity. Such initiatives are user-centred and reveal novel approaches to include stakeholders in the material selection for design.

The evidence above shows that there is no current systematic understanding of the textile selection, and that *a better balance between measurement-based (objective and subjective) and experiential approaches would be desirable to support designers in selecting textiles*. This thesis addresses this gap by investigating how the textile selection sits, how it is performed in the design process, and how it can be supported from this experiential perspective.

An additional insight serves to position this approach in relation to expert practices in general. This moment of clarity happened in a recent talk[8] by Lutz Förster, dancer and the artistic director of the Tanztheater Wuppertal, who, when asked about what *'excellence'* is, defined it as a combination between *craft* and *emotion*, where "if there is too much craft and little emotion, it [the outcome] is boring, and if there is too much emotion and little craft, it [the outcome] is embarrassing". It is this refined sensibility and ability to balance the technical knowledge with the experience that are so unique to designers, or other experts working with a high level of expression, technique and synthesis, and which this thesis will consider. It will do so in order to arrive at both new understanding and a means to support the textile selection, while keeping this wider perspective of achieving 'excellent' design outcomes in mind.

[8] This talk was part of the event Dance vs. Neuroscience, held at the Siobhan Davies Dance studio on 25th September 2015, organized by the neuroscientist Guido Orgs and the choreographer Matthias Sperling.

Finally, an aspect that must be considered when thinking about how to support experiential processes, is that the latter are based on tacit knowledge. Although this is not the central point of investigation, a question of concern to this thesis is about *how tacit knowledge can be harnessed to support design*. Through this thesis, it was necessary to make explicit embodied textile selection processes, so that now we can think about means to help designers to communicate and to support them in using their experiential knowledge. Hence, this thesis is not trying to find a way to make experience explicit, but interrogating it to understand how to support.

This relation between explicit and tacit knowledge is crucial for this thesis, particularly while designing support, as there is a concern to whether awareness of such experiential processes could break the experience. This concern has been recently problematized in a debate between the artist Michael Craig-Martin, professor Richard Sennett and Serpentine Co-Director, Hans Ulrich Obrist at the Goethe-Institut in London[9]. Whilst discussing Craig-Martin's practice and transformations in design and technology, the panel raised a debate around knowledge transfer in art and design, to which Richard Sennett suggested that tacit knowledge should be a major concern to the field. His point was that it is important to understand how to transfer tacit knowledge through tacit means, as much of this knowledge is difficult to explicit, but still should be passed on. This *tacit-to-tacit* aspect will animate discussions throughout this thesis.

1.3. Empirical Background – The Tactile Triangle

In researching means to elicit and communicate tactile experience of textile materials, whilst keeping a correlation to the textiles objective, measurable properties, there is only one piece of work that includes the designers' perspective. This work also proposed a method, a design game, which can be used as an accessible mean for designers to tap into user's tactile perceptions around textiles.

The Tactile Triangle (Atkinson et al., 2016) is the outcome of a previous collaborative research work, developed within the Digital Sensoria project, and which reflected strongly on the methodological choices for this thesis. In the Tactile Triangle we have proposed a framework, building on previous literature, to enable systematic access to

[9] Talk organized by the Serpentine Gallery at the Goethe-Institut in London, in 16 December 2015.

tactile experiences with textiles, which are approached through three levels: physical (properties of textiles that affect their perception, which are measured using specialist machinery), perceptual space (perceptual dimensions that people use to evaluate and understand textiles, for which we used triadic comparisons to describe dimensions relevant to the tactile experience), and communication (the vocabulary used to communicate about these experiences - e.g., words, gestures, for which we created design games to articulate tactile perceptions).

This study reinforced the importance of having a common language to articulate 'feel' (or 'feeling'), in order to bring consumers perceptions closer to the design loop. It also highlighted the need for developing adequate methods to introduce this type of exploration into designer's practice, observing how the methods brought in from other areas would not be suitable, because these require specialist training (in the case of objective measurements), or would demand time investment (in the case of triadic experiments), which does not usually suit the timeframe of a design project in the industry context. This has been one of the main motivations for this thesis, to investigate means to support designers from this experiential perspective considering the nature of their practice.

Additionally, the study showed that correlations between objective and subjective data are reliable, but do not address how to contextualise this within the design process. This thesis builds on this work to observe when designers need such information in the design process. This aspect was further explored in the first study undertook in this thesis work, presented in Chapter 4.

1.4. Researcher's background

Moving textiles moved me. This passion motivated all my explorations so far. I have a Fashion and Textiles BA at the University of São Paulo, in Brazil. During my training I discovered a textile lab in a technology research institute in São Paulo, in which I worked for nearly seven years, and there I had the chance to investigate textiles in the most diverse situations – from working with antique items to emerging new fibres. Alongside, I have practiced as a costume designer, and learned to dress bodies starting from their movement; to do this, a crucial part of my process has always been to attend rehearsals, and closely observe the dancers moving, sometimes also learning

movements from them, in order to appreciate them fully. My interest on the interactions between people and textiles grew in importance when my work at the research institute became focused on clothing comfort, which brought it closer to my practice as a costume designer. This opened up the opportunity to be trained and conduct research on 'textile hand' (i.e., measuring textile properties that affect their hand feel), and also led me to a research internship abroad, which was when I participated in the project *Digital Sensoria*, and got to work with my PhD supervisors for the first time. From the internship, a bigger collaboration unfolded, and I kept measuring 'textiles hand', but engaged with the Digital Sensoria team in investigating people's tactile perceptions around textiles through a design research approach, and combining both knowledge paths. This unfolded in the creation of alternative design research methods to investigate people's experience (and culminated on the proposition of 'The tactile triangle: a design research framework demonstrated through tactile comparisons of textile materials' (Atkinson et al., 2016), reported in section 1.3 above), and to inform the design of digital tools to communicate textiles feel ('Tactile Perceptions of Digital Textiles: A Design Research Approach' (Atkinson et al. 2013)).

Whilst working at the research institute I realised that there was something missing in their methods, and working on the Digital Sensoria project confirmed that impression. My background as a designer and experience as a researcher in a technology research institute has put me in a privileged position to conduct the research reported in this thesis. This background enables me to oscillate between the different methods, and because I understand both worlds I can use methods from both worlds, i.e. I am using my intuitive side (designer) to gain an empirical understanding of what happens in the intuitive practice of designers.

1.5. Research objectives and questions framing the thesis structure

The aim of this PhD is to understand how textile selection sits and how it is performed in the design process, and how it can be supported from an experiential perspective. To do so, the investigations reported here have focused on the designers' experiences with and through textiles to generate new understandings about how these inform the selection process, and to propose modes of facilitating it. Initially, this research pursued a key research question: *How do designers experience and select textiles?* Following the initial phase of qualitative exploratory research, as the research focus has been refined,

this question has been revised to fully accommodate the main aim of the thesis, i.e. to better understand and support the process of textile selection. This led to the definition of four discrete research questions, which were revised iteratively as the research progressed, and which motivated the investigations. These questions are presented through the studies in Chapters 4-8, and are shown in Table 1.

Table 1. Programme of research and structure of the thesis

Focus	Research Question	Study	Objectives	Setting	Main Findings
Descriptive studies (*how-is*)	**RQ1.** What are the processes that designers follow in the selection of textiles and how does the experiential component of selecting textiles affect these processes?	Chapter 4	To uncover when textile selection is performed during the design process and how it is performed.	Lab – in fashion, interior and vehicle design companies (professional)	- Textile selection accompanies the whole design process, as represented in the Textile Selection Model (Fig. 17) - Textile Selection occurs through tacit processes: Collection, Interrogation, Projection, and Transformation. These form the 'Quad-Core Textile Selection Model' proposed (Fig. 18)
		Chapter 5	To unpack the processes that support textiles selection.	Real world - customisation of sports shoes (Semi-professional)	- Confirmed the processes of Collection, Interrogation and Projection - Revealed that Coordination in the physical space and the use of tools adds dynamics to the processes - Projection occurs through Physical, Visual and Social processes
	RQ2. What sensorial information underpins the textile selection processes?	Chapter 6	To understand what information is used to support selection and what the barriers (difficulties) are.	Real world – textile fair (Professional)	- Information used is multisensory: touch, visual, aural, and proprioceptive (e.g. how the hand moves) - Relevant themes in relation to sensory experience in selection: selection is overwhelming (mainly due to lack of structure and lack of awareness), it requires memory (masses of information to synthesise, and which is not provided through technical specifications only) and communication
	RQ3. How does the body support the different forms of textile selection?	Chapter 7	To understand the designer tactile experience with textiles, particularly to: (i) further our understanding of the embodied experience through observing textile touch process with more fine-grained descriptions, and	Lab – experienced designers (Professional)	- 2 types of touch behaviour (active and passive), occurring through 'Active hand', 'Passive body', and 'Active tool-hand'; - They occur through 3 tactile-based phases ('3S Tactile Phases'): Situate, Simulate, Stimulate; - The tactile phases are related to the 'Quad-core Textile Selection Process' (Fig. 42)

Focus	Research Question	Study	Objectives	Setting	Main Findings
			(ii) inform the design of methods and tools to support it during the textile selection process.		
Prescriptive studies *(how-to)*	**RQ4.** How can the experiential forms of textile selection be supported to facilitate a systematic approach?	Chapter 8	To provide a systematic approach to the experiential and embodied forms of textile selection in the design process.	Lab – mature students (Pedagogical)	- Designed a toolkit formed of instruction cards ('the sCrIPT tool') - The instructions facilitate focus and elaboration of the textile experience through externalizing - The toolkit harness the embodied experience and experiential knowledge - Validation confirms support in: systematic exploration (an accessible way to be empirical), approximate feeling-thinking, deeper understanding through subjective experience

Question 1 is responding to the lack of understanding of how the textile selection sits and how it is performed in the design process. It is also interested in observing designers tacit and experiential knowledge, and how these influence the selection process, which is little understood and difficult to grasp. This gap is demonstrated through the literature review in Chapter 2, section 2.2. This question is addressed through Chapters 4 and 5. In Chapter 4 a qualitatively multiple studies using Grounded Theory were conducted to investigate the designers' textile selection in diverse fields (fashion, interior and vehicle design). In Chapter 5 the emergent understanding from Chapter 4 is confirmed by a further study carried out to unpack the processes that support textiles selection, using Distributed and Embodied Cognition Theories to investigate the occurring selection in a natural setting, within a semi-professional environment.

Question 2 is responding to the emergent finding from Chapter 4 that the textile selection occurs throughout all the various phases of the design process. In addition, it was shown that 4 processes (forms) and their interactions support the selection processes. The latter show that embodied experience is crucial for selection, hence question 2 probes this deeper by focusing the investigation on the designers' use of sensorial information to support textile selections processes. This is also responding to the imbalance identified in terms of the type of support that there is in place. Although the textile selection is a very subjective activity for designers, the majority of support is in terms of quantitative approaches. As can be observed in section 2.3 in Chapter 2, the methods of support available (objective and subjective) deal mainly with properties of textiles, but not the experience of them, while design techniques are more related to tacit and experiential knowledge. This question is addressed qualitatively in Chapter 6 through two studies in a naturally-occurring context where there is an intense moment of textile selection, namely, a textile fair. Research tools that bring the body to the centre of investigations were introduced to disrupt and encourage designers to focus and talk about their experience in textiles selection.

Question 3 is responding to the lack of understanding of the designers' embodied experience with textiles and of how it supports selection. It goes a step deeper into the investigation of the embodied aspects revealed through Chapters 4-6, by looking at how the body supports textiles selection. Additionally, this gap is demonstrated in sections 2.2.1 and 2.4 in Chapter 2. This question is addressed qualitatively in Chapter 7 in a study applying a first-person approach through interviews using the Elicitation

Interview method (Petitmengin, 2006) to obtain a fine-grained description of the designers' tactile experience of textiles.

Question 4 is responding to the current imbalance between technical and experiential approaches to support the textile selection, and to the lack of support from an experiential perspective, which is necessary since designers' tacit and experiential knowledge is crucial for this process. This is the gap demonstrated in section 2.4 in Chapter 2. This question is addressed through an action research (Swann, 2002) approach using design workshops to iteratively develop and test a support for the textile selection. The findings from Chapters 4-7 were used as input to inform the requirements for the design of support. Through studying the experience of textiles in these multiple settings the aim is to understand how the designers can be supported from an experiential perspective that complements the current support through technical specifications.

1.6. Thesis structure

This thesis includes 9 chapters, and the main primary research Chapters (4 to 8) are summarised in Table 1 above. Chapter 2 comprises the literature review and Chapter 3 outlines the methodology. Chapters 4-7 present four empirical studies, taking a qualitative explorative approach to iteratively investigate the textiles selection for design, with a focus on experiential aspects emerging through interaction. Chapter 8 presents the iterative design process that resulted in the development of a tool to support textiles selection, which is based on the empirical findings from Chapters 4-7. The design workshops conducted to verify the use and validate the support are also reported in this chapter. Chapter 9 presents a concluding summary, which includes conclusions, contributions to knowledge and future work. The main research chapters of this thesis are further described below:

Chapter 4 (RQ1) – Articulating a Textile Selection Process Model: A Grounded Theory Study to Make Tacit Processes Tangible

The aim of the study presented in Chapter 4 was to uncover when and how textile selection is performed in the design process. It investigated practitioners' experience when selecting textiles for design to provide a better picture of the process of selection

of textiles, one that acknowledges the experiential aspects. A Grounded Theory (GT) study was conducted where 84 designers from industry and academia contributed their experience through focus groups, interviews and observations. Data collection and analysis were iterative, and the three types of data collection were used to allow for data triangulation. In order to comply with theoretical sampling approach characteristic to the GT, three design domains that apply textiles were analysed: fashion, automotive and interiors. For validation purposes, member checking was conducted.

Chapter 5 (RQ1) – Confirming the 'Quad-Core Textiles Selection Model' through an in-situ study: Investigating a Facsimile Design Process with Distributed and Embodied Cognition

The aim of this study was to understand what information is used to support selection, and what are the difficulties inherent to it. It investigated a facsimile design process to understand the textiles selection further, by observing it in-situ. To focus the investigation, a very specific moment of selection was chosen (instead of a distributed approach as was performed in Chapter 4), which is the context of sports shoes customisation in a retailer's in London. To explore these experiences, Phase 1 of the study consisted of observations in context, for which Distributed Cognition theory and method[10] was used. Phase 2 consisted of contextual interviews, bringing Embodied Cognition theory to deepen the analysis (secondary analysis).

Chapter 6 (RQ2) – Observing the more nuanced sensorial experiences of the selection process in a professional environment

The aim of the study presented in chapter 6 was to understand what information is used to support selection, particularly focusing on sensory interactions. Diverse research tools were introduced over two consecutive years to the same textile fair in London (in 2013 and 2014). These tools were introduced to encourage designers to focus on the textile experience in the moment of selection in a fair and to talk about it. The aim was to gather a more detailed understanding through probing designers with the aid of research tools in this intense moment of selection.

[10] The chosen method was the Distributed Cognition for Teamwork (DiCoT) (Furniss & Blandford, 2006).

Chapter 7 (RQ3) - Investigating The Embodied Experience In Textiles Selection

The aim of the study presented in Chapter 7 was to investigate the embodied aspects through the tactile experience of selecting textiles, specifically at the points when these emerged as significant for the designer (as recorded through Chapters 4-6). At this point the research required a shift of perspective to provide more descriptive accounts of the experience, hence a first-person approach was adopted; thus, a Micro-Phenomenological method of interview and analysis was used: the Elicitation Interview (Petitmengin, 2006; Petitmengin et al., 2015). This method has also been used before in Human Computer Interaction (HCI) to study people's tactile experiences, and in order to identify the final outcome of the experience (Obrist et al., 2013). In Chapter 7 the dynamics of the experience is investigated, observing *how* it unfolds and the processes that occur, and to do so, six experienced designers from the fashion and textiles area were interviewed. In order to provide greater rigour, and as a form of validation, two types of analysis were conducted: Thematic Analysis and Micro-phenomenological Analysis – to verify the results from different perspectives and gather a more complete account.

Chapter 8 (RQ4) - The sCrIPT Toolkit: Designing a Tool to Support the Embodied Experience in Textile Selection

The aim of the study presented in Chapter 8 was to build on findings from Chapters 4-7, and using their outputs as inputs to design a support for designers when selecting textiles. The resulting support is a toolkit formed of method cards. Here design workshops were used, as they allow for the inclusion of participants in convergent and divergent thinking, immersed in a lively setting for the investigation to unfold (Suri, 2003, p. 47). Initially, diverse types of tool format were tested, and once the method-card was identified, then the content started to be brought in from Chapters 4-7 to further develop and test how these would be presented. In order to conduct this development incrementally and contextually, Master of Arts (MA) students from diverse art and design institutions contributed to the research. A final evaluation stage was carried out through two workshops: (i) one in an arts university in Germany, where the cards were used in a workshop context, and (ii) another which combined the contexts of teaching (MA fashion students) and a textile fair in London to conduct a final test of the tool prototype, and provide an account of the resulting impressions; this

was achieved through semi-structured interviews conducted after the workshop. Finally, Thematic Analysis was used to analyse the data.

2. Literature Review

* Parts of this chapter were published in:

Petreca, B.; Bianchi-Berthouze, N.; Baurley, S.; Watkins, P.; Atkinson, D., 2013. An embodiment perspective of affective touch behaviour in experiencing digital textiles. Proceedings ACII 2013.

Petreca, B., Atkinson, D., Bianchi-Berthouze, N., Furniss, D., Baurley, S., 2014. The future of textiles sourcing: exploring the potential for digital tools. 9th Design & Emotion International Conference, 8-10 Oct 2014.

Petreca, B. *In press*. Können wir digitale Textilien fühlen? Designforschung, Körpererfahrung und ein Ausblick auf zukünftige Technologien", in: Jana Herwig, Alexandra Seibel (Hrsg.), Texture Matters: Der Tastsinn in den Medien - haptisch/optisch 2 (Maske und Kothurn. Internationale Beiträge zur Theater-, Film und Medienwissenschaft, vol. 61/1), Wien: Böhlau (forthcoming).

Petreca, B., *In review*. Giving body to digital fashion tools. In: *Digital Bodies*. London: Palgrave Macmillan.

2.1. Introduction

Textiles selection is a critical process in the design industry. This is both an inspiring and a crucial task for the design process, and designers need to be imaginative as well as fulfil technical requirements, while achieving a desired experiential effect. Currently, the reality of the industry is that the existing support is mostly focused on technical specifications, where objective and subjective methods are used to assess the properties of textiles, with a few attempts to correlate subjective evaluations to the objective measurements[11], which result in characterisation of the textile. Still, there is little in the way of understanding the selection process in the area, and hence questions remains unanswered in terms of when and how is this measurement-based information used, and what else designers need to support selection. Additionally, currently there is no clear understanding of how textiles are experienced in the design process.

Literature around materials selection shows that in more traditional views of the design process, the materials selection is seen to occur at later stages when designers have already clarified concepts and start working on technical feasibility closer to engineers (Van Bezooyen, 2013). In such view, technical information is the predominant, if not

[11] For a novel design research framework that enables systematic analysis and comparison of tactile experiences with textiles, see Atkinson et al., 2016.

the only, driver of definitions of materials. However, literature centred on designers practice gives the impression that the selection is occurring from early stages of the design process, and that in this moment the materials experience plays a major role (Karana et al., 2015). This view suggests that it is precisely such consideration of materials from early stages that determines the commercial success of a product, as the user experience of materials is constantly considered (Ashby and Johnson, 2010; Karana et al., 2013).

Even though there has been noticeable advance in research towards materials experience (Karana et al., 2013; Karana et al., 2015), efforts remain limited to industrial design and materials engineering, as the focus was mostly given to hard materials and products. Hence, it is not possible to just import this understanding from these other areas, since textiles are different materials. Textiles are mostly soft, malleable, and many times wearable, so the interactions with them are very rich and generally engage the full body. Indeed, these pervasive elements to human perception (Laughlin, 1991), that invariably come into close contact with our skin (Spence and Gallace, 2011), are increasingly spreading into more technical applications[12], and are considered products in themselves (Studd, 2002), which keeps textiles as a separate discipline in academic and industry settings.

To begin to address the gap in understanding the textile selection and the experiential aspects related to it, a literature review was carried out to produce a more detailed picture of the knowledge currently in place. Firstly, what is known about the *textile selection in the design process* is examined, and how it has been described within traditional areas of application, particularly fashion, interior, and automotive industries. Since there is a lack of literature centred on textile selection, the literature on design and materials research more broadly is brought in to gather further information and help interrogate how material selection is currently understood. Subsequently, the literature on *methods, techniques and tools related to textiles selection* in terms of its experiential aspects is reviewed, including: (i) engineering approaches, and (ii) experiential

[12] Techtextil, Messe Frankfurt Exhibition GmbH classifies them according to 12 main application areas, which they identified as: 'Agrotech', 'Hometech', Geotech', 'Mobiltech', 'Buildtech', 'Indutech', 'Packtech', 'Protech', 'Clothtech', 'Medtech', 'Sporttech', and 'Oekotech'. Description of these areas are available at the fair website:
http://techtextil.messefrankfurt.com/frankfurt/en/aussteller/messeprofil/anwendungsbereiche.html

techniques in design (product and fashion). This aspect is deepened by including literature on *human experience of materials* more broadly, also describing the current *methods, techniques and tools used to gain insight into materials experience*.

2.2. Textile and materials selection in the design process

Literature specific to textiles selection is scarce, and in the few publications, which are mostly from fashion design, textile selection is generally considered as a smaller part of the design process. One of the only examples encountered is Dieffenbacher (2013), who proposes a *'Fashion Thinking'* process, through a model grouping activities into three main phases: 'Idea', 'Concept' and 'Design'. Dieffenbacher suggests that these phases can be structured as a linear or random process, and in both cases the textile selection is seen as a single step. Dieffenbacher (2013) further suggests that in fashion the design process, as taught in universities, usually follows a linear approach, which allows students enough flexibility to interpret and develop it individually. There was only one piece of research (Studd, 2002) where the textile design process had been formalised, however, this only modelled the process of designing the actual textile, but did not include the processes of designing with textiles, i.e. their applications. *Here we are left with the impression that textile selection is mostly seen in a simplified manner, as one step of a linear design process*.

In textbooks for fashion design, some authors have organised a series of activities and techniques that designers may perform when sourcing and selecting (Cadigan, 2014; Udale, 2008), however these are not formalised in a model. Because of this unstructured presentation, it is not clear *if* and *when* they are used within the design process. Literature also shows that designers utilise methods such as mood boards[13] at early stages of the design process to articulate concepts. In these, designers include material samples, which shows evidence that material selection is already taking place. *The variety of activities and techniques reported in textbooks, and the indication of selection*

[13] Mood Board is a tool commonly used by fashion and textile designers to communicate the more intangible aspects of a design. Literally, setting the mood of the design. This is a very experiential process through which designers try to create experiences, which is what they do when they create poetic means that try to evoke on others the feel they have when they engage with materials in a certain manner; for more on mood board making process see (Cassidy, 2011).

happening from earlier stages in the design process, is in contrast with the literature that sees it as one later step.

If we try to observe the textiles selection taking the perspective of designers needs, some other nuances become relevant. Generally, designers specialise and develop the required skills for assessing and applying textiles through training and practice (Bang, 2011), thus becoming familiar with their physical characteristics and aesthetics, as well as suitable applications and contexts of use. However, such knowledge is innate (reliant on the designer's sensibility and intuition) and tacit (acquired through training and experience) (Dormer, 1997). In addition, designers report to lack the means for articulating their experiences or for assessing users' perceptions in a more systematic manner (Bang, 2011). To overcome this, designers rely on multiple resources for inspiration and research, which they must skilfully articulate in design proposals in order to communicate with stakeholders, and to guarantee that concepts are translated through manufacture and use. Only recently research has started to synthesise methods that can be used reliably by designers to investigate users' perceptions (Atkinson et al., 2016) and emotions (Bang, 2011) around textiles. *Still, there is not a clear understanding of when and how such information is used and/or needed by designers in textiles selection.*

Since the literature on the process of textile selection in design is limited, the literature on industrial design is introduced here to form a more general understanding, and to help investigate the textile selection towards supporting it.

Research in materials and design suggest that the selection accompanies the design process (Ashby and Johnson, 2010; Karana et al., 2013). Product designers are taught to systematically structure their process in order to achieve definitions of material, form and function, to facilitate and maximize their embodiment in products (Karana et al., 2015; Cross, 2008, Pahl and Beitz, 1996). Ashby and Johnson discussed materials in the design process, and identified "concept, development and detailed design to a final product specification" (2010, p. 33) as crucial phases, which the materials definition accompanies. In these phases, designers need different levels and types of information (Karana et al., 2008; Van Kesteren, 2008), according to the activity, tools and design techniques involved. The materials selection is seen as a funnelling process (as modelled by Ashby and Johnson (2010), in Figure 1) where all materials are considered

at the start, progressing with more detailed specifications until narrowing down to fewer options that are tested in detail.

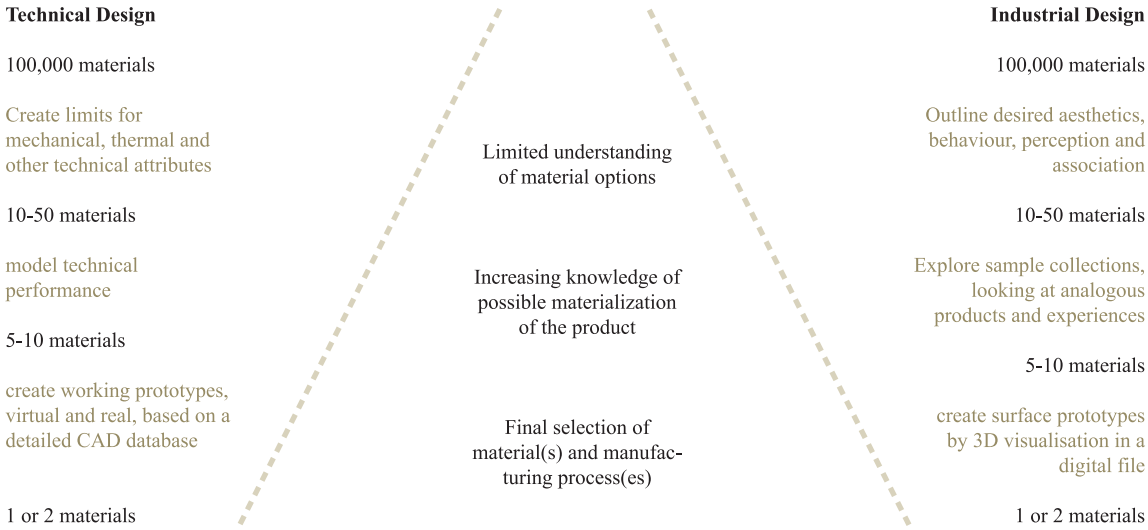


Figure 1. Materials selection in the design process (Ashby & Johnson 2010, p. 33)

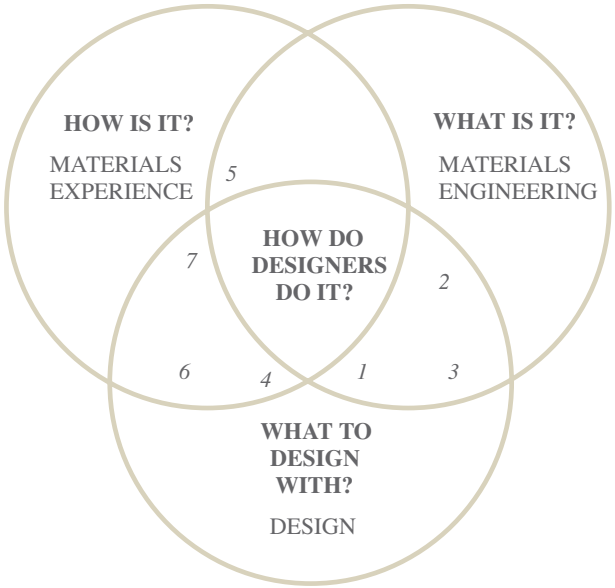
While examining Figure 1, particularly focusing on the industrial design side, we can see that the more experiential aspects (such as defining desired aesthetics, perception and association, and exploring samples and analogous products) are considered critical for narrowing down the material options. Additionally, this image shows a complete split between technical design and industrial design, where in technical design there is no mention to experiential aspects.

Ashby and Johnson (2010, pp. 129-132) also propose a path for material selection that relies on four selection methods – 'Analysis' (deductive reasoning relying mostly on well-defined objective attributes), 'Synthesis' (inductive reasoning using analogies mainly from prior experience), 'Similarity' (basing on associations or perceptions with known materials), and 'Inspiration' (searching more serendipitously for materials). These selection methods differ from existing linear models of materials selection in industrial design, since they can happen in parallel or as complementary activities (Ashby and Johnson, 2010). In linear models, activities follow a succession, and it may be possible to identify *'what'* designers do, but not *'how'* they do it; hence, there is a limited understanding of the cognitive and affective experience of the designer.

Overall, although in industrial design the many instances where the designer needs to experience materials when selecting are acknowledged in the literature, the current

models of the design process do not reflect that. On the other hand, models focused on materials selection show that there are experiential moments (particularly considering industrial designers), but do not specify when these happen respective to the design process. *These perspectives show that there are missing links between the diverse sources of information regarding the selection, and in situating it within the design process*.

In order to bring a more balanced view that considers experiential aspects, research is being developed specifically into materials experience (Karana et al., 2013; Karana et al., 2015), which advanced proposing this as a driver for the design process. Karana and colleagues (2015), building on the proposition by Manzini (1986) that designers need to know not only what materials are, but also what they do, and suggested that designers need to ask: What does it express? What does it elicit from us? What does it make us do? When it comes to materials selection, this questions help designers to go beyond understanding what the material is, and expanding into the experiential aspects of what materials can do. Adding to this, *this thesis suggest that in order to tap into designers' experience towards supporting them from this experiential perspective, interrogating 'How do designers do it?', seems critical to address the cognitive experience by observing the processes they go through, and also 'How does it feel?', to include the affective experience. Here an investigation that considers experiential processes is proposed, aimed at generating new and more nuanced understanding around textile selection for design*. The dynamics between such inquiries is highlighted through Figure 2, which illustrates this gap. The figure is organised by questions that show the main differentiating aspect that characterises a field and its contribution to the bigger picture of materials selection literature. These areas, and respective questions, clearly overlap. Their relationships were used as a basis into which to position the most relevant literature that addressed these questions before, mainly occurring in overlapping areas. In the crossing of all of these areas, a constant element is the designer presence, as has been discussed earlier in this literature review. This is because designers are responsible for synthesising these diverse types of knowledge in making decisions around materials, and hence the question: how do designers do it?



1. Manzini, E., 1986. The Material of Invention.

2. Ashby & Johnson., 2010. Materials and Design.

3. Van Kesteren, I., 2008. Selecting materials in product design.

4. Moholy-Nagy, L., 2012. The New Vision: Fundamentals of Bauhaus Design, Painting, Sculpture, and Architecture.

5. Karana et al., 2013. Materials Experience.

6. Rognoli, V., 2010. A broad survey on expressive-sensorial characterization of materials for design education.

7. Karana et al. 2015., Material Driven Design (MDD): A Method to Design for Material Experiences.

Figure 2. Demonstration of the gap in literature on the need to ask 'How designers do it?'

Although this question has not been directly addressed, Manzini (1986) pointed it out as relevant, in his suggestion that there are designerly competences in materials selection, which are related to investigating aesthetics of materials and user experience. Karana et al. (2013, 2015) also makes reference to this designer perspective, and went a step further in proposing the Material Driven Design method, as a means to provide a systematic approach that considers materials experience. This thesis gives a step back, and with a focus in the textile field, to look at how designers do, in order to have a deeper, clearer understanding of how support may come useful.

So far, this review highlighted that even in industrial design, although it is acknowledged that experiential processes occur in the selection of materials, it is not clear *when* and *how* such processes take place in relation to the design process. When in time? Only once, or are they revisited iteratively? Or does it develop with the overall design process? In fact, *the literature demonstrates that there is no process model that includes methods to use tacit and experiential knowledge*. The section 2.2.1 below will discuss why are the latter important for designers.

2.2.1. The nature of designers' practice

Most of the work to support textiles selection within the textile realm has focused on the technical specification of the textiles. The critical point here is that the studies that measure textiles are focused on knowledge about the textiles only, however there is much more that happens when designers experience a textile, which is not just limited to the material physical characteristics obtained through assessments (objective or subjective), but includes how they are experienced through interaction. These other layers of the experience are related to the nature of designing, which operates through 'abductive' thinking, where designers experiment with what 'may be', "producing proposals or conjectures" (Cross, 2011, p. 27). Abductive thinking embraces the designer's intuitive attitude in defining paths and making decisions, and, unlike deductive or inductive thinking, it relies on the designer's knowledge, experience (Cross, 2011, p. 10), and expertise. *Indeed, experienced designers rely on their intuition, which they refine and master over the years, and the closer they are to their feeling, the more differentiated their design process becomes.*

Cross (2011), when 'thinking about what designers do', suggests a cognitive science perspective, following the proposition by Gedenryd (1998), for whom cognition is a "practical, interactive activity". For him, brain, body and environment are seen to integrate a full system, in which the designer makes use of 'situating strategies', and interacts with "temporary models of the situation being designed for" (Cross, 2011, p. 28). These are produced through diverse design techniques (e.g. sketching, prototyping, etc.), and enable explorations into use scenarios.

It is precisely in this practical aspect of the designers practice, where thinking and doing are intimately related, that makes it so distinguished, and has been associated in the literature with tacit knowledge (Veja, 2015; Dormer, 1994). It is this tacit knowledge, which is at the same time invaluable (as it allows for differentiation) and vulnerable (for the difficulty to communicate decisions to others, specially non-designers). Tacit knowledge has been acknowledged as a type of knowledge that cannot be verbally articulated, but can be demonstrated visually or physically (Dormer, 1994). Craft and design literature reports that such type of knowledge is mostly transmitted tacitly, implicitly (Veja, 2015; Shreeve, 1998). This is reported in relation to design being a practice that is fundamentally based on action, in which designers feel their way through

things (Schön, 1991), and make sense "through a physical experience" (Veja, 2015, p. 79).

Although the experiential processes happening in the selection are acknowledged and discussed, so far there is no clear indication of ***how*** *they may affect the textile selection process for design. Such indications highlight the lack of a systematic understanding about the textile selection process, and of methods that harness the designer tacit and experiential knowledge to support this process.*

Resources for sourcing

There are diverse resources where materials and respective information is available, and which designers can use to source, such as physical material libraries and trade fairs, digital databases and applications. Physical materials libraries and trade fairs offer a wide range of materials and are curated to showcase the most innovative, allowing designers and product developers to be updated in terms of future trends (Mani et al., 2013). Besides the objective information related to characteristics and performance of materials, many factors must be considered for supporting the subjective experience, e.g. mode of display, environmental conditions, accessibility (Amaral et al., 2012). Digital databases offer predominantly technical information on a wide range of materials that can be retrieved, compared and connected to suppliers. Product engineers and material scientists are their main users to whom performance rather than aesthetic needs are paramount (Mani et al., 2013). Here the cognitive ergonomics is crucial to navigate the information system (textual and visual content), for the understanding and comparison of samples (Amaral et al., 2012).

The industry also provides more practical tools, which support designers' activities and are accessible even to non-experts. These tools mediate designers' interactions with materials (organising and/or augmenting their sensory perception or providing 'invisible' technical information) and support the design process at different stages. Some examples include the Pantone colour charts and Capsure tool, which facilitate communication by providing a common language to guarantee colour definition and reproduction; and Adobe Kuler, a synthesis of colour research into a tool for both experts and non-experts. More recently initiatives were noticed such as the Making app, a tool for comparing materials based on Nike's Materials Sustainability Index (MSI),

which specifically provide designers and non-designers with sustainability-related information.

All of these resources support designers in materials selection, but while some of them provide knowledge about the materials only (e.g. databases), materials libraries and trade fairs provide designers with the opportunity to interact with materials and allow for an experiential understanding to emerge from the physical encounter and experimentations.

The section 2.3 below provides a review on the aspects related to textiles experience, to provide a more complete picture of what is relevant for this experiential understanding.

2.3. Textiles Experience

Experiences with textiles differ largely between individuals and the processes through which designers engage with and select textiles are poorly understood. In the textile area, the sensory experience is crucial, especially for designers, who base their material choices heavily on feeling and tacit knowledge. Textiles are everywhere. Besides being surrounded by textiles (Laughlin, 1991; Spence and Gallace, 2011), designers select textiles and create means to surround us with them. They understand their formal use, but also that messages are conveyed through textiles. However, much of these experiences remain unarticulated or inaccessible.

At the start of the interrogations in this thesis there was a challenge in recognizing where the textile experience indeed begins: on the hand touching the textile; or before, in the movement initiated by the hand that moves away from the body and towards the textile; or even earlier, on the movement of the textile that seduces visually and draws the attention, triggering a desire to move the hand towards the fabric? Seduction, anticipation, encounter and experimentation (Tallis, 2003) – these movements seem inherent to human experience with textiles.

In investigating what may drive a textile experience, as the literature shows, the manner in which people describe textiles goes well beyond its physical characteristics[14], and encompasses emotional descriptors such as pleasant (Picard et al., 2003; Soufflet et al., 2004), cosy (Picard et al., 2003), unbearable (Hung and Chuang, 1999) and scratchy (Laughlin, 1991; Soufflet et al., 2004; Wu et al., 2011), which indicates that as one experience a textile, in discovering its properties, an affective experience emerges. The affective terms used in this textile literature describe different levels of the affective textile-handling experience that, following Jordan's structure of types of pleasure with products (Jordan, 2008) can be classified into physiological, psychological (cognitive and emotional), social and ideological. Whilst, with the physiological and psychological levels, the experience is personal and immediate and related to the affective sensation of handling the textile or of its use (e.g. clothing, cover of a seat), the social and ideological levels are related to social and high-level values (e.g. the message that wearing that type of fabric may convey to others). These processes are not so clearly separated. *Here the distinction between feeling (as in perceiving) and feeling (as in emotion) gets complex and hugely impacts designers' practice*.

In philosophy and anthropology studies, these intriguing dynamics have been explored through the themes of action, perception and affect. In order to advance in this direction, Gibson's (1986) ecological approach to perception is useful, as he presents perception and action as inseparable, and views perception within a real-life context, considering the environment and how we interact with it. We perceive the world with mind and body (Merleau-Ponty, 2012), actively exploring it (Noë, 2004). As proposed by Dumouchel (2015), "while perception perceives, discovers or recognizes affordances which are objective characteristics of the world, affect mostly creates or produces affordances". Affordances are relevant to interactions, as they are related to what we can do with the world.

So where does sensing comes in? Sensing is related to affective states, as it has bodily sensuous dimensions, which are in turn related to affordances (Dumouchel, 2015). Hence, sensing is more related to the experience of sensing the world than to the

[14] A comprehensive review of the most frequently employed subjective textile descriptors, according to specialist literature, was used in (Atkinson et al., 2016) to synthesise a vocabulary to be tested with designers and non-designers.

cognitive content of what is perceived. And here mostly is where we lack means to describe the experiences. Could this explain why designers produce poetic representations (verbal or visual)? Are they trying to evoke such states, to overcome the lack of precise words to talk about it? But this ability that designers have to externalize their experience is not trivial, i.e. not everyone can do this, as this is part of designers' expertise.

As literature highlights personal experiences (Merleau-Ponty, 2012) and expertise (Goodwin, 1994; Kirsh, 2013) are crucial for perception processes. Experts develop tools, criteria, organisation and communication strategies that support and specialise their manners of perceiving and producing. Goodwin (1994) showed this through the case of archaeologists training. In this example, students had to become familiar with differentiating and understanding dirt, and to do so they were introduced to diverse techniques (such as tasting samples to verify their granularity) and tools (such as the 'Munsell Colour Chart'[15], which helps them in classifying with consistency and reliability the colour of the samples acquired) that support this process.

In the case of designers using textiles, likewise there are tools that support colour selection, however aspects of the tactile experience are still problematic to support. Hence, it is not surprising that designers' communication in relation to textiles experience usually involves verbal, visual and physical means, and frequently is multimodal. They rely on multiple resources in the design process, which they skilfully use to support in articulating design proposals. The knowledge mobilised in such processes is innate (reliant on designers' sensibility and intuition) and tacit (acquired through training and experience) (Dormer, 1997).

Such accounts show that perception and action are intimately related to feeling. In that, expertise plays a significant role, as our practices and tools shape our perception and interactions with materials in diverse contexts.

So far the textile industry has approached this phenomena trying to understand how fabrics feel to develop means to characterize, classify, reproduce, guarantee quality, and facilitate technical specifications. This indicates a focus limited to the material

[15] More information on the system can be found at the Munsell page. Available at: http://munsell.com

characteristics that are perceived. As it will be explored in the section 2.4, these methods are very technical and useful for manufacturing purposes, however these are not able to capture or take into account the affective component of experiencing textiles.

2.4. Methods, techniques and tools to support textiles selection

2.4.1. The textile engineering research approach

The textile engineering research has well-defined, systematic approaches and are interested in replicating and controlling the feel of textiles for manufacturing purposes. This has been done through the provided methods to describe and measure, predict or even emulate in the digital what is called 'textile hand'. The concept of 'textile hand' is central for the research conducted in the textile field, and the most significant definitions are listed below:

> "This is the reaction of the sense of touch, when fabrics are held in the hand. There are many factors which give "character" to a material observed though handling and "hand" can be considered as a meta-concept that takes into account not only the sensory aspect but also aspects such as formability, aesthetics, drapability and tailorability" (Philippe et al., 2003).

> "... the subjective assessment of a textile obtained from the sense of touch. It is concerned with the subjective judgement of roughness, smoothness, harshness, pliability, thickness, etc." (Behery, 2005).

> "... the tactile sensations or impressions which arise when fabrics are touched, squeezed, rubbed or otherwise handled" (AATCC Evaluation Procedure 5 – 2006).

> "The perceptive experience resulting from the manipulation of fabrics is called the "handle"" (Pelletier et al., 2007).

> "Fabric hand refers to the total sensation, experienced when a fabric is touched or manipulated in the fingers" (Luible et al., 2007).

Most available definitions can be found in a review on the hand of textiles (Ciesielska-Wróbel and Van Langenhove, 2012), which the authors have conflated to devise their own definition of the "subjective hand of textiles". Once 'textile hand' relies on subjectivity of the statements made by subjects about what they have perceived (Hyun *et al*., 1991), the understanding of the way in which mind transforms, organizes, and

structures sensory information is a major concern. To assess the attributes that affect the perception of the 'textile hand', the textile industry employs specific objective and subjective assessments. These are related to physical (thickness, mass per unit area), mechanical (extensibility, bending, shear), surface (compression, friction, surface irregularity) and thermal (conductivity) properties.

Figure 3 illustrates that such initiatives date back to the 1930s, starting with Pierce focusing on fabric bending properties, and included: focus on the physical properties of fibres (Hoffman and Beste, 1951); development of a set terminology for subjective assessment and machinery for objective assessment of a selection of properties that are combined to create a 'Total Hand Value' (Kawabata, 1980); development of a system (the SiroFAST) focused on properties that affect the handle of textiles in manufacturing garments (De Boos, 1994); observing the correlations between objective and subjective approaches further (Behery, 2005); until reaching the development of an instrument (Fabric Touch Tester) that measures all of the properties relevant to the textile hand with one single test (Pan, 2007). These will be explored further in the relevant sections about objective and subjective approaches to assess the textile hand.

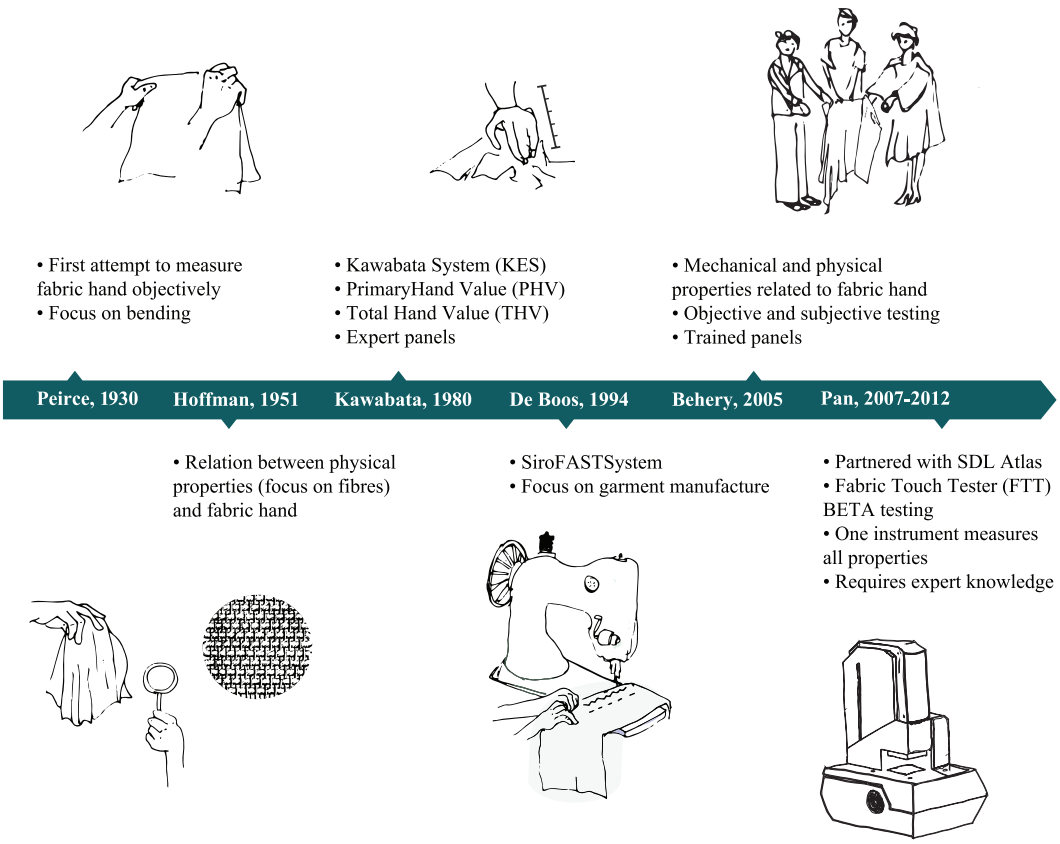


Figure 3. The evolution of methods for measuring the 'textile hand'.

The most significant attempt to standardise the evaluation of textile hand has been made by the 'Hand Evaluation Standards Committee' (HESC), convened in the 1980s by Sueo Kawabata of the Textile Machinery Society of Japan to create a set terminology for the *subjective evaluation* of textile hand (Kawabata and Niwa, 1989). This group created the most usually acknowledged system of objective hand measurement, the *Kawabata Evaluation System of Fabric* (KES-F), which has been widely applied within the textile manufacturing industry for allowing consistent analysis, as fabrics could be judged on a predefined scale. These scales are related to compressional, tensile, shearing and bending properties of textiles and their correlations. The definitions by the HESC are the most often cited for the subjective assessments of hand, though the descriptors are problematic to translate to other languages. *Many researchers have worked on such verbal descriptors since then, yet this language remains inaccessible to non-experts, as the more specific definitions are not disseminated. Additionally, such descriptors are focused on labelling the outcome of the experience, and characterising the perceived textile physical attributes.*

The diverse methods to explore and assess textile hand are further discussed in section 2.4.1.1 and 2.4.1.2 below.

2.4.1.1. Assessing the 'Textile Hand'

The context of prior research into the subject of textile hand should be made clear. Work in this field has been largely undertaken for the purposes of the garment and textile manufacturing industries and has often focused on the comparison of human tactile perception (subjective hand evaluation) to mechanical processes (objective hand evaluation). In objective hand evaluation processes certain properties of the textile are assigned numerical values, these can then be interpreted to indicate how the textile is expected to feel, or to predict how it will behave in garment manufacturing.

Many studies have been conducted to assess fabric hand properties, both objectively and subjectively, in areas such as: understanding of concepts involved and terminology applied; analysis of applied terms and the contribution to global subjective analysis; studies in the psychology and physiology of touch, including the use of samples to

measure neural activity when touching fabrics; works to relate sensorial perceptions to measurable properties of fabrics (Behery, 2005).

2.4.1.2. Textile hand assessment methods

Objective methods

Objective analysis aim to provide quantitative data on textile properties that potentially influences the perception of the handle of a fabric; such data are obtained from tests conducted in appropriate equipment. In terms of equipment, systems such as the Kawabata (KES-F) and SiroFAST (Fabric Assurance by Simple Testing) have been widely applied in association with subjective analysis, where parameters are established according to the correlations emerged; the combination of objective and subjective assessments are classified as indirect evaluation systems for fabric hand. Inversely, direct systems aim at simulating two or more aspects of hand evaluation and produce quantitative measures (Behery, 2005), without corresponding to subjective analysis, as the intention of these systems is to evaluate fabric hand in a simpler and faster manner.

According to the literature (Fan and Hunter, 2004; Behery, 2005), some of the properties of fabrics that can affect handle are physical (thickness, mass per unit area); mechanical (extensibility, bending properties, shear); surface (compression properties, friction, surface irregularity) and thermal (conductivity). There are a number of variables involved in subjective assessments of textiles properties, therefore various methodologies have been applied to gain representative information (Laughlin, 1991; Guest and Spence, 2003; Philippe et al., 2003; Behery, 2005). An alternative to get more tangible information has been to use objective assessment (Howorth and Oliver, 1958; Cho et al., 2002). Objective analysis or 'Fabric Objective Measurements' (FOM) (Bishop, 1996), aim to provide quantitative data on textile properties that can influence the perception of their handle; these data is obtained from assessments in appropriate equipment.

Objective systems were developed aiming at standardizing methods of evaluation internationally, also as an effort to diminish variations due to cultural distinctions in the concept of hand. The HESC system went on to form the basis of Kawabata's later development of the Kawabata Evaluation System for Fabrics (KES-F). The KES-F

comprises five testing instruments, which are applied to objectively measure mechanical (compressional, tensile, shearing and bending) and surface properties of textiles, aiming to predict aesthetic qualities perceived by human touch (Kawabata, 1980, Behery, 2005, Pelletier et al., 2007). This has had a wide uptake within the textile manufacturing industry as it allowed for more consistent production and quality control, as fabrics could be judged on a constant, set scale rather than by the opinion of the assessor. However, the utilisation of this system is constringed by its' high cost and the need for specialist technical knowledge for both carrying out the tests and interpreting the results.

Alternatively, the SiroFAST system was developed by CSIRO enterprise later in the 1980s to overcome difficulties associated with the KES-F, and the high costs to industrial use – mainly when applied outside Japan – but also shifting focus from estimating hand properties to evaluating textiles behaviour in the production of garments (De Boos, 1994; Behery, 2005). KES-F and SiroFAST have been widely applied, being either used for objective assessments alone (referred to as direct systems), or in combination with subjective assessments (referred to as indirect systems) (Behery, 2005). Both of these systems have never become standards because of their complexity in usage and application. The SiroFAST system consists of three testing instruments (compression, bending, and extensibility) and one evaluation method for the dimensional stability. Regardless of improvements in reducing costs and simplification of tests, the SiroFAST system still requires specialist technical knowledge for interpretation of results.

Since the start of this research two new equipment have been developed, the Fabric Touch Tester (SDL Atlas)[16] and the PhabrOmeter, both of which have already been included in the standard AATCC Test Method 202 –Relative hand value of textiles: Instrumental method, but they are still undergoing evaluation by research.

[16] This system provides a simplified process of testing, as it allows for obtaining all of the objective measurements in a single test. More information available at: http://www.sdlatlas.com/product/478/FTT-Fabric-Touch-Tester. [Accessed 27 March 2016].

Subjective methods

There is a general recognition that subjective hand is a complex sensation consisting of a summation *'of the weighted contributions of stimuli evoked by the fabric on the major sensory centres'* of the hand (Behery, 2005, p.11). Considering the complexity involved in fabric hand assessment, and the subjectivity involved in getting varied responses from participants, the industry has tried to create specific protocols for the handling of textiles, and also developed verbal descriptors that are used to label the outcome of the experience. These are all trying to make experiences comparable, but end up limiting the experiences that would be otherwise provided by the textile when encountered in a natural situation. As will be demonstrated through presenting and discussing such handle assessments and verbal descriptors below, these seem problematic as, similarly to objective measurements, they provide information that belongs to the description of the textile only, and do extend to how they are experienced.

Touch as a means to assess textiles

The procedures for subjective assessments[17] encountered in the literature review for the handling and analysis of textiles varied immensely. The great variety in assessment methods is surprising given that there is a published standard since 1990, the 'AATCC Evaluation Procedure 5 – Fabric Hand: Guidelines for the Subjective Evaluation', which sets out protocols for just such experiments. However, similarly to other methods, the AATCC guidelines do not allow for natural behaviours, as they stipulate a restrictive set of manipulations for handling a textile sample, only allowing one gesture for each property evaluated. They also suggest that blind testing is preferential. This renders the process quite unlike anything a consumer would experience when evaluating textile goods for purchase. Only one reviewed text followed these guidelines, which acknowledged that '*there is no evidence that this standard is commonly accepted and widespread*' (Luible et al., 2007).

[17] Blind testing of textile samples appears to be no more common than tests where fabrics are in full view. However, there are many methods for eliminating visual bias such as handling textiles under red light to reduce the effect of colour (Soufflet et al, 2004), using only blind or partially sighted participants (Grineviciute et al, 1996), or using only white fabrics (Kim and Winakor, 1996). Other tests use a screen or box that the participant must insert their hands into to restrict their view of the fabrics.

The interest in gesture as a means to understand textiles emerged from the need to create controlled protocols to evaluate properties of textiles. Specialist sectors have incrementally defined handling gesture to systematize this assessment. Table 2 shows a list of the handling gestures specifically used to interact with textiles found in the literature (AATCC, 2006; Picard et al., 2003; Sülar and Okur, 2008; Valatkiene and Strazdiene, 2006). As can be seen from the descriptions in the 'Handling Gesture', their mechanized prescriptions are tailored to the measurement of the properties (descriptive touch) of the textile rather than to support the overall experience of it (affective touch) (Essick et al., 1999). This mechanized use of gesture may, in fact, be in contrast with the idea that movement enhances affective experience (Bianchi-Berthouze, 2013), and we may question if prescribed movements could in fact promote affective engagement. Thus, in (Atkinson et al., 2013) we studied how people handle fabrics in a more naturalistic way and more generally how the touch behaviour may affect the experience.

Table 2. Prescribed Gestures To Assess Fabrics In (a. AATCC, 2006; b. Atkinson et al., 2013; c. Picard et al. 2003; d. Sülar and Okur, 2008; e.Valatkiene and Strazdiene, 2006)

Handling Gesture	***Physical attribute***[a]
Fingertips' contact [a]	Surface
Hold down the fabric on a flat surface with one hand and stroke or touch with the other hand [a]	Surface
Lightly press the fabric with the fingers and palm of the hand [a]	Compression and Bending
Rub fabric between the thumb and fingertips [a]	Surface
Squeeze the fabric gently between the thumb, fingers and palm by making a fist [a]	Compression and Bending
Hold a specified length of fabric between the hands. "With elbows close to the body, hands are to be pulled apart noting the ease of extending the specimen. The specimen is to be stressed in the lengthwise, widthwise and diagonal (bias) directions." [a]	Shear
Compress the fabric tightly in a fist and then release quickly; i.e., in less than 5 s, observing how it recovers [a]	Compression, Bending and Shear
Rub the edge of the textile between thumb and forefinger [b]	Surface
Rub the edge of the textile within a closed fist [b]	Surface and Compression
Stroke the edge of a textile between thumb and forefinger [b]	Surface
Gather a flat textile into a closed fist (scrunching) [b]	Compression and Bending
Stroke a flat textile with one or more fingers [b]	Surface
Run finger laterally over a fabric [c]	Surface
Hold fabric in the most used hand and squeeze it with thumb and index finger [d]	Compression
Hold fabric between thumb and fingers and flex the fabric [d]	Compression and Bending
Move fingers of the most used hand freely over the fabric surface [d]	Surface
Compress fabric with the palm of the hand over a surface[b]; then take the fabric between the fingers and flex the corners [e]	Compression and Bending
"Fabric sample is taken in to the palm where it is clenched and unclenched"	Bending

Handling Gesture	*Physical attribute*[a]
[e]	
"Fabric sample is held between two fingers in one hand and swept from top to bottom with the palm of the other hand" [e]	Surface, Compression and Bending
Hold sample between thumb and forefinger so that it "drapes" down in the joint. "Flip it to and fro from one side of the hand to the other". [e]	Bending
Move the palm of the hand with light pressure over the fabric [e]	Surface
Slide fabric between two fingers of one hand by pulling with two fingers of the other hand [e]	Surface
Hold fabric with two fingers of one hand and sweep it from top to bottom with the palm of the other hand [e]	Surface
Hold the edges of the fabric with both hands and stretch [e]	Shear
Hold the edges of the fabric with both hands, stretch and leave it to return to initial position [e]	Shear

a. Physical attributes related to constituent elements of hand, comprised in AATCC EP 5 (2006). We have limited the association to qualities present in this standard to facilitate comparisons, but we are aware that some of the gestures can relate to other physical properties.

b. Authors conducted blind tests, using a 'black box' to minimize the influence of appearance.

In all, it is noticed that many specified protocols restrict the area of skin interacting with the fabric to either the fingertips or palms. Although this adds an extra degree of scientific rigor to the process of handle evaluation, it is also very artificial, as opposed to any real life fabric handling process where the fabric can be manipulated freely.

Describing 'textile hand' assessments verbally

Two main types of descriptors are generally used in relation to fabric hand: singular and bi-polar. Assessments can be obtained by employing such descriptors, and are conducted by an evaluator or by a sensory panel of expert evaluators, to devise a sensory profile (Philippe et al., 2003; Pelletier et al., 2007). Participants are usually asked to describe, compare, rank or rate fabrics being evaluated (Brandt et al., 1998). They can either be given a series of terms to choose from, or be asked to generate descriptors. The efficiency of a sensory profile is based on the communicative value of the generated descriptors, which indicates that the terms selected must be well understood amongst subjects, in terms of meaning and use, and representative of the tactile dimension being portrayed (Pelletier et al., 2007).

A consensus appears to be the creation of a standard language for the evaluation of distinct fabrics with reproducibility and for the effective communication of their characteristics, minimising the effect of subjectivity. In the investigation conducted by Kawabata (1980) there is an indication that it was necessary to standardise used expressions, due to personal variations in the way o perceiving fabric hand, even

amongst specialists. The examination of studies in the area of textile hand showed that the most significant attempt at standardisation of the evaluation of textile hand was made by the 'Hand Evaluation Standards Committee' (HESC) (Kawabata, 1980). The committee established the most commonly used descriptors for fabric hand and labelled these 'primary hand' expressions, as well as agreed on definitions for such expressions. The Primary Hand Value (PHV) evaluation system assigns each of the appropriate descriptive values a numerical rating for the strength with which the fabric possesses that attribute.

In terms of standardisation, other initiatives to be mentioned are the ASTM D123 (2009) standard, which presents a set of terms relating to fabric hand; the AATCC Evaluation Procedure 5 (2006), a standard protocol for the evaluation of fabric hand relying on individuals. Though ASTM D123 (2009) is one of very few attempts at standardisation of terms, but it is not seemingly as often referenced as the Kawabata (1980), also it is not made clear how they arrived at their terminology, whether through experimental procedures or expert debate. In Atkinson et al. (2016) a review of the literature around subjectively generated descriptors revealed 69 terms that are frequently used in publications around tactile perceptions of textiles.

Little technical information was given regarding the textiles used in the various studies encountered. In general the information included was regarding fabrics characterisation (e.g. fibre composition and fabric construction). Only one study (Luible et al., 2007) mentioned that fabrics used had been tested in KES-F system. Some studies limit the range of fabrics by end use, e.g. shirting (Kim and Winakor, 1996), in which the context facilitates the understanding of the terms generated; because of their nature, such textiles provide more ordinary descriptors. Alternatively, where studies use the widest variety of textiles they can it is usually to generate a proportionally extensive sample of terms.

In relation to sorting methods to help describe textiles, these were often used in combination within the context of an investigation for extra analytical detail. Where a scale was used to rate the attribute(s) of a textile the use of bipolar scales was marginally more common, occurring in five studies (Civille and Dus, 1990; Winakor et al., 1980; Hung and Chuang, 1999; Phillipe et al., 2003; Sülar and Okur, 2008). Unipolar scales were used in four studies (Cho *et al*, 2002; Grineviciute et al., 2005;

Valatkiene and Strazdiene, 2006; Luible et al., 2007). Scales varied in their incremental structure and some chose to use un-structured scales. There seems to be little consensus on this matter among the studies; nevertheless, Kim and Winakor (1996) noted that previous studies argue nine point scales are the minimum required and eleven point scales are ideal as they give greater detail but are still easily understood.

Here we can see that the types of verbal descriptors mostly acknowledged are mainly related to an explicitation of textiles properties.

Relations between objective and subjective methods

Numerous attempts have been carried out to correlate the quantitative data, provided by objective analysis, and human assessments, where the complexity involved in measuring the magnitude of hand was reported as problematic (Philippe et al., 2003). In this sense various studies have been conducted trying to correlate subjective judgements to fabric objective measurements, relying on methods to gather qualitative data such as: multiple factor analysis (Howorth and Oliver, 1958), free modulus magnitude estimation (FMME) (Cho et al., 2002), analysis of variance (ANOVA) and principal component analysis (PCA) (Philippe et al., 2003), multidimensional scaling (Laughlin, 1991, Picard et al., 2003), among others.

The difficulty with the above-mentioned methods emerges when correlating the subjective qualitative results to objective quantitative measurements of textiles properties. The objective evaluation of textiles can be achieved through various methods, and another concern is to find the most suitable laboratory tests that may be related to handling qualities assessed by subjects. Howorth and Oliver (1958) suggested that the greater the number of tests that can be conducted, the easier it is to observe those ones that correlate in a relevant manner to subjective assessments.

In summary, *textile engineering research developed: (i) controlled protocols and machinery, to evaluate properties of textiles identified as relevant for textile hand; (ii) prescribed gestures, designed to assess a particular attribute; (iii) verbal descriptors that are predominantly making perceptions around textile properties explicit. Attempts to correlate objective and subjective assessments were observed, considering that these measurements are far from real life experience of textiles*. Additionally, such

approaches are mostly lab-based, which again narrows the application of results for designers. The aspects of the experience, beyond what is encompassed by the understanding of 'subjective' within the textile engineering field, are explored further in the section 2.5 below, from a materials experience perspective.

2.5. From experience to experiential methods in design

Human experience of materials

Throughout history people have made with their hands using materials that provide feedback, this makes the process more tangible as they can sense aspects of e.g. fit, texture, and sizing. Moreover, people have also relied on physical interaction to understand the design and quality of products (e.g. handling was crucial for shoppers' browsing activities in the 18th century, to gain "understanding of objects, particularly in terms of design, quality and workmanship" (Smith, 2012)). Considering this historical perspective, as we see many design processes going digital (Atkinson et al., 2013), and also the presentation of textile articles in online shopping, regardless of the platform it is vital that there exists tools with which designers can express their needs or ideas about materials and products. Considering specifically design in the later stages (development, personalization and customisation in retail), there is a lack of support to elicit, synthesize and utilize designers and consumers inherent knowledge to inform decisions.

Unfortunately, as shown in section 2.4, methods provided by the textile engineering research are very technical and not able to capture or take into account the embodied and affective components of experiencing textiles. Such approaches have privileged the systematic description (verbally or with numbers) of textile properties. However, in order to create, designers need to be able to freely experience, and research has shown that the qualitative aspects of a design may be hindered by excessive definition (Edelman et al., 2009), e.g. designers may be too focused on functional aspects of a product, and work in more incremental changes rather then radical innovation, if they work with too sleek prototypes and technical specifications too early in the design process. *Understanding a textile is important, as it provides some degree of confidence in terms of functional use. Nonetheless, it is insufficient for supporting experience, as designers need also to engage their tacit and experiential knowledge to inform their selection for design.*

Designers need to synthesise the quantifiable knowledge (which usually they understand from acquired experience) and the intangible content (affect and subjective experience) and skilfully articulate these in design proposals. And in conversations about, and with materials, their actions with and through materials are experienced though their bodies, and result in embodied answers, i.e. in physical outputs (which may be e.g. a sketch, a prototype, or a final product) – "on the tip of the tongue or from the tips of the fingers, the answer is always embodied" (Saillard, 2012, p. 49). Designers touch to understand materials, materialise design intentions, and to imprint their signature on matter (Sennett, 2008). In this multisensory material and spatial engagement, touch plays an important role. These are difficult processes to articulate, and are also heavily reliant on tacit knowledge, that is, the use of physical things goes beyond verbal communication, as we can show someone how a fabric drapes, but the manner in which we feel and appraise tactile properties is automatic and unrecognised.

If we consider the view that knowledge about materials enhances with expertise (Dormer, 1997; Kirsh, 2013), we realise that much of this experience in the textile realm remains implicit, and is underexplored (Veja, 2015). *The latter remain reliant on the designer training and work experience, and there are no techniques or methods available to facilitate or nurture subjective processes in experiencing textiles. However, authenticity cannot be recorded on spreadsheets, so this is a problem for the field.*

Previously, experimentation and experience have been researched and supported in the contexts of art (Albers, 1934; Saper, 1998) and design (Moholy-Nagy, 1929; 1947), through practice-based methods for research and education that focused on personal experience and discovering processes. In design, such generative practices were not further developed, although significant advances have been noticed in trying to bridge the gap between functional and experiential goals with more systematic methods (Karana et al., 2010; Karana et al., 2015). Similar initiatives were not encountered within the fashion discipline.

These evidences highlight how the embodied experience of materials is important, however it is not being researched in relation to textiles. Literature in other fields show that the experience goes much beyond the object (which has been so far the focus of textile engineering research, i.e. the textile), and is about the person interacting. As Dourish suggests, "(…) our experience of the world is intimately tied to the ways in

which we act in it" (2004, p. 18). Dourish also recalls that embodiment is not a new field of knowledge, and that it is crucial for the discipline of phenomenology. The aspects of embodiment will be explored further in Chapters 5, 6 and 7, but to begin to address this theme in relation to design and with more specific examples, a review of what is known about existing support for experiential processes generally in in art and design is presented.

2.5.1. Methods and Techniques for Supporting Experience in Art & Design

Historically, in design education, material exploration played an important role in the curriculum of avant-garde institutions such as the Bauhaus, relating to their approach to technique and subjective development, and later at the Black Mountain College this was further explored. Moholy-Nagy (1929) described intensive sensorial training and tacit exercises as a core principle from the pedagogical principles from the Bauhaus, which he developed in depth in his preliminary courses. Although he defended that technique must never be a goal in itself, through the practice of understanding or grasping (*begreifen*) materials through experiences, students could produce unique material knowledge that would not be achievable through more traditional, predominantly technical (quantitative) methods. In the Black Mountain College, an iconic art and design institution that was based in USA, former Bauhaus graduate and teacher Joseph Albers (1934) also reinforced a relational approach to the material (*Werklehre* – i.e. design with material) as the foundation for every design work. He argued that *when students engage with materials they learn from personal experiences - as opposed to being taught about materials - which instigates autonomous investigations and, consequently, more subjective and inventive works*.

2.5.2. Methods, techniques and tools used to gain insight into materials experience

Research into materials experience has progressed in a manner that is less about characterising the outcome of the experience only, and leaning towards understanding aspects of interactivity in sense making. If we take interactivity in the sense proposed by Kirsh (2009a), which is related to "how, when and why people interact with their environment", we realise that so far the aspects of environment have been mostly overlooked, as research has mostly considered perceptions of materials, and did not

explore these behaviours whilst unfolding within a particular context. In fact, materials are usually removed from context, and studies are conducted in controlled environment (e.g. laboratories or university context). Overall, as has been previously noticed with technology, also in the materials realm, the "(…) understanding or use of experience is limited." (McCarthy and Wright, 2004, p.11).

We touch to know, we know how to touch, and we also communicate emotions through touch (Bianchi-Berthouze and Tajadura Jimenez, 2014). Since talking about experiences is not easy (Obrist et al., 2013), it is not surprising that both in design and in other fields, such as in HCI, the experience of touching objects has been used as a process of translating experience in a nonarbitrary manner. In HCI, Isbister et al. (2007) explored the use of physical objects, the Sensual Evaluation Instrument (SEI), as an UX evaluation method. SEI are explored as a nonarbitrary manner to express emotions; people select the shape that best translate their emotional experiences, while interacting through touch with a set of objects.

In design and materials, Wilkes et al. (2016) proposed the design of intermediary tools to facilitate the communication between designers and material scientists. The tools proposed are isomorphic sets of material stimuli that are used in experiments to bridge the gap between these communities, through structured exploratory procedures that investigate the relations between technical attributes and subjective experiences of sensorial attributes (which are mostly assessed using a psychophysics approach). One example of such approach was seen through the use of a set of spoons (all in stainless steal and electroplated with diverse metallic coatings), used to assess the perception of taste in relation to the physical properties of the selected metals.

Other initiatives are noticed in the fields of materials and design, where diverse approaches to understand and support materials experience were encountered. These are described further in 2.5.2.1 and 2.5.2.2.

2.5.2.1. The experience of materials

Traditionally literature on materials selection focused on manufacturing processes and technical feasibility (Karana et al., 2015). However, more recently research is turning into the experiential direction, proposing that functionality, usability and satisfaction

(Karana et al., 2013) should all be factored into selection. So far, these have mostly considered the importance of materials in defining (characterising) the outcome of the user experience, which is relevant to what McCarthy and Wright (2004) identified as 'extrinsic meaning' of the experience, i.e. abstracting the meaning out of the context of the experience to put it to use.

People have materials experiences "with and through, the materials of a product" (Karana et al., 2015, p. 37). Many studies have been conducted to explore our relations to materials in terms of how we sense, attribute meanings and elicit emotions.

Some initiatives resulted in the development of tools, such as the Meanings of Materials tool (Karana et al., 2010) – which guides participants on the investigation of sensory aspects of materials that they relate to a predefined design intention, the Expressive-Sensorial Atlas of materials (Rognoli, 2010) – which links objective properties to subjective qualities through the use of illustrative charts, and the Stakeholder Game (Bang, 2011) – which engage stakeholders in a game to develop emotional concepts for future design based on personal experience. There is also an automotive industry tool created by Renault, the Sensotact®, a reference instrument for the tactile characterisation of materials (Allione et al., 2012).

Karana et al. (2015) takes this exploration a step forward, going beyond the understanding of materials to add what we can do with them, and proposes the Material Driven Design method (MDD) to support designing for materials experiences. The latter sees understanding the materials (technical and experiential characteristics) as the first step into designing products for meaningful experiences.

Such initiatives seem more aligned with the type of support that should be pursued in the textile realm, considering the inclusion of experience as integral to the design process. However, further investigations are still needed to ground the development of tools from within the textile field.

2.5.2.2. *Methods used to gain insight into textiles tactile experience*

In Digital Sensoria we used a number of methods to investigate people's perceptions around textiles through a design research approach (which was reported in Atkinson et

al., 2013; 2016). Focus was given to tactile experience, and explorations encompassed the gestures, language and associations that people use to explore and express experiential aspects around textiles tactility. This was done with a focus in devising techniques to create an interactive simulation of digital textile handling for a touch-based display.

The gestures people most commonly use to discern the hand of textiles were investigated in laboratory and in-store studies. From these studies emerged the understanding of how people inherently touch and handle textiles, which generated a taxonomy of gestures that could be further explored for the development of interactive videos, as previously reported (Atkinson et al., 2013).

The language was explored through triad-sorting studies[18], which were conducted to better understand how people perceive textiles by revealing the terms they use to describe 'textile hand'. As reported by Atkinson et al. (2016), this was done using a delimited set of cotton fabrics commonly used in clothing to compare them by grouping the two most similar and naming how they differ from the other.

The associations were investigated to explore how people's subjective relationship with textiles can be represented, and further inform the creation of the interactive videos. Fashion students were involved in the project to create mood boards representing semantic, descriptive terms identified from the literature (see example mood board in Figure 4). The images identified formed the basis of further studies in design game workshops. These workshops were designed to support non-designers in grouping and rating images, thus verifying their ability to convey concepts relating to tactile qualities to non-trained consumers. The gaming aspect, suggested by Bang (2011) for textile enquiry, adds an element of playfulness and helps participants to feel actively engaged with the study. These results initiated the creation of a lexicon of semantically tagged media, which was another source of information to provide visual cues for how textiles

[18] Triads allowed participants to describe their subjective perception by comparing textiles. A comparative approach was adopted as it facilitates the description of the subjective experience by un-trained participants. For further information about the method, specifically related to textiles see (Bang, 2009b).

filming should be performed to devise videos that convey fabric properties as perceived by people (Atkinson et al., 2011)[19].

Figure 4. Mood board created by Digital Sensoria research team in early explorations for the descriptor 'crisp'.

Building on the understanding gathered through the empirical studies was crucial to create digital samples of textiles. The methods to produce interactive content for the application 'iShoogle' (Orzechowski, 2010)[20] – i.e. the above-mentioned interface that

[19] One of the findings from this study that was integrated when creating the videos was related to the use of directional or diffuse lighting in filming.

[20] The iShoogle is an interface that allows for synchronised movement and visual feedback, accordingly to the interaction with the video displayed on a touchscreen device. iShoogle application is not limited to

allows for interactive simulation of digital textile handling for a touch-based display – that would reflect the observed manipulations[21] included: designing filming and lighting methods to bring the textile tactile properties alive in touchscreen interactive media (Atkinson et al., 2013). The resulting interactive videos on the application enable people to manipulate digital textiles through different gestures (e.g. scrunch gestural interaction in Figure 5) and are meant to convey behaviour of fabrics (e.g. movement qualities). The selected gestures used in the 'iShoogle' interface emerged from observations in the retail and laboratory studies previously mentioned, and were matched to the native iOS gestures, resulting in three interaction types: stroke (one finger moving across the screen), pinch (two fingers moving together and apart) and scrunch (three or more fingers converging on a central point).

Figure 5. Digital textile response to the interaction type 'stroke'.

Beyond the creation of this specific digital tool, what is interesting for this thesis research is to observe the richness of the methods created and brought in from other disciplines to investigate people's textiles experience, which successfully supported the design process of the digital textiles. The research in Digital Sensoria showed how a

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textiles, as it has been designed to simulate object interactions by allowing for visual and movement correspondence when touching the screen.

[21] The selected gestures were used on an application according to the retail and lab studies. These were matched to a native iOS gesture resulting in three interaction types: stroke, pinch and scrunch.

multidisciplinary approach is key to investigating the human experience of textiles within a design research project.

2.6. Discussion

The literature review shows that there is currently no process model including textiles selection, and tacit and experiential knowledge in the design process. Additionally, there are no methods in place to support selection from this experiential perspective.

When experiencing physical objects, it is human nature to want to grasp, in order to *get it* (Claxton, 1997). It thus seems logical that most research and industry have focused on characterising and describing physical properties that determine the tactile experience of textiles. The tactile characteristics of textiles involve complex properties, which have been explored in the textile industry through the concept of 'textile hand', and were discussed in this chapter at length.

The communication of fabric feel, encompassing descriptive and affective layers of the experience, is still little explored and is a problematic issue when it comes to textiles selection. Additionally, a "verbal language alone does not appear to be adequate for a comprehensive language of touch" (Teinaki et al., 2012, p. 170), as touch is a sense that can convey meaning and many people do not have the language to articulate these experiences verbally. Likewise, the measurement approaches do not suffice in terms of support for designers, who rely strongly on tacit knowledge to inform their selection. Research into general materials selection explored subjective aspects to support designers beyond technical specifications requirements. These approaches are more experience-related and often subject to culture, market, time, place and context diversity. Such initiatives are user-centred and reveal novel approaches to include stakeholders in the design process, i.e. material selection.

These issues show that there seem to be a disconnection in relation to current research development and the designer experience, with a focus given to measurement directed methods. Considering the view that the tactile experience with textiles is complex, embodied and affective, it may not be fully supported by limiting this experience to the physical aspects of the textile only.

In order to further this research, and to provide a better balance when it comes to supporting the designer selection, new understanding is necessary, particularly on how the embodied experience affects the process of textile selection for design. There is also a lack of understanding on *if*, *when* and *how* designers could be supported from an experiential perspective in the process of textile selection for design.

2.7. Summary of gaps in knowledge

In summary, the main gaps in knowledge identified are:

- There is no systematic understanding of the textile selection process, in terms of when and how it is performed in the design process;
- There is a polarity between qualitative and quantitative approaches to understanding and supporting the experience of textiles in design. Methods that were developed so far in textile engineering research are about objective and subjective properties of textiles, but not the experience of them.
- The embodied experience is not described in terms of tacit and experiential knowledge, and how this can be harnessed to support selection;
- There is no clear understanding of textile experiences, and no method to make it more explicit;
- There is no model available that includes methods to use tacit and experiential knowledge when selecting textiles for design.

3. A Tactful Methodology

The literature review exposed that the textile selection is an important part of the design process, to which there is no systematic understanding and no support from the designer experience perspective. Currently, in the textile area quantitative approaches to objectively characterise textile function have mostly dominated research efforts. Additionally, there is a lack of understanding on how the textile experience informs the selection process, particularly, if, when and where experiential information is used and/or needed to support the designer. The methodology in this thesis was designed to investigate how textile selection sits and how it is performed in the design process, and to understand how it can be facilitated from designers' perspective, taking an experiential approach.

3.1. Overview of the research methodology

This project took a design research approach to investigate designer's experiences with textiles to generate new understandings around their tactile experiences with these materials and to propose manners of supporting designers wishing to understand and communicate the multisensory qualities of textiles, within the design process. The findings from empirical studies (descriptive phase) informed the development of a prototype tool (prescriptive phase) to support designers when selecting textiles.

The design research approach relies on a range of methods to access people's experiences related to products, services and contexts, by investigating what people do, what they say, and what they make to inform the design for enhanced experiences (Sanders and Dandavate, 1999). This is aligned with the design research methodology proposed by Blessing and Chakrabarti (2009), where generating *understanding* and developing *support* are combined in the research process to devise results that reflect and address people's real needs. Also, the designer employs tacit knowledge arising both from training and experience of designing, which are crucial elements to be included in an investigation that aims to support an experience in which such aspects are of fundamental importance, reinforcing the relevance of a design approach.

The Design Research Methodology (DRM) was taken as the overarching methodological approach, and complemented by a selection of methods that enabled the

description of the textile selection process by investigating diverse sectors (fashion, interior and vehicle design), and led to the development of a support for this activity reflecting real industry needs. To understand textiles selection for design, four qualitative exploratory studies were conducted. Study one investigated the textiles selection in the design process, taking a Grounded Theory approach. Study two investigated a facsimile design process, in a sports shoes customisation retail setting, to enhance the understandings from study one, through Distributed and Embodied Cognition theories. Study three observed the more nuanced experiences of the selection process, by introducing research tools in the context of a textile fair. Study four explored more in depth the embodied aspects emerging as relevant through the tactile experience, using the Elicitation Interview method (Petitmengin, 2006) to obtain a first-person verbal description of experiential processes. Finally, an action research (Swann, 2002) approach was taken, and design workshops were conducted to design and validate a support, which built on the findings from descriptive studies in this thesis.

3.2. Research framework

3.2.1. The Design Research Methodology (DRM) Framework

After thorough research, the Design Research Methodology - DRM (Blessing and Chakrabarti, 2009) was identified as a suitable methodology, mostly because it has been developed to combine "the development of understanding and the development of support" (Blessing and Chakrabarti, 2009, p. 5), which was the approach taken in this research. Additionally, the DRM follows a process that is comparable to a design process for product development (Product Development Process – PDP), "which could be considered a sequential approach consisting of understanding, prototyping and refining" (McGinley, 2012: 80). The DRM is composed of four main stages (research clarification, descriptive study 1, prescriptive study and descriptive study 2), which the authors' suggest are flexible to adaptations, following the specificities of each research project.

This thesis is conducted following the four stages proposed by the DRM, but giving varied emphasis to each stage, and enriching it with a selection of methods that were identified as suitable for investigating the research questions. The framework has been adapted and includes: research clarification (through literature review and empirical

studies, to define aim, focus, and scope), descriptive studies (greater emphasis given to investigate designers' use of and need for experiential information when selecting textiles), prescriptive studies (to develop a tool to support the selection based on the findings from descriptive studies) and initial evaluation (to evaluate with designers the concepts that emerged).

The manner in which the research questions have evolved and how they were explored throughout the project can be observed in Figure 6. It shows that the Research Clarification and Descriptive Studies were marked by "how-is" questions, i.e. questions that provide the means to explore the phenomenon under investigation, in order to generate new understandings around it. The Deliverable 2 (formed by: Textile Selection viewed within the design process, Quad-core Textile Selection Model, and 3S Tactile Phases), is the main outcome of these stages. The Prescriptive Studies were marked by "how-to" questions, which are related to the iterative work towards creating support for designers in the textile selection. The Deliverable 3 ('The sCrIPT - Textile Experience Toolkit), is the main outcome of this phase.

Figure 6. Methodology progression and project deliverables.

As can be noticed from Figure 6, this research progressed in a cumulative way, and the research questions evolved correspondingly, hence the subtitle 'A Tactful Methodology'. At its start, the research was focused on obtaining an overall understanding of how the selection process happens in the design process, attending particularly to the experiential components, when and where they occur (RQ1). Responding to the new understanding on the process and experiential aspects, the research evolved to observe the interactions with textile samples more closely, focusing on how the sensorial information may affect the textile selection in intense moments (RQ2). The findings revealed the importance of embodied and affective aspects, which were explored deeper by focusing on the embodied experience in a study investigating how designers' body supports the processes of textile selection, which explores the affective and embodied interplay (RQ3). The qualitative analysis of the studies provided sufficient outputs to be used as input for the design of a support (a toolkit formed by instruction cards), which study investigated how the experiential processes of textiles selection could be supported in the design process (RQ4). Hence, the creative use of the outputs guaranteed that the tool design was grounded in data, and hence reflects practitioners' real needs.

3.2.2. A Tactful Methodology: enriching the DRM with adequate methods

Building on the background research (reported in literature review) and empirical background (participation within Digital Sensoria project), an approach that would enable direct engagement with designers' perspectives was chosen, considering both technical and experiential aspects as crucial for designers (Karana et al., 2008). Given the lack of knowledge identified in terms of the experiential aspects, and that this may be influenced by several layers of the experience (relative to the design process, and to the designer internal and external processes when experiencing textiles), a qualitative exploratory approach was taken, from an interpretive positioning. Hence, a multi-method staged approach was taken, through separate, complementary studies. This was following the DRM overarching structure (similar to the industrial design approach, as described previously), and responding to the complexity that the topic imposed. Hence, the design of the studies relied strongly on intermediate reviews, which defined directions to be further pursued, and the kind of complementary study that would follow. This was always oriented by the ultimate goal of the research: to generate support for designers' selection process from the practitioner experience perspective.

There are a number of approaches through which materials experience can be measured and understood, as was demonstrated in previous research collaboration, where we devised The Tactile Triangle Framework to investigate tactile perceptions around textiles (Atkinson et al., 2016; summary in section 1.3). However, looking at the tactile experience of textiles in the specific context of selection for design requires a careful consideration, as other elements will influence the experience. In the selection, it is not just about experiencing the material, but making sense and problem solving processes are involved. This may be looked at from a more distributed perspective, considering the whole design process, or in a situated moment of selection, considering a specific moment of intense decision, e.g. in a textile fair. These aspects are crucial for progressing in research interested in communicating feel and supporting the experience of textiles responding to the specific needs of practitioners; these should be accounted for, in order to guarantee that outcomes are implicated, and grounded in real industry needs. This has also showed the need for conducting the research in diverse settings (i.e. real world and lab studies), which is further discussed below.

There are many ways in which this could be approached qualitatively, so a selection of methods was organised responding to the research unfolding and to how the research questions evolved. Therefore, I approached it initially from the third person perspective (observation, focus groups), then first person (Elicitation Interviews), and finally gong back to third person at the evaluation stage (design workshops). The interpretive framework was informed by design theories, distributed and embodied cognition theories, and phenomenology theory.

The methodology is structured in seven layers (Table 3): Research questions; Study chapter; Setting; Theoretical perspective; Interpretive framework; Data collection methods; Validation. These indicate the progress of the research, how research questions evolved, and how methods were brought in accordingly. The layers are further described below, and methods used are only briefly introduced, given that a full account of the methodology specific for each study is presented in the relevant Chapters from 4 to 8.

Table 3. Structure of the methodology following research questions.

Layer 1 – Research questions	RQ		RQ1. What are the processes that designers follow in the selection of textiles and how does the experiential component of selecting textiles affect these processes?		RQ2. What sensorial information underpins the textile selection processes (forms)?	RQ3. How does the body support the different forms of textile selection?	RQ4. How can the experiential forms of textile selection be supported to facilitate a systematic approach?
Layer 2 – Study chapter			4	5	6	7	8
Layer 3 – Setting	Distributed		X				
	Situated			X	X	X	X
	Real world (natural)		X	X	X		X
	Created case (natural)					X	X
Layer 4 – Theoretical perspective	Third person	Grounded Theory	X				
		Distributed and Embodied Cognition		X			
	First person	Phenomenology			X	X	X
		Embodied Cognition & Phenomenology				X	X
Layer 5 – Interpretive Framework	Qualitative Exploratory		X	X	X	X	
	Action research						X
Layer 6 – Data collection methods	Observations		X	X	X		
	Focus Groups		X				
	Interviews		X	X	X	X	
	Video recording					X	
	Audio recording		X	X	X	X	X
	Questionnaire						X
	Design workshop						X
Layer 7 - validation	Triangulated data collection		X				
	Member checking		X				
	Secondary analysis	With theory		X			
		With 2 methods of analysis				X	
	Evaluation workshop						X

Layer 1 highlight that the methodology has progressed through an iterative approach, where the emerging results led to new research questions and the reframing of the programme towards the goal of the research, i.e. to create a toolkit. This approach also reflects the tactile experience, given that, as Tallis (2003) argued, "tactile knowledge" is developed through tactile interaction and is " (…) a cumulative understanding of the properties of individual objects". Additionally, the research questions helped to continuously refine the focus of interrogation, which contributed to form a funnelling approach, where the investigation was started taking a more open perspective to the design process and seeing selection within it, to then work with the more specific textile selection processes identified, and then narrowing down to the sensorial aspects, and finally focusing on the body. Building on that, the last research question was tailored to guide the development of a support, on the basis of the emergent findings.

Layer 3 indicates the settings where the research was conducted. In one level this is related to whether the view to the selection was taken more holistically, and considering the whole design process, or if a specific, more intense selection activity was observed in isolation. Additionally, both real-world situations and created studies were conducted. This approach was taken because most research on textile (Atkinson et al., 2016) and materials (Karana et al., 2013; Rognoli, 2010) experience has been conducted in lab or university environments. Given that this research is interested in aspects of the experience of practitioners, these would be better observed in real-world context and with experienced practitioners. Hence, a broader perspective is taken by studying different situations of selection and in diverse industry scenarios. The process of design was observed in Chapter 4 in an industry setting with experienced designers and mature students, and included designers from the sectors of fashion, interior and vehicle (colour and trim) design, which were chosen on the basis that they are the main design sectors utilising textiles. Historically, "Traditional textiles are used mainly for clothing and home furnishing" (Adanur, 1995, p. 6), but as mentioned in Chapter 2, the industry has grown to include technical textiles with diverse technical applications (medical, automotive, agricultural, etc.), so these are also considered here. Hence, we see that the largest sectors are clothing and accessories (34%), home textiles (14%), and industrial and technical textiles (15%) (Euratex, 2015, p. 28). Within technical textiles, the largest sector is the automotive (28%) (UK Trade & Investment, 2011, p. 6). Considering the similarity observed in the selection process amongst these sectors in Chapter 4, the

subsequent studies focused on the fashion sector only. Given its creative[22] and economic relevance[23], global influence, and the speed at which this sector operates (with fashion trends being launched at least twice a year according to seasons, which is greater than the other sectors studied), focusing on this sector provided more opportunities to participate and interact with industry events, such as textile trade fairs, which also enabled recruitment of professional study participants. Besides, designers from automotive and interiors also attend fashion-textile industry fairs, as these sectors tend to be influenced by fashion trends. A facsimile design process was investigated in Chapter 5, with designers and non-designers, to observe the selection in situ and confirm the findings from Chapter 4. Chapter 6 focused on intense moments of selection, in the context of a textile fair, to investigate the selection further by introducing research tools that encouraged designers to focus on the textile experience in selection and to talk about it. Chapter 7 focused deeper on the embodied experience when designers interact with textile samples, and investigated experienced designers from diverse backgrounds and actively working in industry. Such diversity in the recruitment of subjects and scenarios chosen for investigating was envisaging the possibility to make generalisations from the resulting outcomes. Finally, Chapter 8 was conducted with MA students within universities, as this was considered to be a more controlled environment to test and implement ideas. Hence, this research has used a mixture of contexts: design studios, trade fairs, retail spaces, and lab spaces. The choice to run experiments in professional environments was considering the need to investigate this phenomena in-situ, and that designers are used to having to work and concentrate in busy and noisy environments. By conducting studies in real world settings, the results became more robust, as they complemented the lab studies. Specifically, in lab-type setting aspects of the overall dynamics of selection, and interaction with other stakeholders were revealed and embodied aspects only started to surface, while in real world settings the more embodied aspects became more relevant. The latter led to another series of more

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[22] According to the report presented by the British Fashion Council and the Oxford Economics "The UK fashion industry is characterised by a dynamic demand cycle, with designer fashion driving industry-wide activity, in particular the vibrant retail sector. The variety of the UK high street was often referenced as being unparalleled internationally." (2009, p. 75).

[23] According to the UK Fashion and Textiles Association (UKFT) "the fashion industries alone contribute over £20 billion to British GDP; double that of both car manufacturing and chemical manufacturing". Information available at: <http://www.ukft.org/business.php?page=business&mcat=2&catid=49>. Access on: 6th August 2016.

focused lab studies (interviews), which relied on bringing specific theory and methods to enable the research progress. If only lab-type or real world contexts were used, and not a mix, the results could have been different, particularly in terms of the research focus.

Layer 4 reflects the theoretical perspective that guided data gathering. In the case of the first study (Chapter 4, RQ1), since a Grounded Theory approach was followed, there was no theoretical framing prior to the study; only the literature that helped identifying the research gap was consulted to this point. Theory was brought in later, as the data was being analysed, in order to conduct secondary analysis to help clarify the relevance and novelty of the emerging themes. Once these themes were defined and saturation was achieved, which enabled the clear distinction of their characteristics, then I decided to focus on other relevant aspects that emerged, and which would be better explored with more applicable theory and methods. These were relevant to the specific aspects observed in the designer's interactions with physical and digital tools, which could not be further explored with the GT approach. Hence, the investigation in the second study (Chapter 5, RQ1), employed Distributed Cognition in Teams (DiCoT) (Furniss & Blandford, 2006), which is a specific method to investigate a system in terms of Distributed Cognition (DC) (Hollan et al., 2000). This approach was taken earlier by Furniss et al. (2011), who managed to further explore a set of data that had been previously analysed through GT by applying a diverse theoretical perspective through DC. In this study the analysis of the data allowed the better understanding of the DC elements, but other aspects also emerged as relevant, which were further explored by bringing new theory for secondary analysis; this time using Embodied Cognition (EC). The outcome results highlighted the importance of attending further to the use of tools, which could not be further explored with the DC and EC perspectives only. Hence, in Chapter 6 research tools were introduced to a professional environment, probing deeper into designers' experience, to understand what sensorial information are used to support selection, and what inhibits it. In the fourth study (Chapter 7) a phenomenological approach was taken, specifically, to investigate the how the body is engaged in experiencing textiles for selection with a systematic approach. This was done using first-person descriptions (Petitmengin et al., 2015) of the designers' tactile experience with textiles in their selection. With this study, embodied and affective aspects were accessed with more depth, and selection strategies operating in that intersection were identified with fine-grained descriptions. At this stage, adequate information had been

gathered to conduct a combined analysis of the results; the output of the qualitative analysis of all data was organised, and subsequently used as input for designing a toolkit to support textiles selection from this phenomenological, experiential perspective. Thus, the prescriptive phase was initiated (Chapter 8, RQ4), where the creative design took place, and design workshops were conducted to iteratively test the prototypes with Masters level students in fashion, accessories, product and industrial design.

Layer 5 is the interpretive framework, which reflects the position taken whilst analysing and understanding the data gathered. Considering the overarching methodological approach in this research, adapted from the DRM (Blessing and Chakrabarti, 2009), that mirrors a usual product development process and its characteristics iterative stages – understand, develop, and evaluate – two frameworks guide the investigation. A qualitative exploratory approach is used in Chapters 4-7 to understand how textile selection sits, how it is performed in the design process, and how designers interact with textiles when selecting. An action research (Swann, 2002) approach is taken in Chapter 8 to investigate how tools can come into designers practice to support them from a phenomenological, experiential perspective. The qualitative exploratory approach is used broadly in social sciences and HCI to investigate and understand if, what, when and how people interact with things and the environment (Blandford, 2014). The richness of methods provided by this approach was considered ideal to tackle the complexity of this issue. Additionally, some research tools were introduced in investigations in order to encourage designers to talk about their experience with textiles, and also to disrupt this process and get them to think about themselves while selecting textiles. The tools that were part of this research are described in detail in Chapter 6, where these were used.

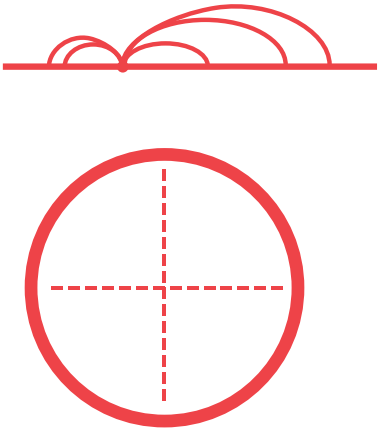
Layer 7 shows most studies were validated individually, through the methods shown in Table 3. Additionally, although the toolkit emerged from results that were already validated through the studies in Chapters 4-7, it has been submitted to a process of validation of its own, which was undertaken through two workshops conducted with MA students in diverse universities in the UK and in Germany. After these workshops, the toolkit kept being tested in diverse opportunities with further workshops and consulting experts that reinforced the findings from the two validation workshops.

Investigating Textiles Selection in the Design Process

Chapters 4 and 5

4.

Articulating a Textile Selection Process Model: A Grouded Theory Study to Make Tacit Processes Tangible



Highlights:

• A model for textiles selection in the design process was synthesised from the literature and verified with and empirical study

• Further analysis of the data revealed 4 tacit processes that were labelled *Collection*, *Interrogation, Projection, and Transformation*

• Articulated a model to demonstrate how the 4 tacit processes interact - the 'Quad-core Textile Selection Model'

4. Articulating a Textile Selection Process Model: A Grounded Theory Study to Make Tacit Processes Tangible

Abstract

Textile selection involves objective function and subjective experience. However, as shown in Chapter 2, while sensory perception has been an acknowledged subject within the textile industry, quantitative approaches to objective textile function have mostly dominated research efforts. Although these are relevant for the selection process, they are insufficient to support the designer throughout the design process, especially at the early stages. To address this imbalance, in Chapter 4 a study is conducted to investigate the Research Question 1 – *What are the processes that designers follow in the selection of textiles and how does the experiential component of selecting textiles affect these processes?* This study investigates designer's experience when selecting textiles for design to provide a better understanding of this process, whilst noting the experiential aspects and how they affect the selection. This is undertaken to support the main aim of the thesis namely, to build a support that is more aligned to the designers' tacit and experiential knowledge, which is currently missing, as the literature suggests (Chapter 2). A Grounded Theory approach was taken to investigate designers' processes and experience when selecting textiles for design. 84 designers contributed their experience through focus groups, interviews and observations. As a result, a model of the textile selection in design is articulated -the 'Quad-Core Textiles Selection Model'-, which introduces the designer experience through four emerging processes: 'Collection', 'Interrogation', 'Projection', and 'Transformation'. The interactions between these processes highlight the interdependence between sensory, cognitive and affective experience in selecting textiles. This process model contributes to design areas that apply textiles (fashion, interior and vehicle), bringing clarity and making tangible tacit and experiential knowledge. This model shows that textile selection is not just based on material properties, which indicates a need to support the other processes. This also requires understanding these processes further, to clarify what support may be needed.

**The work presented in Chapter 4 is a paper in preparation, with the same title of the chapter, to be submitted to a journal (after exam).*

4.1. Introduction

As has been evidenced in Chapter 2, the experience and expertise involved in textile selection is under-researched in the design realm. The experience of textiles has received research attention in the form of quantifying the physical properties, with a few attempts to include subjective evaluations to these objective measurements. However, there is little in the way of understanding the selection process and experiential aspects that affect it in the design area. This study takes a qualitative approach to address this gap, and engages directly with practitioners' perspectives within design, considering both technical and experiential aspects as crucial for designers (Karana et al., 2008). Hence, the aim is to provide a more accurate report on the process of selection of textiles, one that takes account of experiential aspects. To focus the effort the following research question is explored: *What are the processes that designers follow in the selection of textiles and how does the experiential component of selecting textiles affect these processes?*

To address this research question, first the literature presented in Chapter 2 was re-viewed to synthesise findings on textiles selection into a design process model. This model next became a starting point to investigate this process further through empirical studies. First, focus groups were carried out with designers, where they were asked to graphically represent their process and discuss it. At this point experiential aspects were added to the exploration, by probing designers' process deeper using questions to prompt discussions. A series of observations and interviews with designers were conducted in parallel, which were used for further insight, and helped confirm and validate the results emerging from the focus groups. The analysis was conducted using a Grounded Theory approach, and is presented in two main parts: (i) understanding when the textile selection is performed during the design process, and (i) understanding further how it is performed by revealing four tacit processes.

4.2. Synthesising the literature on textiles selection into a process model

This study addresses the gap identified though the literature review in section 2.3.2, which shows that there is no systematic understanding of the textiles selection, particularly how it sits and how it is performed in the design process. Initially, the literature was re-viewed in order to synthesise a model from the information available, and build a structured approach for the empirical study.

In order to make sense of the literature regarding textiles selection, a systematic approach was taken to develop a model that integrates the main characteristics and features encountered in the literature on textile selection for design. This has been carried out through a semi-systematic approach, where references (journals and textbooks) on textile selection were consulted, and particularly looking at the most recently published. After the few existing references were assessed, the most structured design process models were identified, looking specifically for a better understanding of how the textile selection process is seen within those, whilst trying to understand aspects of how the experience of textiles affect it. Unfortunately, no process model was found for the textile selection.

Because there was no process model in the literature, and diverse activities performed (i.e. steps that are taken to achieve a selection) and techniques (i.e. design techniques that are used to explore, investigate aspects of aesthetics that support the process of decision-making) related to the textile selection were encountered, these were collected to see if their descriptions (i.e. how they are carried out) reflect an underlying process. A total of 33 activities and techniques were encountered, and are described in Table A1 in Appendix A (pp. 2-5).

Having identified these activities and techniques, and understanding their definitions and how they may relate to the design process, the next step was to fit these to a model of the design process (based on how they correspond to the definitions of the design phases, i.e. what is carried out in each phase), in an attempt to better understand and visualise when and how they occur in relation to it. The Double Diamond (Design Council, 2005) was used to help structure the design process, considering that its phases ('Discover', 'Define, 'Develop', and 'Deliver')[24] correspond to the 'Fashion Thinking' (Dieffenbacher, 2013) phases ('Idea', 'Concept' and 'Design')[25], based on their

[24] The phases of the Double Diamond are: Discover (identifying initial idea and user needs), Define (aligning idea to business objectives), Develop (developing and testing solutions iteratively), and Deliver (producing and launching product) (Design Council, 2005).

[25] The 'Fashion Thinking' phases are: Idea (is the start of a project, which can emerge from subjective opinion, based on experience, and which exists only conceptually), Concept (is a theme elaborated through investigation of an initial idea), and Design (results from synthesising work gathered from two previous phases, to create something authentic and feasible) (Dieffenbacher, 2013).

definitions. Additionally, the Double Diamond is a more generic design process model, used in many areas of design, and was not found in the literature in areas that apply textiles yet, irrespective of our previous studies having shown that there is a correspondence between designers' information needs in textiles selection and broadly in materials selection for industrial design (discussed in Chapter 2). The phases of both models and how they correspond is illustrated in Figure 7, where these are indicated on the top (Double Diamond phases) and bottom (Fashion Thinking phases) of the Double Diamond image. The manner in which these activities were matched is demonstrated in Table 4, where an example of the rationale for positioning activities or techniques is given for each design phase.

Table 4. Example of the process followed to position selection activities and techniques in the design process.

Description	Type	Definition	Corresponding Design phase
Trends	Activity	Researching, or consulting bureaus and research companies that present what is emerging as relevant in terms of influential aesthetic themes and references.	Discover
Moodboard	Technique	Organising, interpreting and communicating themes, by combining information from 'Trends', 'Definitions of Colour', 'Shapes, textures, volumes, etc.	Define
Prototyping	Technique	Creating models to verify how the textile is formed, and also to specify the steps of the making process.	Develop
Check and approval	Activity	Editing collection before production – there may be material changes up to this point.	Deliver

Figure 7. Textiles selection activities mapped on the Double Diamond.

In synthesizing these works, I propose that the textile selection accompanies the overall design development, instead of being a single step within it, as it has been represented

before (for example, in Dieffenbacher (2013)). In Figure 7, the 33 activities and techniques found in the literature are seen distributed across the phases of the design process, and are also identified with the source (using numbers and colours to distinguish references). However, the process model in Figure 7 has been hypothesised through interpretation of the literature, so it still may not reflect the actual dynamics and how the process flows in the real industry context.

This model next became a starting point to investigate this process further, particularly in terms of identifying and describing experiential situations from the designers' perspective. This was achieved by organising a study to observe how close to the designers reality this model was, i.e. how designers select, by verifying through the following questions: Does this model fit with what designers do? Are these activities and techniques indeed performed or used? If so, when and where they happen? And is there anything missing from this model? Finally, to complement this model, the study went on to investigate how designers use experiential knowledge and how they interact with textiles. These questions are explored in section 4.3.

4.3. Study 1: Refining the process model in-situ

In order to address the above questions, a study was organised to validate and refine the activities and techniques to support the selection of textiles. To focus the investigation the study was designed around the Research Question 1 (*What are the processes that designers follow in the selection of textiles and how does the experiential component of selecting textiles affect these processes?*).

4.3.1. Methods

A series of activities were conducted to address the above question, mainly through focus groups, observations, and interviews, as detailed in Table 5. These diverse activities allowed for methodological and data triangulation, which broadens the credence and generalizability of the findings (Flick, 2004). The main data for this study comes from the 4 focus groups. The other data was used to help inform the analysis of the focus groups, but mainly to confirm and validate the findings. For the focus groups and in-depth interviews, participants were contacted by electronic correspondence. The studies are presented in the order they occurred chronologically in Table 5, which shows

that they were run in parallel, considering that I had to adapt to the opportunities that emerged. The Local Ethics Committee (Brunel University, ethics approval # EC/389) approved the studies, and where participants actively contributed (verbal or graphical input), they provided written consent (form in Appendix B1, signed forms available on request).

The study was conducted with multiple-categories (Krueger and Casey, 2000, p. 31) of designers, totalising 19 participants who directly contributed to this research (focus group and interview), and more than 65 observed who contributed in a more passive sense (Table 5). This sample included a mix of designers from companies and universities in fashion, automotive and interior design, which were previously identified as specialist audience. This followed a theoretical sampling strategy, which aimed to broaden the scope of analysis through recruiting a diverse range of participants (Furniss, Blandford and Curzon, 2011) that leads to "generating and developing theoretical ideas" (The SAGE Dictionary of Social Research Methods, 2006). The participants were identified with a code according to their sector and contribution, with details provided in the last column of Table 5, and which were used throughout the results section to identify their voices.

Table 5. Details of the activities conducted within the study

Activity	Method	Sector	Participants	Expertise	Years of experience	Type of contribution	Participants code
1	Focus group	Automotive company from the luxury sector	4	2 colour and trimming designers (C&T); 1 materials engineer; 1 marketing	> 10	Active	LC1, LC2, LC3, LC4
2	Observation	Textiles sourcing show	> 50	Diverse segments of fashion design	Not controlled	Passive	
3	Focus group	Fashion university student	5	Fashion design 3rd year students	< 5	Active	FS1, FS2, FS3, FS4, FS5
4	Focus group	Architecture - Interior design	5	Interior designers	> 10	Active	ID1, ID2, ID3, ID4, ID5
5	Interview	Textile designer	1	Curator of a large textile fair and consultant for the industry	> 20	Active	TD1
6	Observation	Fashion design house – renowned designer	> 15	Fashion designers womenswear and menswear	Not controlled	Passive	

Activity	Method	Sector	Participants	Expertise	Years of experience	Type of contribution	Participants code
7	Focus group	Automotive company	3	1 textile designer; 2 product designers	> 10	Active	AC1, AC2, AC3
8	Observation	Automotive company	1	Perceived quality expert	Not controlled	Active	AC4
9	Interview	Fashion designer	1	Curator of a textile fair and tutor at a fashion college	> 10	Active	FD1

The diverse methods and contexts used are described below and in Table 5:

- *Focus groups (activities 1, 3, 4 and 7 in Table 5):* The studies were initiated through focus groups (Kuniavsky, 2003), where I used a semi-structured interview guide (Table 6) over the 2 hours. Prior to the study participants were requested to bring to the session a material previously selected for a project, which was used in question 4, to get designers sensitised to their selection process. Some design workshop elements (Martin and Hannington, 2012) were incorporated to generate tangible evidence and support the investigation; this was specifically in relation to question 5, in Table 6, where designers were asked to draw their design process. Only in the 3 first focus groups (activities 1, 3, and 4) designers produced drawings of their process; this was because of time and space constraint in the other activities.

- *Observations (activities 2, 6 and 8 in Table 5):* Observations were conducted in opportunities that emerged and were considered relevant to bring insight and help underpinned findings from focus groups (i.e. in the largest textiles for fashion fair in the world, in a fashion design house, and in an automotive company that welcomed a visit to their colour and trimming department). The observations were conducted in context in three diverse environments: the first (activity 2, Table 5) was a two-day visit (8 hours in total) to the world's largest textile fair, where designers were observed selecting textiles; the second (activity 6, Table 5) was a 2-hour visit to a fashion house from a globally renowned designer in London, UK; the third (activity 8, Table 5) was a 2-hour visit to a laboratory where materials were being assessed for their physical and sensory properties, both quantitatively and qualitatively, in an automotive

company. A report was produced after each observation, focusing on the process of selection.

- *Interviews (activities 5 and 8 in Table 5):* These were conducted to add a third dimension to the investigation. The interviewees were very prominent specialists in textiles selection, identified particularly because of their expertise and position as curators of textile fairs.

Table 6. Questions used in the Focus Group and Interviews

Number	Type	Focus	Semi-structured interview guide
1	Opening question	General materials experience	What is the first texture you can remember having touched today?
2			Is there any material that interests you more than all the others?
3	Transition activity	Go into experiential aspects within design	Discuss and map what is involved in the definition of product aesthetics.
4			Present a mood board and/or sample material that have been previously selected in a project and describe how that material was chosen.
5	Key question	Selection viewed within design process	What is your process of textile selection? Describe and represent it graphically [1].
6	Further exploring the process	Further explore process in terms of resources and information	How do you find materials that you think will embody the textile sensation you wish to convey?
7			How do you search for textiles?
8			When you are in a fair or a shop, what do you do? How do you approach the textiles?
9			How do you select? Are there sensory interactions?
10			When selecting textile materials, what information would you like to have access to: From your consumers? From your suppliers? Consider sensory perception and how they relate with materials.

[1] Only the three first focus groups produced drawings, as in the other situations there was a time or space limitation, and hence they participants only described their process verbally.

4.3.2. Analysis

A Grounded Theory (GT) approach was used, following Strauss and Corbin (1998), because it is an inductive method that allows *"insight into people's values, understanding and experience"* (Furniss, Blandford and Curzon, 2011). GT was identified as suitable for the aim of this study, which is to understand how textile selection sits and how it is performed in the design process, considering the designer's understanding and experience. In GT, data collection and analysis are iterative, so the analysis started soon after the first study was conducted, and progressed inductively through open, axial and selective coding (Strauss and Corbin, 1998). Open coding is where parts of text and quotations are identified with a code. Axial coding follows,

where relationships between codes are explored. Selective coding focuses on the main themes of the analysis.

The analysis process was conducted by the researcher and overseen by an external advisor who is an expert in qualitative analysis from a world-leading lab in interaction design, having extensive engagement with grounded theory in research and teaching over more than ten years of experience. The sessions were recorded and transcribed verbatim (an example of transcription is presented in Appendix C1, and other transcripts are available on request). Only the focus groups results were coded. The interviews and observations results were used through notes and memos, and were brought in to add further insight and help to analyse the codes emerging from the focus groups. Open coding was performed using the QSR International's NVivo 11, as illustrated in Figure 8. Axial coding (Figure 9) and Selective coding were realised on paper with colour-felt pens. In the Selective coding diagrams were used to help visualise the links and hierarchies between codes (Figure 10). Notes and memos organised in a notebook were used throughout the process to play with ideas and relationships, and each new iteration of data collection have built on these, e.g. by adding a few questions at the end of the study, to reflect on findings from previous data collections and to probe ideas deeper with the help of participants. Once the four main themes were derived, their names were refined for clarity. These names were chosen through synonyms search, consulting the literature further, and through a number of discussions with other design researchers.

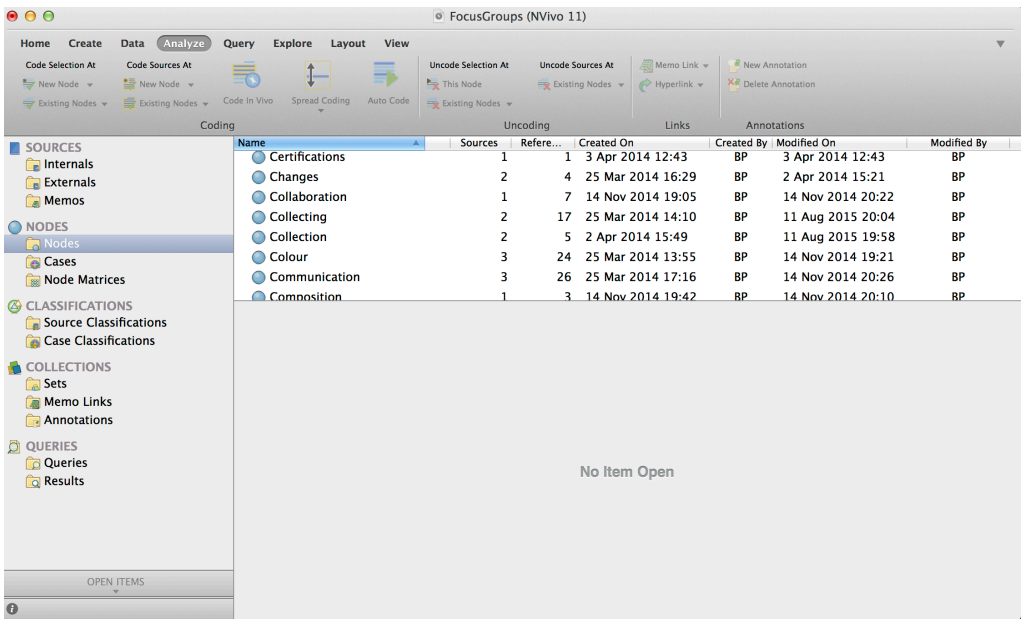
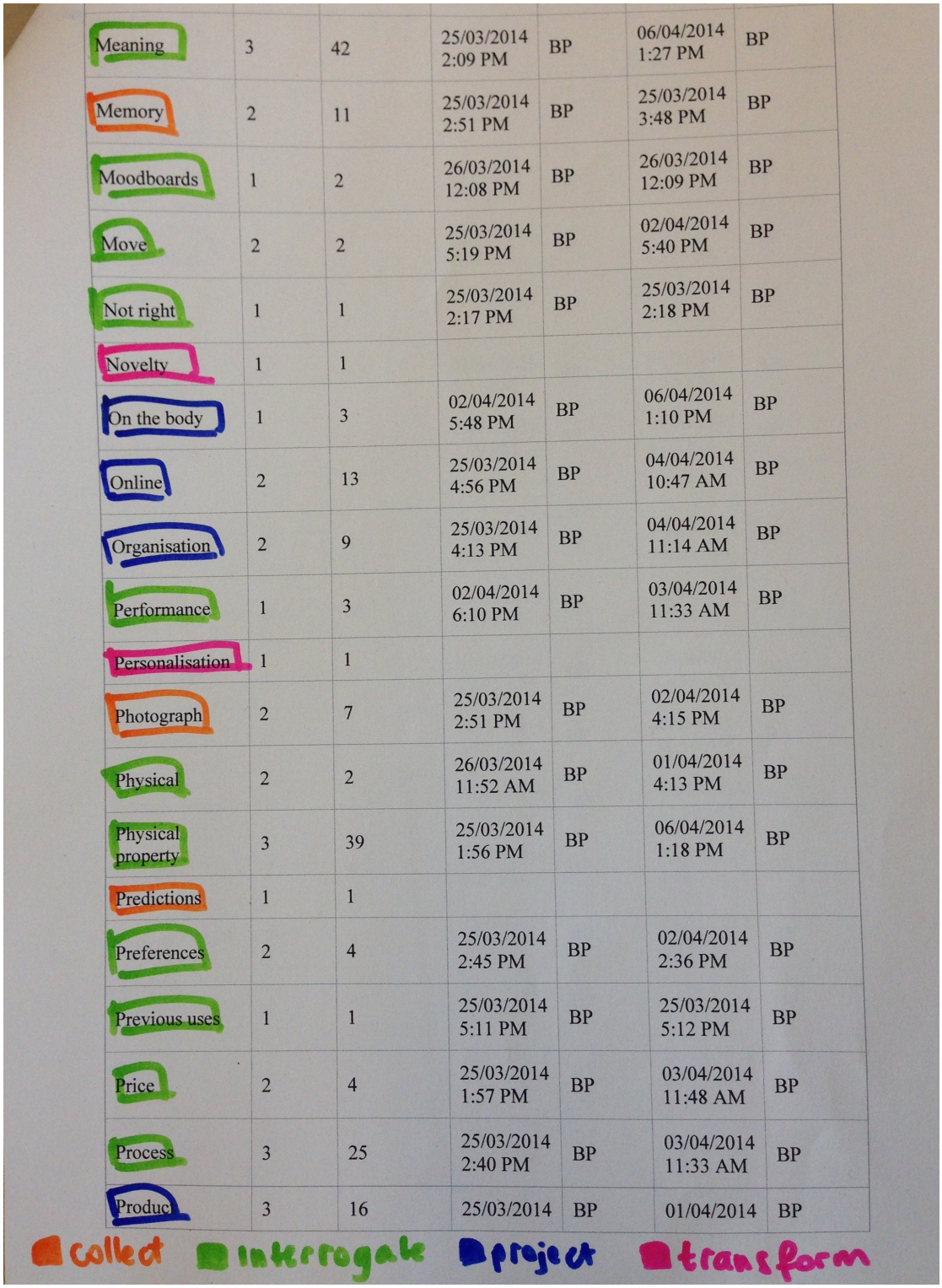


Figure 8. Example of the codes being generated in the open coding process using QSR International's NVivo 11.



Meaning	3	42	25/03/2014 2:09 PM	BP	06/04/2014 1:27 PM	BP
Memory	2	11	25/03/2014 2:51 PM	BP	25/03/2014 3:48 PM	BP
Moodboards	1	2	26/03/2014 12:08 PM	BP	26/03/2014 12:09 PM	BP
Move	2	2	25/03/2014 5:19 PM	BP	02/04/2014 5:40 PM	BP
Not right	1	1	25/03/2014 2:17 PM	BP	25/03/2014 2:18 PM	BP
Novelty	1	1				
On the body	1	3	02/04/2014 5:48 PM	BP	06/04/2014 1:10 PM	BP
Online	2	13	25/03/2014 4:56 PM	BP	04/04/2014 10:47 AM	BP
Organisation	2	9	25/03/2014 4:13 PM	BP	04/04/2014 11:14 AM	BP
Performance	1	3	02/04/2014 6:10 PM	BP	03/04/2014 11:33 AM	BP
Personalisation	1	1				
Photograph	2	7	25/03/2014 2:51 PM	BP	02/04/2014 4:15 PM	BP
Physical	2	2	26/03/2014 11:52 AM	BP	01/04/2014 4:13 PM	BP
Physical property	3	39	25/03/2014 1:56 PM	BP	06/04/2014 1:18 PM	BP
Predictions	1	1				
Preferences	2	4	25/03/2014 2:45 PM	BP	02/04/2014 2:36 PM	BP
Previous uses	1	1	25/03/2014 5:11 PM	BP	25/03/2014 5:12 PM	BP
Price	2	4	25/03/2014 1:57 PM	BP	03/04/2014 11:48 AM	BP
Process	3	25	25/03/2014 2:40 PM	BP	03/04/2014 11:33 AM	BP
Produc	3	16	25/03/2014	BP	01/04/2014	BP

Figure 9. Examples of the axial coding process using paper and coloured pens.

Figure 10. Example of the selective coding using diagrams on paper with coloured pens.

4.4. Results

The results were organised to reflect the most relevant findings related to (i) when the textiles selection is performed during the design process, and (ii) how it is performed (experiential aspects). First, in (i) the insights gathered through the resulting representations produced by designers are presented: these were mostly linear. However, further probing suggested that these processes were more complex and non-linear, and these aspects were explored in the second section (ii) and reported through four themes (identified processes) grounded in data. These were then used in the third section to propose a model reflecting the designers' experience.

4.4.1. Understanding when the textile selection is performed during the design process

When designers in the three initial focus groups were asked to describe their selection process, the resulting visual representations showed a mainly linear process (Figures 11 to 13). The representations are presented here in order of increasing complexity with which designers depicted their process.

The initial representation (Figure 11) presents only a rough depiction of the activities performed, and reflects the educational perspective discussed in the background section. This simplified representation seen in education is typical and used to provide the students with a systematic approach to the process. However, some level of flexibility is already observed, where students have indicated diverse techniques that they used, but identifying points where students' experiences differed. Here the red arrow and text reflects the process of a student who mentioned the need to have textile samples and prototypes since the early stages of the design, while defining initial concepts, while the other students reported this need coming later in the development stage, which is shown with the light blue arrow.

The process produced by designers from a luxury car company (Figure 12) reflects a more complex perception of the process comprised of crucial stages for the design process flow. These are indicated in Figure 12 as: define brief, research outcomes, blue sky ideas, concept check, direction defined, tweak, final decision, production. Designers included little information about the activities performed by the Colour and Trimming (C&T) team, and the whole structure seems directed towards contextualising their work broadly within the company operations. Their representation is similar to the stage-gate model (Cooper, 2014), which is a model proposed in management literature, where gates are usually related to external decisions coming from other departments (mainly marketing and engineering). In this case, the stages reflect production of content by the C&T team for delivery and decision-making with other departments, which represent the gates. In this model designers have added a quantity of themes and materials that are considered at different stages, and these numbers can be seen on the top of the image, above the main stages (e.g. in 'concept check' around 5 themes/personalities are considered; in 'direction defined' these themes have already been translated into 5 to 3 material ideas, which are presented as samples or prototypes to *"sell in best possible light"*). Such definitions help to narrow down the options of materials, which provide more information than the model produced by the students (Figure 11).

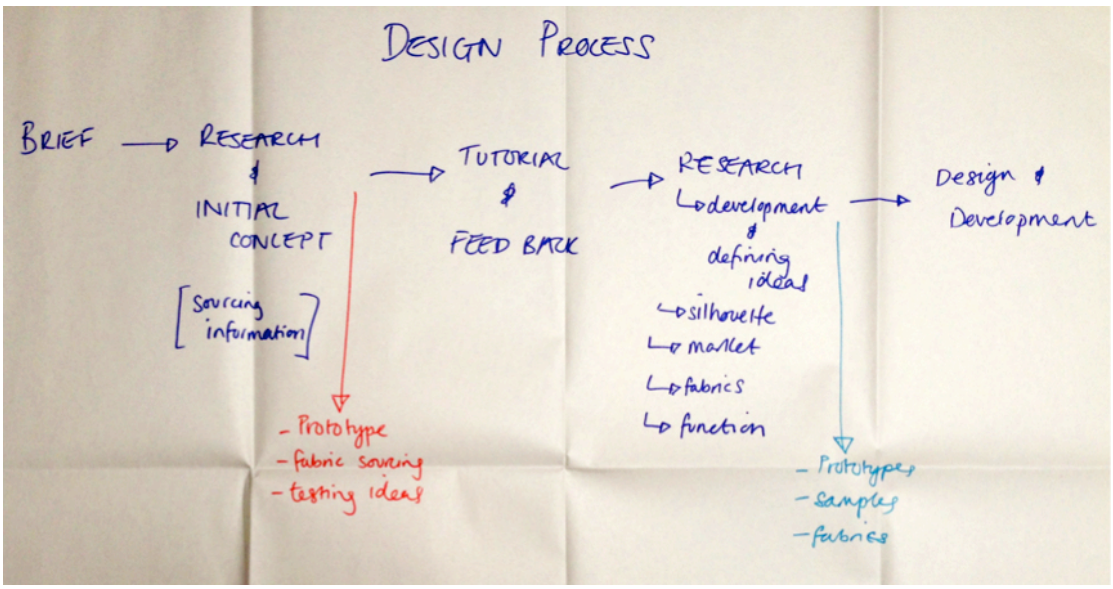


Figure 11. Representation of the selection process produced by fashion students (activity 3, Table 6).

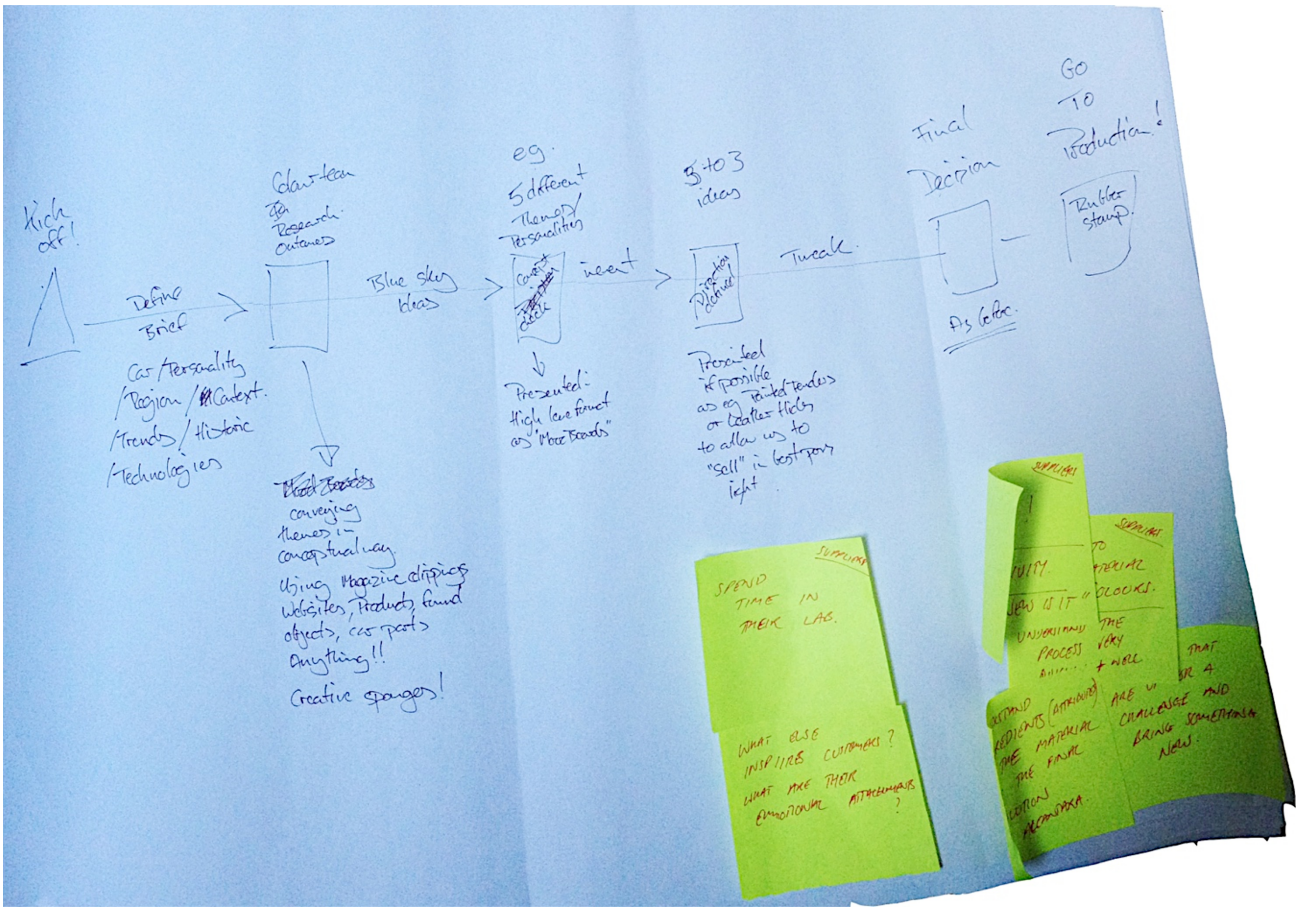


Figure 12. Representation of the selection process produced in luxury car company (activity 1, Table 6).

The third view of the design process was produced by interior designers (Figure 13). This reveals iterations (e.g. between concept and technical stages) and simultaneous activities (e.g. the interaction with suppliers is present throughout the process). These

indicate the dynamics inherent in the process, especially regarding sequencing and duration of activities, which is less evident in the representations by other groups. They show a more explicit understanding of the type of knowledge being utilised at different stages. This suggests that, at early stages, sensory and meaning-related information is used more, whereas technical information only becomes useful at later stages, once the concepts are already defined. However, they do not include the quantities of materials being considered as in the example above (Figure 12).

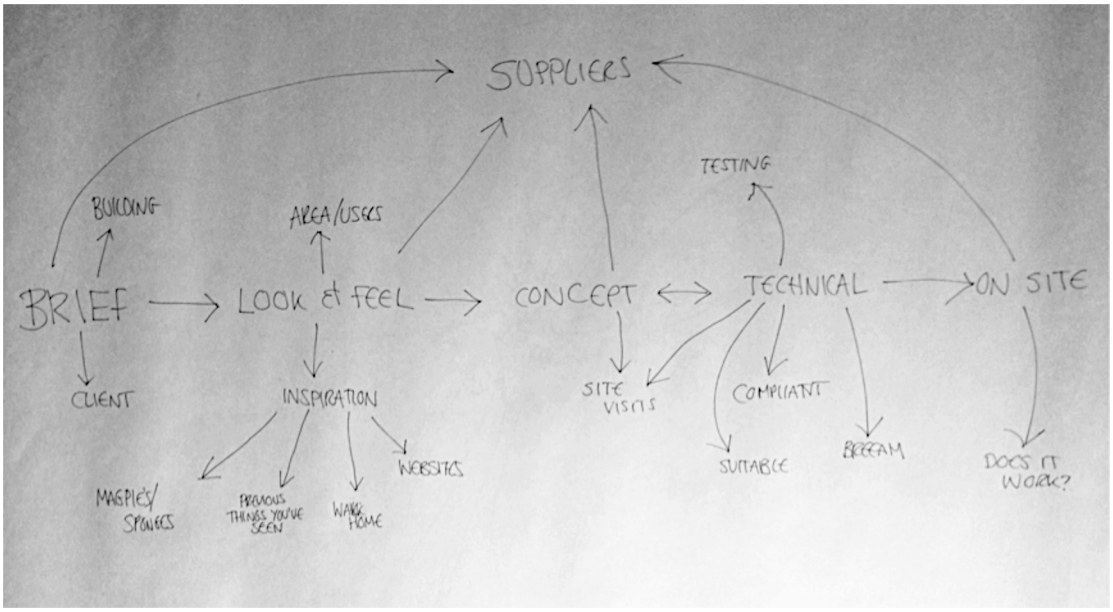


Figure 13. Representation of the selection process produced by interior designers (activity 4, Table 6).

Looking at all of the representations we can see that while the students representation (Figure 11) shows the techniques used in selection, the experienced practitioners (Figures 12 and 13) focus in other aspects (such as materials being considered, outputs produced, and interactions with other stakeholders). Further analysis of these representations, which can be seen in pictures 14-16, reveals six relevant components to their understanding of this process, which are described below:

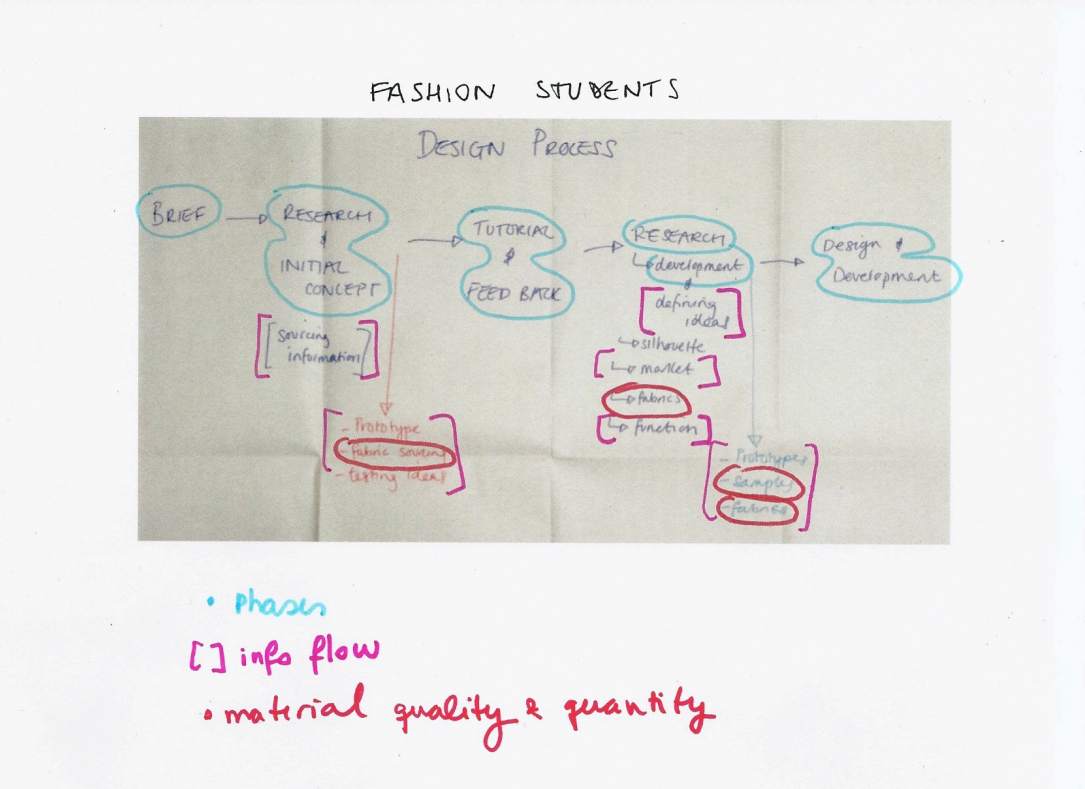


Figure 14. Analysis of the relevant components in the process produced by the fashion students (activity 3, Table 6).

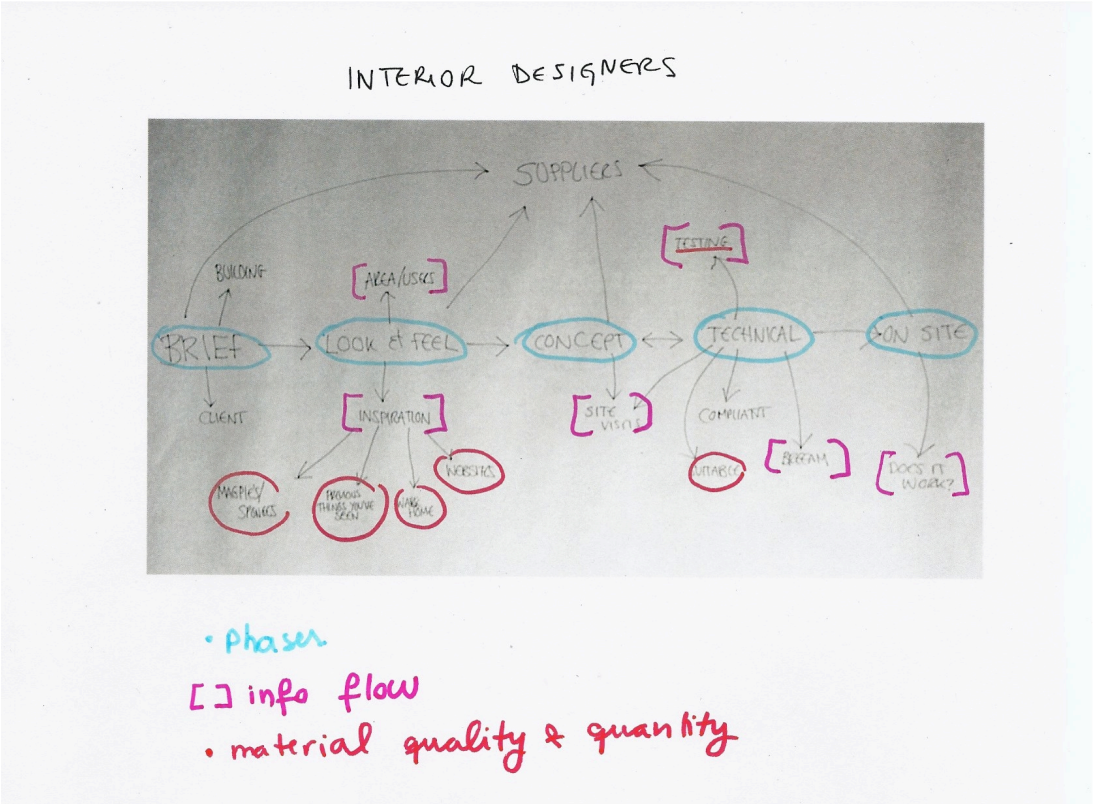


Figure 15. Analysis of the relevant components of the interior designers' process (activity 4, Table 6).

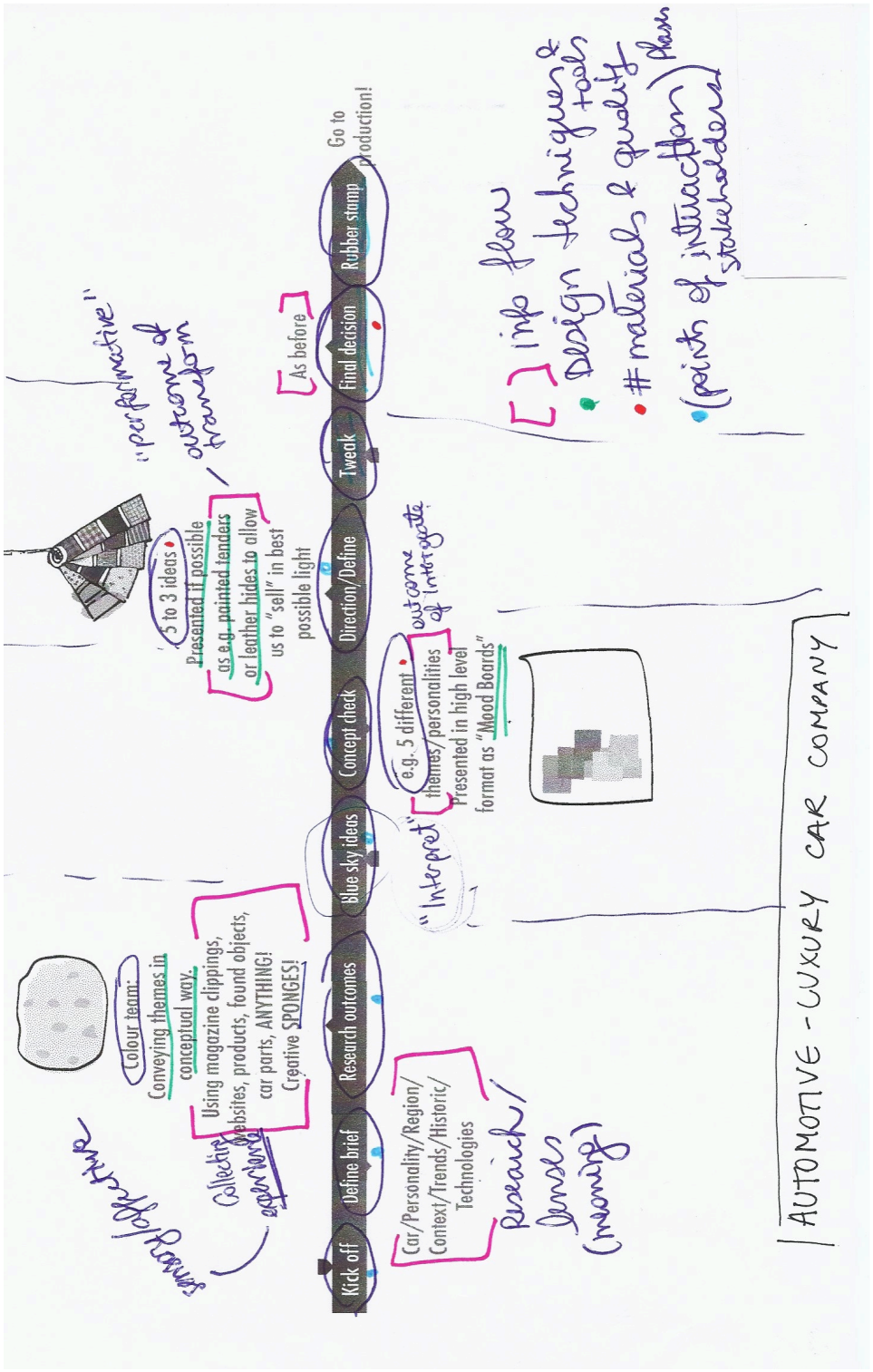


Figure 16. Analysis of the relevant components in the process produced by colour and trimming designers (activity 1, Table 6 - this was digitised for legibility).

Relevant components emergent from designers' process model representations:

1) *Phases of the process*: Usually related to a moment of communication with other stakeholders, e.g. defining a brief, presenting a concept. These are indicated by the words between arrows (circled in blue in Figures 14-16).
2) *Information flow*: Related to information around materials, and how they are transformed throughout the process. This is indicated in pink in Figures 14-16. In the case of the luxury car company (Figures 12 and 16, the latter is a digitised version for legibility), departing from the idea for a car personality, to found objects related to this personality, to definition of themes around personalities, to prototyping material ideas until reaching a final material outcome. In the case of interior designers (Figure 15) departing from a brief, which is elaborated through inspiration (coming from different sources, e.g. websites, on the way home), further refined through site visits, and then feasibility is verified through testing and checking specifications (which they indicate as 'BREEAM'[26]), and the final shaping just emerges after checking 'on site'.
3) *Design techniques and tools*: Including what is used throughout the process in support of the material transformation and information flow, e.g. prototypes (Figure 11), mood boards (Figure 12), websites (Figure 13), etc.
4) *Material status*: Related to the quantity (as shown in Figure 16) or type (may be 'samples' (Figure 14), a 'found object' (Figure 15), or 'things you have seen' (Figure 15)) of materials being dealt with at the different phases.
5) *Time*: The linear progression used by all designers provides an indication of when activities occur and their duration in relation to the design process.
6) *Social interaction*: The social element started to emerge as relevant in all representations produced by designers. First, in Figure 11 fashion design students included 'Tutorial and Feedback' as a phase. Second, in Figure 12 designers included points of interaction with other departments in the company represented as boxes in the process, these indicate points in the process where they need to 'convey' and 'present' their themes and definitions (which I previously compared to the gates, in the stage-gate model). Third, in Figure 13, designers provided indication of the interaction with suppliers as ubiquitous to the process, and finally interaction with the final user is also included as 'client' and 'users'.

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[26] BREEAM stands for Building Research Establishment Environmental Assessment Methodology. Further information available at: <http://www.breeam.com/why-breeam> .

4.4.2. Using Designers' Representations to Revise the Textile Selection Process Model

Having considered the designers' representations, this section builds on the initial model synthesised from the fashion literature (Figure 7), in an attempt to organise a more complete picture, and Figure 17 illustrates the result of this analysis. While verifying commonalities between the model hypothesised in Figure 7 and the models produced by the designers (Figures 11-13), I observed that the model accurately reflects what designers do in terms of discrete activities performed and techniques used. Their positioning in the linear process was verified, as well as how they unfolded in time. The main modifications proposed in Figure 17 are described below:

Clustering activities and techniques under 'Phases from Designers'

Observing the types of terms that designers used to identify each phase, and comparing it to the activities and techniques that were scattered and populating Figure 7, an organisation of these activities was proposed in Figure 17. To do so, more high-level labels for phases were created, by observing the phases proposed in Figures 11-13, which are identified as 'Phase from Designers' in Table 7. Next, the activities and techniques were positioned under 'Phase from Designers', again observing their descriptions and relating them to designers' reports. These are shown in Table 7 and in Figure 17.

Repositioning activities

Some of the activities were repositioned after observing the designers' representations. This was the case of 'Trends' and 'Fabric Producers and Fairs', which were moved to the very beginning of the process, to show that this type of activity is ongoing even from before the start of a project. As was indicated by interior designers (Figure 13) the contact with suppliers is constant, I infer that designers are continuously accessing such information, even prior to considerations of a specific theme or concept.

Including interactions with stakeholders

Another distinction verified through this study is related to activities that are performed by designers themselves, and those that are generally conducted by other departments in a company context. Such a distinction may be closer to the reality, especially in contexts

of vehicle and interior design, when designers normally work within a team, and not individually as is observed in fashion design. These were colour-coded[27] in Figure 17 to indicate the distribution.

While the new process model produced in Figure 17 is richer then what was found in previous literature, the depicted model does not clarify *how* designers achieve a selection, and questions regarding the dynamics and flow of such activities are still left unanswered. Although activities could be placed in a linear manner, it is hard to allocate them just in one particular phase of the design process, since designers may repeat activities at different stages, but with different purposes (e.g. they may produce moodboards in the beginning of the process, to analyse and assemble references and achieve a theme proposal, but they may also use moodboards further ahead in the process to communicate the final collection shapes, textures, colours, etc.). Crucially, what this model fails to depict are the practitioners' behaviours emerging from tacit processes, which are more dynamic (i.e. not linear) and much more intrinsic to their selection. These themes are presented in further detail in section 4.4.3.

[27] The activities that are performed by designers or design teams independently are identified with the colour blue; the activities where designers interact with the technical development personnel (engineers and technicians), particularly for obtaining information or for developing materials and products, are identified with the colour green; and the activities where other stakeholders are engaged were identified with the colour orange – these can be internal to the company (e.g. marketing, buyers, management, manufacturing) or external to the company (e.g. suppliers, trade fairs, vendors, retail).

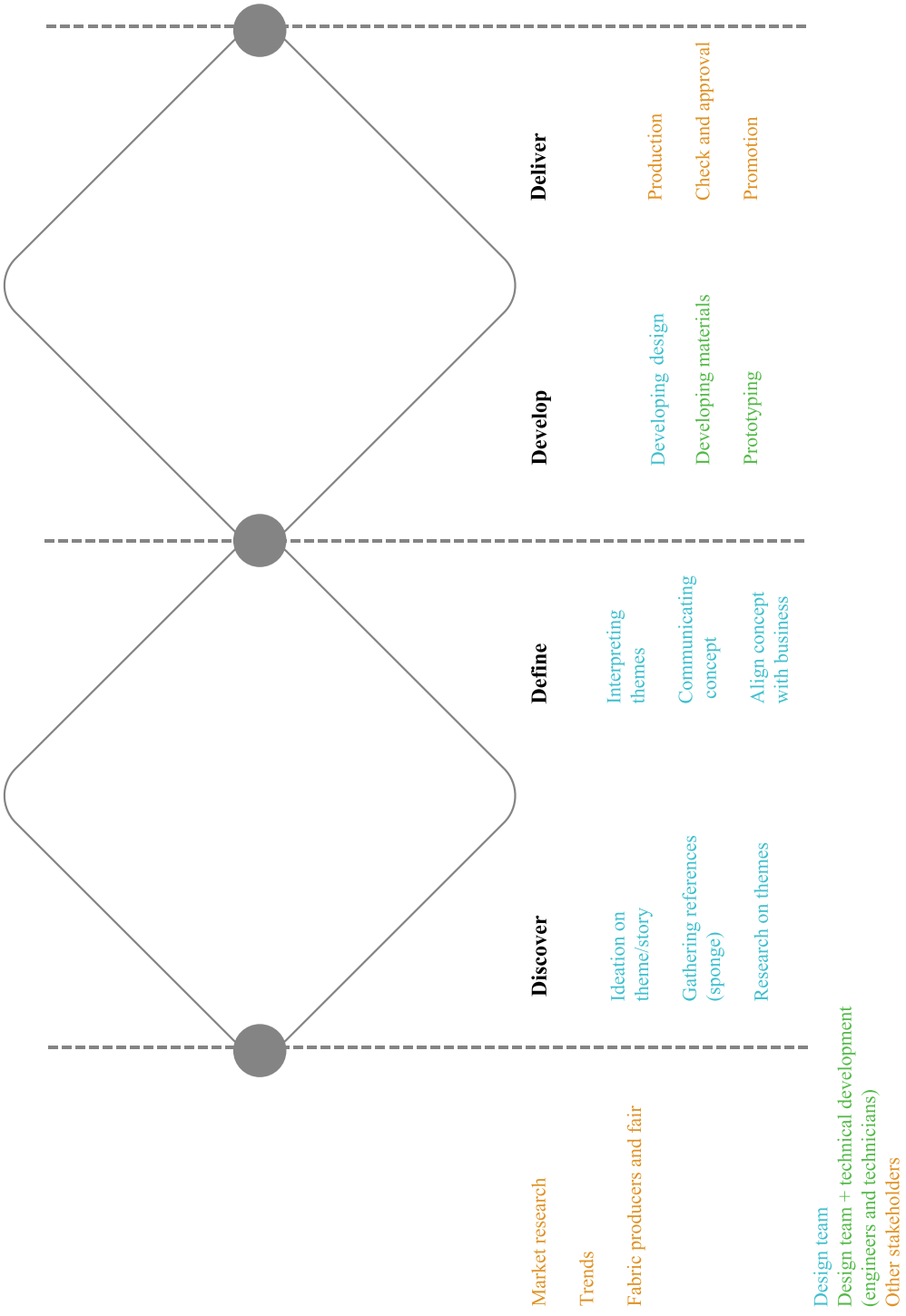


Figure 17. Textiles selection in the design process revised after the study, building on Figures 7, 11-13.

Table 7. Organisation of activities and techniques relevant to the selection of textiles following designers' process models

Process Phase	Phase from Designers	Activity or Technique (from literature, in Figure 7)	Who is involved
Pre-Discover (in all the cases observed these are defined with the design brief specified to designers)	Market research	Analysis from previous designs	Marketing department
	Trends	Consulting fairs and bureaux	Marketing department
	Fabric producers and fairs	Visit to fairs Showcased by vendors or textile mills	Buyers
Discover	Ideation of Theme/story	- 2D annotation - Mind mapping/ brainstorming - Creating straplines	Designers
	Gathering references (sponge)	- Textiles and other materials - Images - Music - All other references emerging as significant	Designers
	Researching on themes	Research around themes to consolidate story (this is more related to textual information)	Designers
Define	Interpreting themes	- Identifying emerging themes - Making choices and narrowing down to concepts	Designers
	Communicating concept	- Moodboards - Initial ideas for shapes, colours, textures - Sketches	Designers
	Aligning concept with business	- Verify how story aligns with brand and market trends - Costs and budget	Designers
Develop	Developing design	- Defining shapes, colours, textures - Developing prints	Designers
	Developing materials	- Developing/sourcing textiles - Technical testing - consider: physical (performance, drape, volume, structure, stretch); aesthetics (colour, mood, trend, historical and cultural influences, pattern, texture); source (provenance, availability, cost); market (level, genre)	Designers and technical development
	Prototyping	- Drape on model - Toiles - Digital drape	Designers and technical development
Deliver	Production	Manufacturing pieces approved through prototyping stage	Technical development and manufacturers
	Check and approval	Quality assurance testing	Technical development
	Promotion	Working to distil main concept to the retail environment	Marketing department

4.4.3. Understanding further how textiles selection is performed by revealing four tacit processes

Even though the model refined with contributions from designers in Figure 17 was already richer than the model synthesised from the literature (Figure 7), further questioning on the design process revealed that there are other relevant aspects for the selection of textiles, which are related to '*what'* and '*how'* designers select. Four themes emerged as the most relevant, following their incidence across sources and considering their scope to accommodate other codes within them during the axial and selective coding stages (see Table 8 for number of codes within each theme).

Table 8. Codes that lead to themes definition (through selective coding)

Theme	Number of codes
Collection	25
Interrogation	52
Projection	35
Transformation	21

The themes – Collection, Interrogation, Projection and Transformation – characterise behaviours that reveal tacit processes happening when designers select, and which generally remain unspoken or unknown. These highlight a practitioner's perspective, and provide scope for creating a narrative into which the other emerging aspects could be woven. The latter are related to the 'relevant components emergent from designers' process model representations' (Phases, Information flow, Design techniques and tools, Material status, Time, and Social interaction) in Table 9. Additionally, Experiential components (Experiential situation and Attention mode) that only surfaced in the discussion are also included in Table 9, to help describe the themes. Each theme is summarised in Table 9 and subsequently explored in the relevant sections.

Table 9. The four emerging themes revealing tacit processes in textiles selection

	Collection	Interrogation	Projection	Transformation
Description (related to Phase and Information flow)	'Collection' is a ubiquitous process of constant actualization through gathering material references, and mostly deals with qualitative traits (sensory and affective)	'Interrogation' is related to understanding both the material and how the designer feels when interacting with it. The designer's perceptions and knowledge about materials is relative	'Projection' is pushing material understandings by experimenting with ideas with support of materials and related information, to come up with possible material solutions	'Transformation' is about creation and goes beyond understanding the material. It is through transformations in the emerging signs that designers come up with final material solutions
Material status	Multiple materials	Multiple materials	Fewer materials, which are probed individually	Material(s) selected
Social interaction	Individual and distributed	Individual and distributed	Distributed	Distributed
Design Tools	Samples, capturing tools (cameras, smartphones)	Samples	Samples, relevant machinery	Samples, relevant machinery
Design techniques	Moodboards, sample boxes	Moodboards, prototypes, sketches	Prototyping	Manufacturing
Time (Occurrence)	Continuous	Situated*	Situated*	Situated*
Experiential situation	Experiencing and Absorbing	Experimenting and Analysing	Experimenting and Problematizing	Creating and Evaluating
Attention mode	Predominantly affective (feel/intuition)	Predominantly discriminatory (evaluation)	Combination of discriminatory and affective	Combination of discriminatory and affective

4.4.3.1. Collection

Designers collect material references to get a sense of the world around them, and feel their way through the selection process. They define themselves as "sponges" or "magpies". Designers report this activity as a source of inspiration.

ID4: Sometimes you go to the design websites, and you have a look at materials, but it can come from anywhere.

ID1: Yes.

ID4: Especially when you are working on something, then in your walk home you just see things…

ID5: I love that.

ID1: And maybe that reminds you of something that you've seen years before…

ID5: I guess you always get inspired, don't you, as well? Anything inspires me.

The new information encountered (references, materials, colours, etc.) is integrated to an existing personal collection, which can indeed exist physically, but is more related to their accumulated experience. 'Collection' is ubiquitous; it *"is just constantly collecting things." (LC2)*. It can also mark the start of a project, because as soon as they receive or define the brief, designers start to collect references with a specific focus. But even during this focused collection, they keep other materials that attract them as a system of

constant updating their material references that support the studio work. It was noticed through the focus groups that designers are not always aware of how this 'collection' affects the design process, or are not used to discuss amongst the team, so this animated discussions where participants enquired each other, and lead to a further articulation of the collection, which helped revealing how they do this. This is highlighted in the discussion between participants below:

> *LC3: When you start collecting all these stuff together, do you collect it with a project in mind? Or are you always out there looking at things and just collecting things randomly?*
> *LC2: Both. I am always collecting bits and pieces. (…) It could be anything… It could be a bottle, or a perfume bottle. A wrapper. It comes from anything. I have a sewing room at home, and it's just full. You can't get in it now. It's just full of useful things - materials, objects, bits and pieces. (…) People always bring car objects or bits of metal or bits of wood and they would appear at the studio.*

'Collection' is further elaborated through three distinct forms of absorbing described in Table 10, which captures designers' 'spongy' behaviour: serendipitous absorption, intentional absorption top-down, and intentional absorption bottom-up.

Table 10. Forms of Collection.

Forms of Collection	Description	Example
Serendipitous absorption	Sometimes designers browse without a specific question or goal, e.g. looking at magazines or being at a fair more casually, taking information in more passively.	*"And it would be absorbing what's happening now with fashion, furniture, interiors, paint, interior paint, finishes… and looking at what is influencing people in their lifestyles, and what their aspirations are, and what's interesting them more… and just absorbing it, and not saying "Right, it has to be that". It's just taking it in." (LC2)*
Intentional absorption top-down	When designers have specific design needs and questions, and search for materials in a top-down process, trying to find a match for a need. They may be actively searching for inspiration, an answer or a sample. "What fabric could I use for X? What is the new concept for X?"	*"Because we do tailor made jackets, and shoulders are obviously important, so something like what weight would work better with this structure. If you would have a really sharp shoulder, what weight would work better? What material would you have, 100% wool, or a 50% wool?" (FS3)*

Forms of Collection	Description	Example
Intentional absorption bottom-up	When designers follow a bottom-up process, which consists of articulating material attributes and defining criteria to help identifying options. "I want a feel X, but with properties a bit more like Y, does this exist?"	*"So maybe for us the perceived richness is very important. (…) So when it's all black, and you have just the seat and a little part, so you have to think 'how can it go richer just with another fabric?' So if it looks very rich, for a fabric, then for us it's very good. So this is maybe how we start to specify what to look for the touch, and etc." (AC1).*

It seems that the ability to abstract information from the collected materials is determined by designers' experience and subjectivity in the design process, which they report as related to their instinct.

> *"And it is just absorbing it, and not saying "Right, it has to be that". It's just taking it in. And then trusting your design instincts, which I do a lot now, because over the years I've seen we've got it right, so I'm not completely wrong or completely bonkers." (LC2)*

In 'Collection' the attention when encountering references is predominantly affective, relying on feel to decide on what will be collected. There was not a clear mention to functional qualities of items collected in designers' descriptions of this activity, but considering that designers are collecting objects, materials and things that do have a functional use, these may be tacitly taken in, but not expressed as a priority in this process. While collecting, designers perceive material opportunities based on affects, as can be noticed from the example below, where the designer described how she was drawn to the colour yellow after seeing it a lot on a trip.

> *"When I went to New York I fell in love with yellow. Everything I did afterwards, there was some yellow. Because it's the yellow taxis, and the yellow everything." (ID4)*

Designers report this feeling as a tacit process that is so ingrained that seems automatic. It is a *feeling-thinking*.

> *"It's kind of subconscious, but when you see something you like, and then you look into it, and then you see it everywhere. And then it's like, "Oh yeah, I really like this", but you didn't really think about it. That's what happens." (FS2)*

Because it deals with affects, 'Collection' is generally an individual effort, but it can also be distributed in contexts of design teams. In observing the collected materials they

notice elements emerging as relevant themes, and relate them to other things they encounter elsewhere.

> *"And then you start to see, even just looking through magazines you start to see that purple, or that orange, or that type of blue. And then you might see it on a kitchen knife, or you might see it in a pen, or just little things and it's the same colour, and you start to see a pattern, and you start to collect those colours." – LC2*

Finally, tools such as cameras, mobile phones and smartphone applications, were observed to support the 'Collection'.

> *ID2: I also tend to photograph things when I'm buying things as well.*
>
> *ID3: Yes, I do that.*
>
> *ID1: I do that when I'm travelling as well. If I see something interesting, I just photograph for future reference. Or when I'm designing something, and I come back home looking around the streets, to see if I find something new, and then I take pictures for reference.*

4.4.3.2. Interrogation

In 'Interrogation,' the designers perform diverse inquiry acts to understand the materials, but also to understand how they feel when interacting with them. This 'Interrogation' is situated (i.e. in relation to a specific project), and occurs through experimentation and analysis of existing materials. Here the designers are trying to understand the physical properties (e.g. drape, weight, effect of light, texture, etc.) and also the feel.

> *"It's really define those ingredients, or the things that are important… What is it about [name of covering material]? Is the fact that it is perceived to be breathable, or grippy, or… What defines it as being sporty?" (LC1)*

Designers start with many materials, and while interrogating they eliminate some materials. To operate in this funnelling process as described in Ashby and Johnston (2010) the attention mode is mostly of making distinctions (discriminatory), which allows for systematic evaluation.

> *AC2: We have choosing gates, so it's costs and feasibility.*
>
> *AC1: Yes. Sometimes we love something, and everybody loves it, but it won't be in because it's not feasible. And then we have to work again and make it feasible, because it's really hard in automotive to make it feasible. It shouldn't burn, it shouldn't scratch.*

The designer's perceptions and knowledge about materials is relative, relying on materials and on stakeholders to provide information. When noticing that they process is quite intricate, participants inquired each other about how they generally interact with suppliers, as can be noticed from the dialogue below:

LC3: When suppliers come with something new, what information is that you need?
LC1: Quite often you ask them if you can keep a little piece, and obviously as a creative person you'll keep the biggest piece as possible…
LC2: … and ask some more.
LC3: Big samples!
LC1: What questions do you ask [LC2]?
LC2: Has anyone else seeing this? And how new is it? Will you match it in twenty-six colours? That is one of the first questions. What is your minimum order quantity? Are you prepared to produce this new thing in 26 interior colours? That is the killer question. (…).

In the above quote it is also noticeable how crucial material samples are. This was noticed with all of the studies run, and it highlights how tacit this process is, and designers rely integrally in the use of materials to inform decisions. To aid the 'Interrogation,' besides using samples, designers report on the use of photographs and images. The process of 'Interrogation' seems to lead to an analysis and interpretation of the material, which is elaborated through the use of design techniques such as mood boards, prototypes, and sketches. In the example below, the designer exposes how she utilises materials from her 'Collection', and creating boards supports the 'Interrogation' process; while referring to colour swatches she manages to refine the selection.

"And then they go into the packet, and at the moment I'm going through the process of putting those all up onto a board, and getting some of the [colour] swatches from our range, and seeing what strength and depth of that colour, because even though I might have picked upon one colour, there could be a more intense version of it, or there could be a lighter version." (LC2)

Finally, designers report they also rely on information provided by suppliers, on technical testing, and also verify previous applications as a means to form an understanding of its applicability.

Researcher: Do you ever need to test materials? Or do you get that information from suppliers?

ID4: Mostly, from suppliers. Although, if you don't trust them, we test them ourselves.

ID2: If you're not sure of it, you always get it in and we take a good look at it. Or if you have used that before, this makes you more confident that it is the right thing, because you've seen it and you see how it works.

ID4: And if you are doing furniture, you can visit other places that have it in-store and see how it has been used before, and how it looks.

However, as can be seen from the quote above, designers seem to not trust technical testing data on its own: their report show that they still need to use their experiential knowledge to be more confident. This has been highlighted across the four focus groups studies, where they report either a lack of technical understanding that would enable interpretation of such information (mainly from fashion students), or they are seen as so abstract and detached from the actual implications of applying the material, that their usefulness is questioned (mainly mentioned in both automotive companies), as is shown in the quote below,

"So, I absolutely want to know everything about it in terms of its processes, I don't want to know about ISO2001 or the accreditations the company has, I'll fall asleep…" (LC1)

4.4.3.3. Projection

'Projection' is about enriching and pushing initial understandings around the materials, by experimenting with ideas with the support of the actual materials. This process is closely related to 'Interrogating', because the designer builds on the knowledge from the material to project possibilities of use, but once they have some information on the making process, designers rely on samples to project and support decision-making processes.

The duration of the Projection process is related to specific projects, and designers experiment with materials and problematize by constantly situating it until achieving synthesis, i.e. designers come closer to a solution, by applying one or more materials, or coming up with a new one. Sensorimotor interaction is crucial to facilitate this process, as it enables the designer to experiment with new possibilities for the material, altering it according to the project requirements.

"So I have to go and make the things. So even if I have one idea, I have to go and make it, so that I can see it, and then I can start developing the others. (…) So, in the design process for me I work like that: making and touching." (FS1)

The attention is a combination of analytic and affective, responding to the results emerging. In 'Projection' designers deal with fewer materials, and usually experiment with one material at a time. In such investigations they rely on stakeholders' support to provide technology and materials. The quote below describes the type of questioning designers pose to suppliers,

"I want to find out how it is produced, what the limits are, how big they can go, how small they can go, what the range of colours are, whether it is a challenge to buy a limited number, all those kind of questions, technically, because if I can understand the process, I'm quite used to thinking about how and what I can do with that process… how far I can push it, where I can take it, what other things we can do with it, what can we combine to it to make it even more interesting." (LC1)

To aid the 'Projection' besides using samples, designers report on the use of technical data, which is usually provided by suppliers and through technical testing, building on 'Interrogation' processes. In terms of tools and design techniques, here samples and prototypes are key to iteratively move thinking and making.

And if doesn't feel good on the sample, we won't take it. Even if it is feasible, and not expensive. (AC1)

The designer is not isolated in making decisions, they communicate and collaborate, and in so doing, produce meaning. This communication happens with the stakeholders (other designers, marketing, engineering, finances, suppliers, and customers), and supports them in expanding what they would be able to achieve otherwise.

Designers rely strongly on memory and imagination to inform their material explorations. The more experienced the designer, the more they will be able to intuit (what they call "feeling"), so they are able to elicit 'inspiration' from people and the environment – they develop skills, tools and criteria.

"I think it is more our feeling. We know the type of car, the type of consumer, who is going to approve at the end, what we want, and we try to do a mix." (AC2)

These are related to tacit and embodied knowledge, and are demonstrated through diverse forms (strategies) that emerged from the data and are reported in Table 11, together with example quotes. These are: Memory and experience, Forward thinking, Creating stories (meaning), Communicating through media, Empathy with consumers, and Communicating with stakeholders.

Table 11. Forms of Projection

Forms of Projection	Description	Example
Memory and experience	Designers rely on their subjectivity, which is brought into their process through memory recollection. The past is presently engaged through their probing and sensing.	*"If you're not sure of it, you always get it in and we take a good look at it. Or if you have used that before, this makes you more confident that it is the right thing, because you've seen it and you see how it works." – ID2.*
Forward thinking	Designers are constantly navigating through a network of references. In doing so, they propose manners of organising and composing with materials to create concepts.	*"So part of our craft is identifying the trends that are more likely to happen and look at trends from a helicopter view, so you stand away from them and try to see what things are happening in the market, reactions of costumers, and try to predict what is going to happen in a couple of years time." – LC1.*
Creating stories (meaning)	Designers frequently create narratives in order to facilitate the merging of perceptual and conceptual knowledge to produce new products and contexts for its use.	*"I think that is where the personality comes. (…) Part of our role is creating and identifying new colours, materials, finishes and the way that they combine, to make a product look interesting. But a lot of that is to do with finding the personality of the product. So, sportive, luxurious, contemporary, well crafted, harmonious…" – LC2.*

Forms of Projection	Description	Example
Communicating through media	Designers' accounts show that in relation to textiles knowledge, seeing embodiment and creating prototypes support their thinking.	*"You are thinking about the body and what you're using it for, e.g. how it would be resting on a body for a jacket? Would it be stiff or is it just going to flow nicely?" – FS5.*
Empathy with customers	Empathizing with consumers is key when designers select textiles. They suggest that having access to the "intangible information" (LC1) about consumers' emotional attachments with materials and products is invaluable, as it provides insight into their preferences. Designers use such information to project and propose material solutions.	*"So when I work with my costumers I have to think about them and go "I think you'll like that"." – FS3*
Communicating with stakeholders	Designers rely on stakeholders to obtain information needed to support their selection.	*"My job is to make it match with my intention. And the goal of the technician is to make it feasible. And the goal of the buyer is to make it less expensive. And we have to find together." – AC1*

4.4.3.4. Transformation

Designers report on material transformation (what the textile can become) and self-transformation (what the designer or consumer becomes when using the final product). They are constantly observing how people engage with materials, and trying to come up with novel ways to stimulate or please them.

> *"[A TV presenter] made reference to the fact that she put her feet in the beautiful deep rugs in the back of her car, and I knew exactly what she was talking about, because that is what people like to do… they go out in the evening… they've been on stiletto shoes… and their feet are aching, they kick their shoes off, and get in the back of their car and just sink their feet in the carpet." (LC2)*

In Transformation, the designer looks for manners to diversify experience, which are fundamental for every design proposition they come up with, as this is what will create an experience for the customer. In the quote below the designer describes how playing with unexpected material combinations can lead to diverse material outcomes.

"So you've got stainless steal sintered metal and glass here that gives this very slight texture, we then cooked it to make it go dark, just completely guessing how to do this. Just playing with it… I love playing with different materials and combinations of different materials and finishes… and combining things that are opposites as well, and just seeing how they work, because we get some amazingly different results." (LC1)

In 'Transformation' designers rely on intuition to observe the emergence of difference, which is essentially a creative act, which goes beyond the understanding generated in 'Interrogate' or 'Project'. It is through transformations in the emerging material evidence (reorganising, combining, deconstructing, etc.) that designers come up with material solutions, i.e. a material selection or innovation, which are relevant for a specific project or brief. This is done iteratively until coming to a final selection. The attention mode is a combination of discriminatory (evaluation) and affective (responding to the results emerging). To transform, the designers observe the material(s) that they like, and assess it against functional requirements, whilst trying to come up with a new solution, as evidenced below,

""What is it you like about this?" or "What is it that you don't like about this?" and "How useful is it?" and "What does this material do that makes it good for this aspect? And is there something else that can do that, that isn't the same?" So it's taking those ingredients, but finding them in another material." (LC2)

In order to materialise these emerging concepts into tangible outcomes, they often need support from the engineering team, or from the suppliers. Designers work collaboratively with stakeholders that provide technology and/or materials. In such engagements they push their understanding of the textiles, by working closely to engineering or suppliers, in order to challenge initial ideas and concepts identified through 'Projection', and to achieve diverse material solutions. This is supported by their use of tools, and varies according to materials under consideration, as do the design techniques used – prototyping, tooling and manufacture processes are involved.

LC2: And often is finding a supplier that's willing to be brave…

LC1: Explore.

LC2: …and explore with us. And we will come up with some really crazy, but incredibly innovative, very scary concepts… and from those, you'll then get something that's a gem.

4.4.4. Articulating a Model from the Four Tacit Processes Described

Here a model based on the four themes emerging from this study is proposed, which is dubbed the 'Quad-Core Textile Selection Model' to facilitate the presentation of their characteristics and the dynamics through which they interact (Figure 18). This model does not replace existing design process models, nor the model produced in 4.4.3 (Figure 17), but is a form of articulation of the designers' behaviours revealed from interrogating textiles selection. It can be thought as a model representing what occurs within each of the phases of the design process, to describe the experiential components of selecting. The contribution of the model is to facilitate a more systematic approach to the designers' process of textile selection, while bringing new understanding around practitioners' activities and the experiential components, but also to establish a platform for future investigation of how such activities may be supported in pedagogic or professional settings.

At its core the model (Figure 18) comprises four themes which inform our understanding of the processes occurring in textiles selection: 'Collection', relating to the processes through which designers acquire textiles and information about and/or related to their selection; 'Interrogation' reflecting the way in which designers inquire textiles, directly through physical interaction, to understand both how the textile feels and how they feel when engaging with it (i.e. characterising a textile and the affects produced when interacting with it); 'Projection' relating to querying the textiles in relation to what is does and what it can become (i.e. identifying possibilities for application through specific situated inquiry) and 'Transformation,' about proposing novel solutions (e.g. new applications, meanings or materials).

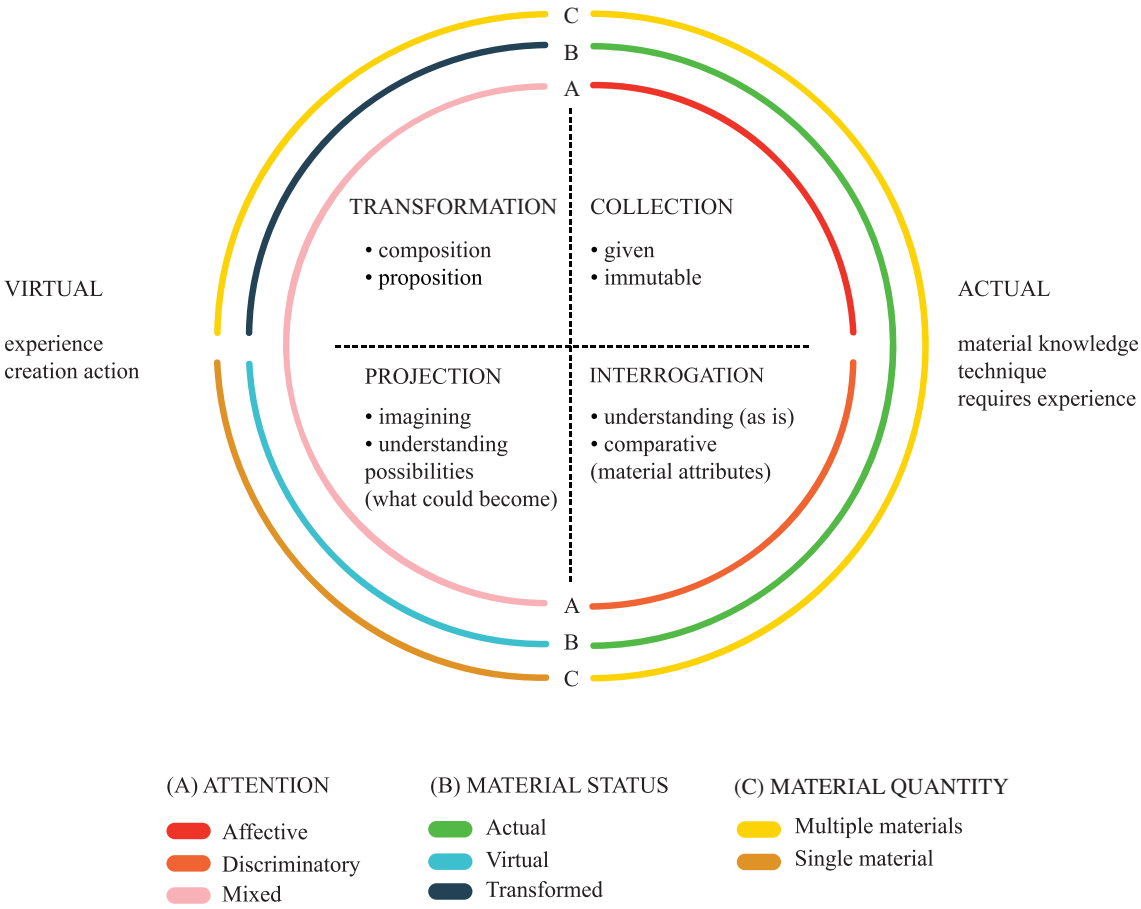


Figure 18. 'Quad-Core Textile Selection Model'

The inner circle shows the areas that reflect each theme, while the coloured outer rings show influencing factors that may affect the selection, and which started to emerge from the designers' representations in 4.2.1, but were still difficult to position in the design process model produced in Figure 17. These are particularly related to their use of materials, and of information around them, to support selection. After analysing their reports focusing on the experiential components of the textile selection, a clearer understanding of how materials are used emerged in terms of the quality of the attention when designers engage with the materials (labelled here as 'Attention'), the type of material engagement (identified here as 'Material Status'), and quantity (named here 'Material Quantity').

The designer's Attention (circle A), which can be discriminatory (i.e. when the designer is focusing on the characterisation of the textile), affective (i.e. when the designer is assessing how the textiles makes them feel) or a mix of both; the Material Status (circle B), which is related to when the designer deals with the 'Actual' textile (e.g. physical samples), 'Virtual' (e.g. an imagined material, or a digital simulation), or 'Transformed'

(e.g. textiles that have been altered, or applied in a novel context); and the Material Quantity (circle C) which is related to when designers are dealing with multiple materials at once, or a single material. Interactions between these themes have been noticed to play a significant role, so they are now explored separately.

Collection & Interrogation

In the cases where there is 'Intentional Absorption' during the 'Collection', an overlap with the 'Interrogation' process was noticed. That may help the designer to collect according to a specific project in mind, and facilitate the eliminating process. 'Collection' and 'Interrogation' also overlap in the processing of the collected materials. Designers make use of design techniques that help assembling and analysing, e.g. moodboards, sample boxes, digital boards (Pinterest[28] or others). Working on boards (or in similar design techniques such as sample boxes) seems to be a process of maturing the absorbed materials. On the boards, physical or digital, designers articulate ideas and observations emerging from their collections, and materials are handled iteratively as a way of opening questions, as well as testing the sensations produced (communicating feel).

> *"But all of those packets at the moment are waiting to go onto a board, and then we will all look at them and decide whether are either absolutely ridiculous, too extreme, not extreme enough… It's a starting point for us. On that board there will be metals, textiles, all sorts of bits, pieces, objects that have some reference to that type of colour that we are looking for." (LC2)*

In the fashion company, designers use vessels to store collected items, which allow them to collectively perceive what starts to emerge as a trend. The most relevant pieces are then removed from these vessels, and taken onto boards that allow for observation of materials in greater detail, isolated and in combination. A similar process was noticed in the luxury car company, where designers make use of packets to store.

> *"So I've got packets of magazine tears, bits of material from all areas, and photographs where I've been out and I've seen something (…). And then they go into the packet and at the moment I'm going through the process of putting those all up onto a board (…)" (*LC2)

[28] This is an image collection website and smartphone application. More information available at the website: <https://uk.pinterest.com>.

In the Interior Design company designers use digital folders, which are shared with the team.

"We always tend to use [digital] images folders that each one puts thing on. And is just a central folder that we just dump things in." – ID4.

Interrogation & Projection

Interrogation and Projection have many overlaps, in the sense that they are both concerned with understanding the materials and getting closer to the selection or development of a material. The main difference between them is what they lead to, the material outcome. At the conclusion of 'Interrogation' designers have produced a moodboard that communicates their concept in material terms. At the end of 'Projection' designers have prototypes, which present much more defined ideas about what the material solution may look like. This is evidenced by the discussion below:

Researcher: So when you have a concept the communication is made through moodboards. Do you also use moodboards to communicate with other departments?
AC1: Yes. It works quite well. Actually, when I do it, I don't need to speak.
R: Do you use samples as well?
AC1: We have samples and moodboards together.
R: Okay. And whom do you need to communicate to in the departments?
AC1: We have product, marketing, engineering, purchasing, design, program… and we have to convince sometimes people that are very at the top.
R: And is this communication still done through moodboards?
AC2: No. We are presenting the final seats, the final prototypes.
AC1: Yes. Here it's prototypes. Moodboards is at first, and after that we have a mock-up so we begin to show it on the car.

Projection & Transformation

If the designer already has ideas about how they would like the material or experience of it to be transformed, then it may be that the Projection and Transformation stages occur simultaneously. That is also true when designers are working on projects that demand new materials, so they need to experiment more

"Interesting is that at the moment we're working in projects which are essentially one-off projects. And there are less different questions you can ask. Because of that, it also means that you can play with a lot." (LC1)

Transformation & Collection

When designers come up with new materials, finishes or another solution, this also becomes part of their 'Collection'. In that case, even if they do not use this solution in the original project that led to its creation, they may pick it up in a future project, as is shown in the report below,

> *"Sometimes we've developed something for a show car or something and then we go back and think, "Oh, we have something here which we've already done years ago", and we know it worked, and we know we can refresh that idea again. And technology has moved on, so we can make it even better than what we've had at that time." (LC3)*

This is observed through designers' comment on being able to "(…) *go through lots of ideas to generate a new product or a new finish (…) to go out of the factory and to visit people to explore materials"* (LC2) and even if those are not used, not all is wasted as they have gained knowledge and experience.

4.5. Validation of the analysis

In order to validate the findings from this Chapter, member checking (or respondent validation (Pidgeon and Henwood, 1996)) was performed with a selected participant. Since an expert advisor oversaw the analysis process, which provided rigour to the investigation, at this stage a consultation with one of the participants was considered sufficient to validate the results. The expert advisor was also involved in verifying questions and results from the one-piece validation, to ensure good practice. The participant selected, FD1, was chosen due to her background as a fashion designer who is presently working both as a curator of a textile fair and as tutor on textiles selection at a fashion college. Hence, she has a very broad experience with the process of textile selection, in industry and education sectors. In order to conduct the member checking, a report with all the models that emerged and their description were shared with the participant, and following that, an interview of 40 minutes length was conducted. The following questions were elaborated for the interview:

1. Did you find the report interesting?
    a. If yes, what did you find interesting?
    b. If no, please comment as to why you did not find it interesting?

2. Did you learn anything new from reading this report?
3. Are the 2 models presented in the report clearly described? The models are:
    a. Figure 17 obtained from the literature and revised following designers' visual representations, and
    b. Figure 18 the 'Quad-core Textile Selection Model'?
4. Are each of the 4 themes (Collection, Interrogation, Projection and Transformation) that compose the 'Quad-core Textile Selection Model' clearly described?
5. Do the 4 themes articulate a new understanding of how the textile selection is performed in the design process?
6. Does the information provided by this report accurately reflect your practice?
7. Do you feel that making these themes more tangible could support your practice in any way? If so, how?
8. Do you feel that making these themes more tangible could support others in the industry? If so, how?
9. Were any topics or facts missing that you think should be included? If yes, which?
10. Did you find the report or parts of it useful in any way? What parts and why?
11. The *'Quad-core Textile Selection Model'* is a name we have invented for the model we present. Does that sound OK to you? Alternatives we have thought of include the *'Quattro Stagioni Model'* or *'Four Forms Model'*. What do you think of these? Do you have your own suggestion?
12. Is there anything else you would like to comment on?

The most interesting point made by FD1 in the validation is the fact that the themes and models were completely understood, considered relevant, and she got excited about how this knowledge had been made more tangible to her, and seeing its potential value to students as an educational material. Overall, she suggested that the main value is in the clarification provided by explaining the process, as shown below:

> *"It is more about the articulation, organisation, and clear documentation of a process that can be challenging to conversationally articulate."*(FD1).

She also mentioned the importance of how this study highlights how designers work require a balance in terms of synthesising knowledge and intuiting. She seemed to value the broader point of articulating intuitive understanding clearly, which designers think they already know, but that making it a more tangible object of knowledge through describing and labelling it can have a bigger contribution to the field. This has been highlighted in the literature before, and makes this study more prominent in terms of its contribution for the textile and design fields, as shown below:

> People were using levers long before they investigated the principles on which levers work. Having established the principles, they can now use levers more effectively [...] What is recent is the systematic, and therefore scientific, study of these things. It may not always yield better answers than the intuitive wisdom of the specially gifted – but then, achievement in any applied science is to raise average standards of performance, not necessarily the standards of the outstanding individual. It also provides an essential means of testing the intuitive answers – too often for comfort, these turn out to be wrong. (Klein, 2005, p. 1-2).

The most relevant topics on FD1's evaluation were in terms of how the new knowledge: (i) reflected her practice, (ii) could have application to her practice both as a textile fair curator and as a tutor, and (iii) related to elements that she thought were missing from the models. These are further discussed below.

Comments on how the 'Quad-Core Textile Selection Model' reflects the practice

FD1 found that the four themes that emerged are like overarching themes for the textiles selection in terms of designers' behaviours. She says that these behaviours are habitual to designers, and that they are not like a *"stop-start thing that finishes there"*. She suggested,

> *"It is so funny that what you think is already out there is not. Because you intuit it, so you just assume that that knowledge is there. (…) It is amazing to have something that you understand intuitively put with clarity. It is really good."* (FD1)

For the 'Collection' theme FD1 mentioned that she encourages students to *"Go out there and be like magpies (…) the birds that go around and stick it all in their nests"*, which confirms the sponge and magpies reports from designers in the Focus Groups. Also in relation to Collection FD1 suggested,

> *"The designers quotes in 'Collection' are really fascinating. It struck me that in the Collection process, that collation, or ordering of groupings is a consistent process, as the analysis continually refines and allows certain choices to surface or become more important."*

For the 'Interrogation' and 'Projection', FD1 made a comment about how it is interesting to think about size of samples, because the possibility to inquire the textile is totally subject to it.

"(…) your understanding of a piece of fabric 'this size' [showed a small rectangle with the hands], *is very different from the headed card which is this big* [showed a bigger rectangle with the hands], *which is again different from* [our] *fair headed cards which are a meter long, because then you can use the whole body. (…) So there is something to do with the scale of the tactile appreciation in relation to the human body, and in relation to how you may form it, each time, from the tiny piece, through to the meter long, through to cutting it, which is an enhanced Interrogation or Projection"*. (FD1)

She recognised Projection as something that affects her work as a curator for the textiles fair, where she realizes that she is already taking this into account intuitively in the manner which she displays textiles, i.e. the samples are cut body-length, which is longer than in other textiles fair, and she explains below.

"We are already doing that intuitively with the meter long sample in the fair. (…) Because the body length is the most obviously effective, when you can go like this [showing her own body], and you can put it against you colleague. (…) And this makes it easier for them to have better, clearer 'Projection', because they can do an enormous amount with their imagination and be right a lot of the time, but you will always get surprised.(…) There is no way you can feel a bias properly through a cloth, unless it is in a big piece. And in this size, as you know, all you'll get is a technical "oh it stretches 2.5", and you can get that, but you won't when it's the whole piece, the whole weight of the cloth. It will make it do something else. Even when you had years and years of experience you can still be surprised by that process."(FD1)

Here FD1 comment indicates once more, how the technical knowledge needs the experiential knowledge for grounding it, otherwise it is just not useful. For 'Transformation', FD1 thought mostly about enhancements and customisations on the textiles.

Application of the knowledge

FD1 was interested in the potential educational applications that the themes and model could have, particularly in creating a language that helps to communicate around the processes:

"And I think this would be so good educationally, for me to have a format for communicating this process with students. (…) And it depends on the student's background, on where they come from, in fluidly understanding something that is ephemeral in nature.

So there is a lot here that I was thinking that a kind of condensed version of this could be an amazing teaching tool. (…) language like this, and unpicking and breaking down that process, could be very helpful." (FD1)

Besides the language aspect, she suggests that this could help bring awareness to the students on the know-how they possess, which can also help in enhancing their skills. As FD1 suggests:

"Is more a clarification of that process, and I think also if I pointed out to students that they were, for example, 'Projecting', and how they were doing that, I think their eyes would just pop out of their heads. I don't think they would be aware that that is what they are doing. And out of that, if you are aware you are doing something, when you are conscious of it, there is a heightened ability to do it. Even if it is something you do intuitively. For the students, when I tell, 'Do you know you just did this?' and they just go 'Really? Did I do that?', and in that, it is powerful to develop a process."

Suggestions for change in the Model

In relation to Figure 7, FD1 recommended that a reference should be made to the 'Initial Stages of Textile Customisation' in the 'Define' stage, inside the 'Interpreting' activity. FD1 suggested this is because before 'Developing Materials' in the 'Develop' phase, designers already start to come up with ideas about what they may need to alter or enhance regarding existing textiles (e.g. colour, dye, print), or if they need to develop a new textile, they already have ideas about what will be required.

FD1 also suggested that somehow creating a third model, that fuse the two models (Figure 17 and Figure 18) together could be very interesting, specially to communicate with students in order to facilitate the application of the 4 themes in relation to their design process. Although these are behaviours that occur in a non-linear manner, trying to make this relation seem desirable to make it more accessible to inexperienced designers. In order to do this, FD1 suggested taking the lines from the 'Quad-Core Textile Selection Model' and plotting them underneath the model in Figure 17. FD1 also commented that the four emerging themes are not related to the 'Deliver' phase in Figure 17, since they just cover up to the point where a textile has been selected, however, Projection may inform a lot the concepts that will be carried through the promotion.

Finally, FD1 considered that the name 'Quad-Core' gives the impression that the themes are of similar features and more static then they are in reality, following their description in the study, as show below:

> *"(…) it makes it sound like each piece of pie is the same, and actually is not. Some of them are a continuum, and some of them are more isolated process, or they might overlap." (FD1).*

She understands that using the 'quad' is interesting as a reference to 'four' and making it easier to remember, and went on to suggest the use of the name 'Four Forms' as a better and more flexible alternative, as it *"gives a sense that they could be doing anything."* (FD1).

4.6. Discussion

In this Chapter a Grounded Theory study was conducted with designers from diverse fields that apply textiles for design, in order to explore their selection.
To uncover *when* textile selection is performed during the design process, the literature on textiles selection was synthesised into a design process model (seen in Figure 7), which was refined with primary data from empirical studies (particularly the graphical representations produced by designers in the focus groups studies, in Figures 11-13), this study first contribution is in the understanding that textiles selection occurs in many places in the design process, which is demonstrated in Figure 17.

In interrogating *how* the textile selection is performed, as a means to explore the experiential components that affect it, deeper questioning revealed greater complexity in this process, highlighted by the four emergent themes, which characterise designers' behaviours relevant to the selection process, i.e. designers' experience of it. The emergent themes of this study are distinct from information currently available in the literature about the design and selection processes and methods. The study attempts to take into account the greater dynamics that these themes suggest, as these are non-linear processes that can happen many times within the design process. Also, it considers that there are no process models in the literature that bring about tacit knowledge, irrespective of the literature discussing its importance for designers' practice. It is not this thesis goal to create a new model for the design process, but to understand how the

textile selection happens, and how it is viewed within the design process. These considerations led to the second contribution of this study, which was to propose the 'Quad-core Textiles Selection Model' (seen in Figure 18), as a means to articulate these tacit behaviours, and observe how materials support this selection (which is demonstrated through the circles around the quad-core).

The 'Quad-core Textiles Selection' model recognises the designer expertise, and the very specialist activities undertaken when selecting textiles, which complement the understanding available in the literature up to this point. The four themes are fundamental for design practice, and show that a focus on experience is crucial for generating knowledge in support of designers in the selection of textiles. These four themes build on the work by Cross (2011) in relation to abductive thinking, showing with further detail *how* feeling and intuition come into play in the design process through more tangible evidence, particularly in the case of textiles selection. This chapter expands on the work based on an assessment of textiles properties, which enables the accumulation of knowledge in databases and directly forms value, and which is mostly about the textile physicality. The experiential components revealed here consider designer and textiles in interaction. The latter perspective shows that there is room to support designers to harness their sensory experience and transit between objective function and experience, which we saw as critical especially in the 'Interrogating' and 'Projecting' activities. Further investigation is needed to increase our understanding of designers' experience with textiles when they select, and second, to foster the development of tools to support the selection from this experiential perspective. Finally, viewing the selection process as extending beyond function to the embodied and affective dimensions of the designer interaction with materials has led to a reflection on the designers' need for real materials and a means to support the experiential processes observed. I argue that this is what it means to select in a 'designerly' way (Cross, 2006). Indeed, this 'feeling-thinking' is required for a successful selection.

Introducing the experiential components to the Textile Selection Process Model

In order to verify the relations between the Textile Selection Process Model (Figure 17), and the tacit themes emerging and communicated through the 'Quad-core Textile Selection Model' (Figure 18), I now bring these together in Figure 19 to observe how

they connect. This is also following the Validation results, where the combination of both processes is suggested.

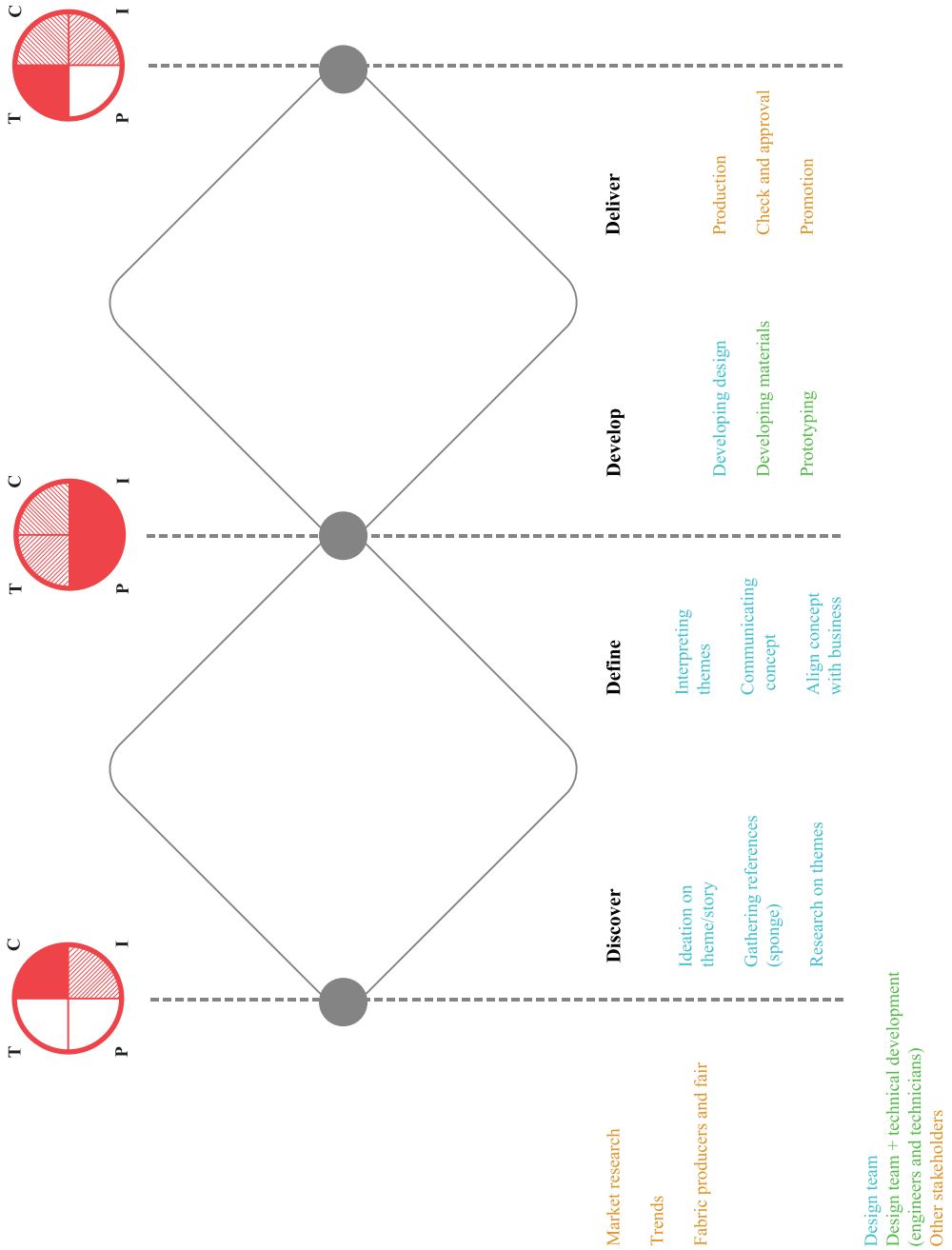


Figure 19. A view to *when* and *how* Textiles Selection happens in the Design Process

In Figure 19 the 'Quad-core Textile Selection Model' was used to reflect on the manner in which the 4 tacit-behaviours are observed to occur in relation to the design process, as synthesised from the literature and this study (Figure 17). As Figure 19 shows, in the Discover phase, the most prominent behaviour is Collection (indicated in the circle where 'C' for Collection is filled with red). Because of the interactions that can occur

with Interrogation, when Collection is intentional, this is indicated by the red stripes in 'I' (for Interrogation) in the first circle. Because of the many iterations noticed between Define and Develop, only one circle is used to illustrate how the behaviours occur. Here all behaviours are observed occurring, but predominantly Interrogation and Projection (indicated in the circle by the red colour filling), as this is where materials are constantly assessed for what they are and what they can become. Collection is observed with less intensity, but as it was identified as a ubiquitous process, here it is indicated by the red stripes in the section 'C' of the second circle. Transformation starts to occur in this phase, in the processes of 'Prototyping' and 'Developing materials'. The last circle indicates that in the Deliver phase the 'Transformation' is predominant, as this is where all decisions are materialised in production, achieving final outcomes. Because designers suggested that there are final materials and products that may integrate their collection, this is also indicated as occurring, but with less intensity, as it is not in focus in this phase.

The proposed model is specific to the textiles selection, and aimed at making these tacit processes more tangible, as well as taking them as a starting point to develop more research into the four emergent themes, towards an amplified understanding of the designers' experience. This in turn will lead to the development of methods, tools and other types of support.

Discussing each 'quad' with additional literature

Considering the complexity noticed in the four emerging themes, I now discuss them further whilst bringing the literature to support further interrogation, before progressing with deeper investigations around them in Chapter 5.

Designers *Collect* to get a sense of the world around them, and this is part of the materials selection - a ubiquitous process that will always influence the final selection, because it increases the designer knowledge and repertoire. In further consultation with the literature, additional considerations highlight the importance of Collection for the textiles selection process. Research in industrial design has looked at the design process from a cognitive perspective (Kim et al. 2010), and such research acknowledges a pressure to speed the initial phases of the design process, particularly the inspiration stages before defining concepts. Bouchard et al. (2003) have focused on the research for inspirational materials, and later developed the TRENDS software that facilitates image

retrieval based on algorithms generated through studying designers' cognitive processes. This software is focused on what the author identified previously as the 'Informative' phase (Bouchard, 2003). This is related to the designers' inspiration sources, and the manners in which they organise and synthesise information in order to come up with design solutions. According to Kim and colleagues (2010), such inspirational processes extend beyond their professional activity, and are evoked in the design process. Here we see a relation to the processes observed in Collection, except that TRENDS only work with images because it is a software, but already is some form of support.

From a more historical and cultural perspective, in the book entitled '*B is for Bauhaus: An A-Z of the Modern World'* (2014), Deyan Sudjic the curator of the Design Museum in London, UK, chose the word 'Collecting' as one of the most relevant terms for the letter C. For Sudjic, collecting is instinctive to humans, and can be taken as a primordial source for understanding our relationship with '(…) our possessions, how they communicate with us, and the various ways in which we value them. Understanding the nature of collecting tells us something about ourselves as well as about the nature of things.' (2014, p. 98). Sudjic points out that when items are collected they lose their 'nominal purpose', and will perform other functions such as memory ('reminders of a time' (2014, p. 99)), conveying messages (2014, p. 102), control of a 'tiny part of the disorderly universe' (2014, p. 103), pleasure (2014, p. 105), or even in the case of proper collectors it could mean status (2014, p. 102). Finally, Sudjic makes a reference to Walter Benjamin's *'The Arcades Project'* that beautifully reveals the importance of the collecting activity. Sudjic mentions that Benjamin analyses the instinct of collecting and suggests,

> For the collector, the world is present, indeed ordered, in each of his objects. (…) It suffices to observe just one collector, as he handles the items in his showcase. No sooner does he hold them in his hand than he appears inspired by them, and seems to look through them into the distance, like a portent of the future. (Benjamin in Sudjic, 2014, p. 109).

This is closely related to the way in which 'Collection' has been observed amongst the participants, who keep updated and informed about materials, but are mostly inspired to new design solutions by looking through their collected items and observing emerging signs. This is also discussed by Merleau-Ponty (2004), while exploring our experiences through our relations to objects and spaces in his essay *'Exploring the world of perception: sensory objects'*, observing that the objects people choose to surround

themselves with enable an interpretation of their '(…) tastes, character, and the attitude they adopt to the world and to particular things' (2004, p. 48). Merleau-Ponty establishes a link with the surrealist art movement, particularly to André Breton (1987, p. 32), who describes found objects as having a *'catalysing'* role, as they are *'revelatory'* (Merleau-Ponty 2004, p. 40) for being 'known things' that can herald the *"not yet known"*. This is particularly so when considering the surrealists *"paranoiac"* exercises, which suggest that an object will always be seen differently by different people with *"their distinct desires"* (Merleau-Ponty 2004, p. 87). Merleau-Ponty goes further to propose that found objects are *'catalysts of desire'*, as they provide *"the place where human desire manifests itself, or 'crystallises'"* (Merleau-Ponty, 2004, p. 50). This is pertinent to the Collection theme, especially considering comments through the validation, when FD1 mentions that in the *"Collection process, that collation, or ordering of groupings is a consistent process, as the analysis continually refines and allows certain choices to surface or become more important."*

The processes of *'Interrogation'* and *'Projection'* are related to the designers' understanding of the textiles and of themselves in interactions with these materials, but also to their becoming (objectively, what a textile can become in application, and subjectively, how wearing or using a certain textile may affect people's behaviours).

'Interrogation' seems to be the process that most closely relates to textile engineering research, as this is where designers interrogate materials to understand them and extract information about them, for more overtly functional over aesthetic purposes. However, what the textile engineering approach lacks is what the Bauhaus methods introduced (Moholy-Nagy, 1929), in terms of explorations that enable designers to understand materials from their subjective experience, instead of just being given information about the materials. It was noticed in the designers' contributions through this study that technical information about materials is useful, provided that they can also rely on their experiential knowledge. Hence, the 'Interrogation' process seems to be a valid and valuable manner of generating understanding, as has been advocated within design education in the past.

'Projection' seems to be a complex process to which there is not much in the design literature. In interaction research, the main author investigating this through embodied cognition is David Kirsh (2013), who approaches it through the example of dancers, and

also cognitive tasks such as playing tic-tac-toe game. Kirsh (2013, p. 18) defines Projection as a 'mental process' through which objects are enhanced or "augmented" whilst being used as an 'anchor' to support our 'mental image' and thinking process. This is distinct from imagination, because of the direct relation to a physical object. This was highlighted through the validation, when FD1 observed the manner in which fabric samples are displayed in the textile fair she curates. In this fair, fabrics are showcased in headed card and are one metre in length. She explains that this length decision was based on *"watching other people going 'Oh how can you tell? It [the sample] has to be bigger'. (…) And this makes it easier for them to have better, clearer 'Projection', because they can do an enormous amount with their imagination and be right a lot of the time, but you will always get surprised (…) Even when you had years and years of experience you can still be surprised by that process."* (FD1).

Interrogation and Projection are processes that overlap a lot, possibly as both share aspects of embodied experience, as clearly pointed out by FD1 in the validation process: *"there is something to do with the scale of the tactile appreciation in relation to the human body, and in relation to how you may form it, each time, from the tiny piece, through to the meter long, through to cutting it, which is an enhanced Interrogation or Projection"* (FD1). Additionally, the embodied cognition aspects of Interrogation and Projection seem very promising in terms of understanding the designer experience in selecting textile. Hence, these aspects are further explored in Chapters 5, 6 and 7.

Considering that a design leads to a creative outcome, 'Transformation' is related to the creation of a new use, meaning, process and/or material. Transformation is related to the designer sensibility to synthesise knowledge that is technical, sensory, affective and meaning-related. This is described in the literature as abductive thinking (2011), through which designers manage to act intuitively whilst relying on their knowledge, experience (Cross, 2011, p. 10), and expertise, and manage to achieve design outcomes that are authentic and applicable. 'Transformation' will not be much discussed for the purposes of this thesis, as this is going beyond the selection moment, and into the actual manufacturing of the product. However, consulting the literature a method that looks into "designing for materials experience" was identified, the 'Material Driven Design' method (MDD) (Karana et al., 2015), which proposes a means to bring this Transformational aspect into the whole process of designing and selecting materials. Here materials are taken as the core element of designing for experiences.

4.7. Limitations of the Study

This work is focused on the perspectives of designers in the context of selecting textiles applied to fashion, vehicle (C&T) and interior design. It does not include the perspectives of other stakeholders (e.g. suppliers, clients and other important relevant actors in the selection process). Such work could produce a quite different account. Also, this activity-centred perspective emphasises behaviours and relations over describing characteristics of materials. It does provide a high-level account of the designer experience of the selection process, which revealed facets of 'what' designers do and 'how' they do it. Although these tacit processes were identified using GT, this type of interview did not manage to elicit tacit behaviour in a manner that allows for fine-grained descriptions. This is also because designers reported on what they think about what they do, and although the observations supported and allowed for further detailing findings, these are still limited. The richness of the emerging themes is that they indicate directions as to how this research may relate to other fields of knowledge. In all of the themes, behaviours are observed that could be further explored in the light of distributed cognition theory and methods, particularly in terms of the environment (artefacts, physical space) and other people involved in the selection process that extend the designers' work (explored in Chapter 5). Elements of embodied cognition also emerged, particularly when designers interact with material samples, prototypes, and all the other material experimentations: these would benefit from further studies, and are explored in Chapters 5, 6 and 7. There are also elements of affective experience, which occur with diverse levels of intensity in the different themes, and would merit further research. Initial explorations, recorded in Chapter 7, take a Micro-Phenomenological approach in order to go deeper into pre-verbal and non-verbal experiences (i.e. movement and touch behaviour). This work also extends investigation into the 'Quad-core Textiles Selection Model' as a basis for developing discrete tools that build on the emerging themes, which is presented in Chapter 8.

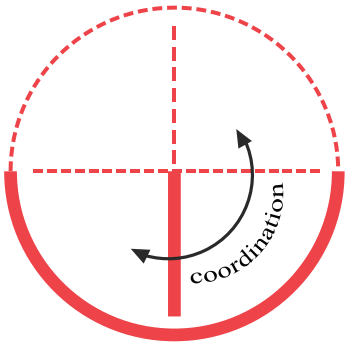
4.8. Summary

This work has contributed in three main ways: (i) a textile selection model was synthesised from relevant literature (Figure 7). This was then used to investigate

empirically how the textile selection happens, through interviews and observations with designers working with applied textiles. (ii) We verified that these processes do occur according to the proposed model, but there are more methods used, and also there are certain behaviours common to designers' practice, which this model does not depict (shown in Figure 17); (iii) Further interrogation of the process revealed four tacit processes – Collection, Interrogation, Projection and Transformation – that occur in the textile selection, and highlight the experiential components that affect it. These themes add complexity to previous models that depicted the selection process as a single phase within the design process, or describe it through a linear lens only. This study adds synchronic, iterative and dynamic processes that more fully reflect the nature of designers' practice. Hence, I conclude that the designers' behaviours in textile selection relate to earlier descriptions of the design process, but iterations can occur many times and at different stages. Therefore, the 'Quad-core Textile Selection Model' (Figure 18) contributes a major finding that addresses the initial gap presented in this thesis in relation to previous research based on quantitative approaches. I argue that the latter are detached and abstract, and do not fully reflect the practitioners' perspective precisely because they lack acknowledgement of experiential knowledge that is integral to textile selection for design.

5.

Confirming the ‘Quad-Core Textiles Selection Model’ through an in-situ study



Highlights:

• Confirmed the processes of *Collection*, *Interrogation*, and *Projection* showing that *Coordination* adds dynamics to these processes

• Elaborated *Projection* as a phenomena occuring through Visual, Physical and Social processes

• Tools and materials use emerged as critical for the selection processes, which enhances the role of materials articulated in ‘Quad-core Textile Selection Model’

5. Confirming the 'Quad-Core Textiles Selection Model' through an in-situ study

Abstract

This chapter responds to the gap identified in the literature showing that there is a lack of understanding around the embodied experience of textiles in terms of tacit and experiential knowledge, and how this can be harnessed to support selection, and also builds on Chapter 4, to investigate further the embodied aspects that emerged as relevant but could not be fully understood through verbal descriptions only, and therefore demand more active, in-situ observations. Hence, the aim of this study was to unpack the processes that support textile selection identified in Chapter 4, which was carried out by focusing on a facsimile design process, specifically a shoe customisation process in a real-life scenario. This process is situated later in the development phase of the design process, however it represents a "condensed" version of a whole design process, which illuminates this process by emulating it.

The study was carried out through observations in context (Phase 1) and contextual interviews (Phase 2) to deepen the analysis. Analysis was conducted using Distributed Cognition theory and method and Embodied Cognition theory. This analysis confirmed the processes of Collection, Interrogation and Projection, which adds to the understanding initially contributed through Chapter 4. Additionally, the aspects of Coordination and Projection emerged as crucial processes for this design space. Projection processes were observed as being a way of maximizing the information gathering and sense-making during the physical experience, and hence Projection is developed here as a phenomenon occurring through Visual, Physical and Social forms, and which shows with more nuances that the embodied experience is crucial for textiles selection. Particularly, it shows that the embodied experience is much beyond hand, and includes full body engagement. Finally, the tools and materials used in this design situation emerge as critical for the selection process.

** This chapter is a paper in preparation to be submitted to a journal (after exam).*

5.1. Introduction

Textiles selection occurs throughout the various phases of the design process, as Chapter 4 records. In addition, it was shown that 4 processes and their interactions support the selection. In this chapter a design process is observed to pursue a deeper understanding of the selection processes. This is done through a study that analyses a service offered by a sportswear retailer to customise sports shoes, where the textiles selection can be observed in a condensed situation, a facsimile design process.

The interest in observing designers in action is to observe closely *how* they behave, particularly noting the situated characteristics inherent to the design activity. Schön (1991) refers to design as a "reflective conversation with the materials of a design situation" (p. 3). Dormer (1997) presents two concepts that are important to understand these dialogues: personal know-how (acquired through and felt as experience) and distributed knowledge (designers rely heavily on the environment they work within – the social, organization and the physical environment, e.g. studio space, equipment, tools, samples and prototypes – to form their knowledge basis, test concepts and support decision making processes). Hence, social interactions, materials, the physical space, and also the digital interactions influence the design practice. These interactions and the dynamics involved could not be understood in detail in Chapter 4, as this was based solely on designers' synthesised opinions on what they do. Hence, in Chapter 5, this process is investigated in situ.

Design activities are undergoing great transformations, and initiatives that change and push the boundaries of the design process are attracting attention through the opening of design processes to participation of stakeholders, and also by the increased introduction of digital tools. These initiatives consider that design knowledge can "be packaged within parametric constraints, ensuring producible outputs" (Phillips et al., 2014, p. 54), and hence allow the design process to be more open. In the case of the textiles arena, most initiatives are noticed in the fashion sector, mostly through tools that are populating the stages of drawing designs, digital draping and pattern making, but also in later stages of customisation and co-creation. Some examples of customisation, such as footwear (e.g. Nike iD, Mi Adidas) and clothing (YrStore), demonstrate a more holistic experiential approach to products. In such initiatives the consumer influences the final product design by directly selecting materials, colours, prints or finishes. The selection

process is performed while interacting with both physical (material) and digital, to design the digital product. Following the customer's exact specification, the product is then physically realised.

This study takes this facsimile design processes as an approachable way of investigating the selection in situ. The main focus is to understand the textile selection process in more detail in relation to the distributed and embodied aspects, particularly in this situation where the design process has been structured and allows for comparisons to be made between participants. With all this in mind, a study was conducted at a well-known sportswear retailer in London, to explore deeper Research Question 1: *What are the processes that designers follow in the selection of textiles and how does the experiential component of selecting textiles affect these processes?*

This study was carried out in two phases. Phase 1 involved a series of observations in context, which were analysed using Distributed Cognition (DC) theory (Hutchins 1995). This theory and a related method (Distributed Cognition within Teams – DiCoT (Furniss & Blandford 2010)) helped to structure the analysis. Phase 2 involved contextual interviews to deepen the analysis, and Embodied Cognition (EC) theory focusing particularly on Projection (Kirsh, 2013) was brought in to support the analysis. The results of both phases are presented together.

5.2. Study 2: Investigating the Textile Selection in a Semi-Professional Environment

In the chosen setting of an existing shoe customisation process, the textiles selection is performed in an organised manner where tools (physical and digital) support the design of a digital shoe, which following the exact specification, is then physically realised. Here all participants are taken as designers, considering (i) that the process is structured enough to guarantee that participants accomplish the selection process, and (ii) that all participants shared the same goal when undertaking this activity, that is, they were all designing a shoe that they would acquire in a real life context. Nevertheless, the sample included both designers and non-designers, so divergent behaviours were noted where necessary.

5.2.1. Context of study

A well-known sportswear retailer store in London, UK was chosen as a case study. This is a large store with 5 floors. This study focuses on the customisation service, which has its own space on one floor, referred to in this chapter as the Shoes Customisation Zone (SCZ). The store provides dedicated staff to work in this service who are identified as 'consultants' and who facilitate the customisation process. According to the consultants, when customers customize shoes online they find it difficult to select materials due to not being able to feel them. Therefore, this in-store service was designed to offer customers the opportunity to experience the materials and gain extra support when customising.

5.2.2. Design of the study

The study was carried out in two phases to unpack the textile selection processes, and relying on diverse methods and participants, as described below and in Table 12.

Table 12. Details of study methods and participants in Phases 1 and 2.

Phase	Method	Participant	Duration
1	Observation	- Customers from the general public visiting the store (more than 40 consumers were observed in total); - 9 designers (in a private event)	3 visits of 4 hours each (total of 12 hours)
2	Contextual Interview	Participants were selected on the basis of their interest in sports shoes, with ages ranged between 24 and 36, and comprising: - Non-designers (2 participants identified as C1 and C2) - Designers (3 participants – 2 shoe designers and 1 product designer, identified as C3, C4 and C5 respectively)	Each participant took around 1,5 hour to customise a trainer and be interviewed

Note: Because some divergence was noticed between designers and non-designers behaviours when customising, they will be identified as customers and customers-designers, to allow for discussion.

Phase 1: Observations were conducted in context during three visits. This included two days where the store was open to the public (including a busy day and a quiet day), and a private event with professional watch designers (a show of gratification by their employer).

Phase 2: A more in-depth interview process was carried out to build on Phase 1 following a contextual enquiry approach (Blandford and Furniss, 2006). The participants performed a trainer customisation task and were interviewed about their experience.

The Local Ethics Committee approved the study (Phase 1: Brunel University, ethics approval # EC/364; Phase 2: UCL, ethics approval # BSc/1213/001), and the store managers provided written consent. Participants provided written consent where relevant (i.e., direct observation, interview) (forms in Appendix B1 and B2, signed forms available on request). In Phase 1, the store agreed to the research on provision that customers were not approached. Hence, for Phase 2 participants were recruited and invited for a visit to the store to customise a trainer and then contribute with an interview, with the consent of the store.

Information recording was limited upon request of the store managers, to avoid disrupting the customers. Therefore, data gathering included annotations made using a mobile phone, field notes and sketches produced post-visit. Open-ended questions were designed for the interviews (Phase 2), organised around two themes: Coordination (questions regarding the task, process and customer experience) and Projection (questions related to the use of artefacts and where and how they support the design process).

5.2.3. Analysis

A Distributed Cognition (DC) approach was used to investigate the textiles selection further in this facsimile design process. Studies on cognition as a distributed phenomenon date back to the early 1980's (Goodwin, 1994). DC is a theoretical approach based on the assumption that cognition can involve phenomena outside of the skull and is not limited to the firing of neurons (Hollan, Hutchins and Kirsh, 2000). DC is employed to analyse the 'coordination' of information processing across individuals (socially distributed), within spaces (spatially distributed) and with artefacts (analogical

or technological), who share a common purpose. It has been applied to "reasoning about the design of distributed systems involving multiple people and interactive devices" (Blandford and Furniss, 2006). The result of a DC analysis highlights the propagation and transformation of information within the system. DC has been used to study diverse sociotechnical systems, from ship navigation (Hutchins, 1995) to software design (Wright, Fields and Harrison, 2000).

DiCoT (Distributed Cognition within Teams) (Furniss and Blandford, 2010) was used as a structured method to facilitate the application of DC theory. DiCoT was chosen as it has been developed for and applied in studies aiming to gain a better idea of the mechanics of systems; to gain insight into tools use, and to generate design ideas (Furniss and Blandford, 2010). DiCoT is a method developed from Contextual Design (Beyer and Holtzblatt, 1998), which proposes five interconnected models for contextual analysis and design considerations. Succinctly, the five models are:

1. The Information Flow Model focuses on how "information is processed, by whom, and by what, from one stage to another" (Furniss and Blandford, 2010).
2. The Physical Model focuses on the physical elements and layout in the space where the activity occurs. This can influence the information processing of the system.
3. The Artefact Model focuses on exploring artefacts, representations and tools that are created or used within the system to store, transform and communicate information. These are considered from the perspective of how they support cognition (Werth and Furniss, 2012).
4. The Social Model focuses on the roles, relationships and responsibilities of the people within the system.
5. The Evolutionary Model investigates how the system has evolved over time. It includes aspects of memory and culture within a system, and accounts for why things are done the way they are.

Each model is associated with a range of principles that provide heuristics for applying DC theory (Blandford and Furniss, 2006). These were used in the analysis of this study and are indicated *in italics*. In Phase 1 DiCoT models were applied to analyse the information processing in this design space. Additionally, notes on movement were made, as the experiential component emerged as relevant since the first observation. Because these other components that emerged as relevant for this study are not explored

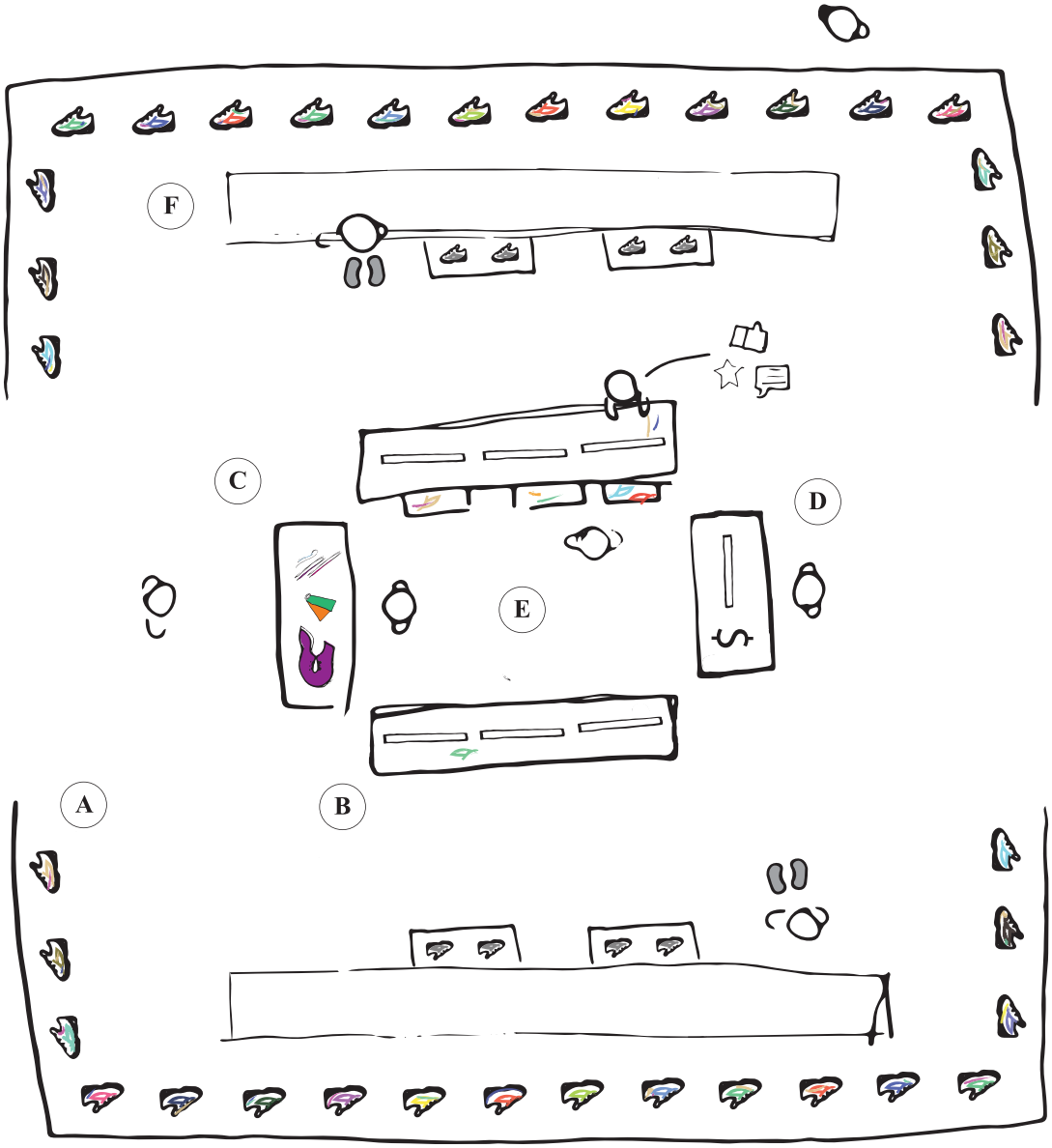
with DiCoT, in Phase 2, the Embodied Cognition perspective proposed by Kirsh (2013) was introduced through the concept of 'Projection' to support the analysis.

5.3. Results: Understanding the Textile Selection through Distributed and Embodied Cognition

This section presents the DiCoT models that were most relevant for investigating the research question, which are the physical, information, artefact and social models, and its associated principles (indicated within the analysis *in italics*). The Embodied Cognition through Projection is presented as an additional model.

Physical model

The physical model of the store is illustrated in Figure 20. The cube-shaped space includes furniture, physical samples (trainers and material swatches) and six computers displaying the digital interface for customisation. The computers are located on desks in the centre of the cube (*arrangement of equipment*), which enables customers to look all over the Shoe Customisation Zone - SCZ (*horizon of observation*) and circulate freely while customising. Under the computer desks, there are drawers only accessible to the staff, where the material swatches are stored. This facilitates the consultants' access to the swatches to make them available when the customers request information about materials. There are sofas behind the computers, where customers sit to try on trainers, and which also allow customers to have companions around them. The consultants have an allocated area at the centre, behind the computer desks, from where they can assist customers and process orders.



Key: A – wall display B – computer desk C – reception D – cashier E – consultants' area F – sofas

Figure 20. The physical model of the SCZ layout visualising the position of the customers and designers.

In terms of *space and cognition* the most important element are the walls where the sample trainers are on display. Participants frequently used sample trainers to support the process of customisation, which is discussed in the Artefact Model. During the interviews C2 and C4 mentioned the importance of going to the store to experience the brand. They consider that customizing a trainer at their homes would be a totally different experience, as in the store they are immersed in the brand. The layout of the store facilitated the design process, as the central positioning of computer desks provided a *hub* of activity with supporting material around the room. This enabled customers to coordinate information flow (e.g. tasks on computer), artefacts (e.g. model

trainers and swatches) and social interactions (e.g. consultants), which are discussed in the next section.

The Information Flow Model

The customisation process that emerged from the study comprises a series of steps that occur sequentially, but the sequence is not tightly defined and some steps are omitted at times. The complete process as the store staff introduced it, is as follows:

1. Design consultant introduces the digital tool.
2. Customer selects a shoe model to be customised.
3. Customer tries on sizes of the model chosen for fit.
4. Customer works with the digital tool.
5. The design consultant introduces physical tools (material and shoe samples) to the customer.
6. Customer refers to samples (e.g. matching textures and colours, and to feel the materials).
7. Customer interacts with consultant for advice/help.
8. Customer uses the trainers on display – assessing how materials take shape in different shoes.
9. Customer defines materials, colours and inscriptions (when applicable)
10. When the customisation is concluded they create a profile to save their design, and proceed to place the order.

Figure 21 represent these tasks and subtasks in a nonlinear manner, to focus on the activities performed rather than on the progression, and also to organise them in relation to the tool that determines their unfolding. The process illustrated on the information flow model contains all the steps involved in this system. Diverse approaches to the process were noticed amongst participants when customising, and not all participants involve the consultant.

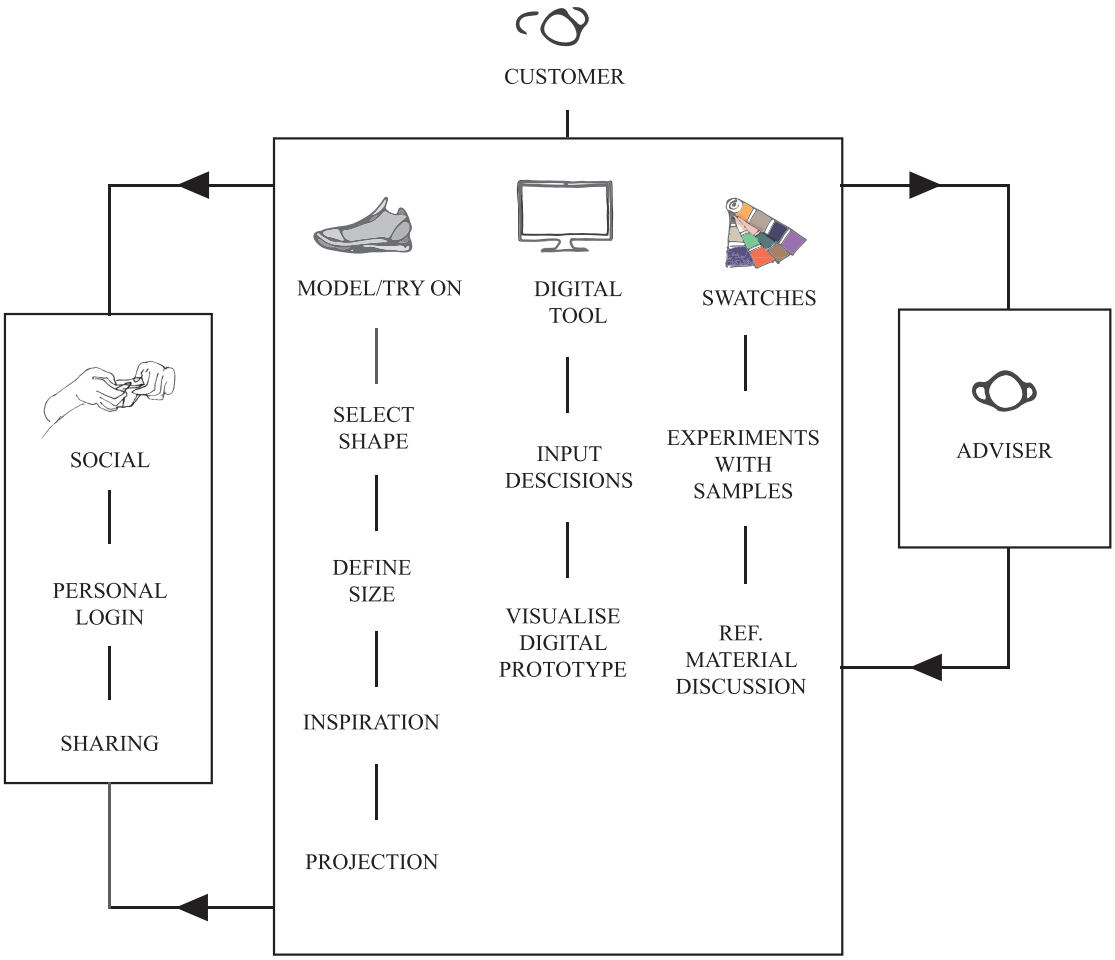


Figure 21. Information flow model for the customisation process.

The diagram (Figure 21) highlights the physical samples (swatches and trainers) and the digital tool, given their importance in mediating information in this process. *When the physical tools were engaged in the process they were pivotal for the information flow*. The physical samples worked as tangible information moving around this system that enhance the understanding, and consequently increase participants' confidence in making decisions. By manipulating physical tools (material swatches or model trainers), the participants were able to acquire information about sensory aspects (mainly colour, shape, light reflection), as well as to create meaning around them (particularly how much they like or dislike the feel).

One example of such manipulation is when a participant had two black textile samples of different construction type, and bent these back and forth in front of a light source to interrogate how the material would absorb or reflect light. Such type of interaction with materials resonates with descriptions of the Interrogation process in Chapter 4. Another example would be a participant who while looking at material swatches, held them up

close to the computer screen, trying to identify the colour shade that represented it within the digital tool. Here we see an interaction between the processes of Interrogation and Projection.

The digital tool is the central focus where design decisions meet and are processed to display the digital prototype of the trainer. The diverse information that participants gathered from physical samples (through Interrogation) was fed into the digital tool, by selecting from the digital model and the material and colour digital palettes, and the prototype gradually takes shape (which seems to be a form of Projection).

Getting sample trainers to model (from the display walls), try on trainers (stored under the benches on the seating area), use swatches (stored under the customisation desks) and computers (on customisation desks) in different parts of the room, show how *information movement* is physically realised in the SCZ. This is very related to the use of physical materials.

The digital tool assists *information transformation* as design decisions are formalised and fed into the digital system. The system gradually creates a visualisation of the digital prototype, as the participant inputs decisions on the colours and material choices. The prototype makes the customisation activity visible and shareable between participants and consultants. A toolbar on the left side of the screen only allows the participant to choose colours and materials for each part of the trainer at a time (e.g. the customer cannot decide the base and the lining materials at the same time). This resembles the form of supporting the Projection process described in Chapter 4.

The main coordination aspect within the information flow is related to the manner in which participants orchestrate the propagation of information obtained from the various communication channels, i.e. verbally (from consultants and social network - present or remotely), physically (when engaging with the physical samples) and digitally (with the trainer digital representation that acts as a *mediating artefact,* to visualise and test designs until the customer is satisfied). It seems though, here, that not only the tools that are explicitly seen in the system interfere in the information flow, but also things that are not there, and are possibly augmented using the existing things as support. These are further investigated in the 'Embodied Cognition Model'.

The Artefact Model

The four most important *mediating artefacts* in the customisation process are the digital tool, the material swatches, the sample trainers and the try-on trainers. The materials (swatches and trainers) are crucial for creating a distinct experience in-store than from the online service. Material swatches are available in different colours, all in the same size (approximately [5 x 20] cm) and are grouped according to the models available for customisation. These are predefined by the brand. The instances of interaction with these swatches were very reliant on sensory and movement engagement. The swatches were manipulated in diverse manners, thus when participants were trying to make sense of materials, they would manipulate them with hands, but would mostly rub them with thumb and forefinger.

Participants also refer to the sample trainers on display on the walls, which are designed by the brand to exemplify possibilities of applications and combinations of materials. These would be assessed visually and through touch, and sometimes participants would use them as support to wrap swatches around, in what seemed like an effort to understand how the material would take shape. Both swatches and sample trainers are limited in the sense that they do not represent all the variety of materials that exists via the digital tool. In that respect, C1 and C5 mentioned that the limitations of the materials and colours of different models could be made more explicit through the artefacts, e.g. by organizing them in a physical booklet or on the wall displays close to the model trainers.

During observations, many customers did not refer to material swatches, but just to sample trainers when making decisions. During interviews, the customer-designers used only the physical trainers. C3 and C4 mentioned that they were already familiar with the materials that the brand uses, and therefore they knew what to expect from the materials and did not need to verify the swatches. C3 highlighted that if she had used textiles with a more complex knitted structure on her trainer, then she would benefit from the physical samples. This shows that experiential knowledge is built through time – participants trust their prior knowledge of materials, which reduces the need to feel.

The digital prototype is a simulation of a real trainer, which can be visualized from diverse perspectives, zoomed in and out and dragged when zoomed in, inside the digital tool[29]. The rendering of the simulated shoe is one of the main issues with the tool:

> *"I would say it is better to have a physical representation there as well, again this is probably to do with the interface and the graphics. I found that the rendering of the materials on the screen was almost a bit too stylized, so you don't quite get a real sense. I mean, if you compare what's on the screen, and then look behind and see what it actually looks, that's great because you can kind of see how it is actually going to look." (C2)*

The above quote shows that in the intersection between interactions with the physical materials and the digital tool, the digital prototype and the physical trainers seem to present participants with a platform for *coordination of resources*, so that they have enough support to base their decisions on. The most relevant artefact for the coordination is the digital tool, as it is the focus of activity. It enables participants to identify where and when they need input from consultants or to refer to the sample materials. The latter supports them to sense and have an understanding of what their designed trainer will look and feel like. The digital tool enables the participant to visualise, test and reflect on a digital prototype of the trainer they are customising and with this they are *creating "external scaffolding"* for their cognitive tasks (Kirsh, 2009a).

Most participants reported the digital tool as being intuitive; to choose materials and colours the participant could select the area that will be altered and the options for that are shown on the left hand side; once they selected the material and colours they desired, these were automatically changed and displayed on the digital prototype. During interviews, most participants noticed as a positive aspect that only the materials related to the area being customised were displayed at each time. This related to how they were able to check physical samples, or even externalise their thinking process in the visual simulation, which is another Coordination aspect. When the customisation was complete, the participant could place the order, save it, and/or share with friends through email or social media; these options were located on the right hand side of the

[29] The digital tool layout is designed in a similar manner to other design software (e.g. Adobe creative suite), which has the design tools allocated on the left side of the screen and the digital prototype in the middle.

screen. Most participants (C3, C4 and C5) found the tool intuitive, and C3 highlighted that it was very similar to the design tools she used for her work (she designs shoes for the high-street fashion industry).

Lastly, the coordination of the physical and digital tools was facilitated by the physical space, presented in the Physical Model (Figure 21), mainly because of the walls where the sample trainers were on display. Both participants and consultants frequently referred to sample trainers to support the process of customisation, either looking from a distance, approaching them at the wall, pointing at them in conversations with consultants, or taking them to the SCZ to allow for manipulation during customisation.

This was confirmed in the interviews, where all participants mentioned the critical influence of the sample trainers on the walls to illustrate the possibilities of combinations of materials and colours that could be explored. They also highlighted the importance of these trainers to spark inspiration, and that they could serve as a starting point for the customisation process. It was observed that more than half the customers walked around the shop to see the trainers on display and chose a model before starting their customisation; this also happened in the contextual interviews, and when describing their process, some of them identified this stage as making 'mental notes' of the design ideas, which they could incorporate into the design of their trainer. This process relates to the Collection theme proposed in Chapter 4.

The Social model

The *socially distributed aspects of cognition* were observed in several instances in the customisation process. The interactions were observed with store consultants and other people in the store. The interaction with consultants is characterised by the following:

a) *Inspiration (related to Collection)*

   The consultants can also inspire customers by showing sample trainers, in order to exemplify how combinations of materials have previously been used. The design consultant team see themselves as "ambassadors" of the brand concept, as they feel that when they are walking around in their customised trainers, they are divulging the project, which is credible as customers mention how they are affected by the in-store brand experience:

"I think so, because you're surrounded by the branding, and you're probably influenced by all those trainers in all the different colours. That probably influences what you chose to do." (C2)

b) *Materials sense-making (related to Interrogation and Projection)*

Customers engage with consultants frequently during observations, mostly to ask questions regarding the relation between function and aesthetics in a specific context of use (e.g. is this material appropriate for running? And can I wash it? Will it keep the same colours?). Using physical samples or replying to more performance-related questions, the consultants guide participants through this task-specific journey, where they have a very controlled environment to act upon, with predefined trainer shapes, a limited material selection and colour palette. It is usually the consultant who introduces participants to material swatches, before they start to use them to make sense of the material and also to form a better idea of what the colours look like, as they differ from the colours on screen.

Here it is important to observe that the designer-customer framed their questions with a more specialist vocabulary, asking consultants about material specificities, using terms such as depth, granularity, colour reflection and absorption, textures and finishes. Their experience and knowledge about materials behaviour seemed to enable them to interrogate materials in a different manner, and it was also noticed that they manipulated samples in diverse ways (bending, stretching, rubbing, stroking and flipping it) and would lay the materials over the desired model in order to analyse their behaviour.

The interactions with other people in the store is characterised by:

c) *Direct feedback*

Participants usually ask their companions for opinions on their designs. Participants also have the option to share their designed trainer digitally through email and social media (Facebook, Pinterest and Twitter). Hence, they can get feedback remotely from people, or share what they have achieved.

d) *Social influence*

When customers are using the digital tool, they are interested in the other people customising, and many times check what they are doing and how they are

progressing. This was expressed by one of the customers interviewed as one of the influencing aspects that made the experience of customising in-store distinct to having done it at home.

"And even the people around you, like I was keeping an eye on what the guy the opposite was doing, even though I was doing my shoe." (C2)

Both customers and consultants affect the coordination within the social model. From the customers' side, they are the main actors in the customisation process who have input from consultants and their social network (present or remotely) (represented in the outer boxes in Figure 21). From the consultants' side, they have the sensibility to provide assistance to customers when required, but also to tailor their support depending on where the customer is in the process and what issues they have.

Embodied Cognition through Projection

The DiCoT highlighted the importance of the coordination of the physical and the digital tools, and the social engagement as crucial for the selection of materials in the customisation. However, when looking at this system, and making an analogy with the process of designing, other aspects were observed through the analysis. Hence, not only the coordination of things that are there should be considered, but also things that are not there – i.e. when creating the sports shoes, the participants use the clues from the space to imagine something that does not exist. When analysing this system similar processes to those described by Kirsh (2013) from an Embodied Cognition perspective were observed. He suggested that there are three determinant processes in thinking with the body and with things – *Perception, Projection and Imagination*.

According to Kirsh (2009b, 2013) 'Projection' sees what 'could be' through 'what is', i.e. it is a sort of augmented reality supported by things, which are projected upon. Unlike 'Perception', which sees what is, and is therefore tied to physical stimuli, 'Projection' relies on stimuli as a support (*"anchor"*) to predict. It also differs from 'Imagination', as imagination has no link to a physical stimulus, and the process is held internally to the subject who is imagining. Kirsh (2009b, 2013) has observed Projection in two specific contexts: problem solving (e.g. through activities such as tic-tac-toe) and creative process (particularly through the case of dancers)

Similar processes were noticed when analysing the information flow in the customisation process. When participants engage with the physical samples they *perceive* the real trainers and materials. When participants use the sample trainers and place swatches over them, they *project* their desired trainer and "augment" the sample trainer. When participants *imagine* their trainers they are creating the experience. This experience seems to be externalised through the digital prototype.

Because of the limitations of this study in terms of engagement with customers and methods used, we are not able to analyse processes of imagination. Also, the elements related to the perception of textiles have been discussed at length elsewhere (Atkinson et al., 2016). Hence, this investigation has taken a step forward by focusing on elaborating Projection as a phenomenon, and by establishing parallels to Kirsh's findings from studies with dancers (2013). The findings from this study are presented below, and are organised under three types of projection: Physical, Visual and Social. These started to emerge through the DiCoT analysis, so here they are presented in a condensed form, and additional theory is brought in to support descriptions.

Physical projection

The gestures for handling materials function as a method of anchoring projection. The manipulation of physical samples supports the customers in interrogating the materials, and in making decisions. The physical samples respond and change according to manipulation, and so provide tangible information. The manipulation of swatches and trainers is very active, and at times is more informative than using words. By physically engaging with the materials customers make use of their experiential understanding of materials that is more easily accessed kinaesthetically. As an example, many participants observed wanted to know how a certain material would look when placed on a certain location on the trainer, and with the help of consultants or on their own they would place the material on the desired area and get a sense of how the material take shape and look. When they had the samples structured in this shapes, they would use them as a reference to point to and discuss with consultants or their companions, or to look at from different angles. Although this is a very rough construction, with the edges of swatches sticking out and overlain with an actual trainer (which the participants commented on in the interviews), they still seem to facilitate the decision-making process, as if they could enable the customer to form a mental image that expresses further detail.

When relying on physical samples to inform their selection, the complexity of gestures used and questions posed to consultants seems to vary with expertise (Goodwin, 1994; Kirsh, 2013). Customers with a design background show a specialist vocabulary and gestures used to interrogate materials. In one example, as noticed earlier through the observations in Phase 1, some participants with a design background enquired about a material's grain and used the lighting in the store to verify how a material would absorb or reflect, or to check the light impact on a colour in different materials. Such detailed interrogation types were not observed amongst participants without a design background, whose questions were more related to the material suitability for a certain context of use (e.g. "How many washes will this material resist?") or to the aesthetics (e.g. colour and texture combinations).

Visual projection

The digital prototype of the trainer functions as a visual projection that also anchors the mental image of the target trainer. Kirsh (2009b) used the tic-tac-toe game to assess the difference between projection, imagination and perception, and showed that when playing in the projection condition (in which a sheet with a blank grid is provided so that participants can augment it with moves), and given a greater level of challenge, the grid seems to function as a "*scaffold for projecting moves*". With this example he shows that visualization anchors mental simulation. Although this work is focused on visual thinking, it shows that projection facilitates thinking by relying on an "external structure" (physical things) and that this enables people to simulate with more control (Kirsh, 2013, p. 26).

As in the tic-tac-toe example from the literature, the digital prototype functions as an external structure where customers can translate information acquired externally (perceiving the physical samples and engaging socially) and internally (from their memory, imagination, emotions), into a visualization that anchors their mental simulation and gives them confidence to proceed to next stages. Every material and colour selected is entered as a digital input that is displayed as a simulation rendered in the digital tool.

The digital prototype functions as 'persistent reference' (Kirsh, 2009a), an external memory, which allows them to keep track of their progress and assess it iteratively. The

digital prototype facilitates the creation of "focal points of thought". The visualization of the digital prototype, akin to marking in dance (Kirsh, 2013), functions as 'interactive sketching', which enables the customers to focus on each specific part. When this attention is given, it enables consumers to make use of the physical samples to get the information needed to decide on materials for each part, which is then input in the digital tool.

Social projection

Projection has social and individual implications as it enables a "physical dialogue" between customers and consultants that supports the social distribution of this activity (Kirsh, 2013). The physical samples (material swatches and trainers) and the digital tool are shared references; they enable communication between actors through diverse channels, visual, verbal or through movements (e.g. demonstrating material features by manipulating samples or finger pointing) performed to show certain features of a material that are easier to enquire and grasp through a tangible anchor.

5.4. Discussion

This study investigated a facsimile design process to understand the textiles selection further by using Distributed and Embodied cognition theories and methods. If experiencing materials is crucial for their understanding, interaction observed through *"tangible reasoning"* (Kirsh, 2013) is key to this process, which this study revealed through observing how tools are critical for the selection (highlighted through the processes of Coordination and Projection). Both in materials experience research, as in the textiles arena, there is no prior research from this interaction perspective of investigating the selection process (i.e. *how, when and why* they interact with textiles). Within the sphere of customisation, the mechanics of the system (observed using DiCoT) is also scarce or unexplored, with no publications found on the topic, however the coordination aspect was seen as crucial for the interaction to unfold.

In terms of the research question, the processes of Collection, Interrogation, and Projection were confirmed. Even in this condensed, facsimile design process, Collection was observed in terms of how participants' initial impetus is to gather information around the store, where they used trainers on display as a source of gathering inspiration.

They rely on things that already exist, in a similar manner to that observed in Collection in Chapter 4.

Interrogation and Projection were observed in a very overlapping manner, which in the case of customisation is blurred by the fact that participants have a very clear motivation driving these processes, that is, to accomplish the design of the sports shoe. This highlights the focus on what they can make with the material, and how it behaves when applied. For the Interrogation participants used both samples and sample trainers, and they also interacted with consultants to further enquire about functional aspects of materials. These processes confirm the initial findings reported in Chapter 4.

Projection was first seen in *information transformation* accomplished in the digital tool, as this facilitates imagining the shoe. This confirms that selection is not just about the material properties, but also about imagining the shoe, and the tool is facilitating that by externalising something that participants do anyway. Projection enables participants to gain an applied understanding of the materials, as they focus on what they can make with them. Even when they do not have previous experience of material, the manipulation will motivate them to a dialogue with consultants, which is usually a "physical dialogue" (Kirsh, 2013), as well as verbal, i.e. they manipulate materials to demonstrate ideas and discuss them.

Transformation was not observed, which is related to the context of customisation, where the selection process is totally constrained in order to achieve producible outcomes, so there is no possibility of altering materials or creating new materials. Clearly there are more aspects of embodied and subjective experience affecting textiles selection, particularly in this intricate relation between Interrogation and Projection. Hence, in Chapters 6 and 7 these will be explored in even more depth.

Finally, this study confirmed and allowed to clarify aspects of the relation with textile materials in their selection, which were depicted by the outer rings in the 'Quad-core Textile Selection Model' (Figure 18). This is further explored here, to provide a focus on how this material use has been noticed, as can be seen from Figure 22. In Collection real objects are used (in this case the real trainers), which are gathered as a source of inspiration. In Interrogation samples (here trainers and textiles) are used to support understanding on the material physical and sensorial properties. In Projection samples

(trainers and textiles) and a digital tool are coordinated to allow for designers to progress with their creation.

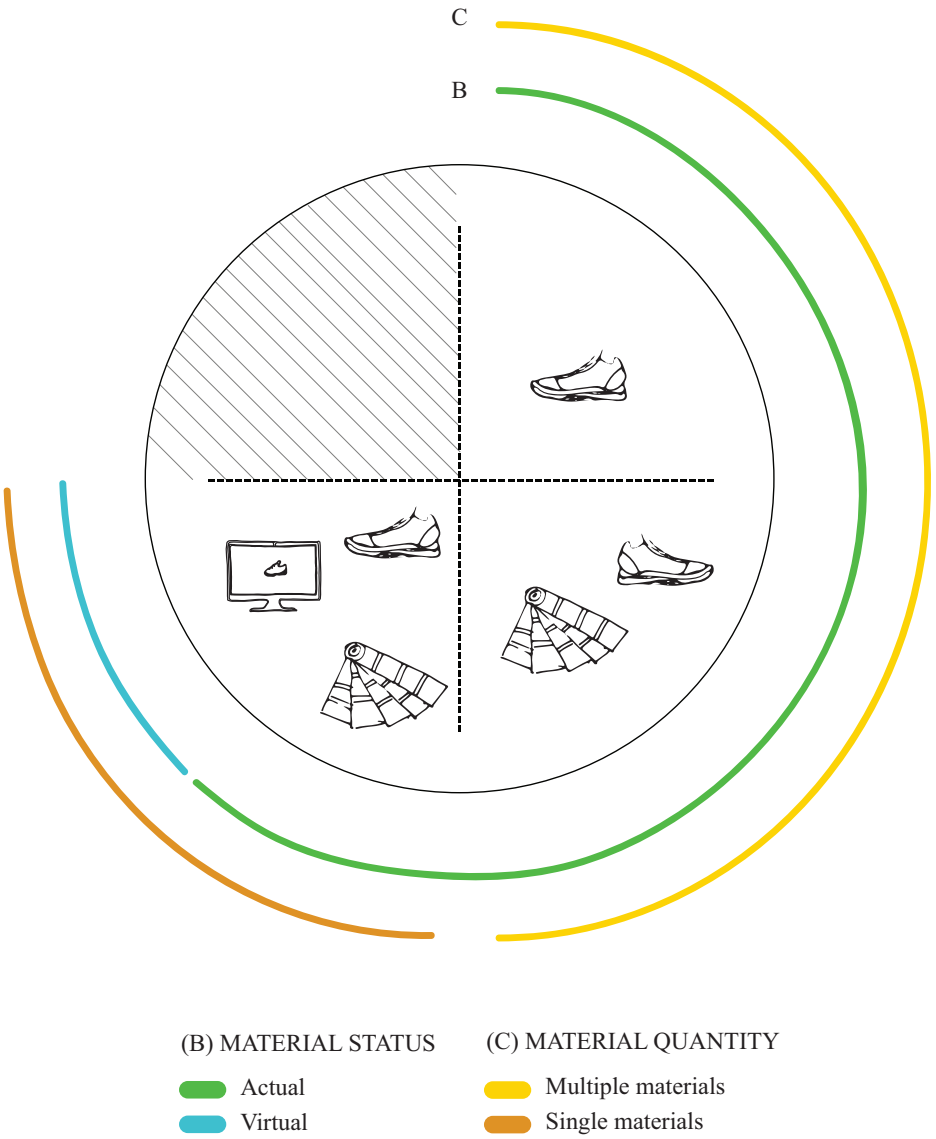


Figure 22. Use of materials in the customisation context, observed in relation to the 'Quad-core Textiles Selection Model'

Discussing 'Projection' with Additional Literature on Embodied Cognition

Embodiment theory introduces the idea that our knowledge about the world is grounded in our bodily existence (Dourish, 2004; Sheets-Johnstone, 2009). As pointed out by Dourish (2004, p. 21) this is not a novel field of investigation, and it is influenced by several disciplines through the 20th century. Sheets-Johnstone (2009, p. 2) suggests that this is a *"corporeal turn"*, that is responding to centuries of Cartesian thinking that split mind and body, privileging the first to the detriment of the second, and which looks

much beyond body-mind integration into "the human condition" in which "the body is the foundation" (Sheets-Johnstone, 2009, p. 3).

Both Dourish (2004), positioned in HCI, and Sheets-Johnstone (2009), a bodily practitioner, point to phenomenology as the main advocate of embodiment, and that to approach the world through this phenomenal perspective, an interdisciplinary positioning is required. The interest in embodiment emerging from this rich array of disciplines highlights the relevance of investigating interactions that depart from our experiences of the world to all that is in it.

> *"(…) they attest to the importance of exploring the living realities of corporeal life and of understanding in the deepest sense in each instance what it means to be the bodies we are."*
> (Sheets-Johnstone, 2009, p. 3)

Expanding on the brain-body-world integration, Thompson and Varela (2001) suggest that this dynamic is crucial for approaching consciousness, something they have studied through their proposed "*enactive or radical embodiment*", which is also highlighted by Alva Noë when suggesting that perception is enacted (2004). Kirsh (2013) builds on that proposition by adding that it is through our "perceptual-action" that concepts and meanings are derived. That brings another important dimension to this discussion: movement. If our interaction with the world is embodied, in order for these experiences to happen, we must act. And ultimately, the world is experienced with all of the things that are in it. We think in movement (Sheets-Johnstone, 2009, p. 28-63) and with things (Kirsh, 2013, p. 26).

The understanding that our thinking is in movement and with things bring us closer to the designers' experience when selecting textiles, as we have seen in Chapters 4 and 5. Kirsh's (2013) work reminds us that tools are incorporated into our bodily understanding, and it has been shown that tools affect our perception (of our body and of things) and our conceptions (Clark, 2007). However, Kirsh (2013) adds a crucial element to the discussion within this investigation. Namely, tools were previously understood to become a part of our embodied understanding through processes that were internal (i.e. "internal simulation"), whereas he suggests that external simulation through our bodily interactions with things should also be considered as thinking (Kirsh, 2013). Here, inspired by Kirsh's (2009a,b; 2013) work, the concept of 'Projection' was

introduced to extend this investigation into the *"perception-like"* processes. These were observed when designers interacted with textiles and the other types of tools (physical and digital) that were available in this design space.

Kirsh (2013) also showed that the body itself can be used to model, simulate and create, by examining dancers' practices such as marking (i.e. "*a simplified or abstract*" version of a dance sequence, which is used by dancers when memorizing or rehearsing). Besides dancers' movements, literature shows (Kirsh, 2009b) that simpler hand movements also seem to enhance mental simulation, which was discussed in the context of students calculating with the 'mental abacus': they perform better if they are allowed to move their fingers, to simulate their action on the beads. These findings around how the body is also used to support the experience and knowledge creation are taken here as an incentive here to investigate deeper the embodied experience in textiles selection in Chapters 6 and 7.

Limitations of the study

The main limitations of this study are related to the context chosen, since this is a facsimile design process that, while supporting understanding, is in a condensed and public situation. Different results could emerge from observing designers directly in their studios over a longer period of time. Also, only one store was analysed, and different findings may have emerged by analysing different stores, or different products. Another limitation is related to the particular theoretical angle taken, using distributed and embodied cognition. Other theories may have brought different aspects to the surface. As a limitation of this study, none of the theories used have enabled the investigation of affective experiences, which also plays a determinant role in this process. More applicable methods are introduced in Chapter 7, where the affective starts to be investigated.

5.5. Summary

This study was conducted to understand further the textile selection in the design process, where a sports shoes customisation process was chosen for allowing in situ investigations with a large number of participants. Applying Distributed and Embodied cognition theories Coordination (DC) and Projection (embodied cognition) were identified as crucial for this system. The DiCoT models were useful to organise data,

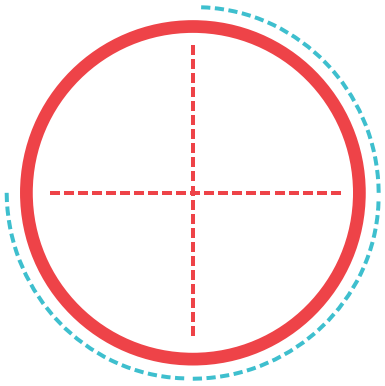
and when used alongside embodied cognition theory, allowed for confirming the processes of the selection (Collection, Interrogation, and Projection), and to understand further elements, ones that enhance the 'Quad-Core Textile Selection Model' articulated in Chapter 4, particularly in terms of the experience of materials in selection (which is demonstrated through the external circles in Figure 22, based on how predominantly they are used). The DiCoT results reveal Coordination as a determinant element for the dynamics between the tacit processes presented in Chapter 4. Projection was elaborated further in terms of Physical, Visual and Social processes.

Investigating the Designer Embodied Experience When Selecting Textiles

Chapters 6 and 7

6.

Observing the More Nuanced Sensorial Experiences of the Selecion Process in a Professional Environment



Highlights:

• Introduced research tools as a means to encourage designers to focus on their experience and to talk about it

• Identified tool needs: support in understanding and communicating, structuring selection, focusing on movement and touch behaviour

• Designers revealed a concern that tools allow for subjective experience and an interest in having greater awareness of this process

6. Observing the More Nuanced Sensorial Experiences of the Selection Process in a Professional Environment

Abstract

Following the emergent importance of experiencing textiles through the body in their selection in Chapter 5, here this is investigated deeper to understand what sensorial information underpins the textile selection processes. In this study, designers' textile selection activities are investigated by introducing research tools to focus on the embodied experience. Such tools were purposely introduced to disrupt the way designers generally interact with textiles and generate conversations around it. The study was conducted over the course of two years in a textile fair with an expert audience who were in the mind-set of sourcing. A textile fair was chosen as the setting because it is a situated moment of selection, occurring at the early stages of the design process. In Fair 1, a simple study was conducted with an existing digital tool that allows textiles manipulation to enable conversations on the sensorial experience. In Fair 2, a selection of discrete research tools, which were encouraged by emergent results from Fair 1, were introduced to prompt designers to talk about the experience of selection, and to discover more about themselves in experiencing this process. This study revealed the importance of the multisensory experience to textile selection, and the complexity of remembering and communicating such experiences in the design process. These results deepen the understanding of the experiential components of textiles selection, which are presented in relation to the 'Quad-Core Textiles Selection Model' for organisation purposes.

* *Parts of this study have been published in the papers:*

Petreca, B., Atkinson, D., Bianchi-Berthouze, N., Furniss, D., Baurley, S. (2014) The future of textiles sourcing: exploring the potential for digital tools. *Proceedings of the 9th Design and Emotion International Conference*. Colombia, 8-10 October, 2014.

Petreca, B., Atkinson, D., Bianchi-Berthouze, N., Tajadura-Jiménez, A. (2016) Investigating nuanced sensory experiences in textiles selection. In Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct (UbiComp '16). ACM, New York, NY, USA, 989-994.

6.1. Introduction

Given the importance of experiencing textiles through the body in their selection, which started to emerge in Chapter 5, here the significance of the body is further investigated, to understand what sensorial information underpins the textile selection processes. In this study, designers' textile selection activities are investigated further by introducing research tools to observe how the embodiment aspect could be enhanced and leveraged. Such research tools focus on the embodied[30] experience and were purposely introduced to disrupt the way designers generally interact with textiles. These different types of tools were brought in not as definitive tools, that is, a solution, but as research tools that invited designers to reflect on how they interacted with textiles in the context of the fair and beyond, in the design process. Hence, the technology introduced was not used to do what it was designed to do or expected to do, but to disrupt and enable conversations that might bring new insights into this complex issue of the experience within textiles selection.

In the textile engineering literature the touch interaction with textiles was explored to verify properties and describe the material, which provides a numerical or verbal descriptor of the outcome experience (discussed in Chapter 2), defining the 'textile hand'. These assessments are not usually made available to designers, instead such information only supports consistency in manufacturing. Within this disconnect between engineering and design, this study wants to interrogate what really matters for designers.

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[30] Up to this point the experiential aspects of the textiles selection were considered in a more general manner in this thesis, where the term 'experiential' has been used to accommodate the diverse levels of the designer experience (from sensorial to cognitive and affective) that could emerge as relevant for this activity. This perspective follows an understanding of experience as "the result, the sign, and the reward of that interaction of organism and environment" (Dewey, 1980, p. 22). As the embodied processes increasingly emerged as crucial through Chapters 4 and 5, from Chapter 6 on a greater focus is given to these. Here the use of the term 'embodied' is related to the corporeal basis of human experience (Dewey, 1980), where sensorimotor levels of the experience are seen as crucial to the bodily manner in which we generate knowledge and organise information (Petreca, 2011). Hence, the 'embodied' processes are considered a crucial part of the 'experiential' forms of textile selection. The transition to the term 'embodied' from this point highlights the iterative approach through which this research has developed, where a more specific terminology is required to demonstrate this focus and the greater definition achieved in the description of designers' experience in textiles selection.

In this chapter, a study was conducted over the course of two years in a textile fair with an expert audience who were in the mind-set of sourcing. A textile fair was chosen as the setting because it is a situated moment of selection, occurring at the early stages of the design process. This context is the most intense moment of selection a designer can experience, considering that the number of textiles at display is overwhelming, and that usually designers cannot take samples immediately at the fair, i.e. suppliers send these later. In such an extreme situation, what is important for designers' selection? And what do they need to remember after they leave the fair? Considering results from Chapters 4-5 such questions become even more relevant, since it was shown that the embodied experience is crucial for textiles selection. So what happens to the selection processes if the textile is not available anymore?

Another instance where the textiles are missed is when designers need to source online, before (e.g. to streamline the visit) or after (e.g. for ordering the textiles) going to fairs, where most websites only provide still images (Atkinson et al., 2013). In research for supporting tactile experience with textiles in the digital realm (Dillon et al., 2000; Magnenat-Thalmann et al., 2007), again focus was given to physical properties. The studies encountered attempted to emulate textiles in the digital, which was undertaken with the aim of allowing people to differentiate textiles when they are shopping for garments online. Such initiatives relied on methods such as the Kawabata (KES-F) and FAST (Fabric Assurance by Simple Testing) to use mechanical characteristics as input parameters for the virtual simulations derived (Luible et al., 2007). Atkinson et al. (2013) started to bring embodiment to communicate the tactile properties of textiles, and designed interactive videos for the application 'iShoogle' (Atkinson et al., 2013) – an interface that enables interactive simulation of digital textile handling for a touch-based display. iShoogle was inspired by phenomenology, hence its facility to allow active investigation of the textile through hand movements and related visual feedback (Orzechowski, 2010). Because of this consideration of the embodied experience, iShoogle was chosen as the first research tool to be introduced in the study presented herein.

In Fair 1, a simple study was conducted introducing the iShoogle as a research tool to disrupt the selection and encourage designers to talk about their sensorial experience with textiles. In Fair 2, a selection of discrete research tools was defined based on the results emergent in Fair 1, and introduced to facilitate designers to articulate their

experience of selecting textiles. The methods of both studies are presented separately, and subsequently results are reported altogether.

6.1.1. Context of the Future Fabrics Expo

It is common practice in the fashion and textiles field to travel abroad visiting fairs where companies showcase their latest designs and innovations. This context was chosen for the investigation as it offered a natural approach, i.e. it was possible to observe and question experts while they were performing the sourcing activity in an actual selection process.

The Future Fabrics Expo (FFE), organised by the Sustainable Angle (a non-profit organization), was chosen to host these studies. The collaboration with FFE arose from our shared interest in quality, performance, sustainability, and experience in textiles sourcing. The FFE provides invaluable support to the fashion industry, which is highlighted by their unique work in selecting and curating sustainable textiles, and by establishing a platform that facilitates dialogue between researchers and the textiles industry. The fair exhibits hundreds of textiles from more than 50 international companies committed to reducing environmental impact throughout the supply chain. In this fair, as in many others, visitors are not allowed to collect samples immediately but rather request them from exhibitors.

6.2. Study 3: Investigating the use of sensorial information in textiles selection

A series of studies was conducted at the Future Fabrics Expo, in two consecutive years, focusing on the Research Question 2 – *What sensorial information underpins the textile selection processes?* This study aim is to understand what sensorial information is used to support selection and what the barriers in using them are. The studies were organised through an incremental approach, where in Fair 1 a simple set up was used to initiate investigations, using only one research tool. In Fair 2 more research tools were brought in, which were encouraged by findings from Fair 1. The contexts, participants, and tools are organised in Table 13.

Table 13. Tools and participants forming studies in Fairs 1 and 2.

Fair	Context	Tools	Participants
1	Third FFE held at Fashion SVP, in London on 22-24 September 2013	iShoogle (Orzechowski, 2010)	24 experts - from the apparel industry (12 participants), education (4 participants) and others (8 participants) – identified as **PI#**
2	Fourth FFE held at Fashion SVP, in London on 28-29 September 2014	- Pocket-tool - Sensory Tagged Media (Atkinson et al., 2011) - Sound of Fabrics	14 fashion and textiles experts – identified as **PII#**

6.2.1. Fair 1 Method

To address the Research Question 2 (above) designers' reactions to a digital textile tool are investigated. A digital tool was introduced as a way to represent a phase in the design process where the embodiment is gone (after leaving the fair without sample), and to trigger reflexion in its importance. Participants were encouraged to engage with digital textile samples and to express their impressions, prompted by open-ended questions displayed on a board to which their answers were attached using sticky notes (Figure 23). The questions were related, but not limited to the tool being demonstrated. The Local Ethics Committee approved the study (Brunel University, ethics approval # EC/389), and participants provided written consent (forms in Appendix B1, signed forms available on request). Participants were recruited at the FFE13 and had been identified beforehand as a specialist audience.

Figure 23. Fair 1 study set up.

Apparatus

An application called iShoogle (Orzechowski, 2010) was presented as a research tool. The iShoogle enables people to manipulate fabrics through different gestures and is meant to convey fabric behaviour, particularly through movement and interaction, i.e. the digital textiles respond to being touched. Here it was used as a boundary object (Lee, 2007) to investigate the more nuanced experiences of the selection processes, by familiarising participants with the tactile interaction with textiles, and disrupting it through bringing a "digital touch". With this in mind, the use of the iShoogle aimed firstly, to prompt textile experts to discuss how their activity is currently performed, and how the introduction of a tool may alter it (positively or negatively); secondly, to indicate how textile selection may be supported, and thirdly, to identify in which stage(s) of the design process support would be desirable. The main apparatus were the iShoogle tool and a board with questions around the activity (Table 14). FFE organisers selected four fabrics from the fair and digital samples were created from them, following the methodology described by Atkinson et al. (2013). The fabrics—heavy jersey (Figure 24a), linen jersey (Figure 24b), denim (Figure 24c) and felt (Figure 24d)—were showcased on first and second-generation iPads at the fair. Because of the diverse characteristics of these fabrics, they differed especially in movement behaviour. Figure 25 shows the iShoogle gesture interactions for manipulation of the digital fabric samples.

Table 14. Board questions.

Theme	Question
Touch behaviour when interacting with fabrics	What type of gestures do you use when you interact with fabrics?
Quality, use and impact of technology on designers' craft	Do you think digital samples could be a good way of communicating properties of fabrics?
	What would the impact on your craft be, if sourcing materials were primarily digital?
	How useful do you find digital databases for sourcing? Do you use them?
	Do you think the way fabrics are shown online needs to be improved, and if so how?
Designers' activities if technology was available to support fabric sourcing remotely	Would you minimise travelling to textile sourcing fairs if you could source more effectively online than is currently possible?

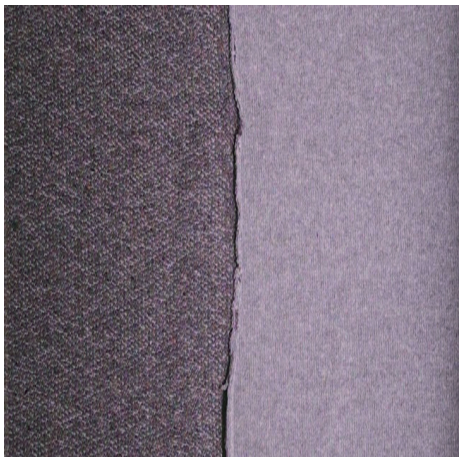


Figure 24a. Heavy jersey

Figure 24b. Linen jersey

Figure 24c. Denim

Figure 24d. Felt

Figure 24. Fabrics used to create digital samples

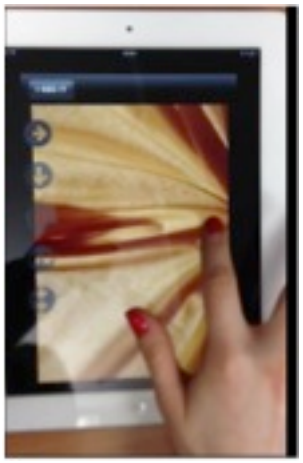


Figure 25a. Horizontal stroke

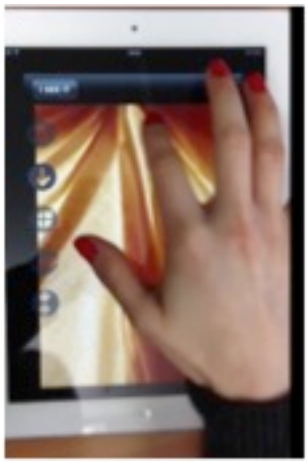


Figure 25b. Vertical stroke

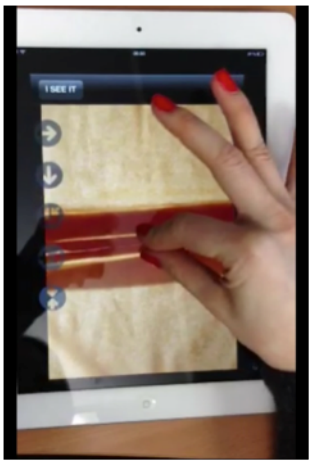


Figure 25c. Horizontal pinch

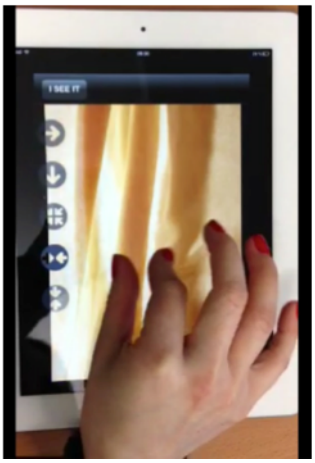


Figure 25d. Vertical pinch

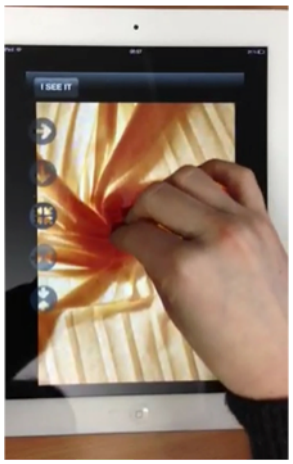


Figure 25e. Scrunch

Figure 25. Gestural interactions with digital samples thorough iShoogle

Three main themes were explored through six questions (Table 14); the latter were displayed on a board and after engaging with the digital interactive videos of the textiles, participants wrote down answers on sticky notes and attached them to the board. Each

theme was given a broader focus, considering the overall aim of the study was to get a comprehensive understanding and scope the opportunities for tools development. These questions were tailored to get designers to reflect further on how they interact with physical textiles, by contrast with the digital ones, and also to reflect on how their practice is currently taking place, by introducing a 'disruptive' element to it. Finally, the theme regarding touch behaviour is further explored with a design (expert) community to allow for comparison with a previous study (Atkinson et al., 2013) that focused on consumers.

6.2.2. Fair 2 Method

Encouraged by the outcomes of Fair 1, it was considered that other tools could be introduced to encourage designers to talk about their experience, following a reflexion on how to disrupt the selection more and get designers to articulate the tacit processes. Hence, in Fair 2 the study presents a more complex set up where different concepts were explored through discrete research tools, assembled in the 'Textile Multisensory Toolbox'. In the fair, a research corner was set up where a selection of textiles was exhibited in relation to the set of tools presented (Figure 26). The Local Ethics Committee (UCL, ethics approval # BSc/1213/001) approved the study, and participants provided written consent (form in Appendix B2, signed forms available on request). Participants were recruited at the fair and had been identified beforehand as a specialist audience.

The designers were introduced to three research tools: the Pocket-Tool (which explored touch behaviour), sound of textiles, and the Semantically Tagged Media cards (a set of images produced in previous research by Atkinson et al. (2011) to communicate about the experience of textiles through visual associations). These tools are further described in Apparatus.

Figure 26. Study set up at the Future Fabrics Expo 2014.

Designers were prompted by open-ended questions in a contextual interview that followed the interactions with the tools. The questions were used as an interview guide (so their use was not strict), and were related but not limited to the tools being demonstrated. These are listed below:

Touching the Pocket-Tool: Participants were asked to find the textile pocket that best represented a verbal descriptor suggested by the researcher. The verbal descriptors used were: smooth, rough, soft and hard.

1) Find the: (I) smoother, (II) rougher, (III) softer, and (IV) harder.
2) Touch the fabrics again and look at the plotted lines on the screen.
    a) How would you use this information?
    b) How would you like it to be presented?

Sound of fabrics: Participants were asked to listen to audio recordings of the fabrics being manipulated. The sounds were recorded from the same fabrics used for the Pocket-Tool. After listening they were prompted by the questions:

1) How would you use this information?

2) Would you like to hear the sound of stroking a fabric when you source remotely?

3) Would you like to record your own sounds when you are sourcing from the fair to recall a fabric?

Visual metaphors: Participants were introduced to the collection of Semantically Tagged Media (Atkinson et al., 2011), and prompted by the questions:

1) Would you like to use images to describe the feel of a fabric?

2) Do you think that having an archive of "sensory tagged images" could facilitate this?

3) Would this be useful for creating a reference board for fabrics when you're sourcing in the fair? And online?

General questions about tools: at the end participants were asked more general questions on their impressions emerging from interacting with the tools.

1) Would you like to be able to combine all of these tools in a toolbox to support your selection?

2) How would you use it?

3) Do you see value in having a toolkit to generate more experiential content to inform/support your sourcing process?

4) Would you like to find such content available in fairs? And online?

5) Would you like to be able to create your own content, or to have the content already made for you?

Apparatus

In order to build on the ideas generated through Fair 1 (FFE13), this study brings together a selection of tools focused on the embodied experience, combining them in what was called the 'Textile Multisensory Toolbox', for the purposes of communicating the concept at the fair. The prototype tools that form this toolbox are not seen as final solutions, but as research tools. Therefore, they are not necessarily used to achieve what they were designed for. For example, an interactive tool (the Pocket-Tool) is introduced with a focus on getting designers to talk about their tactile experience with textiles, and not to quantify touch behaviour through pressure, which the tool can do. Although this data was recorded and observations were made, the main interest at this point was to introduce these tools to get designers to focus, reflect and talk about their subjective experience. These tools are individually described here.

Pocket-Tool (Figure 27): To investigate the touch behaviour further, and attempting to better discriminate it when handling textiles, a research tool was designed, which was

dubbed the Pocket-Tool, centred on Arduino-based technology and force sensitive resistors.

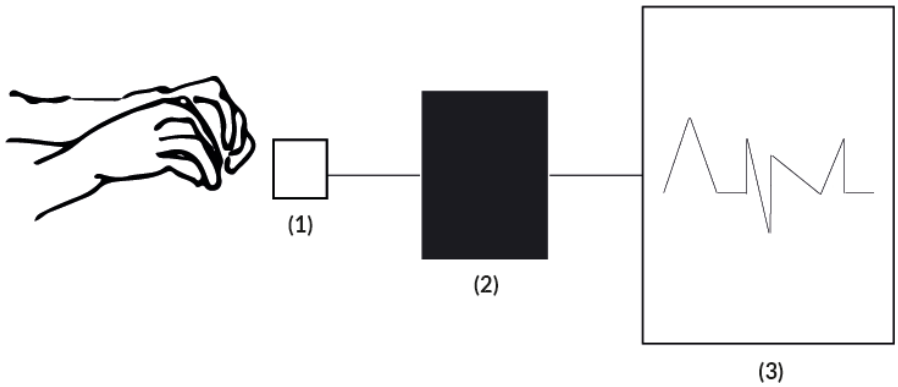


Figure 27. Schematics of the Pocket-Tool interaction, where (1) is a force sensitive resistor ("pressure sensor"), with 1.75x1.5" sensing area and is covered by a fabric pocket, (2) is the box holding the Arduino board and (3) represents the lines plotted as a result of the interaction.

The Pocket-Tool comprises six different textiles, all of different constructions, but all in white or cream colour. Their set up can be seen in Figure 28.

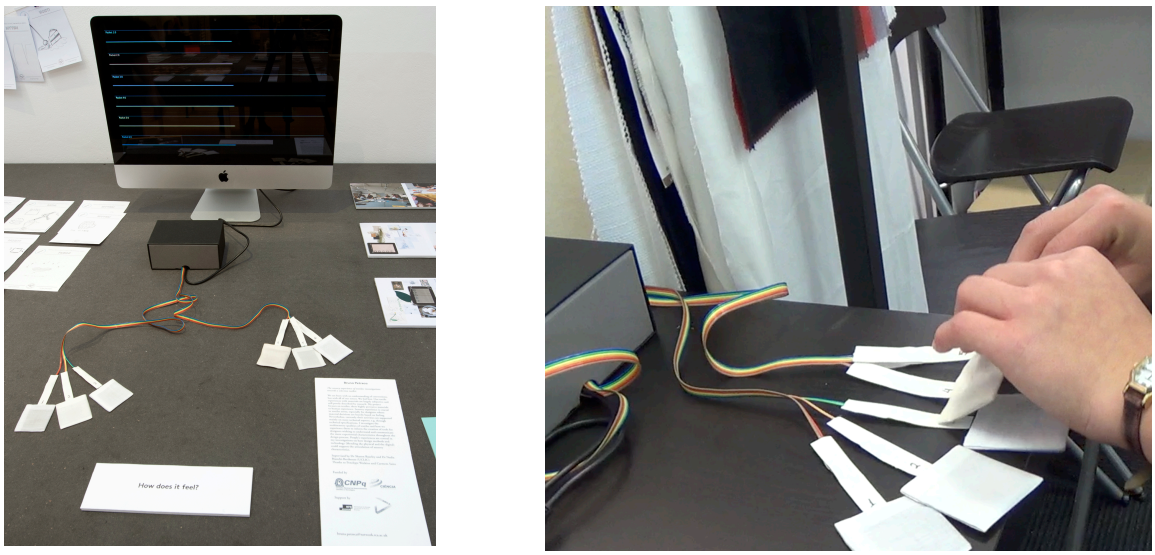


Figure 28. Pocket-Tool: (i) exhibited at the Work in Progress show 2015 at the Royal College of Art, on the picture on the left; (ii) Pocket-Tool being used at the Future Fabrics Expo 2014.

Semantically Tagged Media cards: here the lexicon of semantically tagged media created in the Digital Sensoria project (Atkinson et al., 2011) was introduced to give participants a chance to test a non-arbitrary manner of expressing their experiences with textiles. This semantically tagged media cards were originated through studies by Atkinson et al. (2011), where design students were presented with diverse matching task, to relate images to verbal descriptors. The authors used the following terms (identified

from the literature) to base such studies: Thick – Thin, Stiff – Flexible, Warm – Cool, Rough – Smooth. Only the images were provided, without explicating their relation to the verbal descriptor that led to their selection. Example images are shown in Figure 29, to demonstrate the type of content that was made available.

29a. Flexible **29b. Rough** **29c. Warm**

Figure 29. Example of images used on 'Semantically tagged media' cards (Atkinson et al., 2011).

Sound of textiles: sounds were recorded from the textile samples used to build the Pocket toll while these were stroked. After the sounds were recorded, any background noise was removed using the software Audacity 2.1.2[31].

Analysis

All data was transcribed verbatim. The Thematic Analysis method was used for systematic analysis of the data, following Braun and Clarke's (2006) guidelines, which suggests that the analysis should follow the six steps described below:

1) 'Familiarising' with the data by reading the transcripts to get a general understanding
2) Identifying initial codes by systematically categorising transcripts with labels; such labels should "identify a feature of the data (semantic content or latent) that appears interesting to the analyst" (Braun and Clarke, 2006, p. 88)
3) Identifying themes based on clustering the codes generated in step 2
4) Reviewing and verifying if themes do reflect the content of the whole dataset
5) Formalising themes and renaming where necessary, to help construct the narrative the communicates the results

[31] This is a free software available at: http://www.audacityteam.org

6) Reporting themes with the support of selected quotes

Coding was conducted using QSR International's NVivo 11 software. The questions were used to guide the analysis, but focus was given to themes and sub-themes that emerged from responses, which are described in the results section.

6.3. Study 3 Results: Revealing the multisensory richness of the textile selection processes

The results obtained from both fair studies indicated four main themes: textile touch as a multisensory experience, tacit knowledge in touch behaviour and experience, difficulty in communicating, and complexity of textiles selection. These are described using the notation PI# (for Fair 1) and PII# (for Fair 2) to indicate participants' anecdotal evidence, and are presented in Table 15 alongside the subthemes that form each of them.

Table 15. Themes and subthemes resulting from Fair 1 and 2 studies.

Theme	Subthemes
Textile touch as a multisensory experience	Multisensory aspects (touch, visual, aural, and proprioception), combine different senses, engagement, exploration, movement of the textile, impression of the textile
Tacit knowledge in touch behaviour and experience	Information on how you touch, information on how other people touch, need to touch, knowledge about touch behaviour
Difficulty in communicating	Communication, knowledge, understanding, importance of associations, being able to describe a textile
Complexity of textiles selection	Need to touch the textile, need to remember the textile, need to familiarise with the textile, bring structure to selection process, subjectivity in textiles selection, importance of social interactions

Textile Touch as a Multisensory Experience

Designers discussed aspects of how experiencing a textile is a rich multisensory experience, where tactile, visual, aural, and proprioceptive perceptions are reported.

> *"Yeah, because when you feel a fabric, you're not just using your hand, are you? You're using your eye, and then you're listening, especially with some fabrics. They can be very loud, and then it might be smooth and loud, and that doesn't mean it's soft, so the noise will tell you. The visualization of the movement of the fabric is like so important."* (PII7)

"There are other little things. There's how would light affect that? How does it affect being in this sort of light vs. that light? That's really important to me." (PII9)

Designers generally revealed an interest in tools that facilitate *combining the senses* as a means to facilitate the absorption of information around their experience of a textile. Designers suggest that the more sensory elements can be highlighted to support selection, the better.

"Yeah, 'cause they would have a lot more information in their head whether that's the sound, the image, and, you know, all these extras." (PII10)

"I think that I would really get like familiar with the fabric. Like, to have it all together, with all the senses, like hearing, and seeing how it moves also… that would be great, I mean, to combine the different things." (PII5)

Designers report that working with this type of content enables them to gather a more complete impression from the textiles.

"Yeah, of producing sound with the fabric, to sort of like give an impression of what the fabric is like.
*(…) I think that would be great, 'cause you get a lot of that association between the pictures and the fabric, and you realize how the fabric is to touch." (P*II6*)*

Designers saw interactive videos as a step ahead from the current online stills *["Gives more information than photos. Seems to be a good way to go… But how to give the textural information?"* (PI1)]. They would like to have more three-dimensional information and possibly related to a context of use. *"It's only shown flat. You can't get the feeling from drape."* (PI23). They consider that interactive videos would be useful *"especially for online e-retailers."* (PI22), but still lack refinement for designers.

Movement and feel

Participants' understanding of 'feel' seems to encompass both sensory stimuli and their hand movement, which indicates that proprioception also plays a role in forming the understanding of a textile. This relates back to the definition of 'textile hand' by Philippe et al. (2003), which comprises both sensorial and movement aspects. Overall, designers consider touching the textile a crucial step for their sourcing and believe that *"The actual sampling will never go away completely."* (PI11). This importance of

physical touch was strongly remarked by the views on the digital textile, which disrupted designers' selection. Participants considered that interactive videos provide a better idea of the fabric behaviour, in comparison to current still pictures found online, which *"Gives a sense of drape qualities."* (PI22). Although, they suggested that digital samples could inform them about the movement and texture of fabrics, they still consider the manipulation of the actual fabric crucial for its appreciation.

"To review texture and movement, yes. But it's very important to touch for handfeel." (PI6).

Tacit Knowledge in Touch Behaviour and Experience

While intrigued by what they experienced with the digital textiles, some participants clearly expressed their need to *"see fabric in different situations and in different manipulations"* (PI14). They also suggested additional features, such as magnifying and improving interactivity (PI16) to support understanding of fabrics' properties. *"Magnify / zoom. Stay once deformed. Connection between length of gesture and recovery"* (PI17), or showing different aspects such as to *"Combine verbal and visual descriptions. Show close ups and on a person."* (PI13).

This need to see fabrics in diverse situations and with a reference to the body (either by manipulation or seeing on a person), shows a relation between proprioception and the experience of touch, which reveals a very complex language of touch, one that is tacit. This experience is so implicit to the designers, that the need to touch and to see bodily references is pressing (further discussed in 'Need to touch'). Additionally, designers were not even aware of how they touched differently in searching for the diverse descriptive terms with which they were prompted, which again shows how unconscious this process remains (further discussed in 'Knowledge about touch behaviour').

Need to touch

In Study 3, when presented with technology related to the tactile experience, designers emphasise how crucial this is for their understanding of a textile. They need to touch, and this extends to their selection beyond the fair.

"Obviously, when you go and shop online, or whenever you're sourcing fabrics, regardless of where, a key thing is touch and feel." (PII12)

"It's the touch, the feel. It's we're still human beings, and we wish to, through our very nature, engage with things." (PII9)

Designers recognised difficulties or gaps in the process of selection, in the fair and beyond. These are mainly related to *understanding*, particularly when designers have to source online and have difficulties in understanding the textile from still images.

"I do have to source a lot online, and it is really difficult because you pay for the samples, and you want to be careful about what you're picking, and sometimes when it arrives, it's definitely not what it looks like in the picture, so…" (PII3)

Knowledge about touch behaviour

Many designers showed an interest and even excitement with the possibility to reflect and see *more information about how they touch* a textile, which was done in the case of the Pocket-Tool in a very basic manner. Designers expressed a lack of awareness about their interactions with textiles and were therefore interested in having more information concerning the touch behaviour, as a means to support their explorations and consequently their understanding of a textile. Designers showed interest in seeing hands and seeing the lines plotted from the Pocket-Tool; and this includes information both about themselves or other people touching.

"I think it would be good if you'd be able to see it, because you can – I think it would give you a lot more information on how you touch things. Because then you can see what I'm doing." (PII2)

Not only were designers interested in their own experience, but they would also welcome *more information on how other people touch*.

"… if there was just a video of someone moving the fabric you know, taking it and scrunching it, or showing how the light reflects or, I don't know, maybe showing something else in a similar weight." (PII10)

"Probably it won't give you everything, just seeing people touching it, but it will definitely give you a feel, 'cause I'm guessing a lot of people touch similarly when they're looking for similar things." (PII10)

Observing touch behaviour with the iShoogle and Pocket-Tool

Results from the iShoogle show that the gestures designers used (Figure 30) partially overlap with those observed in consumers (Atkinson et al. 2013), but also includes some new gestures. Whilst the most frequent gestures (rub, stroke, pinch and scrunch) were observed also in non-experts consumers (Atkinson et al. 2013), fold, pull and drape seem to be more specialist gestures, which were only noticed in the study with designers herein reported. This may be an evidence that designers have more diverse, or specialist, touch behaviour when interacting with textiles, but merits further research.

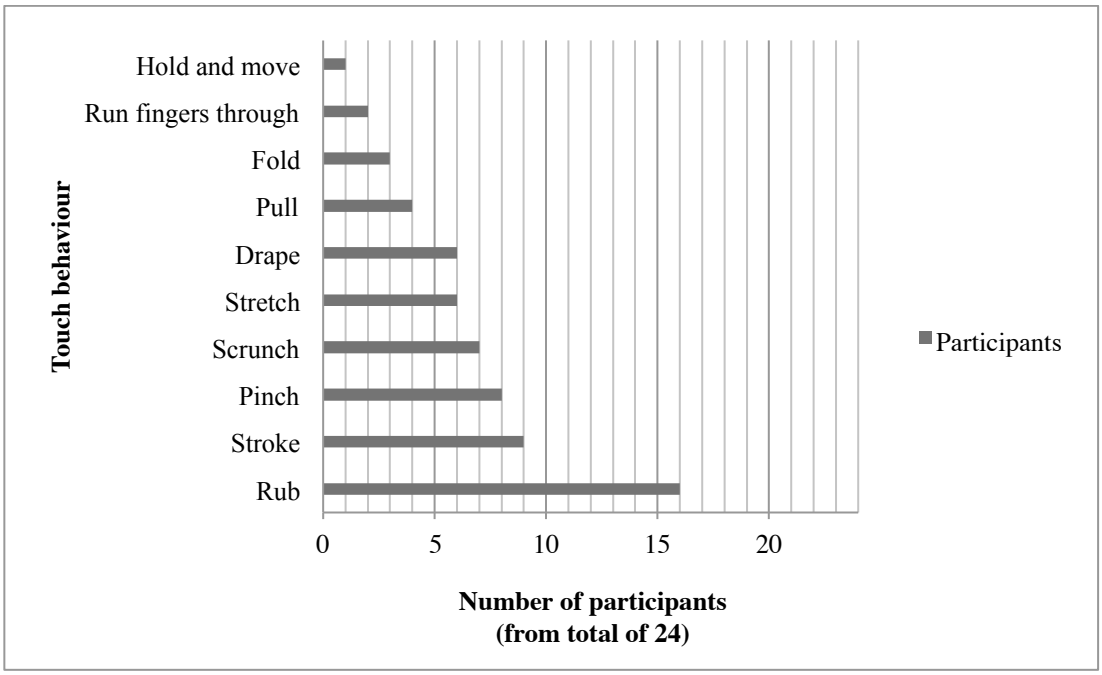


Figure 30. Designers' touch behaviour for exploring textiles.

Finally, some results were gathered from the Pocket-Tool (Table 16), on types of touch behaviour that were observed through the videos. Data showed rubbing again as the most used gesture, which served to identify different properties; pressing was frequently used to sense hardness, and scratching was used to feel roughness.

Table 16. Touch behaviour performed by designers to identify fabrics according to a given verbal descriptor.

Verbal Descriptor	Most frequent touch behaviour	Frequency
Smooth	Finger and thumb rub	11
Rough	Finger scratch Finger rub	6 6
Soft	Finger stroke Finger press	6 4
Hard	Finger rub and press Finger press	7 2

Difficulty in Communicating

As the designers were engaging with different tools, many aspects started to emerge in relation to what they do, or which are important for their experience in selection more generally, rather than directly related to the working of the research tools. The predominant aspects were related to communication and knowledge about textiles. Most designers highlighted the importance of being able to articulate the experience and to communicate it to others when performing their work.

> *"I learned the importance of being able to describe a fabric to somebody else, or even communicating its properties to someone in your team, or maybe communicating to someone over the phone."* (PII7)

Such communication happens in several instances: when designers need to be able to explain to suppliers what kind of textiles they are looking for, or when only one designer from a team visits a textile fair, and they need to be able to communicate to others what they saw once back in the studio but before they have samples to show.

> *"Just you saw, and you took a picture of it, but it's like bad lighting. So that's all you have when you go home right now. And you know what you're talking about, but the other person won't."* (PII10)

Tools would be welcomed at *initial stages of selection* in *communications* with suppliers, which are not a straightforward process, especially if the supplier is new and there is no prior experience to inform conversations.

> *"I could show them what they're like without them having to take a trip somewhere, then I think that would be a good first step. And then, obviously, they'd want to see them in real life as well."* (PII11)

Besides facilitating their own understanding of the textiles, the content generated through this type of exploration could also support in *describing the textile* and therefore improving communication. This was already highlighted as something crucial for their experience of selecting textiles, and which presents difficulties, particularly when designers cannot articulate their subjective experience.

> *"I do like giving people more and more ways to describe it or think about it, or just, just more information in their heads. When they leave, they have a lot more. If someone asks them about their fabric, they're not like, "Uh, I can't really tell you." (PII10)*

If designers were able to better describe their experiences, they consider this would impact in aspects such as *engagement*, which is important for textiles selection in the fair context and beyond. This also reinforces that fact that the selection is not conducted by designers in isolation, as has been shown in several instances in this thesis.

> *"I think they'll draw in at fairs and things. I think that would be – 'cause it gets you engaged and gets you talking to other people. So even if online, like if you're stuck with something or whatever, I think it's really hard to – but yeah, if you can email them, and be like, "Oh, yeah –". (PII2)*

Complexity of textiles selection

Textile selection as an overwhelming process

Participants considered interactive videos useful as a filter before traveling to textile fairs, declaring it a *"Good starting point."* (PI6), but they still need to touch in order to make final decisions. They mentioned a tool would be useful for the initial stage of design, during the research process when they have to come up with ideas of textiles, before checking what suppliers have to offer.

> *"For the research it would be really useful, at the start of the creative process." (PI5)*

> *"You could filter samples down to your favourites." (PI14)*

Structure to selection

Designers stressed that the selection was so overwhelming, that some *structure* would be welcomed, particularly in terms of searching before visiting the fair, to make the visit more efficient.

> *"I come here, and I'm a bit like, "There's so much to see," and I'm a bit overwhelmed. So then I get really frustrated, so I just go through it quickly, without actually seeing anything, but if I can – you know, if there's something I can search by subject, by category, by field, by sound, even, then, actually, I think that would be great, 'cause then I can know what I want to see."* (PII8)

Remembering (memory)

Observations of designers' behaviour highlighted that it is common practice to take pictures of exhibited fabrics, also registering their technical specifications (Figure 31) as samples generally cannot be taken and must be requested from suppliers by post. These factors indicate an opportunity for tools that support collection in fairs. When presented with the possibility of having digital textiles, designers considered them a more resilient format than the current textile samples provided by industries (*"Definitely save time! (…) Efficient and durable."* (PI24)), and still providing an experience through interaction (*"Good to carry fabrics with you in a lighter and interactive way."* (PI23)). This would have an impact on the Collection activity reported in Chapter 4.

Figure 31. Visitors taking photos and making annotations.
© The Sustainable Angle Photography Green Lens Studios 2013. Source: http://www.thesustainableangle.org/futurefabricsexpo/Photos/FutureFabricsExpo2013.aspx

What information they need when experiencing or when remembering experience?
Designers also reported difficulties in managing all the information they have to absorb in a fair context, particularly the textile experience, and that currently they lack support in this sense, as the only means they have to register their experience is by taking pictures.

> *"Yeah, yeah, 'cause at the moment, you just take photos, which is great for just the kind of visual, but then a photo, like you might even forget how thick it is or how stiff it is…"* (PII4)

> *"You have the memory of you feeling it and the picture."* (PII10)

Since designers were not able to take samples directly from the fair, they were interested in having tools that helped them to register and recall the experience with more richness than they could generate via pictures,

> *"Yeah, and do you think that would be a good way of recalling what – how a fabric feels, because you can't take them away."* (PII2)

> *"So you could take a picture and then a mood board next to it, and then you remember."* (PII3)

They considered using these tools in the fair, to enrich their recollection currently produced by taking pictures.

> *"Amazing, 'cause I just tried to take a picture of the mushroom, uh, mushroom leather, and it didn't look…"* (PII14)

> *"So having something that they have prepared, but also having the tools to come to the fair."* (PII3)

Subjectivity in selection

Designers made a point about the importance of leaving enough flexibility for *subjectivity* when introducing support, as this is a crucial aspect when thinking about how designers understand and select textiles.

*"As long as it is very representative. I mean, the thing is, it's quite subjective, isn't it? So one person might think that this is very smooth because of the way they see it, but then someone else might think it's really rough and of not good quality or… so it's the subjectivity of it, I think, is very important." (P*II8*)*

*"I think I'd have to see the how that information was actually displayed to allow me to be able to create my own interpretation of that information. But again, it's interesting, we mentioned it right at the beginning, how that resonates through each and every person." (P*II9*)*

Social interactions

Designers highlight the social side of fairs, where they have the chance to meet suppliers, colleagues and to build networks. Some designers mentioned they *"Would definitely still attend larger fairs."* (PI19). Those who would still travel would welcome the inclusion of digital means to support their current activities. *"I source from hundreds of mills based on conversations. So no, but it might streamline the trip and help plan."* (PI8). *"I find it important to meet people in the fair (producers), so I would like to see a combination of fair, but also being able to source online."* (PI10).

6.3.1. Discussion

This study pursued the Research Question 2 (*What sensorial information underpins the textile selection processes?*). Overall, designers consider touch imperative for experiencing textiles. They need to have a multisensory engagement with textile samples, interact and communicate with their stakeholders, and to share information with suppliers and other designers.

It is clear that designers want and need to better understand and communicate sensory properties of textiles: this is an integral part of choosing textiles, and touching is the one single thing that no participant would remove from their fabric sourcing process. Sensory perception facilitates cognition: this is reinforced by designers' need to feel the fabric as a crucial step for understanding and making decisions.

Participants' responses indicate that when experiencing a textile, one gains an understanding of it and of how it feels. Moreover, designers argue that the social side of fairs is important for sourcing, which from a distributed knowledge perspective

potentially indicates that designers' decisions are more a team activity (design team and stakeholders) than individual, which connects with findings form Social Projection in Chapter 5.

This study showed that support may come useful for designers to (i) enhance their tactile interactions and understanding, (ii) provide a memory (recording and remembering) around the multisensory experience of a textile, (iii) facilitate describing and communicating their experience, and (iv) provides structure for the selection process. These four areas were synthesised from the findings demonstrated through the four themes (textile touch as a multisensory experience, tacit knowledge in touch behaviour and experience, difficulty in communicating, and complexity of textiles selection) revealed through the introduction of tools to the textile fair context. This study achieved its aim, namely, to engage designers in talking about their experience in selecting textiles, and to highlight the most significant processes in this intense moment of selection. However, it also achieved more - through looking more extensively and including moments that affected the selection in the fair and beyond (e.g. when sourcing online before going to the fair, or in communicating the outcomes of a visit to a fair to a design team).

In relation to the theme 'tacit knowledge in touch behaviour and experience', designers revealed a lack of awareness of tactile behaviour during handling, and saw an opportunity for using concepts such as the one demonstrated through the Pocket-Tool to further investigate tactile experience by enhancing their awareness. This in turn provided impetus for this researcher to further investigate touch behaviours in order to more fully understand what happens when designers touch textiles. This step relates to the embodied cognition content already highlighted in Chapter 5, and will be further investigated in Chapter 7.

The literature supports the interest in expanding the investigation towards this embodied experience direction, in terms of the 'feel' and 'touch behaviour', and also in terms of the awareness of this experience. Firstly, Sheets-Johnstone (2009) suggests that to study 'corporeal' matters is an "open-ended spiral of enquiry", and this is because new understandings lead into the need for deeper investigations. For this, Sheets-Johnstone suggests that in researching "experiences as the grounding source of knowledge" there

is a need for discipline, in terms of "dedicated examination", and an interdisciplinary approach, as investigations are highly complex. Finally, in Sheets-Johnstone's essay *'Thinking in Movement'* (2009, p. 28) she begins by presenting a "descriptive account" of the "experience of thinking in movement", which establishes a stable ground for further research in dance and other types of movement. Such "descriptive account of thinking in movement" is still missing from the understanding of how designers experience textiles in this thesis, and seem to be a fertile ground by which to explore designers' accounts of the importance of 'feel' and 'touch behaviour'.

Secondly, a study by Mentis et al. (2014) records an attempt to bring technology to enhance the experience of people in art galleries. Although the technology enabled people to record their experience and then communicate it, the authors noticed that people were more drawn to using the tool to reflect on their own experience. This interest in reflecting on one's own experience was also revealed by designers, who showed interest in becoming aware of their experience of touching a textile. Taking both of the directions emerging from this study, and in order to explore the significance of emergent embodied aspects even further, a micro-phenomenological approach is taken in Chapter 7. This allows exploration of how designers experience textiles, using a method that takes a first-person perspective to provide fine-grained descriptions. This method supports subjects in becoming aware of their experience, whilst revealing the dynamics of 'how' such experience unfolds.

Relation to the 'Quad-core Textile Selection Model'

Observing the results presented here, some links can be established with results emerging through Chapters 4 and 5, which are now discussed. The theme related to the importance of touch, particularly in terms of movement and feel, revealed as crucial throughout this study, show how critical physical samples are for the selection process, confirming findings from Chapter 5 in relation to materials use. This study also shows with more detail that designers have specialist movements in exploring textiles, but that these need further investigation to allow for understanding of what is happening when they perform these. Building on findings from Chapters 4 and 5, these movements show relations to *Interrogation and Projection*, as they are used to understand the textiles and its potential applications, but require further research to investigate how the observed touch behaviour types relate to the tacit themes (from the 'Quad-Core Textile Selection Model'). This is further explored in Chapter 7.

In this study, the concept of 'Collection' was confirmed as valid through both studies (Fairs 1 and 2), and raised the real concern of designers having to leave the fair without any physical sample. 'Collection' is further understood as an overwhelming encounter, in fact, as in the context of the fair designers cannot collect, select everything. Here there is a clear indication of need for support, they need remembering, which was highlighted in their suggestion that they would like tools to record the experience, and to manage samples gathered. Designers also expressed interest in other means to "collect" their experience, which could help them remember the different fabrics, and progress with their projects even before they received the samples from suppliers. This reveals an opportunity to explore tools that relate to the 'Collection' theme, as through this process, designers gather information and inspiration that nurtures the textiles selection. Additionally, where it was noticed that designers take pictures of fabrics and of technical specifications, this also confirms the 'Collection' process, and reveals another opportunity for further research in terms of supporting collecting activities.

Interrogation and Projection were seen in several instances, where designers wished to see textiles in application, or were willing to communicate with suppliers. The ideas emerging through the digital textile tool show a potential for exploring aspects of *Interrogation and Projection* further, particularly when designers suggest how they would like to magnify the textiles, or see how they deform (which relates to *Interrogation*), or when they suggest that it would be desirable to see the fabric in different applications and situations (which relates to *Projection*). Additionally, designers' comments on the importance of social interactions in the fair confirms the importance of the process of *Social Projection* identified in Chapter 5, but here this could not be observed in detail. This was noticed in designers' reports on the need to communicate with suppliers to enquire about previous applications, which is related to the *Projection* process (see Chapters 4 and 5), which is seen to allow the designer to envisage what fabrics can become.

It was difficult to see Transformation happening because the studies reported in Chapter 6 focused on more intense moments of selection, rather than viewing the selection impacting on the whole design process. Hence, there is no direct relation established with the processes of modification, manufacture or creation of textiles.

Limitations of the study

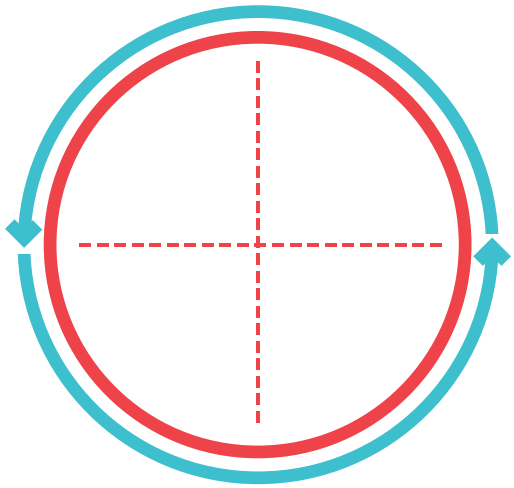
Both the participants' sample size and the sustainability context of FFE are limitations to this study and could have biased responses. The choice of tools that were brought in also has influenced the findings, where diverse tools may have disrupted the textiles selection in a diverse way and triggered different responses.

6.4. Summary

Chapter 6 investigated the Research Question 2 (*What sensorial information underpins the textile selection processes?*) focusing on an intense moment of selection to investigate how tools are used, and to further the understanding of the textile selection processes. Two studies were conducted in a fair context in which research tools that encourage designers to focus on their experience when selecting textiles were introduced. This was undertaken to understand further the selection processes, particularly focusing on the sensorial elements integral to it, which was achieved by introducing diverse research tools iteratively (in Fairs 1 and 2) as a means of engaging designers in reflecting on their experience when selecting textiles and talking about it. The results were gathered around four main themes: textile touch as a multisensory experience, tacit knowledge in touch behaviour and experience, difficulty in communicating, and complexity of textiles selection. These results show that designers consider touch fundamental for experiencing textiles, and they argue that they need to touch to 'feel'. Of further critical import was the outcome whereby designers considered the physical presence as crucial in seeing and feeling fabric samples, interacting and communicating with stakeholders, and for sharing information about previous experience with suppliers and materials.

7.

Investigating the Embodied Experience in Textiles Selection



Highlights:

• Applied the 'micro-phenomenological' interview, analysis methods and thematic analysis

• The thematic analysis revealed 2 types of touch behaviour (active and passive) and 3 tactile-based phases: *Situate, Simulate* and *Stimulate*

• The 'micro-phenomenological' analysis confirmed the 3 tactile-based phases and revealed the diachronic structure of the experience

7. Investigating the Embodied Experience in Textiles Selection

Abstract

Chapter 7 aims to further understand the tactile experience during textile selection with fine-grained detail and the dynamics of the lived experience, in response to the diverse findings from Chapter 5 and 6 that reveal how the textiles selection relies on embodied experience that goes beyond perceiving the objective properties of textiles. To achieve this aim, it focuses on the Research Question 3 – *How does the body support the different forms of textile selection?* This question will focus on observing textile touch process and embodied interactions, through a study using the Elicitation Interview method (recently renamed as 'Micro-phenomenological Interview' method) to obtain a first-person verbal description of experiential processes. Interviews were conducted with 6 experienced designers from the fashion and textiles area. The analysis revealed that there are two types of touch behaviour in experiencing textiles, active and passive, which happen through 'Active hand', 'Passive body' and 'Active tool-hand'. They can occur in any order, and with different degrees of importance and frequency in the 3 tactile-based phases of the textile selection process – 'Situate', 'Simulate' and 'Stimulate' (3S Tactile Phases) - and the interaction has different modes in each. Further analysis revealed the manner in which the designers' tactile experience of textiles unfolds in time, both in a simple experience and situated within a selection process, which are related to the '3S Tactile Phases'. The emerging findings are discussed in relation to the 'Quad-Core Textile Selection Model', allowing for the touch behaviour dimension to be added to it. This study provides a descriptive, fine-grained account of experiencing textiles, and shows that the textile experience during the selection processes goes beyond assessing properties of textiles.

* *This chapter is an extended version of the paper:*

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7.1. Introduction

The findings from Chapters 4-6 show that the role of the body goes beyond the assessment of textile physical properties. Chapters 5 and 6 highlighted in diverse manners the importance of investigating the embodied experience aspects further. This was indicated (i) through the elaboration of Projection as an important process in Chapter 5, and (ii) in Chapter 6 when research tools were introduced in the textile fair context, and designers reported their *need to experience physical textiles*, and to see their hands (their own or of others) and not just the textile movement to recollect such experience or to understand how it feels. They exhibited different touch behaviour types for different textile properties, and showed an interest in increasing this *awareness of the touch behaviour* when exploring textiles. In response, Chapter 7's enquiry focused on gaining a deeper understanding of how the body is engaged in the experience of the textile to support selection.

A study was conducted to explore Research Question 3 – *How does the body support the different forms of textile selection?* This qualitative exploratory study took a first-person approach, using the Micro-Phenomenological Interview method (or Elicitation Interview), in which 6 experienced professionals from the fashion and textiles area were interviewed. This chapter is organised as follows: first an additional literature review focusing on embodied experience is included, to support the deeper enquiry of its relevance for textiles selection. Second, the Elicitation Interview method used for the interviews is introduced, and the two types of interviews conducted are described. Third, the interviews are analysed using two different methods: Thematic Analysis is used as a means to generate themes to reflect the phases of the tactile experience, and to observe the types of touch behaviour; Micro-phenomenological analysis is carried out later to provide deeper insight on the identified phases, and to order them diachronically. Finally, a discussion is presented, where the emergent touch behaviour dimension is added to the 'Quad-core Textiles Selection Model'.

7.2. Additional Literature on Embodied Experience to inform the investigation of the role of the body in textiles selection

Experiences with textiles are crucial, as these materials invariably come into close contact with our skin (Spence and Gallace, 2011), and surround us in diverse

applications, which provides a rich experiential repertoire. Despite this importance, as has been discussed throughout this thesis, the experiential components are lacking in the tools and methods that are currently in place to support designers when selecting textiles. As has been discussed in Chapter 2, there is a disconnection in how the textiles experience (mainly tactile) is approached between industry segments. While the textile engineering research is populated by objective approaches, in their practice, designers mostly rely on tacit processes to inform decisions (shown through Chapters 4-6). To investigate the attributes that affect the perception of the 'textile hand', the textile engineering research either provides prescribed (mechanic) gestures to perceive textile physical characteristics (subjective assessments), or specific machinery to provide measurements (objective assessments), as presented in Chapter 2. These focus mainly on identifying the characteristics and behaviour of textiles, while no mention is made as to how the experience emerges and how the tactile behaviour contributes to forming it. In addition, the tactile experience used in these tests is limited to the physical characteristic of textiles, relying on prescriptive assessment protocols, which overlook embodied and affective dimensions.

The HCI field has tried to support the experience itself by reproducing the movement of the textile (Magnenat-Thalmann et al., 2007), using objective measurements as input to emulate textiles digitally. The 'iShoogle' (Atkinson et al., 2013) introduced in Chapter 6, introduced the embodied aspect to improve the communication of textiles behaviour. The latter allowed for engagement through active manipulation of the textile as well as a better understanding of some properties. A study by Obrist et al. (2013), even though is not focused on textiles, also takes an embodied approach to understand touch. The authors introduced technology that provided two distinct tactile stimuli based on vibrations delivered through modulated ultrasound waves. The tactile system used in Obrist et al. (2013) is contactless and was designed so that the tactile stimuli are experienced in both the palm and the fingertips. Participants were allowed to move their hands, but the movement was limited by the size of the box in which the system was contained. This is in contrast with Atkinson et al.'s approach (2013), as it does not allow the simulation of different handling, thus strongly limiting the overall touch experience.

However, all the above-mentioned studies stay away from *how people touch* and *how the body movement* of touching contributes to the experience. Studies by Hertenstein et al. (2009) have demonstrated an affective touch experience exists. Studies in games

(Gao et al., 2012) and robotics have also shown how the hand movement contributes to the experience. Following the embodied perspective these have shown that, beyond describing and understanding objects (dubbed the "what system" by Lederman and Klatzky (2009)), the way our body is engaged (e.g. moves or touches) has the potential to: communicate what we feel to observers (Gao et al., 2012; Hertenstein et al., 2009) but also informs us about what we feel or anticipate feeling (Bianchi-Berthouze, 2013; Niedenthal et al., 2005). Additionally, in HCI it has been argued, "That is, it is not just what we touch but also how we touch that explains what we feel." (Bianchi-Berthouze and Tajadura Jimenez, 2014).

But how does the hand or body contribute to the experience of textiles? Although we now know that our skin is rich of different types of touch receptors[32] (Essick et al., 2010) to study the semantic and affective properties of what we touch or are touched by, we still do not know how the hand contributes to the textiles selection. Chapter 7 explores this dimension of *how we touch* further, focusing on the designer tactile experience with textiles when selecting them for design.

Taking the body as foundational for experiences

As was identified in the literature, in order to start the investigation of the embodied experience in textiles selection, we must turn to our bodies. As suggested by Sheets-Johnstone (2009), this is the 'corporeal turn'. The understanding of our bodies as the "condition and context through which I am in the world" (Mentis et al. 2014, p.1) is crucial for this shift of focus. Our relation to the world is shaped by our bodily configuration and specialisations. We understand and act upon the world, and touching is crucial for both processes. Our understanding is clearly influenced by how we touch the world, which is evidenced by our language use when referring to knowledge as it makes clear reference to our actual hand movements, e.g. 'grasp', 'hold', 'get', 'produce', etc. (Flusser, 2014, p. 32). This proposition is developed by Lakoff and Johnson (1999) as the notion of conceptual metaphor, "which allows us to use the physical logic of grasping to reason about understanding". Thus, this perspective suggests that our knowledge is embodied (Niedenthal et al., 2005). Through the

[32] Affective touch is based on special fibres (CT afferents) that seem to be specialized for the more pleasant aspects of touch. These fibres respond to stimuli that move slowly (1-10cm/sec) on the hairy part of the skin (such as a caress) (Essick et al., 2010).

coordination of embodied actions we also evaluate and produce things in the world, i.e. we also embody our knowledge.

Taking a view from philosophy and phenomenology, Flusser (2014) proposes the study of gestures as an interface discipline that should be created to promote true interdisciplinary studies. In 'The Gesture of Making' (2014), Flusser suggests that our physiology shapes our interactions with the world, that is, since we think as we do, and "Because of the symmetry between our two opposed hands, the world is "dialectical" for us." (2014, p. 33). Flusser (2014) sees hands as curious; they want to grasp the world, and once they understand an object, "hands seem to know how the object should be" (2014, p. 37). In relation to what objects "should be", Flusser raises some questions in his essay: "What does it mean to "know" in this context, or indeed to "have understood" an object? And what kind of difference is there between "is" and "should be", between reality and ideal?"(2014, p. 37). He dismisses such questions due to the fact that they lead to a polarized argument between "real and ideal" and "material and form", whereas he is interested in a more holistic understanding of gestures. However, for this chapter such questions remain relevant, particularly as Chapter 5 showed projection as a process that deals with what textiles could become. There is a challenge in trying to address these questions from an integrated perspective, as it requires focusing on *how* we interact with the world, and dealing with pre-verbal (unconscious) dimensions of our experience, which is why they are of interest to the study presented in this chapter. To do so, it is necessary to turn to the phenomenal world, where everything happens in a two-way street – between body and things (Merleau-Ponty, 2014). There are some fundamental aspects to this experiential perspective, in relation to human perception, which are related to the understanding that perception entails movement, action and attention focus, of the body in the world (Noë, 2004).

7.3. Study 5: A Micro-Phenomenological Approach to Further Understand the Embodied Experience Through Touch

This study builds on findings from Chapters 4-6 that point to the importance of embodied experience, and supported by additional literature on embodiment that shows the relevance of a phenomenological perspective to approach this experience from the body, the focus of investigation in Chapter 7 was established. To investigate Research Question 3 (*How does the body support the different forms of textile selection?*) the

Elicitation Interview method (or Micro-phenomenological Interview) (Petitmengin, 2006), which was identified as appropriate, particularly in its allowing for a descriptive account of the lived experience in fine-grain detail, and also, because it takes a first-person perspective, which helps to bring awareness to 'how' such experiences unfold (that is, how do we do what we do).

The choice of method also followed Obrist et al.'s study (2013), observing their approach to articulating the tactile experience, where the Elicitation Interview method was introduced to encourage people to verbally express their tactile experience. The study led to the systematisation of a 'human-experiential vocabulary' emerging from the tactile experiences, and which was related to objective data gathered on the human hand (both neurophysiological and psychophysical). *The possibility to articulate the embodied experience, and the direct relation to our bodily construction and functions was identified as fruitful direction for the explorations conducted in Chapter 7.*

7.3.1. The Elicitation Interview Method

This study follows a qualitative approach based on the Elicitation Interview method (Petitmengin, 2006; Petitmengin et al., 2013), which combines psychology and phenomenology approaches to obtain a first-person verbal description of cognitive and experiential processes (Varela and Shear, 1999). This method aims at assisting interviewees to verbally explain the subjective experience that is generally inaccessible, unknown or difficult to articulate. This method has been recently renamed as Micro-phenomenological interview (Petitmengin et al., 2015), considering its capacity to provide first-person fine-grained descriptions of specific moments in lived experiences.

The focus of these interviews is in the *how* and *what* of the experience, while *why* is never asked (Obrist et al., 2013). This is to avoid explanations or abstract considerations and focus on revealing introspective acts "through specific prompts and questions, in order to help a subject to become aware of the unrecognized part of the process being described" (Petitmengin et al., 2013, p. 657). Such questions are content empty (not inducing), and instead explore the unfolding of the experience in time ('Diachronic' dimension) and the facets of an experience at a specific time ('Synchronic' dimension). An iterative approach was used for this investigation, organized in two phases: (i) Phase 1 consisted of 2 interviews conducted in order to enable the researchers to refine the

interview protocol and research question; (ii) Phase 2 consisted of 5 interviews. Interviews were video recorded when there was consent from the participant. The researcher had received a total of 3 weeks training on the 'Elicitation Interview' method by an expert over the previous two years, and for the analysis, an extra session was attended, totalising 4 weeks of training (details of the training undertook are included in Appendix D, p.59).

Phase 1: Pre-study to refine protocol

The first interview was conducted with a fashion design tutor who has experience of 20 years working in industry and is also currently the curator for a textiles sourcing fair. This interview lasted for an hour. The results from this interview are not included, as it was used for refining the protocol only.

In the second interview, a pilot was conducted where the researcher was interviewed by an expert on the Elicitation Interview method, with a focus on tactile experience of a single textile, which lasted 20 minutes. The purpose of this pilot interview was to test the method, and to bring awareness to the researcher about her tactile experience and what it means to be interviewed using this method. The results from this interview were analysed to bring clarity to the interview process, and to support in refining the interview protocol in subsequent studies. A table with the preliminary findings from this interview can be seen in Appendix A (Table A2, p. 6). After this interview, it was possible to notice that in order to observe the tactile experience in depth, it was important to conduct the interview in two stages: first interviewing the designer just about a tactile experience with a single textile, and a second interview with more samples in relation to a selection process. This was important in order to observe diverse situations when designers come into contact with textiles, as was discussed in Chapter 4, which can be a more serendipitous process (without a project or brief in mind), or with a more specific design brief definition.

Phase 2: Investigating how the body supports textiles selection

After observing the initial results obtained from Phase 1, the protocol for the interviews was refined. The participants were met individually and a short interview was conducted to demonstrate the method. In all cases they agreed to be interviewed, and consent form was signed (example form in Appendix B2, signed forms available on

request), which was approved by the local ethics committee (UCL, ethics approval # BSc/1213/001). The interview process consisted of two experiences that were conducted in the same session and that lasted for a total of an hour. In ***Experience 1*** designers were given a textile sample of (20 x 20) cm, which they were invited to explore for 20 seconds, and right after they were interviewed about their tactile experience with that specific textile. This interview lasted for a maximum of 20 minutes. In ***Experience 2,*** designers were interviewed about their experience when selecting textiles. The experience was either from a previous project they had worked on, or they were given the option of making a selection on the spot, just before the interview – for this a set of textile samples (six textile samples, all white and in different constructions) and a design brief (around designing a basic white shirt) was prepared to allow for an in situ approach (Light, 2006; Obrist et al., 2013). These interviews lasted for 40 minutes maximum.

Participants

The participants in this study included designers of mixed backgrounds in the fashion and textiles field, and with experience ranging from 7-30 years as show in Table 17. Each participant received an identification that is shown in the first column, and will be used throughout the chapter to identify quotes.

Table 17. Participants Profile

ID	Field of experience	Years	Gender
Fashion 1	Womenswear couture and teaching	20	Female
Fashion 2	Womenswear high-street	7	Female
Fashion 3	Menswear high-street, couture, teaching	30	Male
Costume 1	Costume design for television	20	Female
Textile 1	Textile designer and researcher	7	Female

Analysis

All data was transcribed for analysis, including annotations from observing the videos. The data was analysed using two different methods: Thematic Analysis and Micro-phenomenological Analysis. These are described below:

Thematic Analysis: A Thematic Analysis was conducted to identify the most important themes, which followed Braun and Clarke's (2006) guidelines (as reported in Chapter 6). Coding was conducted using QSR International's NVivo 11 software. The research

question was used to guide the analysis, but focus was given to the themes that emerged from responses, which are described in the results section. This was done to produce a high-level picture of the tactile experience by designers, particularly in terms of their behaviour, before analysis of the dynamics of this experience.

Micro-Phenomenological Analysis: The Micro-Phenomenological was conducted to provide deeper insights into the data by: (i) confirming the phases identified through Thematic Analysis, whilst looking for further detail, and (ii) allowing investigation of the micro-dynamics of the experience (by investigating the diachronic structure, particularly focused in understanding how the phases of the experience unfold in time). The Micro-Phenomenological analysis consists of the following steps. First, the interview is organised by removing questions, removing the satellite dimensions (which is all the content that presents judgments or reflections on the experience), and then rearranging the order (in order to get a sequential description). After that, the content interview is analysed to observe what the main phases are, as well as the transition points (which are called hinge points of the experience). Once these are identified, the phases are named. Following on from that, the main sub-phases within each phase are also observed. The phases and sub-phases are characterised by excerpts from the interview, which was conducted using hard copies of the transcripts, which were marked using coloured pens. Through the reorganisation and identification of phases, the diachronic structure is identified. These were organised in diagrams produced using paper and coloured pens. These are reported were relevant in the results section.

7.3.2. Results: understanding how the body is involved in textiles selection

Results from Thematic Analysis: Identifying the '3S Tactile Phases' and touch behaviour types

Three main tactile-related themes emerged from the Thematic Analysis of *Experience 1*: 'Situate', 'Simulate', and 'Stimulate'. These will be identified collectively as '3S Tactile Phases'. In addition, the analysis of verbal reports combined with the video-recordings showed different types of attention and touch disposition according to the type of engagement with the textiles. These were categorized as: 'Active hand', i.e. touching to explore the textile, to perceive the tactile experience and to use it to interpret the feeling from the textile; 'Passive body' (generally not the hand), i.e. being touched,

only receiving, without the possibility to actively change how the fabric behaved on it; and 'Active tool-hand', i.e. driving the experience as an enactive tool that shapes how the textile interacts – the if, when, how and what the textile will touch – with the aim not to experience it but to let another agent experience it (e.g., our own or someone else's body). The themes and the role of active and passive touch within these themes are discussed below.

Situate

When designers encounter textiles they situate, i.e. all touch behaviours observed in these moments are about understanding the textile and how it feels to the respondent. The touch behaviour aims at feeling it through the different types of receptors: first, through the discriminatory ones, mainly from the hand, to understand what it is, and then through the affective receptors (Essick et al. 2010) (not on the hand) to feel the sensation it produces.

> *Fashion 1: "I was able to hold it and understand it and use my knowledge, I was like, "Okay, I think I know what it is". (…) Once I knew what it was, I put it next to my skin but not in my hand."*

These behaviours are further described below.

Understanding the textile with hand

Here the touch behaviour is mostly 'Active hand' centred, i.e. using one or both hands, in diverse ways – these are the closest to the touch behaviours explored by textile engineering research as surveyed in Chapter 2 (section 2.4.1.2). Their touch behaviour aims to explore and compare characteristics of the textiles. They touch it to experience its properties and how the textile reacts to their touch. Designers focus on the physicality of materials, and probe them to enable understanding.

> *Fashion 1: "Is this what I want? Is this the right thickness? What's it feel like, and what's its bias? Like, does it stretch? Just what are its-- what its quantity, if you like. "Okay, it could be a twill silk. It could be a cotton."*

Designers performed diverse touch behaviour according to the property they investigated, e.g. holding by the corner to see how it falls (drape), squeezing or

dropping to feel weight (e.g. in the extract below), shaking or stroking to feel the temperature (warm, cool, fresh, and so on), pulling to feel its resistance (weak or strong), touching around the edges to understand size (Figure 32).

Interviewer: And how does it feel when it feels light?

Fashion 2: Ah… it feels airy like [moving hands to show the feeling]… like it can fly a bit and go…

Interviewer: Hum-hum. And what do you do to feel that it is light?

Fashion 2: Also just by squeezing and dropping.

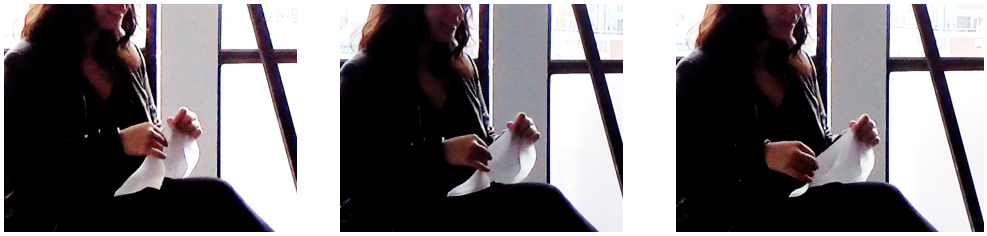


Figure 32. Fashion 2 touching edges to understand the size of the textile swatch.

This understanding is also related to how they touch the textile to anchor (Kirsh, 2013) their thinking about how it would behave in the making, e.g. in quotes 1 and 2 below.

Quote 1:

Costume 1: Because the thickness has to be right, the weight, the way that it goes along your fingers, the way that it bends. The thickness, so that you know that it is not going to be very bulky when you've sewn it.

Quote 2:

Interviewer: And when you imagine that you are sewing it, how do you do that?

Fashion 2: Ah it is also the same… also by stretching it and seeing how consistent is the fabric and how it will slide [moving hand as if she was inserting the fabric] through the machine.

Understanding textiles on me

Here the touch behaviour is a combination of 'Active hand', 'Passive body' and 'Active tool-hand'. Designers used one of their hands to actively touch another body part, usually the hairy skin of the forearm. Through this orchestration, they can feel how it is to be touched by that textile. All the interviewees did this only after they thought they

knew the textile properties and wanted to explore their own bodily reaction to it. Some designers referred to the textiles as 'living' things, which 'want' (Fashion 1 quote below and Figure 33) and 'move' (Fashion 2 quote below) by themselves. There is a continuous shift between the body surface that experiences and the 'Active tool-hand' that is there to drive the experience of the other body part rather than its own.

Fashion 1: Yeah. To me it's all about, "What does that feel like? Do I want it close to my skin? Will it hold a tighter fit? Does it want to be a little bit looser?"

Figure 33. Fashion 1 Active and Passive touch.

Interviewer: So when you feel with other parts of the hand, what does it feel like? How do you do that?

Fashion 2: Just by putting it on the top of my hand and moving it.

Interviewer: And then what happens next?

Fashion 2: It is very fast. You just rub it very fast in your skin, and then you feel how it moves, and how it falls. (…) Because when you touch with the fingers you get pressure, and then you get pressure from feeling the fingers again. And when you put the fabric on top of your hand, then is just the fabric.

Simulate

After understanding the textile, its behaviour and one's bodily reaction to it, the designers use tactile exploration to simulate concepts and support the creative process. To aid selecting the most suitable textile for a design brief, the body is used as a surface to test ideas, e.g. where on the body we are going to wear the textile. Here again, there is an orchestration of active and passive touch, which involves mostly 'Passive body' and 'Active tool-hand' types. This time however, it is not about feeling the textile, it is rather about feeling the concept that is made by the textile. The 'Active tool-hand' was used to produce different shapes, drapes or folds with the fabrics, and then these were placed using the other arm or other body parts as support – 'Passive body'. Both the

active touch that manipulates and the passive touch that receives the results of the manipulation participate and support the process of forming the design concept (see Figure 34 for an example). Here again, the 'Active tool-hand' becomes a facilitator and a driver for the projection of the textile as an animated thing.

Fashion 1: Most fabrics I would generally have put up against my body. And because this has big holes, I have held it against my skin or on my chest over my bra, because it's the kind of fabric is, "Oh, do we need to make an under piece?"

Figure 34. Fashion 1 simulating a sleeve.

Because fashion designers create for bodies in movement, this combination of movement and feeling over the body supports imagination in a very implicit manner. This is also used to determine the best way to apply the textile to a design. The 'Active tool-hand' directs the '*if, when, where (what part of the body) and how'* (its weight, speed, direction, texture) the textile-based concept (e.g., a simulated sleeve) will touch the body. While this is happening, the body experiences manipulations through an alternation of contact and lack of contact with the textile. The tactile experience is blocked from the 'Active tool-hand', as it is active in driving the experience of another body part that receives the textile.

There seem to be a continuous switch in the attention from the tactile perception in the hand to the tactile experience in the body, and the attention focus is on the part of the body that is being touched. The 'Active tool-hand' becomes part of the simulation that the designer is projecting, which occurs in a similar manner to what Kirsh (2013) observed with dancers when they use their hands in a sketching manner to practice dance sequences.

Stimulate

Stimulation is about experimenting beyond the initial concept, by stimulating an experience that the textile can provide. This experience helps designers in building metaphors. Using diverse touch behaviours and experiences that derive from them, designers manipulate textiles to enable associations. These are mostly active and use both hands, but sometimes they involve other parts of the body. Here designers seem to explore the relation between sensation and metaphor in ways that lead to very different types of touch behaviour than have been previously reported in the textile engineering literature (reviewed in Chapter 2). Metaphor use is crucial for the design process as a communication tool. The metaphor generates the gesture and the tactile experience that emerges will reinforce, or complete, or refine the metaphor. There is here a relation between touching, thinking, and imagining, which will be discussed later in light of Clark's (2013) propositions. When 'stimulating', designers create verbal and visual metaphors based on their movements and the textile reactions, which are described below.

Feeling moves

From the interviews, it is highlighted that what moves designers is to sense that this physical encounter presents new possibilities. The touch behaviour and the movement of the textiles afford multiple opportunities for transformations. The designers move to find new interactions and to experiment with new ways of being stimulated. The textile is present as an animator (in the epistemology of the word, as something that animates, gives motion, inspires) of bodily configurations that on their own would seem impossible to be lived or communicated, as they rely on the textile's reaction. This is the case of the feeling of *"feathers and air"* (Fashion 1), or *"butterflies"* (Costume 1), or *"fresh and not cheap"* (Fashion 2).

These are verbal indicators of the affective tactile experience taking a more important role, and here the touch behaviour observed is unconstrained. It is this imaginative (or, in their words, *"wondrous"*) relation with fabrics that inspires these experts, and indicates this perception of textiles as 'alive'. The touch behaviour here is playful, free and dynamic. Taking the metaphor *"feathers and air"* as an example (Figure 35), the designer moved her hands in front of the body, facing each other, in very rapid circular

movements, having the textile loose and floating between the hands. The movement was that of alternating hands, as if the designer was juggling with the fabric. The fabric falling in her hands triggers her movements to then throwing it again.

Figure 35. Fashion 1 stimulating for *"feathers and air"*.

Touch enabling tactile mental imagery

Through touching, the designers create a mental imagery (visual) of the textile, i.e. a textile is imagined on the basis of its perceived tactile characteristics. This is helped by movement, which allows them to experiment with new ways of stimulation. As suggested earlier by Kirsh (2013) on imagination, when designers *imagine* the fabrics they create a visual experience.

> *Textile 1: I can see the textile image through my hands. I can see it much thicker than I know it actually is. But at the moment I hold it in my hands, I could see it much thicker.*

Results from the Micro-phenomenological Analysis: Revealing the Dynamics of the Tactile Experience in Textile Selection

In order to go deeper into the dynamics, or rather, the micro-dynamics (Petitmengin et al., 2015) of this experience, a second analysis of the interviews was conducted using the Micro-phenomenological approach. This analysis is more concerned with the structure through which an experience unfolds, and with the physical or inner acts performed in it. Following the same processes described in the Phase 1, descriptive categories were identified for the tactile experience of textiles, and to the experience of selecting a textile. The relationships between 'descriptive categories' (Petitmengin, 2006) were also identified, which will be described in the relevant result sections below.

The results of the Micro-phenomenological analysis led to identifying the same phases found with the Thematic Analysis. Here, more details were found, as the analysis allowed observation of the sub-phases occurring within the '3S Tactile Phases', which aided understanding of the unfolding of the experience, i.e. its dynamics. Hence, it was possible to derive a generic diachronic structure of the tactile experience with textiles both for Experience 1 (which is a textile experience with a single textile, seen in Figure 38) and Experience 2 (the experience of a selection, seen in Figure 41). The overlap with the '3S Tactile Phases is indicated through the colour scheme, where the following colours were used: red indicates 'Situate', green indicates 'Simulate', and blue indicates 'Stimulate'.

Tactile Experience with a single textile

The analysis of the interviews was initiated by producing a diachronic structure for the participants, which were later analysed altogether to produce a generic diachronic structure. Two examples of such analysis process are indicated in Figures 36 and 37 below, and digitised versions were included in Appendix A2 (pp. 7-8) to facilitate reading. All of the written excerpts (in pink) are there to support the identification of the phases of the experience, while phases are written in black. The notes using the green colour are related to ideas that are still in formation throughout the analysis.

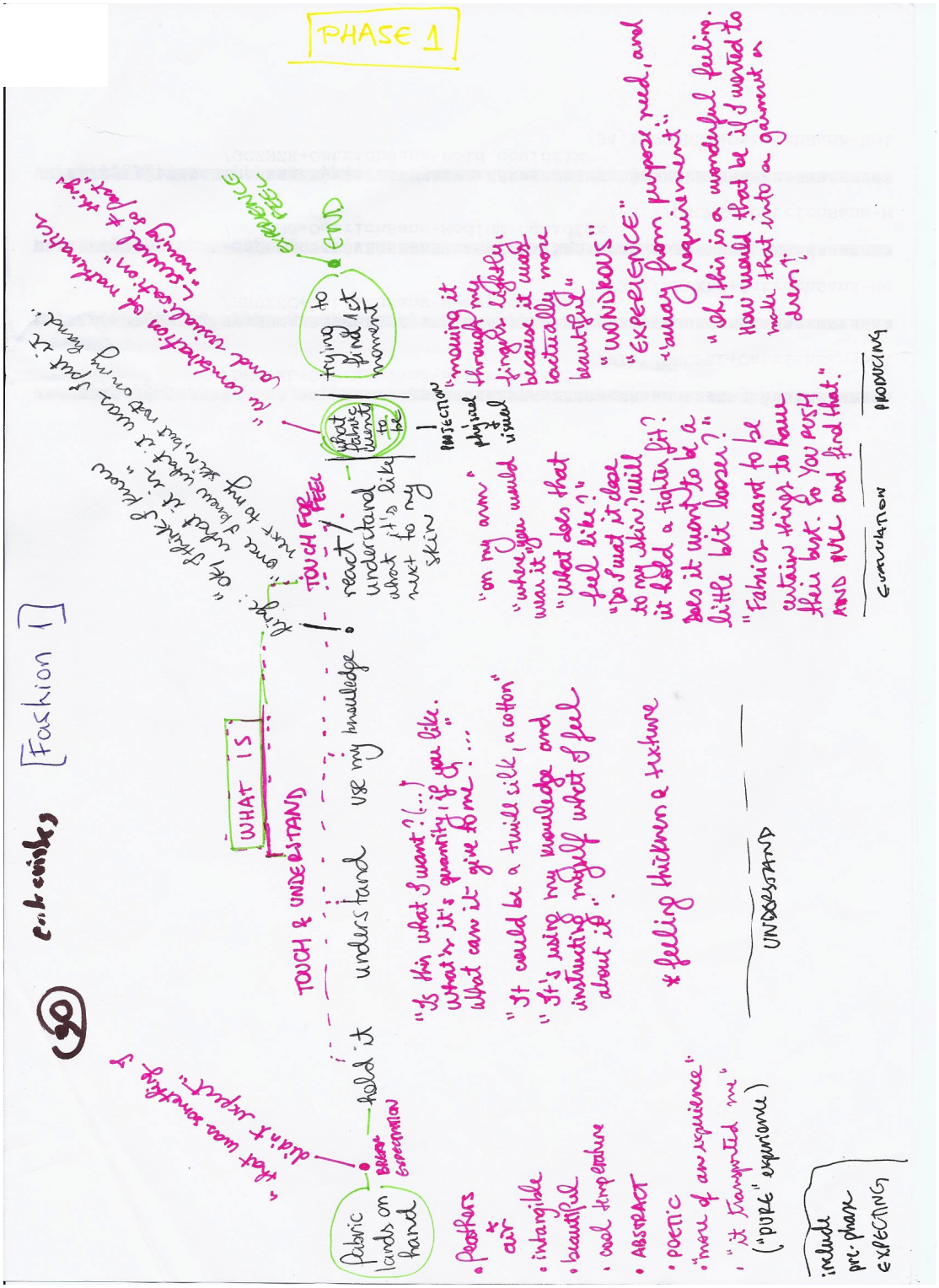


Figure 36. Analysis to produce diachronic structure of experience with a single textile-Fashion 1.

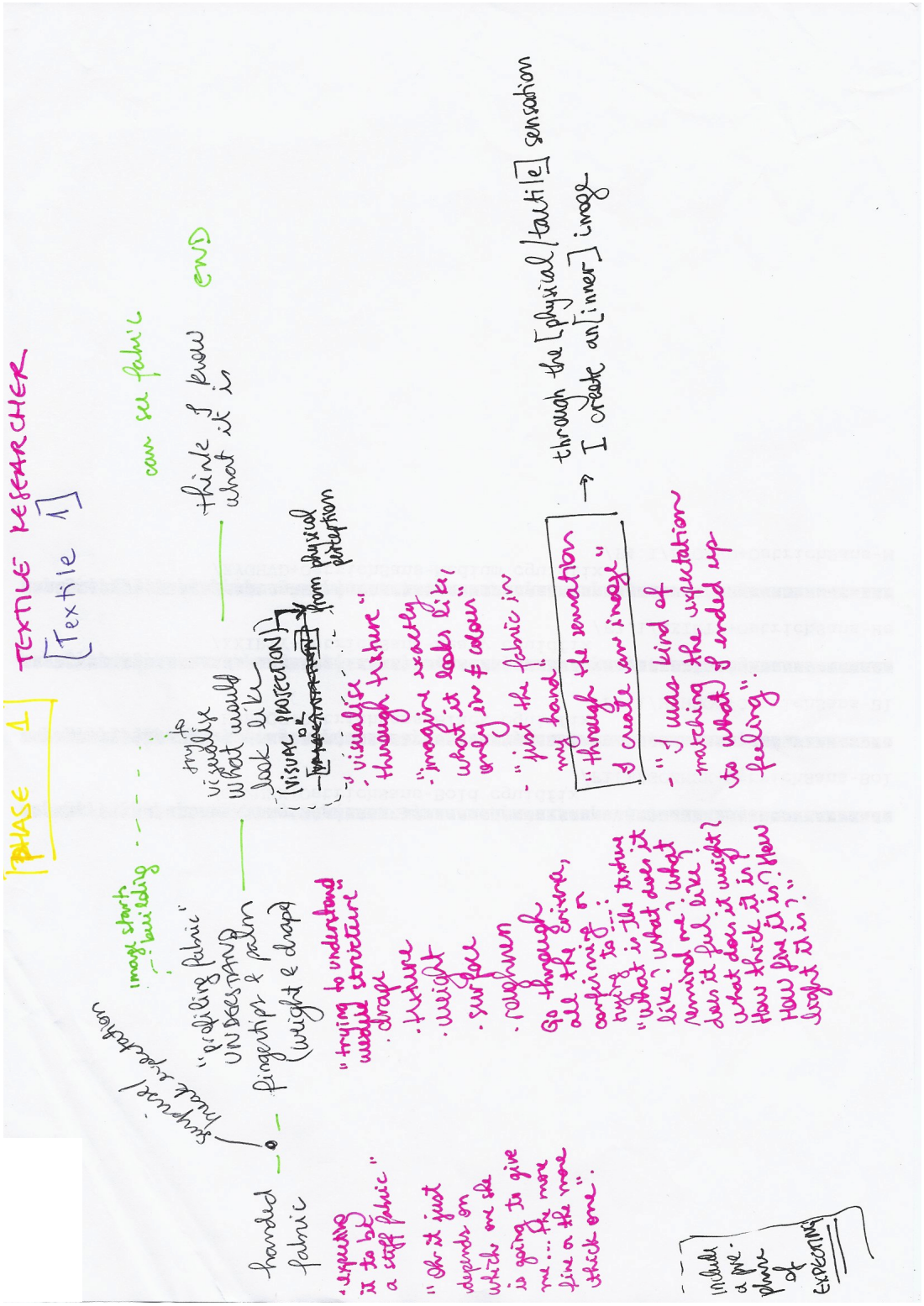


Figure 37. Analysis to produce diachronic structure of experience with a single textile – Textile 1.

In Figure 38, all of the analyses were merged to produce a generic diachronic structure of the experience with a single textile. The Expecting phase consists of a preparation stage, where the designers are waiting to receive the textile. Their attention is focused on the hands, which are open and still. The Encounter phase is where the "pure experience" takes place. It is a brief experience of not knowing what has just landed in

their hands, and the impression is that there is a sort of dissolution of the 'self', and the only thing the participants describe is a sensation, which they describe as *"abstract"*, *"poetic"*, *"it transported me"* and *"more of an experience"* (Fashion 1), or as if *"it may be an aura of something that happened to the area on top of my skin, somehow"* (Fashion 3). These are descriptions of an immediate response, a first impression, like a character, which is felt in the interruption of the "Expecting" phase, so that the 'Encounter' phase starts to take place.

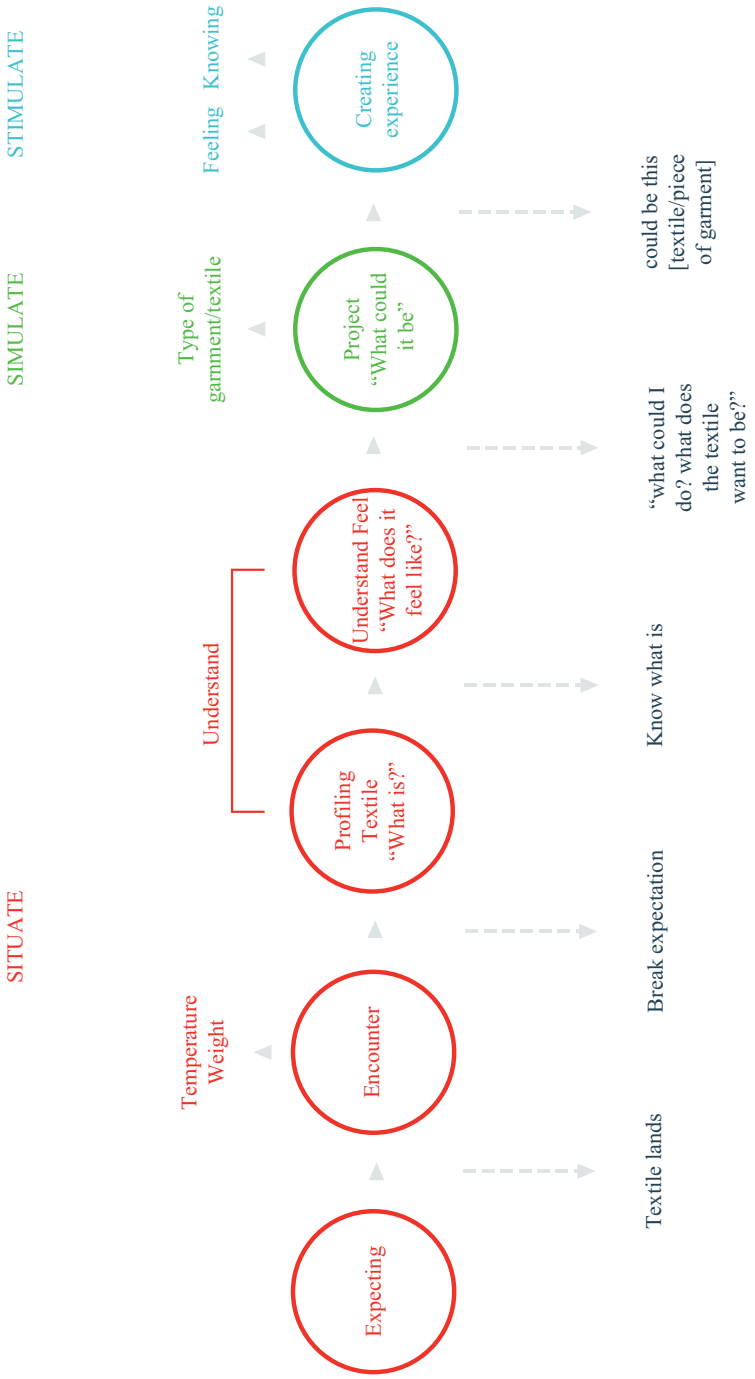


Figure 38. Diachronic structure of the tactile experience with a single textile.

After that dissolution designers reported a feeling of surprise or break of expectation (*"that was something I didn't expect"* (Fashion 1); *"I was expecting it to be a stiff fabric"* (Textile 1)), which marks the hinging point for moving to the next phase, which is about understating the fabric. The first sub-phase is 'Profiling Textile', which is about meeting the fabric and getting to know it. Here the designers actively touch the fabric, and interrogate it trying to identify what it is.

"… shift a bit, move it (…) it's not just the weight, but to find out how the fabric moves by the weight"(Fashion 3)

"What is the texture like? How thick is it? What does it feel like? (Textile 1)

"I touch it until I have a feeling of what I had in my hands." (Fashion 2)

The hinging point for shifting to the next sub-phase of 'Understanding' is when designers feel that they know what the fabric is, and so they want to feel what it is like next to the skin, but not on their hands, to understand how they react (*"Do I want it close to my skin?"* (Fashion 1)). This is the 'Understand Feel' sub-phase, and here their reactions are expressed in terms of what the fabric feels like, so designers question themselves about their previous experience with other fabrics, or other things in general, to help articulate their feel.

"What does that feel like? (Fashion 1)

"What does it remind me? (Textile 1)

The next phase is when designers start to envisage what they could make with the textile, or what the textile *"wants to be"* (Fashion 1). This is when they 'Project' by creating shapes with the fabrics through diverse manipulation that helps them visualize applications, and determine the significance of the textile (i.e. what it could become). Once they identify what the textile could be, then the final phase of the experience unfolds, and here they are 'Creating an Experience' that is either about trying to retrieve the feeling of the first encounter when the textile landed on their hands or to create an experience that helps progress the idea of what it will become, as is shown in the two excerpts below.

"… moving it through my fingers lightly, because it was actually more beautiful" (Fashion 1)

"*So I didn't focus in continuing in this step, because maybe it's just nice to do something completely different with it. I think I have this nice feeling of lightness, and volume, and a blouse or a nice dress. I was thinking about some teetering, and some details. And maybe I was feeling this, some of it is fringing a bit, and then you think… ok, maybe that as well… only now I recognise that it maybe makes me think of the volume…"(Fashion 3*)

Observing Tactile Experience within the Process of Textile Selection

The analysis of selection task (Experience 2) showed overlaps with the tactile experience (seen in Figure 38). However, because in the case of our interviews, which included a specific design brief (either those conducted in-situ, or the ones referring to a previous project), there were clear limitations (e.g. related to the design brief, or somehow envisaging clearer functional requirements); hence, the experience did not seem to include a 'Stimulation' phase, which seems to relate to the fact that the designers set out the selection by defining criteria for it, which they used throughout the experience to guide their funnelling of choices. In the tactile experience, those criteria seem to have emerged in response to what the fabric evoked, out of freer experimentation, and not from searching for the fabric that better matches an expected feel, according to the set criteria. Examples of the analysis processes are included in Figures 39 and 40.

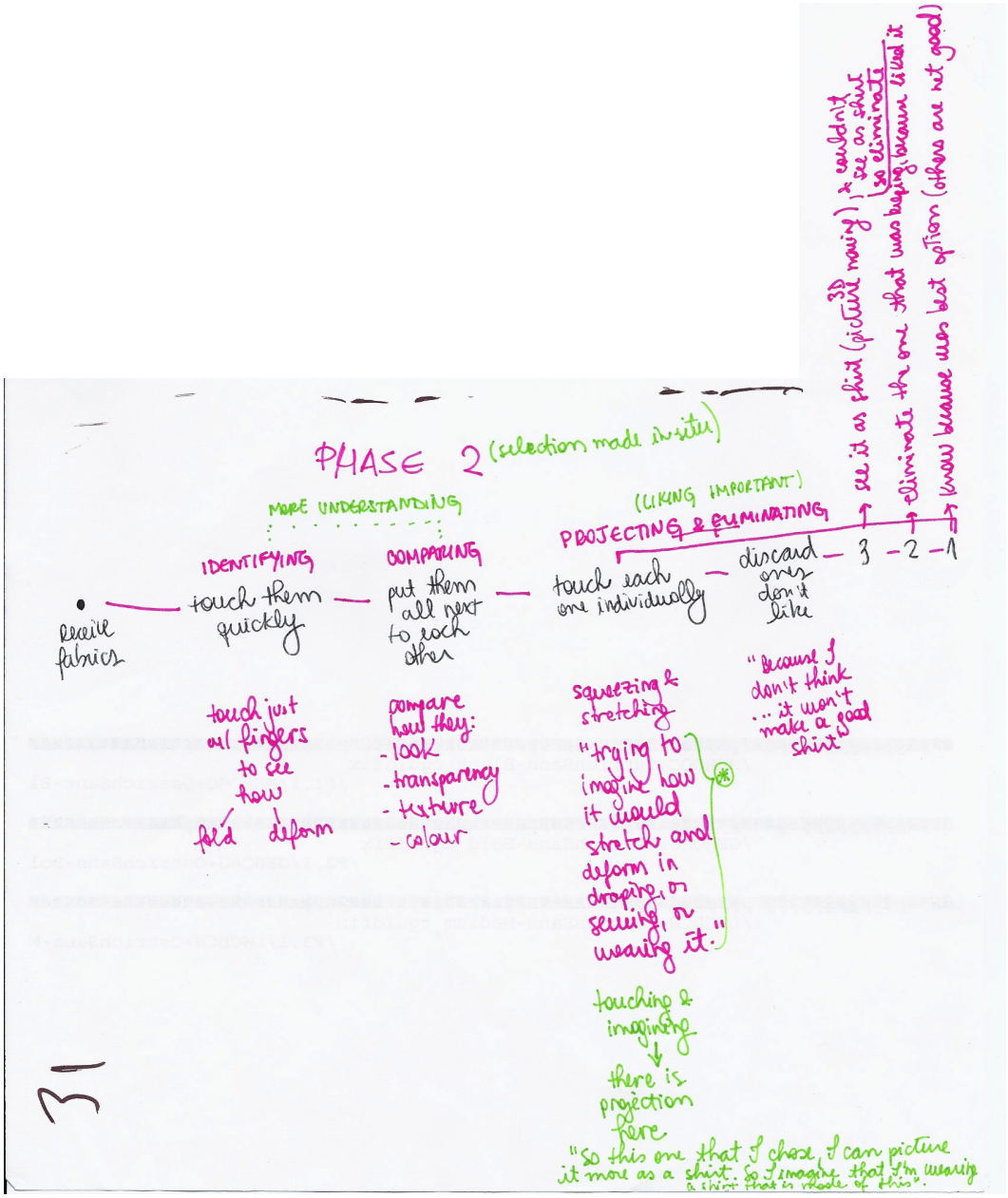


Figure 39. Analysis to produce diachronic structure of selection – Fashion 2.

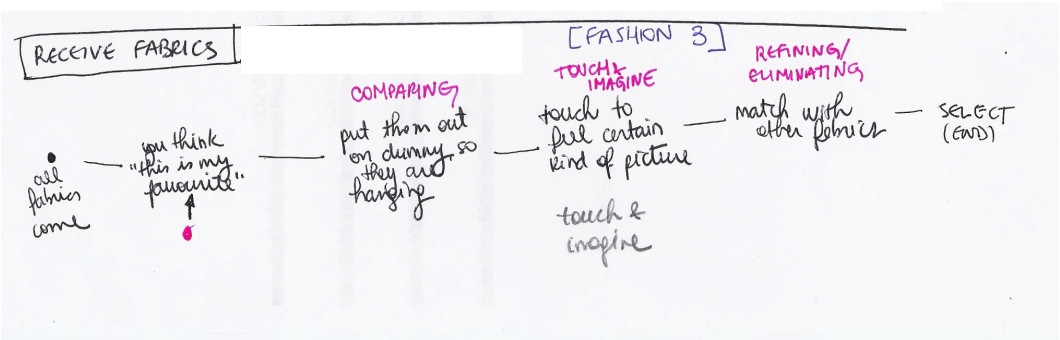


Figure 40. Analysis to produce diachronic structure of selection – Fashion 3.

In Figure 41 a generic diachronic structure of the selection was produced. The sub-phase of 'Profiling Textiles' is a quick scan of all the textile options presented to them, which consists of touching and looking at the textiles, very quickly, to gain an overall sense of what is on offer. Most of the designers concluded this sub-phase by finding a favourite textile, either in relation to the brief, or their personal choice (which may not fit the brief and they acknowledged it, but still made a note of their preference). Also, by this point, they had already eliminated those textiles considered not applicable to the design brief.

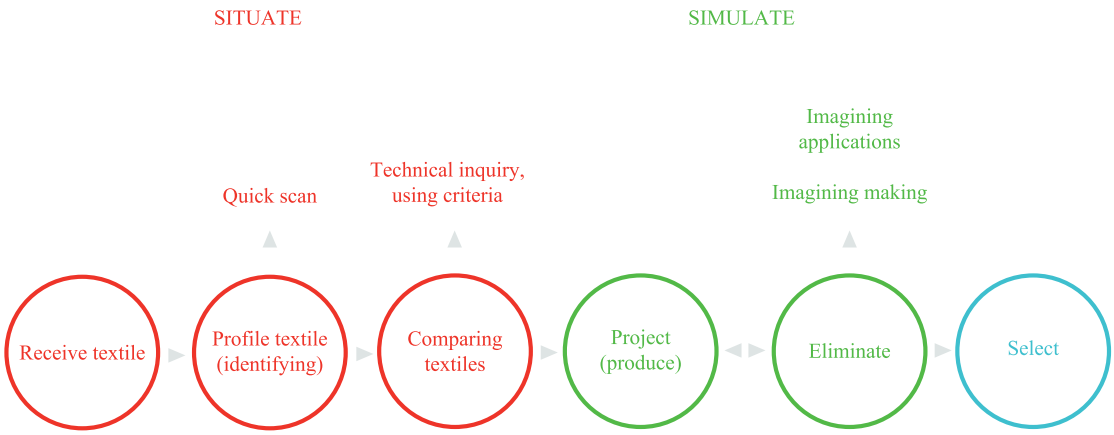


Figure 41. Diachronic structure of the experience of selecting textiles from a set, for a specific design brief.

They progressed with 'Comparing Textiles', but here each textile was assessed individually and thoroughly (this could be *"Putting on a dummy, so that they are all hanging" (Fashion 3)*, so that they can assess them visually and also pick each at time and touch in diverse manner to evaluate their properties (*"… trying to imagine how it would stretch, and deform in draping, or sewing, or wearing it." (Fashion 2)*). The designers recalled the characteristics of each textile in a manner that enables comparisons to be made in relation to e.g. how they look, their texture, transparency, colour, etc. This was also noticed as a physical grasp, as sometimes they were holding textiles whilst comparing, having one in each hand. Here again some textiles were eliminated through this process. In the next step, 'Project' and 'Eliminate' formed an iterative loop, where the designers touched the textiles actively while imagining the application, and started by eliminating the textiles whose mental image of the application was most difficult to create. They ended up with the textile that enabled them to *"feel that certain kind of picture" (Fashion 3)*, but also one that might be

adequate for a bigger context of coordination with other textiles, when already imagining a garment that would be worn with other pieces.

7.4. Discussion

Chapter 7 aimed to understand the role of the body in supporting textiles selection. At the beginning of this research we thought that touching was focused on knowing the textile (as literature on textile engineering showed in Chapter 2), in Chapter 5 we saw touching being used to help with decision-making by supporting designers in projecting. In Chapter 6 the complexity of touch as being multisensory also revealed the importance of proprioception in this experience, expressed as an interest in understanding touch behaviour (their own or others). Now, in Chapter 7, we go deeper and know better why that hand is important. This was explored using the Elicitation Interview method, which was identified as appropriate, particularly to allow for a descriptive account of lived experience in fine-grain detail (in this case the tactile experience with textiles), and also, because it took a first-person perspective, it helped to bring awareness to 'how' designers go through such experiences.

This study showed that designers feel their way in interactions with textiles. These are sensuous, affective encounters. In such encounters, the manner in which designers experience textiles is crucially related to touch behaviour and bodily engagement; the hand is at times the one that experiences the touch and at times the one that drives the experience on a different body part. These touch behaviours involve both active and passive touch, in different intensities and modes, with the three main purposes of Situating, Simulating and Stimulating – the '3S Tactile Phases'.

The 3S Tactile Phases reveal a dynamic that seems connected to the suggestion by Clark (2013) that perceiving, knowing and imagining are intrinsically related activities. This relates to the literature in cognition and dance studies, which suggests that we move to experiment new ways of stimulating (Noë, 2004). As proposed by Noë (2004), perception and movement are intrinsically dependent – we enact our feelings (perceptual experience). In the case of designers, when 'Situating' they enact their perception, they touch and move to understand; both when 'Simulating' and 'Stimulating', designers touch and manipulate textiles to experiment diverse stimulations while imagining certain pieces of clothing, and experiences they evoke.

The ‘Active hand’, the ‘Active-tool hand’ and the ‘Passive body’ are there to enact the experience and to form the knowledge of the fabric, how the body will react to it and what the fabric may become. Only through acting on a fabric are certain qualities of the fabric revealed. In our study, variations on touch behaviour through which designers interact with fabrics enables them to discover more about the fabrics, to imagine possible applications, and to go beyond concepts by stimulating diverse experiences that the textile can provide.

Revising the ‘Quad-core Textile Selection Model’ with the ‘3S Tactile Phases’

This Chapter shows the phases of the tactile experience when designers have an experience with a textile, both in experiencing a single textile (Experience 1), and in a selection situation (Experience 2) where a set of textiles was experienced. The results in both cases consistently show that the tactile experience unfolds though the ‘3S Tactile Phases’ – Situate, Simulate, and Stimulate. These tactile phases have a relation to the ‘Quad-core Textile Selection Model’, which are explored in Figure 42, and is illustrated through the dashed-line outer ring ‘D’, and are discussed here.

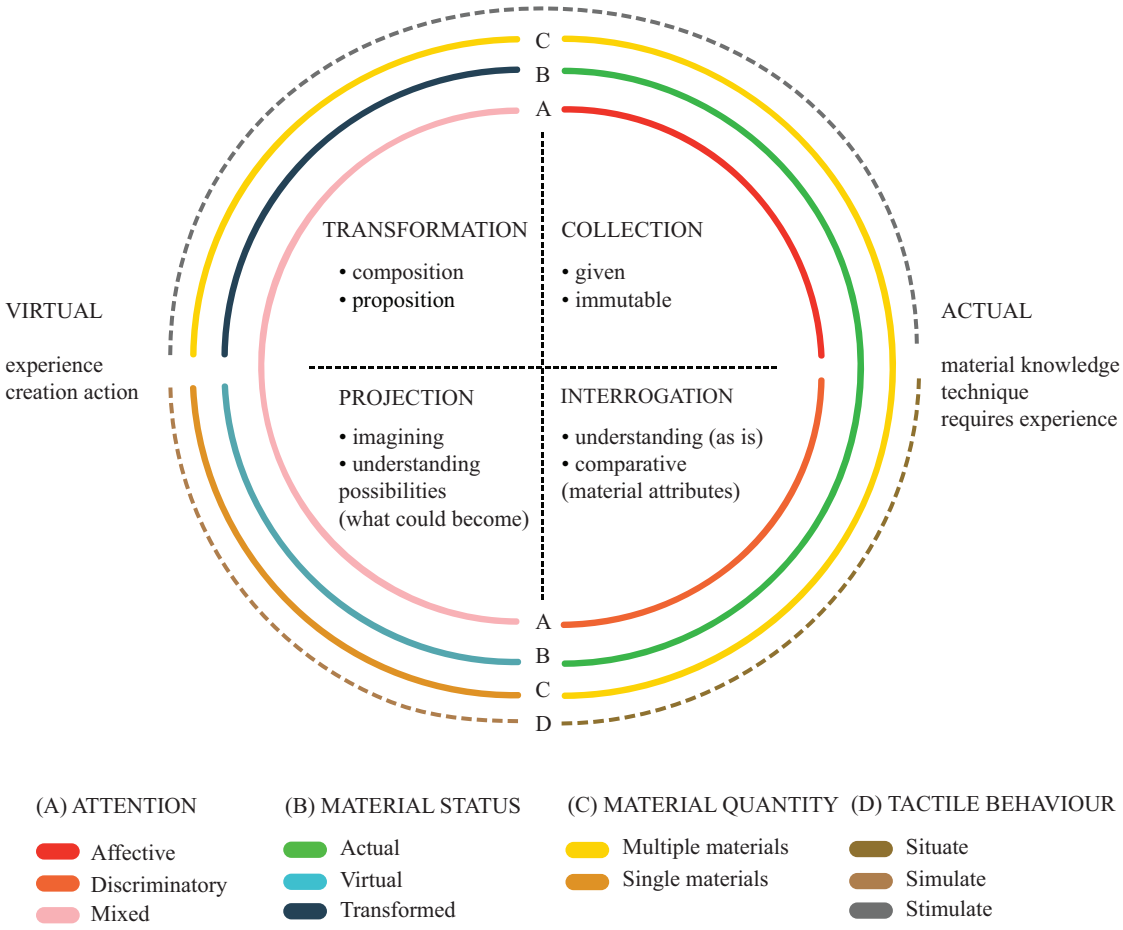


Figure 42. Enriching the ‘Quad-core Textile Selection Model’ with the ‘3S Tactile Phases’.

The relationships between the tactile phases and the selection processes have been explored on the basis of how these predominantly seem to occur, which means that they are not solely occurring where its been suggested here. This is being proposed in the interest of allowing further understanding of the textiles selection processes, and to provide us with the necessary knowledge to later design means to support it.

The behaviours observed and described through the 'Situate' phase are related to the findings previously described for the 'Interrogation' phase, as in both of these processes, designers are interacting with textiles and gathering an embodied understanding of it, both of *what it is* and of *how it makes them feel*. This is indicated by the ochre dashed-line in the outer circle 'D'. The behaviours observed in 'Simulate' are related to the 'Projection' process, which are both about manipulating fabrics and discovering *what it could become*. This is indicated by the beige dashed-line in the outer circle 'D'. The behaviours described in 'Stimulate' are more related to free manipulation and metaphor generation, so they fit with the descriptions in both 'Transformation' and 'Collection' processes. Here the main difference is that in the 'Transformation' designers use 'Stimulate' with the intention of pushing design concepts forward and coming up with novel solutions, while in 'Collection' the phase 'Stimulate' happens more as a first encounter and "pure experience". This is indicated through the grey dashed line in circle 'D'.

Discussing the '3s tactile phases' and touch behaviour types with additional literature

In this section more specific literature on touch provides a basis for further exploring the results. This was undertaken through the themes: 'touching and being touched', and 'beyond touching to know textiles'.

Touching and Being Touched

The study presented in this chapter revealed a dynamic between touching and being touched when designers engage with textiles, which can be noticed particularly through the active and passive touch, observing the 'Active Hand', 'Passive body' and 'Active tool-hand' touch behaviour types. In order to discuss this further, historical background is required.

The approximation between subject and object, opposing Cartesian dualist ontology of mind and body, and the understanding of perception as active are a legacy of phenomenology, at the heart of 20th century philosophy, with Merleau-Ponty as its most prominent figure. This integrated form of studying subject and object has been investigated and discussed by several authors since, stemming from phenomenology, structuralism and post-structuralism schools of knowledge (Manning, 2007; Barad, 2012). These authors paved a path where distinctions such as actor and receptor do not make sense, since from an experiential perspective everything is seen as a two-way road, i.e. it is a relational perspective. This understanding of perception as relative supports the proposition of the dual quality of the touch experience, which is that of simultaneously touching and being touched. These *"double sensations"* were initially proposed by Merleau-Ponty (2014, p. 95). Merleau-Ponty discussed this looking at hands touching each other, without the introduction of an external object, as can be seen below.

> When I touch my right hand with my left hand, the object "right hand" also has this strange property, itself, of sensing. (…) So when I press my two hands together, it is not a question of two sensations that I could feel together, as when we perceive two objects juxtaposed, but rather of an ambiguous organization where the two hands can alternate between the functions of "touching" and "touched". (Merleau-Ponty 2014, p. 95).

In this study, the introduction of an object does not seem to break this cycle of "double sensations", but here we also need to consider that textiles are familiar objects of human experience, which, when worn, inhabit our peripersonal space (the close space around our bodies (Rizzolatti, Fadiga, Fogassi, and Gallese, 1997)).

This twofold characteristic of touch experience is observed in literature that explores human relations with objects, which suggests that the way we perceive objects not only tells us about the objects, but also about ourselves, as they reveal what belongs to the relation (Merleau-Ponty, 2004, p. 47). Because of that, it is not unusual that the manner in which we describe materials from an experiential perspective, i.e. related to meanings beyond the actual description of physical characteristics, many times, relates to human qualities, as in describing the "character of objects" (Merleau-Ponty, 2004, p. 45). "Indeed our experience contains numerous qualities that would be almost devoid of meaning if considered separately from the reactions they provoke in our bodies."

(Merleau-Ponty, 2004, p. 46). This was noticed particularly in the 'Stimulate' phase that was highlighted through this study.

With all that in mind, in the context of this thesis, this study brings empirical evidence to the importance of supporting designers beyond providing the knowledge about the textile (in terms of measured or described properties), which will be further explored below.

Beyond Touching to Know Textiles

The literature on affective touch has revealed a relationship between the emotion conveyed and the type of touch and its kinematics (Hertenstein et al., 2009). With our study, we encountered other important aspects of the tactile experience: a) movement that enables diverse interaction types and experiences, as well as the alteration of the textile that reacts and provides different stimulations; b) different purposes that exploit attention shifts and a variety of touch behaviour types. Specifically, in 'Simulate', the 'Active tool-hand' is shaping the surface that will touch the body, and shaping the dynamic of the surface as it touches the body to dynamically create the tactile experience. By going beyond Kawabata's method (1980), mainly aimed at eliciting a verbal description of fabric properties or expressing it numerically, we uncover a more complex process of experiencing textile through touch.

There are diverse physical characteristics that can be assessed haptically, which research has divided into material (free form substance) and geometric (related to their formal realization, i.e. the object structure). The manner through which we haptically perceive such properties varies, and research has identified conventional touch behaviours that people perform in object explorations. These systematic processes have been identified as "exploratory procedures (EPs)" (Lederman and Klatzky, 1987), which consist of recurrent patterns of exploration people perform with their hands when prompted to explore objects to learn about them, mostly without vision. Some of the observable EPs are: "static contact" for temperature, "pressure" for compliance, "unsupported holding" for weight, "enclosure" for volume, "lateral motion" for texture, and "contour following" for shape (Lederman and Klatzky, 1987). Again, comparing this research to the '3S Tactile Phases', it seems that such types of explorations are mainly related to the 'Situate' phase, but mostly to the understanding of the physical object only. That is, it does not cover the experience of understanding how we feel when interacting with such

objects, which is also part of 'Situate'. These EPs do not seem to relate to the explorations in 'Simulate', which are looking into what is 'not there' in the textile, i.e. 'Simulate' is interested in figuring out what can be done with a textile, or rather in what the textile can become. Also, these EPs do not cover freer explorations noticed in 'Stimulate', which lead to a rich array of relations to be established with textiles, by allowing a more creative space for subjective experience to be expressed. This is a crucial aspect for the designer experience of a creative process, since they not only need to understand the physical object, but need to be inspired and create concepts that will allow them to create new designs that are authentic and meaningful.

Sennett (2008) also discusses the relation between "grasping" physically and conceptually the world surrounding us, and defines the concept of "prehension" to describe movements through which the body "anticipates and acts in advance of sense data" (Sennett, 2008, p. 154). According to this author, it is the prehension that allows us to "anticipate meaning" and create the connection between understanding and action. In the sense of connecting cognition and physical action, Sennett (2008) mentions Tallis (2003), who systematizes prehension in four dimensions: anticipation (how we think the touching experience will be), contact (when the actual touch happens and sense data are accessed), language cognition (when describing what is being touched) and reflection ("…on what one has done" (Sennett, 2008, p. 155)). In the case of the designers' experience with textiles, similar processes were noticed through the '3S Tactile Phases', particularly in the 'Situate' phase, as this also results in a "labelling" through verbal descriptors ('language cognition') of the final outcome of the experience. However, in 'Simulate' where designers think of what things could be, and in 'Stimulate' where they look for new experiences that a textile can provide, this seems to be extending the proposition by Tallis. It does so by including these aspects that are more related to the activity of designing, of experiencing things not only for what they are, but also for *what they can become*, or for the several experiences that it can provide. These dynamics also seem related to the proposition by Massumi (2011, p. 30) that "Things and their experience are together in transition", again connecting physical properties and experience, which is precisely the knowledge that designers access in synthesising all of these streams of knowledge to come up with textile selections in the design process.

7.5. Summary of Chapter 7

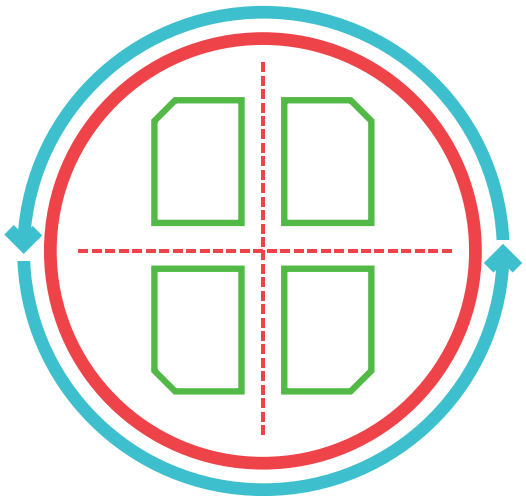
Through a phenomenological approach, this chapter uncovered the complexity of tactile experience of textiles during processes of textile selection, by using the 'Elicitation Interview' method. It is important that this complexity is uncovered and considered in designing support for the designer in textiles selection. The designers' contribution revealed that there are two types of touch behaviour in experiencing textiles, active and passive, which happen through 'Active hand', 'Passive body' and 'Active tool-hand'. They occur in any order, and with different importance and frequency in the '3S Tactile Phases' of the selection process – Situate, Simulate and Stimulate - and the interaction has different modes in each. In 'Situate', the tactile behaviours are the specialist ones employed to understand the textile. These are similar to those discussed in the textile engineering literature, and which designers develop and specialise through training and practice to interrogate textiles. As the textile is understood, the affective tactile experience starts to take on a more important role and the tactile behaviour is unconstrained. It is about understanding the textile through and on the body – what it is and how it feels. 'Simulate' is about creating concepts through tactile exploration and 'Stimulate' is about experimenting beyond the initial concept through tactile exploration to generate metaphors. The hand is at times experiencing and at times an active tool that drives the tactile experience of a different body part. These are significant behaviours within tactile experiences with textiles that were not accessed with previous methods, and no previous descriptions were encountered in the fashion and textile literature, or more generally in relation to materials experience. The '3s Tactile Phases' were matched to the 'Quad-core Textile Selection Model', based on their predominant occurrence, which allowed for the embodied aspects to be seen with more clarity in relation to the textile selection processes identified in previous chapters.

Designing a Tool to Support Embodied Textile Selection Processes

Chapter 8

8.

The sCrIPT Toolkit: Designing a Tool to Support the Embodied Experience in Textile Selection



Highlights:

• Build on studies in Chapter 4-7 to design a deck of instructions cards to support designers when selecting textiles

• The instructions (tactics) supported the articulation of textiles experience and encouraged designers to have a phenomenological approach to selection

• The cards provide an accessible way to be empirical in harnessing the textile experience to inform the selection process

8. The sCrIPT Toolkit: Designing a Tool to Support the Embodied Experience in Textile Selection

Abstract

In order to address the lack of support to explore designers experiences in interactions with textiles, and to build on the experiential practices revealed throughout this thesis, in this chapter a series of design workshops were conducted to explore the question: *How can the experiential forms of textile selection be supported to facilitate a systematic approach?* Building on the results emerging through Chapters 4-7, a deck of cards and lab-like exploratory stations were designed, composing a Textile Experience Method, which is based on 'The sCrIPT toolkit' (System for Collection (re)Interrogation, Projection and Transformation). The sCrIPT is a generative method comprised by instructions (within cards) that support designers in articulating feel in a self-directed manner (i.e. open to subjective interpretation), encouraging an experiential approach of inquiry when interacting with textiles. The research and creative process behind the development of the method is reported here, through a design research perspective. This was achieved through a series of design workshops run in different European universities (UK, DE), where the toolkit was investigated. While method cards are mainly used with a focus on generating ideas (product development) within a specific project in an industrial context, this study showed that method cards can have a disruptive impact in how designers relate to materials broadly in their practice. This also serves as an interesting example to raise relevant disciplinary issues, as it demonstrated that designers' embodied experience can be harnessed as a rich and powerful resource for generating knowledge, and support textile selection processes. This approach shows a potential to strengthening the design field with methods and tools emerging from within the discipline. Hence, this study also aims to contribute broadly to debates on the role of embodied experience as a design tactic, and generate discourses on how design knowledge is being created, transferred and practiced.

**This chapter is a paper in preparation to be submitted to a journal (after exam).*

8.1. Introduction

The iterative research process through which this thesis has been carried out, allowed for identifying and understanding the embodied textile selection processes, which are relevant for designers' experience. These were compiled in the Chapter 7, where the 'Quad-core Textile Selection Model' has been enriched with the '3s Tactile Phases', which was presented in Figure 42. These are tacit processes, which demanded a thorough investigation of *'how'* they happen before any type of support could be envisaged. This is what has been done so far in this thesis: to make these processes more tangible, in order to think about how these can be supported. Additionally, Chapter 6 has shown that the complexity of the multisensory experience of textiles, and the needs around communicating and remembering are issues that surround designers embodied textile selection processes. These embodied textile selection processes identified are tacit processes, which rely strongly on tacit knowledge. Here a question emerge whilst considering how this support should be designed, which is related to how to support these tacit processes, or rather, on how to harness these tacit processes to support design. The chapter explores this through a more focused question, the Research Question 4: *How can the experiential forms of textile selection be supported to facilitate a systematic approach?*

To address this question, a design research approach, namely action research (Swann, 2002), is taken in order to address the lack of support to explore designers' experiences in interactions with textiles, and to build on the embodied processes revealed throughout this thesis. This chapter builds on the descriptive studies presented in Chapters 4 -7, specifically, on the 'Quad-core Textile Selection Model' after incorporating the '3S Tactile Phases' from Chapter 7 (Figure 42), and on the phenomenological perspective. The latter was used much beyond understanding the dynamics of the tactile experience of textiles and the touch behaviour types, towards working with the embodied strategies identified, those mobilised as a source of sensory training based on instructions and actions specific to experiencing a textile.

This approach is also responding to the problematic observed in the literature review, which shows the disconnection between currently available support (assessment based on objective and subjective approaches that characterise textiles physical properties and performance) and the designer experiential knowledge. Hence, here means to support

experiential aspects will be investigated, considering the findings emergent throughout this thesis.

This chapter describes the iterative design process for the development of a toolkit formed of a deck of instruction cards, which were created as an initial support for the embodied textile selection processes and to help designers articulate these better, and therefore enable them to communicate their decisions better. For conciseness, first the design process of the cards is described (these came out of an iterative process of design workshops, to which informal evaluation was conducted), and second the workshops that allowed for observing how the cards are used and to validate them. As the cards design is described, the process will be grounded either on findings from previous chapters, or on insights from iterative informal workshops that were conducted to inform this process.

In this chapter the focus is given to the fashion arena, and the work reported was developed through a series of workshops conducted with MA fashion students in a university in London, UK. Validation was conducted through two workshops with MA design students in Europe (UK and Germany).

8.2. Additional literature: What are the tools and methods used by designers and artists to support investigative and experiential processes in creative projects?

Sets of method cards have become a popular design tool that provides structure, a creative path and inspiration for design practitioners. These are well known in the fields of design interaction and product design, though in the field of applied textiles such tools have not yet been properly explored.

As was shown in Chapter 2, experimentation and experience have been researched and supported in the contexts of art (Albers, 1934; Saper, 1998) and design (Moholy-Nagy, 1929), through practice-based methods for research and education that have focused on personal experience and discovery processes. In design, such generative practices were not further developed, although significant advances have been noticed in trying to bridge the gap between functional and experiential goals with more systematic methods (Karana et al., 2010; Karana et al., 2015). Additionally, similar initiatives were not

encountered within the fashion discipline. In Chapter 2, the most acknowledged methods and tools in art and design were presented. To better situate the development of support, additional literature about methods and techniques dedicated to supporting the designer in processes of ideation, problem-framing and –solving is introduced. Moreover, inspiring examples from the performative arts are introduced to inform the study about how instructions have been used within creative practice.

8.2.1. Methods Cards in Design

Today, method cards are a common tool for design practice, largely used in the creative industry within the realm of *Design Thinking* (Cross, 2011) to assist in processes of ideation and problem solving. The analysis of a series of different sets of method cards for design – i.e. IDEO (2003), Adobe Kickbox (2015), Method Kit (2010), Design with Intent (2010) – reveals a distinct approach to their art-led counterparts. Unlike the emancipatory methods developed in the twentieth century, these recent design tools are project and product oriented.

Additionally, three sets of method cards developed and used in an educational context were consulted to provide further insight. These were firstly, the DSKD Method Cards (2011) developed by tutors at the Kolding School of Design and further explored with students to facilitate collaborative work; secondly, the work by Hélène Frichot (2013), from the School of Architecture and the Build Environment at KTH, Stockholm, which is deeply engaged in the development of feminist design. In this case, methodologists have drawn from a combination of philosophy, critical theory, speculation and instructional art to create fictional scenarios to address design issues in classes on Critical Studies within Architecture education. Thirdly, from the field of textile design comes the TED's TEN, a set of ten cards developed by the research group, Textiles Environment Design at Chelsea College of Art and Design. This focuses on sustainability strategies for textile designers.

While mapping the methods presented here that cover arts and design applications, it is noticeable that although they have seemingly comparable formats, i.e. method cards, their approaches are fundamentally distinct. While the artistic methods are focused on divergent, generative approaches for wayfinding, the design methods functions more like convergent, deep reasoning, approaches for orientation (Ingold, 2000).

8.2.2. Instruction cards in performative arts

In the performative arts, experience-based methodologies have also been explored extensively, as highlighted through the network Fluxus during the 1960's and early 1970's (Saper, 1998). One crucial aspect of their practice was the focus on the exploratory process beyond the final work (i.e. product). Convinced that 'play' was an essential strategy within their practice, they developed a series of methods in the form of games. One consisted of a deck of cards containing scores (instructions) for performative acts, in that way, being an alternative to the notion of choreography and allowing for the emancipation of the artist, i.e. it enables performers to interpret instructions independently. In this sense of 'knowledge emancipation', the performers approach shows similarities to that of Albers (1934), for investing in development of knowledge and creative process from individual experience.

Other sets of cards have been developed and used in art since, with some well-known examples such as the *Oblique Strategies* (1975) by Eno and Schmidt, which presents prompts (phrases or provocations) used by the artists in support of their creative process, and the *DO IT* by Hans Ulrich Obrist and Kate Fowle (2013), which bridges the more instructional and the more random (by chance) approaches in artwork (since the results cannot be anticipated): a project concerned with rethinking *how* and *where* art is exhibited. Other methods have been developed that attend to the specificities of a discipline, e.g. *The Observation Deck* (Epel, 1998), which is a tool for writers that contains methods for experimentation to support the creative process, derived from experts' strategies for creativity in writing, and the *Arqueologia do Futuro* (Bonavita et al., 2011) – which translates "Archaeology of the Future", and is a tool developed to foster imaginative exercises in support of the creation of performances.

8.3. Design of the sCrIPT toolkit

An iterative design approach (illustrated in Figure 43) was taken to design the cards. First, findings of Chapters 4-7 were used to set the requirements and aims for the cards. Second, a first set of cards and method were developed. A series of informal workshops was then used to refine the cards. In the rear section we highlight the requirements that emerged through this process, and then present the design of the cards.

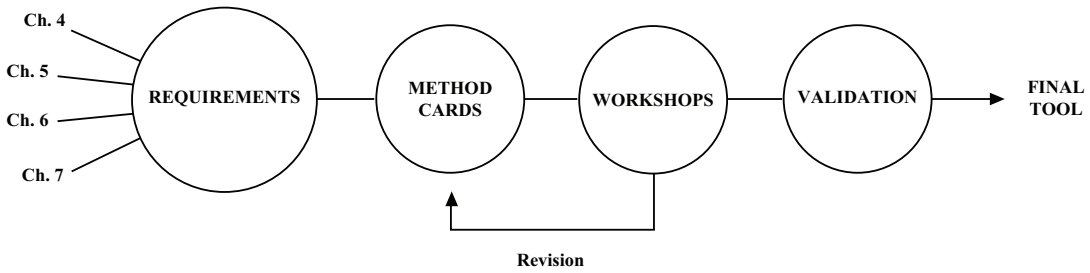


Figure 43. The iterative design process of 'The sCrIPT toolkit'.

8.3.1. Requirements and aims for the cards

The design of the cards considered particularly the following:

- From Chapter 4: that the textiles selection is a complex process, which has its own systematics and underlying dynamics, and that it involves many layers of the experience – sensorial, cognitive and affective. This systematic understanding, articulated through the Quad-core Textile Selection Model, should be taken as a framework from which to propose a holistic support for the selection process;
- From Chapters 5: that samples and tools to think with are crucial for designers understanding and decision-making. These should be included in designing the support.
- From Chapter 6: that tools should support designers in externalizing the experience and provide means for recording such experiences, both for purposes of collecting and communicating.
- From Chapter 7: that designers strategies observed through the 3S Tactile Phases are crucial for their selection. A tool should accommodate such tactile explorations, as the embodied experience is determinant for the textile selection.

A series of informal workshops were conducted with an initial prototype of the cards, which revealed: that the designers need a support that comes in during the selection; that it is playful, as engaging instructions are preferable, rather than with isolated activities "at the desk"; and also that allowing for movement explorations should be a crucial element. Considering the specifications outlined above, the concept behind the first iteration of the cards was revised, after an opportunity was identified to use the output of the identified fine-grained description of the designers' tactile experience with textiles (Chapter 7) as input strategies that could be translated into instructions for cards forming a toolkit. This opportunity emerged through the informal workshops, when diverse means to articulate the experience were tested, however those were not

providing designers with means to nurture explorations that are applicable to the selection process – these were making the experience explicit, rather then supporting the embodied processes. These instructions were to be playful and engaging, whilst allowing for subjective experience. These instructions would suggest a focused and systematic exploration of textile samples that would lead to a physical outcome, which could later be used as a material trace that informed the selection throughout (to be collected or used for communication purposes). Also, the instructions were to be matched to the structure provided by the Quad-core Textiles Selection Model, so that designers would have instructions that could support them at any point of the selection processes. The final prototype is seen in Figure 44.

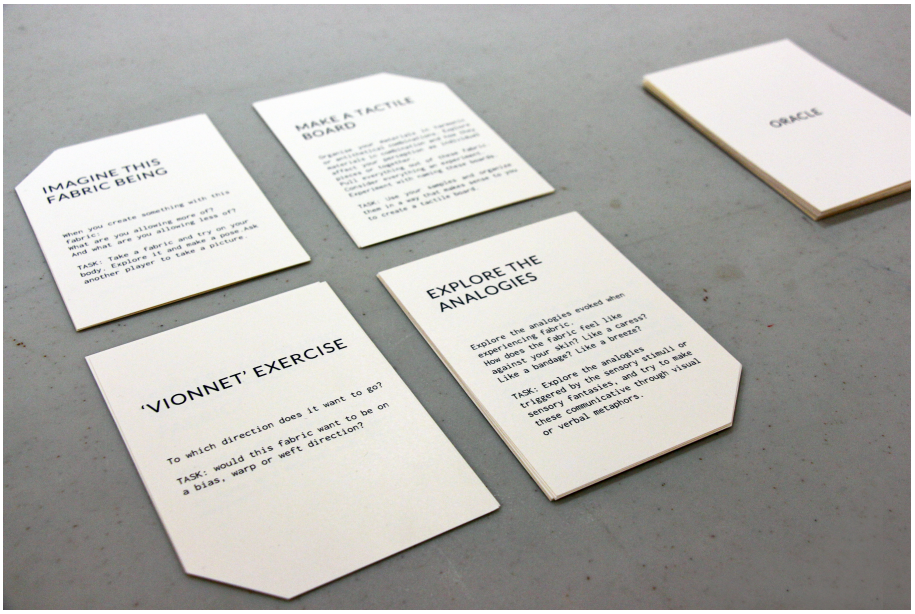


Figure 44. The cards that form the 'sCrIPT toolkit'.

8.3.2. Design process

Translating the designers' strategies (techniques) gathered from interviews into instructions mapped onto the 'Quad-core Textiles Selection Model'

In order to explore this gap, and adopt a closer perspective to the designers' practice, which was demonstrated through Chapters 4-7, the territory of methods, practices, techniques and strategies will now be addressed through the term *tactics,* as in Walter Benjamin's notion of *taktisch*[33] (Wilke, 2010), embracing the indeterminate (mutant)

[33] Wilke (2010) argues that Benjamin used the word *taktisch* purposefully because of the ambiguity of the word in German, which encompass both tactile and tactics.

interplay between tactile-tactics. In this study, tactics to support the designers' experience when selecting textiles for design were devised, tested and proposed as a method. Such tactics were identified after a second iteration of analysis of the Elicitation Interviews was conducted, this time applying a new coding strategy, which revealed an opportunity to focus on selecting tactics. This responded to the problematic raised above, in terms of supporting the embodied processes, rather then making them explicit only. The team who were analysing consisted of the researcher and an independent design researcher, both with a design background. The designers' tactics (strategies used when selecting) were interpreted to extract instructions. These were based on the tacit processes that had been mobilised through the interviews. They were de-codified both from verbal and nonverbal accounts (gestures). This is a novel approach to creating instructions, as it brings a new type of knowledge creation, one that emerges from the designers' behaviour.

The coding strategy:

I. Strategies were extracted from interview extracts and videos on Chapter 7: these were selected on the basis of their similarity (that is, if a strategy was recurrent - more than one repetition, intra or inter-subject - this would be considered relevant for the selection process) or if they were recognised as important by the team analysts;

II. The most representative strategy (the one therefore described in greater detail) for each category of strategies was selected;

III. The strategies chosen were translated into instructions by the researcher, and verified by the independent design researcher. The translation process involved the instructions including a question that inspired reflexivity on one's own experience, and an action that encouraged exploration, experimentation. Both question and action were open to subjective interpretation. This approach to translation was building on indications seen in results from Chapter 6 and on literature on performative arts, where the subjectivity aspect emerged as relevant. The instructions were to suggest externalization of the experience, so that it could lead to an output that could be collected or used for communication (as indicated in Chapter 6). The instructions were to provide an accessible way

of being empirical, so that designers could build an understanding of the textiles through experiential knowledge. Here it should be noticed that the translation process is a creative process, and hence the researcher's tacit knowledge was determinant for the elaboration of the instructions. Such translations require an understanding of both technical specifications (for textiles) and design knowledge required in the selection processes, so here the researcher's own experience was used to design the instructions, on the basis of her familiarity and ability to work within both fields.

The next step consisted of situating the instructions in relation to the four tacit themes and within 'Quad-Core Textile Selection Model'. Table 18 shows examples of how this process was conducted. An additional group of cards were brought in containing quotes by famous designers (from literature and websites), which were gathered throughout this research, and were proposed as a source of inspiration for designers to go through the explorations proposed. The latter were put in a separate group dubbed 'By chance'.

Table 18. Description of themes and corresponding instructions

THEME	EXAMPLE OF QUOTE WITHIN THEME	TRANSLATED INSTRUCTION	INSPIRING QUESTION	ACTION
Collection - Process of constant actualization. The designer acts as a sponge, gathering references (i.e., textiles and non-textile materials, objects, imagery, etc.). Driven by sensation and intensity	*It was a fabric that I've definitely had before and loved, but it hadn't ever found the right place for itself, within in an idea in a collection. When I came back to it, it was a very positive feeling.*	Identify existing relations	Have you met this fabric before? Have you made anything from it or encountered anything made out of it before?	Produce an image that represents the feeling(s) from this fabric, and map these relations

THEME	EXAMPLE OF QUOTE WITHIN THEME	TRANSLATED INSTRUCTION	INSPIRING QUESTION	ACTION
Interrogation - Focus on questioning what the fabric is and how it feels to interact with. The designer uses previous material knowledge (both relative and relational) to perceive it.	*I first touch just with the fingers, and then I try to see how they would fold, how they would deform. [interviewee squeezes the fabric and through it back on the floor]. Like that.*	Touch and hold it for a moment	How does this fabric affect you?	Touch the fabric with intensity and desire. Notice how it responds and how it stimulates you in return. Play with the samples and draw the sensations emerging from this experience.
Projection - Is about understanding what the fabric can become by pushing the previously obtained understandings of it and experimenting. More materials can be used with the original fabric as form of exploration of possibilities.	*Fabrics want to be certain things to have their best. So you push and pull and find that. They are closer-- how far and close do you have it to your body.*	Imagine you are the fabric	Who would you be if you were this fabric? How would you describe yourself? What would be your desires?	Each fabric has its own personality. Fabrics know how and why they should be formed. Take a fabric and build a character inspired by what this material evokes. If you have a small sample, sketch your character and attach the fabric to it. If you have a large piece of fabric, dress up and ask someone to take a picture.
Transformation - Relates to the emergence of (re)designs. It is through the performed experiences that transformations can come into being.	*And because this [textile] has big holes, I probably would have held it against my skin or on my chest over my bra, because it's the kind of fabric is, "Oh, do we need to make an under piece?"*	Observe if there is something missing from the fabric	What can you add to or change in this fabric?	Either draw it or search for an object or a material that can complement it.

Although the cards were positioned in specific areas of the 'Quad-core Textile Selection Model', this organisation does not suggest a formal beginning, as it considers the behaviours as non-linear, and as a process, more like a complex system, which has a sense of continuity. The tactics suggested in the cards are not anticipating answers, but

impressions and stimulations. Because of the relation with the 'Quad-core Textile Selection Model', and considering its tacit-themes the toolkit has been named The sCrIPT (System for Collection (re)Interrogation, Projection and Transformation), which works as a textile experience toolkit.

Subsequently, to add rigour to the development of the tactics, the performer Thelma Bonavita[34], who has extensive experience on working with instructive art, was invited to collaborate in one of the workshops in order to bring the bodily practitioner perspective, and to support in refining the instructions. This collaboration was vital as Thelma challenged the researcher to revise the semantic and structural construction of the cards, to think of means to stimulate autonomy of production. Following this consultation, the researcher revised the text and also the manner in which the content of the cards were arranged, so that they would have a main tactic (title), an inspirational inquiry and an action, thus, they would be focusing on the support of embodied experiences (Figure 45).

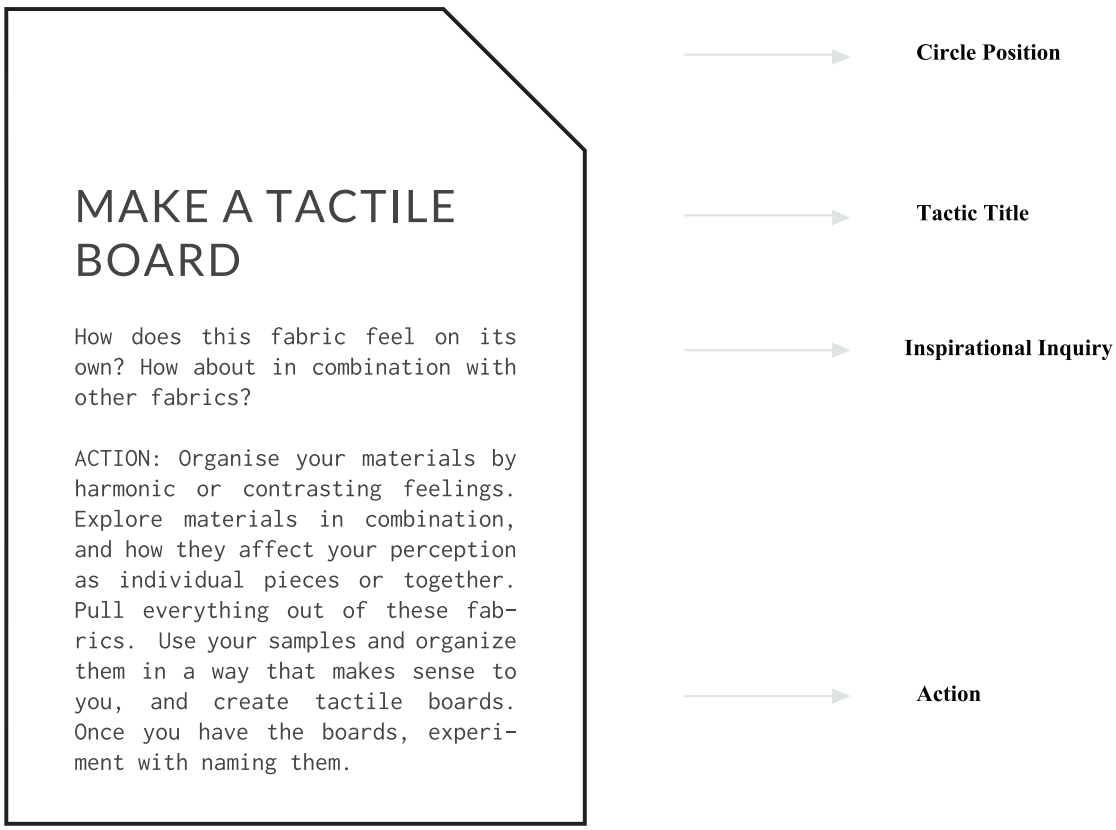


Figure 45. Organisation of the content in the cards.

[34] An artist from São Paulo-Brazil currently based in Berlin-Germany whose work inhabits the cross sections of choreography, visual arts and fashion.

Design of the cards

While method cards are commonly colour-coded to situate the designer through the process, this set of cards was designed in an off-white background and black text, using edge cutting to arrange the cards within the 'Quad-core Textile Selection Model', and showing through the cuts to which area of the circle each instruction belonged. This aesthetic decision was motivated by the desire to see designers appropriating the cards, and taking them into their practice, which could happen in diverse manners and contexts as follows. Firstly, considering that imagery and associations play a crucial role in the fashion design process, the aesthetics of the tool should not interfere in their work in that sense, but rather should be easily composed with sketchbooks, mood boards and samples. Secondly, the order of the cards as positioned in the circle should not be seen as an imperative, which is why the processes were modelled as a circle instead of in a linear manner in the first place. This acknowledged that designers not only move within their own process iteratively, according to their subjective needs and/or external factors, but also overlap steps of the process (i.e. collect and project at the same time).

The divisions are only one suggested structure of many possible paths, which can be explored by designers individually or in teams. A total of 40 cards were developed, 26 tactics and 14 quotes (in the box accompanying this thesis).

8.4. Workshops for Finalising and Testing the sCrIPT tool

To continue exploring the cards design, a series of workshops were conducted with MA students in three different universities in Europe (Table 19) to further the design process and to validate the toolkit. Participants presented diverse backgrounds, encompassing Fashion and Product Design, of varied nationalities (U.K., U.S., Hungary, China, Brazil, France, Germany) and speaking different levels of English.

Table 19. Details of the workshops conducted

Workshop	Type	University	Participants	Level of study	Course	Participants code
1	Design workshop	Art college in UK	12	Master of Arts	Fashion, Textiles, Product Design	R1 to R12
2	Validation	Art university in Germany	20	Master of Arts	Fashion and Integrated Design	B1 to B20
3	Validation	Fashion college in UK	10	Master of Arts	Fashion Design	F1 to F10

This sample included a mix of designers, and followed a convenience sampling strategy, which aimed at guaranteeing access to universities that would have the flexibility to support the workshop and offer it as an extra-curricular activity.

Data Collection

The studies were conducted in the format of design workshops (Martin and Hannington, 2012, p. 62). The Local Ethics Committee (UCL in Workshops 1 and 2 – ethics approval # BSc/1213/001; RCA in workshop 3, email approval Appendix B3) approved the studies, and participants provided written consent (forms in Appendix B2 and B3, signed forms available on request). Recruitment was made through invitation by tutors in the hosting institutions, or the workshop was advertised using posters. Participants were requested to bring to the session a material previously selected for a project (in progress or concluded). The sessions were recorded and transcribed for the analysis. Additionally, a report was produced after each workshop, focusing on the manners in which the cards were used.

Analysis

The analysis for the last series of workshops and validation followed Braun and Clarke's (2006, p. 87) recommendations, using the same six steps described in Chapter 6. All data was transcribed for analysis, and coding was conducted manually using paper and coloured pens to mark sections. The research question was used to guide the analysis, but focus was given to the themes that emerged from responses, which are described in each relevant result section for the different workshops. In this chapter, two coders, the researcher and an invited design researcher, conducted the analysis. They

have conducted steps 1-3 independently, and combined their efforts in steps 4-6 to agree on the most relevant themes and best way to report them. The researcher produced the final report alone.

8.4.1. Workshop 1 – Design workshop to observe the use of the cards

Method

This was a half-day workshop, and participants were reported in Table 19. No background research was presented, as in this workshop the main focus was to observe how the set of cards could create a dynamic by itself, without the interference of the researcher. At first, participants were simply instructed to explore the space and play. The performer Thelma Bonavita was present, as she had been invited to collaborate in conducting the workshop. The room was prepared as a Lab/Playground-like space, composed of diverse stations. The deck of cards was presented in the main station, set according to the 'Quad-core Textiles Selection Model' in four different piles of cards, and a roulette was placed next to it. The other stations are described below:

'Go Pinch' station

The observation that most designers across studies have a habit of picking the textile samples, holding them by the corners to observe how it falls, and that designers always want "bigger samples", formed the inspiration to create the 'Go Pinch' station (Figure 46). This station was built with larger pieces of textiles, using the same selection used in the Pocket-Tool, as these were plain fabrics in white or cream colours, which provided a very basic "white canvas" structure for experiencing freely. An instant picture machine was provided in this station, so that participants could register their explorations. This station had the following instruction attached to it:

Gestural interactions tell us much about what the fabric is, what it can become, and how it makes us feel. Use these fabrics for a full-body engagement and exploration. You can follow the instructions in the cards provided, or explore it freely. When you have finished exploring it, strike a pose and ask a facilitator to take an instant picture.

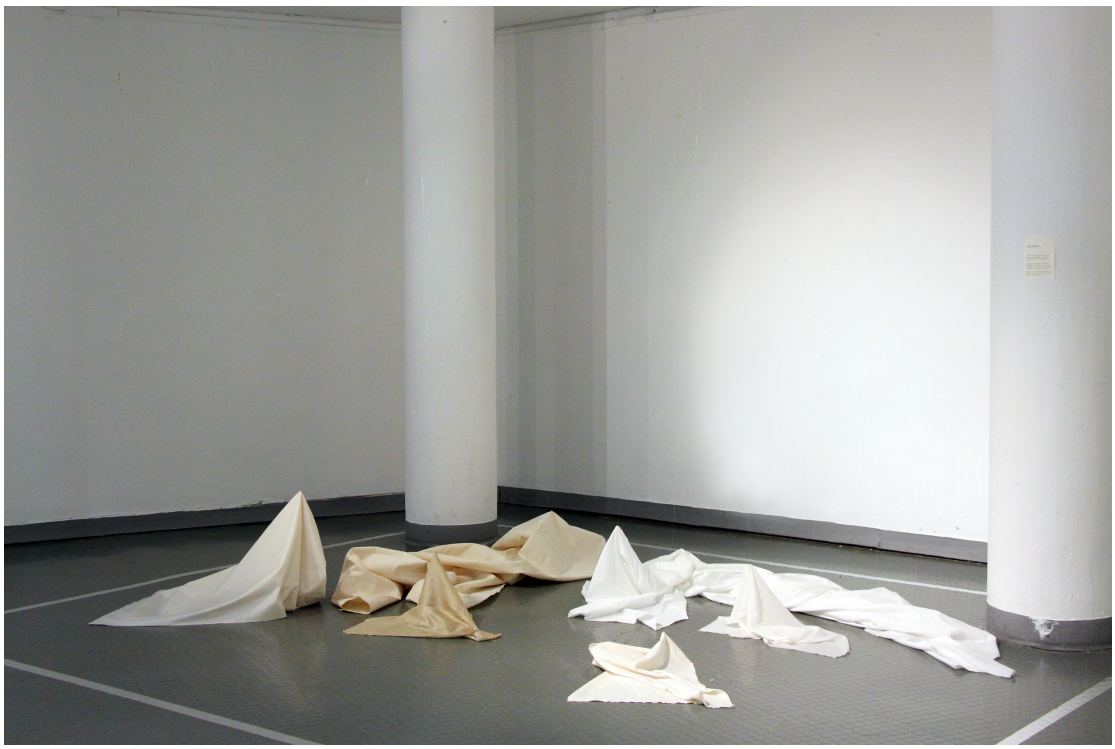


Figure 46. 'Go Pinch' station

'Gesture Selfie' station

The findings from empirical studies showed that designers are interested in gaining further knowledge about touch behaviour (Chapter 6), and it was recorded how crucial these are indeed for the textiles experience (Chapter 7). From the outcome of the series of the informal workshops conducted to inform the design of the cards, in which designers appeared very interested in exploring their own touch behaviour as a means of communicating their experiences around textiles, gestural exploration was also brought into the workshop scenario. The 'Gesture Selfie' station (Figure 47) explored this, by encouraging participants to record their explorations if this proved desirable for registering their experience. The instruction provided in the station follows.

To experience and learn about fabrics, handling them is crucial. Use the instructions in the cards and the samples provided for this exploration. Register this using the camera on the computer.

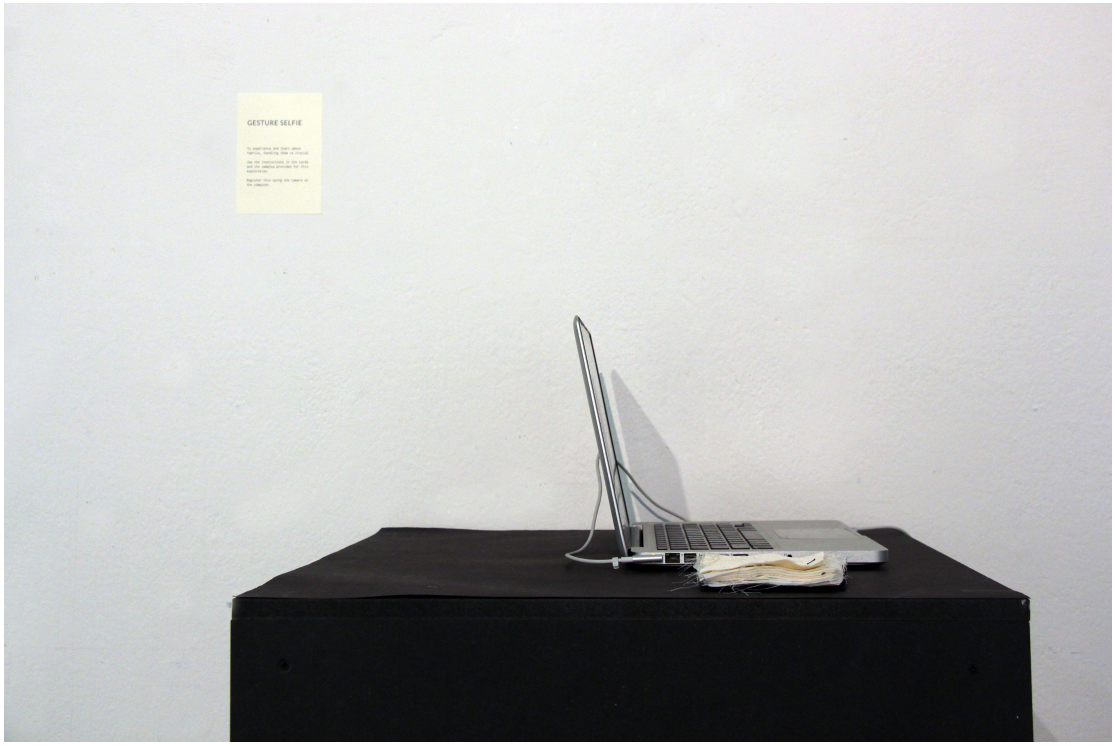


Figure 47. 'Gesture Selfie' station

'Augmented Reality' station

Considering the diverse findings from Chapters 5 and 6, where designers showed interest in explorations involving tools, various kinds of apparatus were introduced as research tools, to continue encouraging participants to focus on this experience. The tools supplied were the Pocket-tool (from Chapter 6), a stethoscope, a microscope, and multi-coloured cellophane paper (Figure 48). Textile samples were also provided. The instruction attached to this station was:

Many times our engagement with materials brings curiosities that are greater than our bodily skills. Here you can use these equipment to enhance your exploration. Leave traces (as objects, notes, sketches, etc.).

Figure 48. 'Augmented Reality' station.

8.4.1.1. Results from Workshop 1

In this workshop, the students gathered around the card station and played it together as a board game. Through the instructions from the cards, they started to explore the other stations to perform their tasks. Although interesting investigations with materials were produced throughout the workshop, their engagement improved significantly after a first discussion.

This workshop was the first test with the cards, and what was significant was that the instructions could be understood and motivated significant explorations. However, because there was not an initial presentation of how the cards were reflecting the 4 tacit-themes of the 'Quad-core Textile Selection Model', the participants had a lot of difficulty in understanding how to choose a section of cards with which to work. Also,

in the final discussion when participants were informed about the references that motivated the format of the cards and instructions, they expressed the fact that the action-oriented tasks indeed encouraged them to freely explore and play with the textiles; this created a very intimate and relaxed mood for open exploration and discovery.

The main learning to be taken to the next studies were: to include some contextual explanation of how the cards are related to the 'Quad-core Textile Selection Model', introducing the 4 tacit-themes and explaining their dynamics. To replace the word 'task' on the cards, by the word 'action', as this seem to reflect better the dynamics that was observed through participants activities, they were much more freely experimenting and discovering than accomplishing a prescribed, fixed task.

8.4.2. Workshop 2:Workshop validation

Method

The second workshop was conducted at an Arts University in Germany with the students from Integrated Design (BA and MA levels), and ran on two consecutive days. All participants spoke German and could communicate well in English, and are described in Table 19. On day one, the setup followed the one from Workshop 1, but this time an introductory lecture was conducted where the 'Quad-core Textiles Selection Model' was presented. Additionally, all the cards were displayed on a big table, to allow the students to see all the tactics, and another two sets of cards were available for them to pick from. The dynamics of working with the cards in this workshop was more fluid. Students worked both individually and in self-organized groups, and they moved more around the stations. Subsequently, they shared their findings in a discussion.

On the second day, participants were asked to bring materials that they were working with or interested in. Two exercises were proposed based on Moholy-Nagy's (1929) sensorial training, asking them to organize materials according to different triggers, mostly based in aspects of contrast and composition. Finally, in the last activity participants were asked to create their own tactics; these were written on new cards, which later were exchanged with the other participants.

8.4.3. Results from Workshop 2

During the discussion, all students affirmed that the cards helped in developing awareness of their processes, and to relate to the material in itself through experiencing it intensively. Four main themes were identified through the analysis: deeper and broader understanding, diversifying explorations, approximating technical and experiential knowledge, externalizing feel.

Deeper and broader understanding

The participants reported that the cards allowed them to have a ***deeper*** (they learn more about the specific fabric) ***and broader*** (they learn about the fabric in relation to other fabrics, or other associated content) ***understanding*** of a fabric, through associations that helped them to elicit or through changing the perspective or approach through which they experimented with a textile.

> *"**I brought a fabric that I had already used in my last project (…)**. And this fabric, I bought it really intuitively, because I kind of freaked out when I saw it… I was really astonished, and I was really surprised. I spent some time in this table and I did a few tasks … and there was one [card], which asked for a song for this fabric, and I thought I found the perfect song, I was really sure. Then I asked [another student] about the fabric, and his suggestion for a song. Then it became really interesting, because I suddenly saw that I don't know. So far, **until today, I saw two aspects of this fabric, and now I see like fifty**." (B1)*

> *"I would say that **the experience I had here was changing the viewpoint and me viewing stuff**. So like, before I maybe just look at this point, and this was a key moment for me to see I never did that. And this was really interesting, and maybe changes how I look and maybe thinking a little bit more on how to choose materials, or fabrics, or anything… it is like having a different process and other ways to choose, and other ways to differentiate between things." (B4)*

Participants reported that the cards helped them to ***explore textiles beyond the initial interest***, with more criteria, and also to ***consider the aspects of making at an early stage***, which would generally be encountered only later on, in the actual prototyping stage. Exploring through their embodied knowledge at this early stage could anticipate such issues.

> *"(…) now looking at some fabrics, I will actually think more of it like, "Oh, **I can now explore this more, and maybe get lots out of it", whereas sometimes I would have just seen a fabric and***

think "Oh that's nice!" and take it, or "it feels really nice" and take it, but not like really getting into the fabric, and maybe have a different decision. That would maybe also help to, like when you have a collection and you sew all the stuff and then you finish, and then you see some stuff just doesn't work… it's too heavy, or the fabric doesn't make the things I thought it would do, or the colour suddenly is really different. ***And, this just because you didn't look into the fabric deep enough***. So this is something that I actually think that this really helps me with, that I first made the right decision… and then I go and make stuff." (B2)

Diversifying explorations

The cards encouraged them to experiment and discover the different types of experience that a textile could provide, which are important to consider at an early stage, as these aspects enable design with and for the experience of their customer in mind.

"Because later they will be, like… as a wearer, like the person that will wear this garment, all these experiences come from the clothing. So, when I touch it myself, just by putting on a backpack, I touch it, I smell it… When I put the pullover over my head, I listen to it… when I scratch something… ***so all these experiences, the person who wears it will have, so I think it is good to think of all these.*** *" (B2)*

This was also observed after the designers developed their own instructions for cards. Participants suggested that their perception towards materials had undergone a deep change, as they recognised that the understanding of textiles can start by appreciating the diverse forms in which they can experience them.

"I think that working now with the cards changed my spectrum of what I can do to explore stuff. So I also think that I am now more capable to think of ways how I can get to know the fabrics." (B1)

"And it made me more interested, and actually doing them, and understanding them… and maybe it could be the other way, maybe you write your own, and then you feel like you are part of the game, and that every other card is more like of your own, and maybe not something different. (...) I can imagine doing cards at home and doing more of them, and being more focused." (B4)

Approximating technical and experiential knowledge

An interesting aspect is that the cards allowed students to consider the textile 'feeling' in association with the functions. This seems to be achieved in a manner like that emerging from a conversation with the textile or, as reported as, "listening to it".

"And the whole view on fashion also, that you give the fabric more importance, not only the shape, not only the colour, but also that the fabric is not only a feeling, but also has a main influence on how it will look. That sometimes, for me, ***I have the feeling I push and try to manage the fabric in the way I want it to be… and not listening to the fabric really****." (B2)*

Additionally, the discussion revealed a conceptual separation between doing and thinking in producing knowledge, i.e. participants seems to consider them as independent processes.

*"****I don't know what I'm doing, I only do it without thinking about it, it doesn't result in knowledge but it results in feeling****, what you actually do is to* ***translate a feeling into knowledge*** *and I think this can be really helpful for working" (B1)*

However, their reports on the work stimulated by the cards suggest that a deconstruction of that pattern occurred, as participants realised that their experiences can produce knowledge that is valid, besides revealing extremely interesting and helpful information about the textiles and about themselves, especially in terms of how they approach textiles.

"I liked it, because it actually emphasises what I just said that ***it helped me to change my attitude towards exploring fabrics.*** *(...) to me it is really interesting, because* ***it is such a subjective matter, but you are actually doing science about it****. Like,* ***science is always numbers****. And that help me to recognise that I could still be super subjective when I want to find out the qualities of a fabric." (B1)*

Externalizing feel

It was also pointed out by the participants that, generally, in their practice, they felt difficulty in articulating feel when asked to come up with descriptors for materials, and in conversations amongst themselves. This generated a discussion on the existing vocabulary to describe materials, and how they felt that there was a shortage of words - both in English and German - and that it was uncommon to discuss material "feel" among colleagues. They also commented on the use of metaphors as a helpful tool, beyond understanding the material and developing concepts further, but also to communicating about it.

*"**I also recognized pretty soon that I struggle finding words for feelings.** In English more than German, but in German already. It is not so easy. I was a bit surprised… I was a bit ashamed that I have such a lack of words to describe materials" (B1)*

*"(...) we have discussed in the course that there aren't many words to describe textures...**we don't talk about it**." (B6)*

"(...) it [metaphors] *helps you to have another view on this fabric and to create new images by combining them, and I really like this idea, especially with the sound, as well. In my mind, it was new to be so concentrated. I always heard "ok, maybe listen to some music", and "listen to the sound the fabric makes", but when you are very concentrated on this and working, I think, speaking about this…. Talking is very important. And sharing this experience, **so you can create a new thing by just talking and showing stuff to each other.**" (B3)*

8.4.4. Workshop 3: Validation of the sCrIPT tool in a textile fair

This validation workshop was conducted with MA fashion students in a fashion college in London, UK, in the context of a course activity. This activity was planned with the course leader, who was interested to see how the students would engage with the tool, and was also willing for them to visit the textile fair and promote a focused reflection. The participants (shown previously in Table 19) came from a variety of nationalities (U.K., Canada, Finland, China, Netherlands, Korea, Germany) and spoke different levels of English.

Students were given a brief to source for textiles in the context of the Future Fabrics Expo 2015, which took place in London in 29-30 September 2015. The brief specified an existing brand (chosen together with their course leader to consider the scope of their course), with a preference for a specified sustainability requirement (e.g. water use, recyclable, local), but no specification of collection theme or colour palette. Ten MA fashion students participated in this study and were split into two groups, so that half of them would receive the cards prior to going to the fair to select, and the other half would not. After that, the students participated in a day workshop with a series of activities specifically tailored to unpack their selection from the FFE'15. Participants received the code F1 to F10, with which their quotes were identified in the results section.

At the workshop, the initial activity consisted in sharing their process of selection, and verifying how the use of cards affected it. Subsequently, all students had a chance to work with their selection of textiles, while using the cards. Finally, students participated on a debrief about their impressions from using the cards, both the ones who used it at the fair, and the ones who only got to know it at the workshop. This was followed up with a post feedback written and sent to the researcher.

Apparatus

Five copies of the deck of cards were provided for the group of students that received them prior to the workshop. In the workshop session another two copies of the deck of cards were available. All of the textiles that the students selected at the fair were borrowed from the Future Fabrics Expo, and were used on the day of the workshop. Stationery was also available. After the workshop the students were sent a questionnaire with the questions outlined in Table 20.

Table 20. Questions sent to students after the validation session

Question #	With cards	Without cards
1	Did you do the kind of exploration suggested by the cards before, or was this the first time?	Do you think the cards would have helped you in this selection? If so, could you explain how?
2	Did the cards help you in this selection? If so, could you explain how?	Did you do the kind of exploration suggested by the cards before, or is this the first time you're encountering such instruction types?
3	Have you noticed any difference in the way you have experienced the fabrics? If so, could you describe what have changed?	What is the value of doing the type of exploration suggested by the cards?
4	What is the value of doing the type of exploration suggested by the cards?	Now that you know the cards, would you use it in future selection processes?
5	Now that you know the cards, would you use it in future selection processes?	Would you think about using the cards with a design team, or more as an isolated activity?

8.4.5. Results from Workshop 3

The third workshop showed the potential for the cards to be used both in facilitated workshops, and independently by designers as self-directed support for their practice. This would require some kind of booklet with instructions to accompany the cards, which was tested through adding some additional cards that explain the 4 tacit-themes of the 'Quad-core Textile Selection Model'. The results presented here are a combination of contributions on the validation workshop, and from the answers sent after the workshop. Six out of the ten students sent the answers for the questions shown in Table 20. These answers were balanced out, having three students who selected in the fair with the cards, and three who did not have the cards.

The students' reflections on the use of the tool centred on the experience of textiles within a selection process, due to the specific context of the activity proposed. Similar themes were identified in this validation study as the ones that had emerged already in workshop 2. These are related to a deeper and broader understanding, diversifying explorations, approximating technical and experiential knowledge and externalizing feel. Figures 49-52 illustrate some parts of this workshop.

Figure 49. Fashion students using the cards when selecting fabrics.

Figure 50. Fashion students using the cards to support embodied processes.

Figure 51. Fashion students using the cards to support investigations with support of the body.

Figure 52. Fashion students using the cards to support explorations using other supports.

Deeper and broader understanding

The impact of the use of the toolkit was acknowledged to provide greater **deeper connection with the fabrics** and also a more sophisticated understanding of the potential in applications

"A much deeper connection to the fabric you choose or reject." (F2)

"It is very creative! It helps to develop a very sophisticated collection since every imaginary propositions start from the fabric and its aesthetic potential." (F4)

Diversifying explorations

Designers reported that the cards provided them with a **breadth** (variety) of tactics for experiencing textiles for their selection.

"It gives you a more in depth research approach and a different way to explore the materials." (F3)

The students found that the thorough experimentations with the textiles lead to a more **considerate selection**, which they related to a greater reflexion about their **feeling** of the textile, a better **understanding** of the textiles selected.

"I did feel and touch the fabrics more considerably, I think, which made me think about the choice more. I felt the fabric, thought about the feeling it gave me, and felt it once more to confirm if I would choose that specific fabric." (F5)

"Before using the toolkit, I went to the Expo to find the fabric I need. I felt like I know "how" to select the fabrics I want according to the requirement. I tried to feel the fabrics, through seeing and touching. But I don't think I "understood" the fabric at that time." (F6)

Approximating technical and experiential knowledge

The reports by students show a relationship between their understanding of **feeling** and **thinking** processes taking place in the selection of textiles. They see the cards acting in this interface, and bridging a possibility to go beyond the feeling, by bringing the thinking closer to the *"just touching"*. This seems to be a thinking that emerges from the deeper, persistent feeling.

"(...) the cards definitely gave me a wider perspective to how I experience a material and if I want to work with it. Also the cards are really good to go even further: that is to think beyond the feeling. To think about advantages and disadvantages and so on." (F5)

"Because you start think about the fabric in another way, it's not just touching it, but really thinking about all its facets." (F2)

"Feeling and imagination is the difference!" (F4)

The use of the cards seem to **endorse** the designers' way of approaching textiles, and in this sense, support their selection from within their practice.

"The cards helped me in the selection because they reinforced my own thoughts in very credible words on the fabric selection process." (F1)

Externalizing feel

Finally one of the designers considered that this type of exploration provided the means for a better **communication** through the selected textiles, that is, the textile itself and the final designed garment will reflect the designers intended meanings.

"The value of doing this type of exploration suggested by the cards, I think, is to help individuals responsibly and meaningfully select fabrics, so that they are put to good use, cared well for, and

loved, and are honest. ***This means that the designer can communicate well through the fabrics*** *they have chosen because they have thought well about it. This can then help the designer communicate the meaning of his or her design better with the customer, so that the customer can have also, a strong relationship with the fabrics chosen in the garment made."* (F1)

8.5. Discussion

This study aimed at developing further means to support the embodied textile selection processes identified through this thesis as relevant for the designers' experience. Building on empirical studies from Chapters 4-7, a toolkit was designed, which was further developed through iterations in design workshops, which have been reported here. The several instances where designers participated, while improving the toolkit and relating back to empirical studies, lead to the identification of three main themes that seem crucial for supporting the designer experience when selecting – Externalizing the Experience, Feeling-Thinking, and Embodied Understanding.

8.5.1. Externalizing the experience

There seemed to be a consensus amongst all participants in all three workshops on the struggle to communicate textiles feel. Though the workshops were conducted in English, apart from German speakers who also highlighted the concern with a limited vocabulary for expressing their experiences around textiles, no other participant mentioned any advantage or concern in terms of vocabulary for expressing their impressions around materials or textures in their native language.

The opportunity to explore an experience of a textile through an association is a familiar process to designers, e.g. through the use of moodboards. It was noticed from the workshops that non-arbitrary forms of communication, such as using gestures, verbal and visual metaphors, blind drawing, or other techniques suggested in the cards, effectively mobilised the feeling a textile could provide, and were not only meaningful for the designer producing them, but also to the colleagues observing, who could connect to them and understand in a more intuitive, but nonetheless structured manner. This aspect related to literature on psychology and HCI, where shapes and physical objects (Isbister et al., 2007) have been explored as a means to characterise the outcome of sensory experiences.

Some students also debated the notion that by better understanding the textile they could better communicate subjective thoughts through their choices for textiles. This aspect would merit further research, as it complements previous studies where we worked with sensory-tagged media to communicate the textile feel (Atkinson et al. 2011). Also, since instructions came from very experienced designers and quotes from renowned designers, this raised a debate around the value of apprenticeship - as in guidance – and how this type of education should be reflected upon with regard promoting autonomy in learning. This is an aspect that would benefit from reflection on the preliminary training at Bauhaus, and in light of the philosophical discussion around the emancipation of knowledge through sharing the "sensible" (Rancière, 2004), and also in terms of political standing and ethics that this would entail (Barad, 2012; Manning, 2007).

8.5.2. Feeling-Thinking: Approximating experiential and technical knowledge

Experiential tactics to explore textiles were applicable in promoting a greater awareness of actions within the selection of textiles for design. By engaging intensively with the material, designers developed a broader and deeper understanding of the material and about themselves experiencing materials. These tactics can help not only the designer's creative process – from material selection to prototyping – but also help their awareness of their own practice. In other words, they could recognise the knowledge they constructed through making, something that they themselves considered to be given or instinctive. It also reveals that the tactics provided by the cards resonate with the practice and support that designers need within the disciplinary context, which are complementary to quantitative forms of understanding materials, as they help the knowledge to emerge from the awareness of their subjective experience. To recognize that design practice (feeling) is also a reflective practice (thinking), and not distant from systematised knowledge (science), is a step towards blurring the gap between technical and experiential knowledge. The toolkit provided the means for approximating the experiential knowledge to the technical knowledge, by providing instructions that help designers to systematically experiment with the textiles, and be empirical in an accessible, natural manner to their practice.

As discussed in Chapter 6, designers experience textiles through diverse types of touch behaviour, and in so doing they enact the experience and form knowledge about the textile – as it is, and in terms of what it could become – as well as about themselves. Interaction is crucial for these aspects to emerge, and the freer the touch behaviour, and the more the body is involved beyond hand, the more the affective experience starts to happen. As the affective experience develops, more associations and metaphors are generated. This kind of dynamics was also observed through the study in this chapter with the use of the tactics, as through the full body engagement in experimentations designers easily and independently realised the actions proposed, and achieved outcomes that lead them to believe this was *"to translate a feeling into knowledge"(B1)*.

8.5.3. Embodied Understanding

The cards provide tactics to acquire greater understanding of the material from a situated perspective. Students mentioned that they experienced a deeper connection both with the material and with the future wearers of a garment, but also with themselves, as they also account for how they are affected by the textiles. Understanding with and from the material is a relational dynamic that acts in both embodied and affective levels, while students experimented with *what* and *how* they experience a textile. This embodied understanding is what allowed for designers to acknowledge a **deeper and broader understanding** of textiles, as well as to observe the value in **diversifying explorations**. Also, this is a generative process, as it showed a potential for long-term transformation of designers' practice, and fostered autonomous learning as well as production of knowledge through personal experiences. Here we see processes of transformation, of the self, of the materials and of the others (potential wearers).

Previously, Ingold (2011) proposed that artists 'correspond' with the world, as this is a dialogical process, which is also noticed through this study and is highlighted when designers suggest that in experiencing they are *"listening to the fabric"*. Ingold (2010a) also suggests that artists work *with* materials. In doing so, they experience to creating experiences, taking risks, feelings. He suggests,

> (…) what Klee said of art is true of skilled practice in general, namely that it is a question not of imposing preconceived forms on inert matter but of intervening in the fields of force and currents of material wherein forms are generated. (Ingold, 2010a, p. 92).

To recognize that feeling is crucial for a reflective practice because of its generative power, and not distant from systematised knowledge (science), would merit further research towards into how knowledge is currently produced and transferred within the design field, much beyond the observations emerging though the studies in this thesis around textiles selection. This discussion is centrally about recognising and expanding the practitioner perspective in order to produce work that is relevant for the expert knowledge maintenance, development and transference.

8.5.4. Beyond a Toolkit

When asked to reflect on their use of the toolkit, the participants confirmed it to be a helpful tool, as it opened up their spectrum of possibilities. All participants suggested that they would incorporate the toolkit in their practice. This indicates that the cards have the potential to be used as an educational tool, which is open to experience and suggests material and self-transformation. Additionally, they mentioned that they would have benefitted significantly if they had been through this workshop as an introductory course at the beginning of their studies.

Currently, design toolkits *optimise* the design process, as they support a specific form of practice that determines a structured path, and their methods imply a linear progression in a design project. The cards presented here have shown to open, broaden the spectrum of possibilities for textiles applications (what they can become) and to favour an *embodied* and thus, *generative* approach, which supports risk-taking and feeling as means for experimentation. In that sense, the tool presented in this chapter would be better related to the methodologies applied the Bauhaus, the Black Mountain College and Fluxus (Saper, 1998), than with the other design method cards introduced earlier in this chapter.

This could lead into a broader discussion of knowledge creation in the design field. There is a problematic separation between design research and practice, which was also noted in the students' reports throughout this study. This is an issue of how knowledge is created, transferred and practiced. As has been observed through this study, which also reflects previous studies in the area (Albers, 1934; Moholy-Nagy, 1947),

knowledge in design is related to deep experiential insights, which can be obscured by trying to artificially impose other methods into the field. This is a discussion that addresses issues of tacit versus explicit knowledge, and considering that design is a fundamentally embodied practice, it should be further developed in that vein, so that common languages and new methods can emerge from within explorations that embrace such knowledge. This is shown in this thesis through the case of textiles selection.

In the particular case of method cards, they have become a popular design tool to support creative process. Under the umbrella of Design Thinking, design toolkits provide structure, a creative path and inspiration for design practitioners. By tracing a map of existing method cards for design, this study points toward a gap between different approaches in the content presented in the cards proposed here, and that from the other toolkits available, from generative/wayfaring to optimization/transmission (Ingold, 2011, pp. 161-163). This seems to represent a much greater issue for design as a discipline, which is about creating methods that allow for both convergent and divergent outputs. Both are necessary processes in design.

While existing method cards in the design field are mainly used to focus on idea-generation towards a final outcome, it was noticed through this chapter that method cards could have a disruptive impact in how designers relate to their practice more broadly. The later proposition considers firstly that designers usually conduct their practices automatically, 'tacitly' (Cross, 2011), assuming it is given and instinctive - therefore not recognizable as science, which is systematic and explicit. Second, looking from a phenomenological perspective, and taking this study as an example, it is possible to suggest that embodied experience is essential to the designer practice, since this research shows that there is expertise generated from designers tacit knowledge, and although it is indeed subjective and instinctive, there are underlying processes and traceable acts relevant to it, which are vital to be recognised as knowledge, and as a design science. These can be harnessed and systematised to support designers with methods and tools emerging from within their practice. From this standpoint, understanding 'how' designers make and why it is valuable, diverse methods may start to emerge from within the discipline that can be reproduced and distributed towards strengthening the design fields from a practitioner perspective.

8.6. Limitations And Future Work

The cards have only been used with MA level students, which already suggests an advanced degree of expertise, even though within an academic context. In order to apply the cards in an industry context, further investigation would be required. Some steps towards this expansion of the cards have been taken: to be discussed further in relation to future work (Chapter 10).

Lessons learned from this study can also be applied without the cards within an educational context, mostly as the study revealed opportunities for further research on phenomenological approaches within design. Such an approach has the potential to generate deeper understanding of how designers do what they do, which can bring novel methods of creating knowledge in design and research by practice. Particularly in fashion, this study foregrounds that fashion design is a fundamentally embodied practice and the cards help designers acknowledge and communicate the complexity of their practice, which can be a step into further pedagogical reforms in the field of fashion, in terms of bringing the practitioners bodily engagement more purposefully, but also in investing in more research and methods that embrace this phenomenological approach.

8.7. Summary

The three design and validation workshops have shown that the cards can become an integral part of the foundation for designer's embodied training, and also to support professional designers in textile selection. It supports designers by enhancing the awareness of their activities when they are experiencing a textile, and also allows for externalising such experience, which enables them to better understand textiles on a subjective and material level, that is, what they want from it and what it can become. The cards have an impact on three levels: (i) on the 'experience and awareness' level, the cards showed to effectively enhanced the textile exploration, which is why the designers reported that they were able to make better informed decisions; (ii) in terms of 'transformative processes', the cards helped designers to understand what the textile is on a subjective and material level, and also to articulate what they wanted from it and what it can become; and (iii) in terms of 'embodied learning', the cards seem to act as a disruptive tool, that could be applied in educational and industrial contexts, as they

expanded the possibilities of how designers approached textiles with autonomy, and brought transformations that were very welcomed by all participants, because they were natural to the designer practice.

9. Concluding summary

This thesis has presented new understanding on the textile selection in the design process, in terms of when and how it occurs, specifically observing tacit aspects and embodied processes. These embodied textile selection processes were articulated in a process model, on the basis of which a toolkit was proposed to support designers. The aim of the process model (conceptual) and supporting toolkit (practical) is to provide a systematic approach to textiles selection that is reflective of the designers' practice. To achieve this, the studies in this thesis provided understanding that (i) the textile selection is distributed and accompanies the design process, (ii) the textile selection is not based just on physical properties of textiles, and the embodied processes taking place are crucial for its unfolding. These contributions have gone beyond prior knowledge stemming from textile engineering research, which is concerned with the physical properties of the textiles only, and are not related to specifics of the design process and to designers' experience in performing such activity. This thesis work shows that the field needs to go beyond the concept of 'textile hand', towards an understanding that encompasses the embodied experience, which is crucial for designers' decision-making processes. The reason why this is crucial for designers is because, as this thesis showed, the processes of formation (Ingold, 2010b) are crucial for designers' as much as the final product, in fact, they are determinant for achieving desirable final products.

The work in this thesis had to make explicit the embodied textile selection processes, in order to think about how these can be supported. The toolkit proposed is a first step in doing so from this experiential perspective. This is advancing the knowledge and support previously available within the field, as it moves beyond quantifying (objective approaches) and qualifying (subjective approaches) the experience of properties of the textile only. It does so in a complementary way, though, since it is not replacing previously existing methods, such as Kawabata (1980), or FAST (De Boos, 1994), which were the most acknowledged systems to express properties of textiles (verbally or numerically). In relation to these existing systems, the contribution of this thesis impacts in two main ways: First, the better understanding of the textile selection process helps to situate these systems in the bigger picture of the design processes, by clarifying when and how information about textile properties are mostly useful. This was seen predominantly in the later phases, but also supporting the embodied textile selection processes, specially 'Interrogation'. Second, by providing a more systematic

experiential approach for designers' explorations, the toolkit enabled them to gain a deeper knowledge of textiles (and as they reported approximating feeling and thinking), and to communicate more clearly about it. This should put designers in a position to communicate with engineers more fluently and to make a better use of the technical information, with a basis on their experiential knowledge.

The relation between objective and subjective approaches is an issue that affects research in user experience more broadly. In research around human tactile experience, both the qualities of the tactile experience (which are distinct from those of the tactile input, i.e. source of experience) (Obrist et al., 2013) as the emotions experienced when touch is mediated through technology (Obrist et al., 2015) have been object of research[35]. These have shown that the finer combination of qualitative and quantitative approaches contributes to identifying more specific and better-defined design opportunities. With this in mind we may question 'How would objective and subjective approaches be complementary in supporting textiles selection?' As was shown in this thesis, the toolkit provides designers with ways to reveal and to bring their experience to the surface, and to be more aware of their understanding of textiles, which arises from cultivating their own subjective experience. This awareness of their experiential knowledge creates a disposition for utilising the objective measurements in a manner that makes sense for the designer. That is, if designers are attuned with their experience of textiles, they will be able to identify how objective data about textiles becomes useful, i.e., how to use it, as is exemplified here:

> *...to me it is really interesting, because it is such a subjective matter, but you are actually doing science about it. Like, science is always numbers. And that help me to recognise that I could still be super subjective when I want to find out the qualities of a fabric. (B1)*

> *I found that doing experiments with fabrics can be an interesting process. I choose different metaphors to link a fabric with something I have experienced in my life. Like, I imagine a fabric to be a cup of caramel macchiato, so all of a sudden the fabric has colour, smell, even temperature! (F6)*

[35] Obrist et al. (2015) investigated the relation between haptic stimuli (generated by a mid-air haptic device) and emotions, and were able to define set parameters (spatial, directional and haptic) that can inform the design for emotions using mid-air haptics.

Therefore, subjective data is highly relevant for supporting designers in revealing qualities of a textile through experience in order to utilise objective data, which is useful and necessary for facilitating engagement between designers and engineers, and is essential for product realisation. Future research should run studies similarly to user experience research, where a combination of methods is used towards more detailed specifications of how objective and subjective data can be used to design into experience.

Additionally, the phenomenological approach to propose support led to a method that supports know-how, much beyond knowing information about the textile only, and which nurtures tacit knowledge through transferring tacit processes. This is responding to the importance of tacit processes, which was highlighted in the introduction by the reference to Richard Sennett, who suggested the importance of keeping processes tacit, as bringing them to full consciousness or making them explicit, may hinder the creative process by making it difficult to take risk. The toolkit proposed in this thesis acts within this tacit-to-tacit relation, and in so doing opens up space for experience and discovery, which is reported by designers as leading to deeper knowledge of the textiles. Most importantly, this is achieved in a 'designerly' (Manzini, 1986) way, since this thesis addressed the gap in uncovering 'how designers do it', and based on that knowledge, proposed a means to enhance their way of selecting. This approach is very complementary to the literature reported in Figure 2 (p. 42), as it introduces embodied processes in a more systematic and contextualized manner, as a means to underpin experiential aspects through the design process, and still not prescriptive or limiting the designerly modes of selecting. This approach helps designers to capitalise on their experiential knowledge, and to be able to communicate about it. This thesis results seems to complement the approach seen in the Materials Drive Design (MDD) method (Karana et al., 2015), which is the most recent in the area, and where the body is more clearly seen in its Step 1 – understanding the material. However, there may be opportunities to bring embodied selection processes as were seen in this thesis to other steps of the MDD, for example, by introducing some Projection strategies to support explorations and help articulating answers to the questions suggested in MDD's Step 2 – Creating Materials Experience Vision. The latter will be discussed further in Future Work.

The acknowledgement by designers that this toolkit provides systematic exploratory means to acquire deeper knowledge about the fabric, which emerges from experience, instead of being given general information about the textile properties only, may be important to reflect on the potential that there is in this approach, in terms of creating bridges between engineering and design approaches. In the case of this toolkit, this is seen in two main ways: First, the toolkit helps designers to articulate embodied textile selection processes, and therefore enables them to understand and communicate their choices better through the design process with a language familiar to them (beyond the abstract numbers and descriptors currently available). This may facilitate communication with other stakeholders, such as engineers and manufacturers. Second, the toolkit may provide a means for engineers to understand better how designers select textiles, and what their needs are, which may lead to better textile solutions.

Finally, this thesis suggests a connection to the propositions by Ingold (2010b) on improvisation in relating to materials. Ingold suggests that "improvise is to follow the ways of the world, as they unfold" (2010b, p. 10), and to follow, as he suggests requires an itinerant disposition. When exploring textiles it seems like designers are always driven by a forward movement, a movement interested in what to do next, which "gives rise to things"(Ingold, 2010b, p. 11). We saw throughout this thesis that the more designers open up to real-time discovery (about the textiles and themselves) when engaging with textiles, the deeper is the knowledge they report as emergent from this correspondence. In such explorations, free, improvised, full-body explorations are key for the outcome experience, particularly when it comes to creative outcomes (as was seen through the 'Stimulate' tactile process and the metaphor generation). This related to Paul Klee's proposition, recalled by Ingold (2010b), suggesting, "Form-giving is movement, action. Form-giving is life" (1973, p. 269). To allow for this focus on "form-giving", a focus on the body is crucial, and supporting embodied textile selection processes makes a strong contribution to this.

9.1. Meeting the research objectives

The study reported in Chapter 4 (*RQ1. What are the processes that designers follow in the selection of textiles and how does the experiential component of selecting textiles affect these processes?*) supported a deeper understanding of the textiles selection processes for design through three main aspects. First, through **understanding how the**

textiles selection sits within the design process, as this study provided a process model to organise the activities accomplished by designers when selecting textiles, considering the different stages of the design process, which was obtained from synthesising the literature around textiles selection, and also enriched by empirical data from the studies reported in this chapter (show in Figure 17, p. 101).

Second, an **understanding of the textile selection through tacit processes** that contributes to the designers' experience**.** This was achieved through a deeper exploration of textiles selection with Grounded Theory, which revealed further relevant aspects for the selection noticed through designers' behaviours, which remain implicit for being related to experience and experiential knowledge. These behaviours were articulated through four emerging themes – Collection, Interrogation, Projection and Transformation. These are non-linear processes that are dynamic and overlap, and uncover a more abstract level of understanding of the designer's practice and experience in relation to how they select textiles. These were articulated in the 'Quad-core Textile Selection Model' (Figure 18, p. 115).

This work expands our current knowledge of the textile selection, as in the literature described in Chapter 2, textiles selection was mainly seen as one-step in the design process, or as discrete activities, but no prior model had been proposed to observe the designers behaviours that affect such activities and which demonstrated the interactions between them. This advances the literature, seen in Udale (2008) and Cadigan (2014), where a compilation of activities and techniques around more explicit processes was provided, however without clear reference to how they interact or to the unfolding design process. These are now synthesised in a model where the process flow became clearer, and further detail on the designers' behaviours was added through the proposed articulation of tacit processes. Such clarification and organisation including tacit processes, which are relevant to the designer experiential knowledge, were not encountered in previous literature. These were made more tangible through this study, and the validation showed the value attributed to bringing clarity and the ability to be systematic for these processes: pedagogical (as a teaching tool) and industrial (as the understanding of these processes can help tailor the communication of textiles, through their own physicality, as was exemplified by the sample size used in a textile fair).

These embodied textile selection processes also contributed to Ashby and Johnson's (2010) propositions reported in the literature review (section 2.2). First, it shows with more clarity how some elements of the Figure 1 (p. 40) have an impact on the selection, for example, by clarifying *how* designers use sample collections to increase their knowledge about materials. In fact, it shows that 'Collection' is a process much more ubiquitous to the overall design process, where clearly this is not just one step in help narrowing down a material selection. The four processes reported in Chapter 4 also relate to the selection methods proposed by Ashby and Johnson (2010) – Analysis, Synthesis, Similarity, and Inspiration. This is because the instructions that were derived in Chapter 8, based on the understanding gained through Chapters 4-7, provides heuristics for applying such methods, from an embodied experience perspective. For example, the method of Inspiration would benefit from the explorations proposed through the 'Collection' and 'Transformation' processes, the methods of 'Analysis', 'Synthesis' and 'Similarity' would benefit from explorations suggested through the 'Interrogation' and 'Projection' processes. These would have to be tested in such a way, and would require further research.

Third, this study provided a better **understanding of the need for** support, since it helped to clarify *which* selection activities occur during the design process, and *where* they happen. This shows that previous research on textiles, which provides technical specifications and measurements, was only supporting the later stages of the design process; technical specifications are unquestionably necessary, but they are not sufficient – there is much more that affects the selection of textiles, and which merits support. These tacit processes affect other layers of experience, beyond material description and sensory aspects, and include the conceptual and affective aspects. Including these processes is crucial for supporting designers to design for experiences.

The study reported in Chapter 5 (*RQ1. What are the processes that designers follow in the selection of textiles and how does the experiential component of selecting textiles affect these processes?*) revealed distributed and embodied aspects that are relevant for the selection of textiles, and which are crucial to appreciate how movement and physical textiles inform designers in making sense and in making decisions. Through investigating a situated design process in the context of a sports shoe customisation, and adding a Distributed and Embodied Cognition perspective, it was possible to confirm the processes of Collection, Interrogation and Projection. Further to that, Projection was

elaborated as a phenomenon, which occurs as Physical, Visual and Social. These results are aligned with the most recent findings in Embodied Cognition, particularly through the work by Kirsh (2013), and have the potential to influence strongly the manner in which design is taught at present.

In Chapter 6 (*RQ2. What sensorial information underpins the textile selection processes?)* research tools were introduced to encourage designers to talk about their experiences and think about themselves when interacting. These studies were conducted in the Future Fabrics Expo, and the research tools included a mix of existing tools and new prototypes developed for the purposes of this thesis work. This study revealed the importance of the multisensory experience to textile selection, and the complexity of remembering and communicating such experiences in the design process.

These research tools bring an important learning in terms of how tools can be used beyond what they are designed to do, and are effectively brought in to get people to talk, and to think about themselves in situations where there is no current solution or support provided. This creates a platform for rich exploration and provides effective insights to inform opportunities for truly valuable support. This result relates to what has been observed in HCI before, where technology brought about unexpected results, as users showed greater interest in "their own reflective experience" (Mentis et al. 2014, p.1), rather than on the aspect that the study was investigating, which was related to socially sharing. In the case of this thesis, it was observed that a similar process occurred when designers interacted with the 'Pocket-tool' and were more interested in the unfolding of their tactile experience, and on how the tool helped them to become aware, than in trying to discriminate textiles based on the visualisations that were provided by the tool, which was based on the contact-pressure data gathered from their touch behaviour. This was a useful indication for the direction that should be taken when designing the support for designers, having in mind that they feel more informed by exploring their relation to the textile, than by receiving more abstract information about it. In the case of the 'iShoogle' tool, designers revealed their need to feel textiles, which was further explored later on in the thesis and led to many relevant findings in terms of what is entailed in "feeling" for designers. They also revealed an interest in seeing hands in videos, which was further pursued through research by an MSc student (Cary, 2013), with whom there was a collaboration, and who showed the true potential there is in

including hands and adding more affective information than was observed with the videos that do not show hands.

The study in chapter 7 (*RQ3. How does the body support the different forms of textile selection?)* revealed that the designers' tactile experience of textiles occurs through active and passive touch, through 3 touch-behaviour types, identified in this thesis as 'Active hand', 'Active tool-hand', and 'Passive body'. These touch behaviour types are a generic level of description, under which diverse types of tactile explorations were observed. They occur in any order, and with different importance and frequency in the 3 tactile-based phases of the selection process – Situate, Simulate and Stimulate - and the interaction has different modes in each. Looking at the tactile experience in the textiles selection, it is noticed that they occur with greater incidence at the different stages of the selection, but that actually they occur at any point, and overlap significantly. These findings were used to enrich the proposed 'Quad-core Textile Selection Model' including experiential and embodied components of the textiles selection (Figure 42, p. 211) that go well beyond 'textile hand' (AATCC Test Method 202-2012), and highlight the dynamics and interactions between the textile, the body and the product to be, which emerged as crucial for this process.

These findings contribute to the current literature in two main ways. Firstly, by building on the work of Kawabata (1980), and similar approaches, by including touch behaviour types that go beyond hand discriminatory touch, to include full body explorations and affective touch. When designers *feel* they move beyond 'textile hand', and engage the whole body in the explorations. Also, these findings go beyond solely describing the outcome of the experience (labelling the resulting perception – e.g. rough, soft, etc.), and add new understanding on 'how' these processes take place, and the dynamics through which this experience arises. Secondly, it contributes to the works in phenomenology, especially based on propositions by Merleau-Ponty (2012), showing with a specific case study and providing detailed description of how the relation between 'touch' and 'being touched' happens in the case of engaging with objects.

This work builds on previous research started through the project Digital Sensoria, now pointing to directions in which engaging the body further is an essential way of supporting the experience, which can be developed both through digital and with analogue tools. There is scope for developing this further by building on the work of

embodied metaphors proposed by Lakoff and Johnson (1999), especially in the 'Stimulate' tactile-phase of the designer experience with textiles, where the metaphor generation was observed as a relevant aspect to enriching design proposals. Additionally, this work builds on literature on tactile knowledge (Tallis, 2003; Sennett, 2008), by showing *how* cognition and physical action are connected; further to that, it reveals that besides the themes of 'anticipation, contact, language cognition and reflection' (Tallis, 2003), for designers there are additional aspects relevant to grasping a textile, which are related to the affective experience that emerges, and also to the transformations that result from the interaction (material and subjective), particularly in the 'Simulate' and 'Stimulate' phases that emerged.

The study in chapter 8 (*RQ4. How can the experiential forms of textile selection be supported to facilitate a systematic approach?*) built on the output analysis from Chapters 4-7, which were used as input to develop the 'The sCrIPT Toolkit' (System for Collection (re)Interrogation, Projection and Transformation) to support embodied textile selection processes. The toolkit is formed by instruction cards, which builds on the knowledge generated through this thesis work: tacit processes in selection (Collection, Interrogation, Projection and Interrogation) and embodied selection processes (emerging from the articulation of the tactile experience). This method is a first step into further involving the body in textile experience, which this thesis revealed to be a crucial aspect in forming understanding around textiles. It shows that the relation between "grasping" physically and conceptually the surrounding world is a very proximate one, as is mediated through our bodies, which is the most familiar place to start such explorations – this is to experience textiles beyond experiment, and understanding them beyond measurements.

These findings correspond with a recent publication by Mendoza and colleagues (2015), where user experience frameworks for the design of movement-based interactions were reviewed. In this paper the authors suggested that one of the most interesting design strategies observed is "exploring the design space through moving and through experiential knowledge about movement" (Mendoza et al., 2015: 412). They suggest that this could have a radical impact in design curriculum, to introduce "a strong component of theoretical, practical, and even experiential knowledge about movement" (Mendoza et al., 2015: 412).

The tactics proposed by the toolkit led designers to create material outcomes, which result from their experiences, and this is what they can take forward as physical stimuli to support decisions, which was seen as relevant in Chapters 5 and 6. In this way, the cards allow designers to articulate their sensory experience, which emerges through the suggested bodily engagement. The toolkit works more like an instruction guide, or a manual, and is based on the premise that this guide is a situating tool that opens a space for a reflective experience, adding awareness and quality of presence when experiencing textiles. They are also bringing attention to what affects designers in experiencing, which is what makes this work go beyond experiment, and is more limited to testing, differentiation, classification. Through experiencing, designers experiment openness to discovery, which is why this has shown to be a generative process. The latter was noticed in reports from designers, which considered that the instructions in the cards enabled them to have a deeper knowledge of the textiles, and also to diversify their forms of approach to a fabric.

In terms of exercising the knowledge around textiles, this could be taken back to Gilbert Ryle's (1945) reflections on 'knowing-how' and 'knowing-that', where he suggests that there is no separation between intelligence and practice. In the case of textiles selection, the 'know-that' would be related to the information (measurements or verbal descriptors of the physical properties) that are abstracted from textiles, but which are of little or no use for designers', provided that they possess the 'know-how'. Ryle (1945, p. 5) argues that truths (e.g. facts, information) around a practice are only supportive if they are considered in the *doing*, which leads to an intelligent action, i.e. there is a know-how in applying such truth. However, as Ryle (1945, p. 7) ponders, these are applied 'implicitly', hence are rarely articulated or "formulated", and they require ability that goes much beyond "knowing-that". Such ability is observed though principles in the practices by people who have the required "know-how" to do things, however these are not easily translated into statements ("indicative mood"), as Ryle (1945, p. 12) notes. These translations are reported as having a pedagogical value to Ryle, particularly " in lessons to those who are still learning how to act" (1945, p. 12). More specifically in relation to bringing pre-reflective (implicit) processes to awareness, Petitmengin (2006) claims that once students are trained to make explicit their processes, this "(…) enables them to put their own experience into perspective, and thus be less imprisoned by it." (p. 260). They consequently become more conscientious, which makes them flexible and open to transformations. All of these propositions seem to support the value of the work

conducted in this thesis, in terms of translating experts' selection strategies, which are related to their embodied and experiential knowledge, into tactics (instructions) that are used pedagogically to support more novice designers. Finally, another point suggested by Ryle (1945) is that 'learning-how' differs from 'learning-that', in that to learn-how pupils need to be trained "to do something intelligently" (1945, p. 15). This means that by acquiring a skillset, they are nurtured to autonomously judge their own performance, beyond a set of formulas or habit, and are ready to use that knowledge to solve problems when these emerge.

The work presented in this thesis also builds on the work from the Bauhaus, Black Mountain College, and Fluxus (Saper, 1998) to create a method that encourages embodied explorations as a means to emancipate the knowledge around textiles, in the terms proposed by Rancière (2004). This is because the knowledge being created and transferred through the 'sCrIPT tactics' requires no explanation – it emerges from the subject's autonomous understanding of their own experience. Besides the fact that the tactics (instructions) are natural to designers' practice, for having emerged from their practice, they invite play, which is what makes them so accessible. The playfulness aspect suggests a connection to Agamben's (1993) proposition that experience is related to infancy, not to be considered a *phase* that is lived and surpassed, but as a *state* that we only have if we are open to discover and to learn. Hence, the knowledge created through this method is not limited to one design project, as it is about developing a way of practicing, a way of being a designer. With that, it animates much bigger discussions on the importance of embodied practices in design (which are seen, for example, in apprenticeship).

9.2. Further reflections on methodology

The methodological approach in this thesis allowed the focus and investigation to be iteratively deepened, which enabled a detailed understanding of the embodied textile selection processes. This is seen as a funnelling approach, which provided a sound base on which to ground the development of a support for textiles selection, from this experiential perspective. This process is illustrated in Figure 53, which shows that the research started by uncovering when and how the textile selection happens in the design process, which is accompanying it rather than being one step in the process. Then, the forms through which the selection happens were revealed through the 4 tacit-themes

articulated in the ‘Quad-core Textiles Selection Model’. Following to that, the embodied processes where introduced through the ‘3S Tactile Phases’. Building on those emergent findings, the support was designed.

An aspect that affected the methodology used in this PhD was the use of third and first person approaches, as the diverse perspectives revealed very different aspects in the results achieved with each. The third-person perspective led to a more conceptual understanding, through which it was still challenging to get to a level of interpretation that would allow for proposing a solution directed at supporting the embodied textile selection processes. The first-person perspective revealed experiential aspects with greater definition, particularly the importance of the embodied processes, which added a new perspective to how the dynamics occur between discriminatory and affective tactile experience when designers interact with textiles. Therefore, this iterative approach also reflected on how the concepts dealt with became more specific throughout the thesis, from a more general treatment of experience (marked by the more frequent use of the term ‘experiential’), to a more specific focus on the embodied processes (with the use of the term ‘embodied’ to highlight the more refined focus on this crucial aspect of experience).

This understanding enabled envisioning how an initial, simple support could be introduced, that would enable interaction with these layers of the tactile experience in the selection of textiles for design. Additionally, considering this phenomenological approach broadly within the field of design research, disseminating its use presents exciting opportunities for a positive impact on practice, particularly in terms of knowledge creation and transfer, and in teaching, with the potential to supporting the understanding of the needs and means for transferring knowledge and introducing tools.

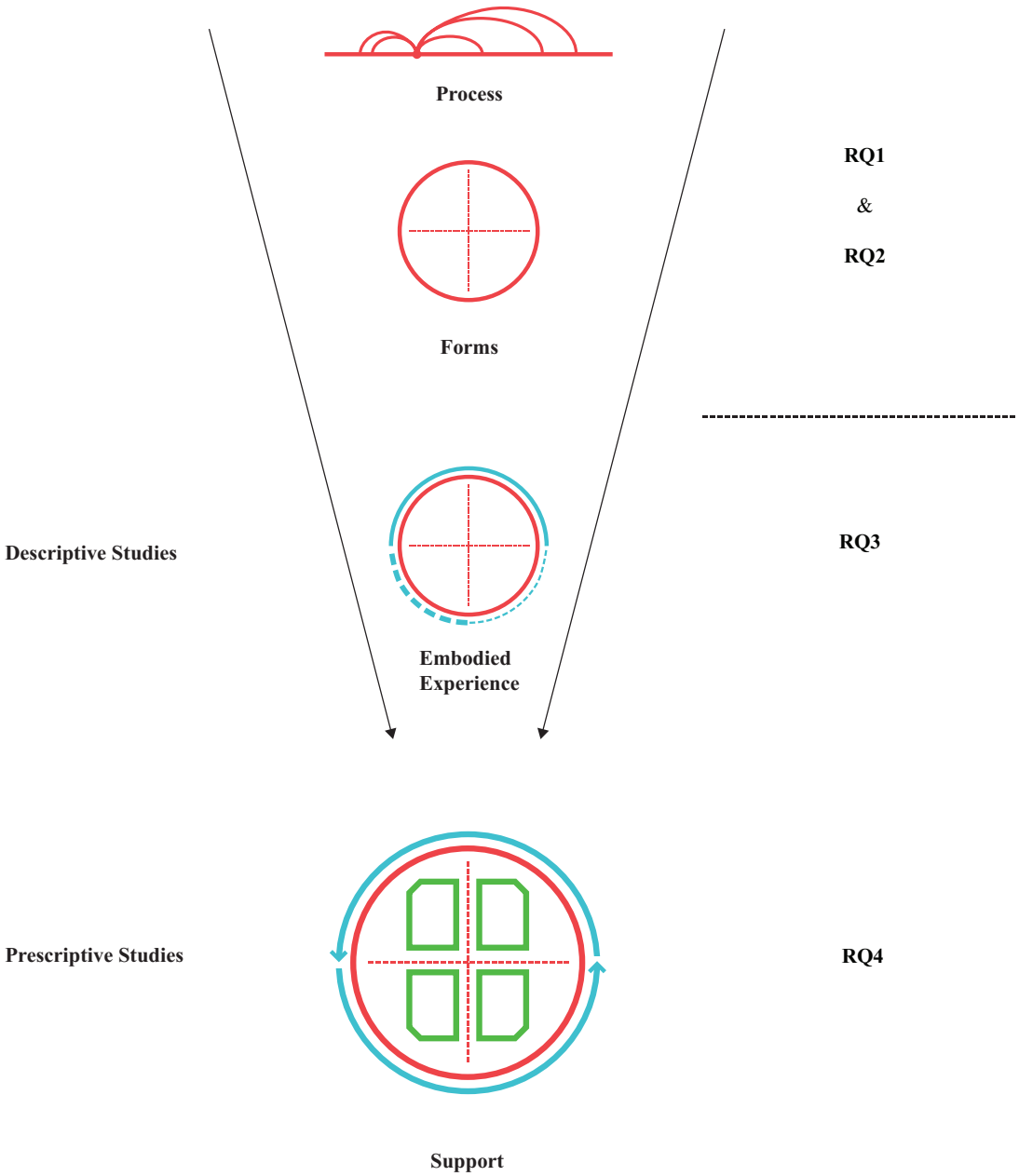


Figure 53. The funnelling approach through which the research unfolded.

9.3. Limitations of the research

The limitations of this research were presented individually in the studies in Chapters 4-8. In terms of the overall structure of the PhD, the main limitations are related to its methodological choices. Firstly, considering that an interpretive approach was taken, which is affected by the researcher background, hence other researcher analysing this data may have focused in different aspects to develop upon. In order to guarantee the validity of the overall findings, each study had an internal validation, which followed established methods, as was shown in Table 3 in Chapter 3 (p. 74), but discussed in

each study more in-depth. The tool achieved only an initial stage of evaluation, through the series of workshops conducted. However, in this thesis it is considered that since the content that lad to it were the outputs from studies in Chapters 4-7 which were individually validated, these should guarantee its relevance for the designers practice. Another aspect of limitation is the fact that this thesis focused only on the practitioners' perspective to textile selection (even if from a wide range of sectors). Hence, the results would have been different if other stakeholders (e.g. suppliers, or consumers) were involved in the investigations.

9.4. Contributions to knowledge

The contributions of this thesis to knowledge are demonstrated in three ways. Firstly, through the new understanding on the selection of textiles for design; secondly, through the new understanding on embodied aspects that are relevant to the selection of textiles; thirdly, by designing a support to the embodied textiles selection processes, which is provided as practical instructions through the method cards toolkit.

A *conceptual contribution* emerges through the theoretical understanding of the textile selection for design through understanding when and how the textile selection happens in the design process. Further emergent understanding on the tacit processes was articulated in the proposed 'Quad-core Textile Selection Model'. Deeper questioning revealed embodied aspects contributing to the experiential processes in textiles selection, providing a description of its dynamics (observing 3 tactile based themes: Situate, Simulate and Stimulate) that happen through diverse active and passive touch behaviour types (Active hand, Passive body and Active tool hand). These findings enrich the proposed 'Quad-core Textile Selection Model' including experiential and embodied components of the textiles selection that go well beyond 'textile hand' (AATCC Test Method 202-2012), and highlight the dynamics and interactions between the textile, the body and the product to be, which emerged as crucial for this process.

A *practical contribution* is demonstrated through the creation of support for embodied textile selection processes, which is presented as a practical set of instructions, designed in the form of method cards - 'The sCrIPT toolkit' (Chapter 8).

A *methodological contribution* was achieved through applying a combination of methods that are new to the design field. First, by introducing the DiCoT, which also led to observing its limitations in systems where specific skillsets are required, and to expand it by bringing in Embodied Cognition literature to support the analysis (Chapter 5). Second, by using a first-person approach through the Elicitation Interview method. The latter proved to be an applicable method for a fine-grained understanding of the design practice, which led to knowledge creation.

These contributions allow the design and textiles engineering fields to understand better *how* designers select textiles, moving beyond 'textile hand', by engaging the full-body in explorations. This has the potential to support new thinking around textiles, particularly in terms of understanding better the human experience of these materials, both in physical and digital contexts. These reveal opportunities for pedagogical development[36] and new thinking about textiles[37], which is grounded by the theory and method contributed by this thesis to readily take this into design training. Additionally, the knowledge generated around textiles experience could be further explored to inform technology development, but also reveals new ways to utilise subjective and objective data in design, towards supporting practice with tools and methods that reflect more integrally the designer practice, including sensory, cognitive and affective aspects.

9.5. Impact

The several instances through which this PhD research has interacted with academia, particularly at MA level where most of the workshops for the toolkit development were held, demonstrated that there is room for this research to be further developed into credible pedagogical methods. This is demonstrated by the numerous participations in events that emerged since this work was initiated. The toolkit has been used in several

[36] As is exemplified in the following anecdote by the fashion tutor who participated in Study 1: "(…) if you are aware you are doing something, when you are conscious of it, there is a heightened ability to do it. Even if it is something you do intuitively. For the students, when I tell "Do you know you just did this?", and they just go "Really? Did I do that?", and in that, that is powerful to develop a process." (FD1)

[37] Highlighted in the following contribution by a student participating on a workshop in Study 4: "I would say that the experience I had here was changing the viewpoint and me viewing stuff. So like, before I maybe just look at this point, and this was a key moment for me to see I never did that. And this was really interesting, and maybe changes how I look and maybe thinking a little bit more on how to choose materials, or fabrics, or anything… it is like having a different process and other ways to choose, and other ways to differentiate between things." (B4)

opportunities in further workshops within academia (used in teaching and workshop opportunities at the Royal College of Art, London College of Fashion, Delft University of Technology, and University of São Paulo), which supports the claim that these are relevant contributions to the field.

The toolkit has also attracted attention from industrial design and materials engineering research, and initial tests have shown that the instructions would need slight alterations for being applicable in these different fields, but that the rationale behind them is desired in these other fields. The interaction with the Knowledge Transfer Network in the UK (KTN) also revealed a potential for expanding the work with the toolkit in a commercial setting, looking for industrial partners to further develop this in relation to databases that provide objective measurements of textiles, in order to look for means to bring these two aspects, experiential and technical specifications, closer.

9.6. Future work

The research in this thesis focused on investigating the textile selection processes experienced by designers and means to support them. The discussion of the findings opens up questions about how the contributions around embodied selection processes could be further explored, mainly in three directions: into other materials, into other types of support, and going deeper into embodied explorations.

In relation to *expanding into other materials*, for the practical application of the 'sCrIPT method', further research would be necessary to observe which strategies can be used for other material types, or how they may be adapted, and to discover embodied processes (sensory, conceptual and affective) that are specific to the experience of other material types.

In relation to *devising other types of support*, this could be explored with a similar approach, or using the knowledge to explore other sensory modalities, as well as technology development. In considering a similar approach, a broader discussion in relation to the phenomenological approach taken is that of augmenting this presence in the design research as a means to leverage knowledge creation and transfer. This is an important shift in relation to the current method cards available in design research and

practice, which are mainly focused on idea-generation towards a final outcome, as was discussed in Chapter 8. Differently, the method cards proposed in this thesis can have a disruptive impact on how designers relate to materials broadly in their practice. Further research could follow this approach, while getting inspiration from alternative models that were previously explored in the history of arts and design such as the sensory training at the Bauhaus and the Black Mountain College, and the work with instructions by the Fluxus movement (Saper, 1998), in order to create alternative types of design methods. This approach has the potential to build on designers' expertise, generated from designers' tacit knowledge, which although is indeed subjective and instinctive, reflects underlying processes and traceable acts relevant to it. The latter are vital to recognise as knowledge in the design realm: that is know-how. A concern to keep in mind whilst exploring such methods is related to how to provide support without breaking the creative process, which awareness could do by forcing ideas to be "expressed explicitly and precisely" (Ashby and Johnson, 2010, p. 29).

This research focused on the embodied textile selection processes, and mainly through touch interaction; further research would be needed to observe other sensory modalities more closely, e.g. sound, smell, taste, as these have been shown to have a potential for design in HCI research (Obrist et al., 2013; Obrist et al., 2014). Further research could be conducted to make the concept model and the instructions on the method cards reflective of the multimodal experience.

New questions were raised through this research. For example, in terms of the touch behaviour types observed (in Chapters 6 and 7), this research could be expanded through experiments using quantitative approaches. Bringing in technology could help provide further detail, by observing aspects of the touch kinematics: speed, direction, intensity, frequency, etc. This could be applied to rethinking technology to allow engagement with textiles digitally, or to introduce tools that support designers in the diverse embodied selection processes here identified. Also in relation to objective data, another instance worth of further investigation could be to use the 'sCrIPT toolkit' as a platform for engagement between designers and engineers. Here, the cards can be used to sensitise engineers by using the tool in the same way designers do, in order for them to gain an understanding of the perspective of designers, and therefore a different perspective on objective data.

Finally, in *going deeper into embodied explorations*, this could be explored from within the design field, but also reaching out to engage further with bodily practitioners. In design, researchers into materials experience have recently proposed a 'Materials Driven Design' method (MDD) (Karana et al., 2015), which is interested in designing for experiences. In the model proposed in this work, one of the steps is related to creating a 'material vision'. This is currently done with a list of questions that suggest thinking routes, and from the work proposed in this thesis these could be explored to verify how including embodied processes could expand these questions. A future step could be taken into testing the instructions of the 'sCrIPT' toolkit to expand this work by adding heuristics in applying more experiential investigations, through the embodied selection processes identified in this thesis. As a further step to this research, it would be desirable to try to align the 'sCrIPT' toolkit with the levels proposed by the MDD – affective, sensorial, interpretive, and performative – and verify if these could be complementary, in order to introduce the embodied layer into this already established method of material experience driven research.

To start a connection with bodily practitioners, 'The sCrIPT Toolkit' was presented to bodily practitioners on different occasions. The performer Thelma Bonavita –who engaged with the research during the development of the cards – highlighted the potential that the instructions in the cards have to creative exploration, and to create access to knowledge through means that are more playful. After the final evaluation workshop, the cards were presented to the bodily practitioner Giovanni Felicioni (certified Advanced Rolfer, a Rolf Movement practitioner and a Yoga Teacher, and one of the directors of the British Academy of Rolfing® (BARSI)), who suggested that the work with the cards could have an application in pedagogical contexts where bodily skill is crucial. In the case of the cards, he suggested that the explorations included are less discursive, and more sensible and embodied. Because of that, they are opening a space for independent in-depth exploration, which is very different from being given knowledge about things. The depth of understanding provides a quality to the experience of learning that can be very transformative.

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