Making Preciousness
Interaction Design through Studio Crafts

VASILIKI TSAKNAKI
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KTH Royal Institute of Technology
Computer Science and Communication
Media Technology and Interaction Design
SE-100 44 Stockholm, Sweden
Abstract

This dissertation explores value-creation in interaction design through practical collaborations with studio craftspersons. A focus is on the meaning of “preciousness” from a design perspective – what I refer to as Making Preciousness – which highlights aspects of material properties, design processes, and the attitude to the design space. Theoretically, the work takes inspiration from the Japanese philosophy of Wabi-Sabi, which is based on the fact that things are impermanent, incomplete, and imperfect. This reflects a view of preciousness beyond notions of practical use, luxury or monetary cost. In addition to theoretical studies, I engaged in practice-based research at the intersection of interaction design and studio crafts, in the domains of leather, silversmith and textile crafting. Through an approach that blends these practices with the making of interactive artefacts, preciousness for interaction design was explored.

Through this work, I extract three qualities, all of which are closely linked to attributes and values embedded in the craft practices examined. I refer to these as resourceful composition, material sensuality and the aiming for mattering artefacts. Resourceful composition refers to approaching a design space “resourcefully”, meaning that the designer actively values and uses the specific qualities of materials and tools consciously, for what they are suitable for. Material sensuality is about appreciating the sensory experience of interacting with materials, arriving through particular material qualities, such as texture, temperature or smell, but also interactive qualities. Aiming for mattering artefacts involves actively designing for impermanence, incompleteness and imperfection, and through that contributing to notions of preciousness through use, care, ownership and interaction between users and artefacts over time.

The attitude of making preciousness can be seen as tying together materials and making with user experiences of computational artefacts. For interaction design, this points towards making processes in which computation and material knowledge, craftsmanship and aesthetic intentions are placed at the core. These values relate to cultural, but also sensual experiences, which can be seen as under-explored in the design of interactive products. An increased focus on preciousness also highlights values which, in the long term, can lead to more varied, culturally grounded, and sustainable designs.

Keywords: Interaction design, materials, making preciousness, studio crafts, resourceful composition, material sensuality, mattering artefacts, impermanence, incompleteness, imperfection
Sammanfattning


Genom mina empiriska studier har jag ringat in tre egenskaper som alla är tätt kopplade till attribut och värderingar i de hantverkspraktiker jag arbetat med. Jag hänvisar till dessa som resursmedveten sammansättning, materialsensualitet och strävan efter betydelsebärande artefakter. Resursmedveten sammansättning (resourceful composition) handlar om att designern aktivt värdesätter, hushåller och utnyttjar material och verktygs specifika kvaliteter, samt använder dem medvetet till det som de lämpas för. Materialsensualitet handlar om att värdesätta den sinnliga upplevelsen av det som designas. Detta innefattar inte bara den fysiska formen, utan även andra materiella egenskaper som t ex textur, tyngd och doft, samt även dess interaktiva egenskaper. En strävan efter betydelsebärande artefakter tar hänsyn till att värde kan växa och omformas över tid, genom användning och i samspel med andra. Översätt till interaktionsdesign handlar det om att formge interaktiva artefakter där medie- och materialkännedom, hantverkskunnande och estetiska intentioner står i centrum. Dessa värden anknnyer till kulturella och sociala, men även rent sensoriska upplevelser, vilka alla kan ses som underutnyttjade kvaliteter i studiet av interaktiva produkter. Ett ökat fokus på värdefullhet lyfter också fram värden som på sikt kan leda till mer varierad, kulturellt relevant och hållbar design.
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Contents

1. Introduction ........................................................................................................ 4
   1.1 The Design Aspects in Interaction Design Research .............................. 6
   1.2 My Background and the Context of PhD Studies ............................... 7
   1.3 Research Questions and Objectives .................................................... 9
   1.4 Research Approach and Method .......................................................... 10
   1.5 Summary of Main Contributions .......................................................... 10
   1.6 Limitations ............................................................................................ 12
   1.7 Colleagues Involved in the Research Studies .................................... 12
   1.8 Thesis Outline ...................................................................................... 13
   1.9 Overview of Papers Included ............................................................... 14
   1.10 Related Publications not Included in the Thesis ............................. 18

2. Theoretical Background: Understanding Studio Craft as a Concept and Practice .......................................... 22
   2.1 The Arts & Crafts Movement .............................................................. 24
   2.2 The Bauhaus School ........................................................................... 27
   2.3 Craft Qualities Embedded in the Japanese Philosophy of Wabi-Sabi ........................................................................ 31
   2.4 Three Contemporary Studio Craft Practices ..................................... 34
      2.4.1 Leather Crafting ........................................................................... 35
      2.4.2 Silversmith Crafting ................................................................... 37
      2.4.3 Textile Crafting ........................................................................... 37
   2.5 Main Attributes of a Studio Craft Practice ......................................... 39
      2.5.1 Materials, Tools and Workshop Space ...................................... 39
      2.5.2 Skill and Experience .................................................................. 42
      2.5.3 Personal Judgment and Craft Aesthetics .................................. 46

3. Related Work: Crafts in Interaction Design .......................................... 54
   3.1 Interaction Design as a Practice of Making Computational Artefacts ........................................................................ 54
   3.2 Emerging DIY and Digital Fabrication Making Practices .................. 56
   3.3 Craft Practices and Materials ............................................................... 59
   3.4 From Materials and Making Practices to User Experience ............... 62

4. Methodological Approach: The Studies ............................................. 70
   4.1 Design Research in Interaction Design .............................................. 70
   4.2 My Design Space ................................................................................. 72
   4.3 Overview of the Research Approach
5. Methodological Reflections .................................................. 92

5.1 The Three Interaction Crafting Studies:  
Design “Experiments” and Exemplars ................................. 92

5.2 Studying Preciousness Through Craft Theory: 
Sequencing Theory and Practice ......................................... 94

5.3 Articulating Making Preciousness: 
Intermediate Level-Knowledge Abstraction ....................... 95

5.4 Research Validation: Contestable, Defensible, 
and Substantive .................................................................. 96

6. Making Preciousness for Interaction Design..................... 101

6.1 Resourceful Composition ................................................ 102

6.2 Material Sensuality .......................................................... 106

6.3 Mattering Artefacts ............................................................ 109

6.4 Interrelations Among the Three Qualities 
of Making Preciousness ....................................................... 113

7. Discussion ........................................................................... 118

7.1 Reflections on Studying Preciousness through  
Studio Crafts ........................................................................... 118

7.2 The Contradictory Aspects of Preciousness Through 
Impermanence, Incompleteness and Imperfection.............. 120

7.3 What Values Does Craft Bring to Interaction Design? ....... 122

7.4 Reflections on the Authorship of the Maker 
in Studio Crafts ...................................................................... 123

8. Conclusions ........................................................................ 130

References ............................................................................ 134
Chapter 1

Introduction
1. Introduction

There are many different reasons why any artefact, physical or computational, could be considered to be precious. It could, for example, be due monetary cost in the case that something has been bought as an exclusive or expensive artefact. Additionally, preciousness and value could emerge through the material qualities or the design properties of an artefact, as in the case of well-crafted artefacts that are considered to be of good quality, reflected in vintage value, for example. On the other hand, we tend to value things beyond their monetary cost, their ease of use or their robustness. Instead, we might value something that is fragile, ephemeral, or has been bought very cheaply from a second-hand market. Preciousness could also emerge due to the personal meaning and significance inscribed on an artefact through use over time, or due to emotional attachment, in the case of something that was given to the owner by a loved one. Similarly, in the case of computational artefacts, the reason why something might be considered precious or valuable to a user depends on a number of factors ranging from efficiency and usability in terms of functionality (Buxton, 2007; Hassenzahl & Monk, 2010; Overbeeke & Wensveen, 2004), to meaning and considerations of user experience beyond the usability of a computational artefact (Broms, 2014; Djajadiningrat et al., 2000; Lowgren, 2009; McCarthy et al., 2006).

Several interaction design researchers within the domain of Human-Computer Interaction (HCI) and interaction design have studied the relationships between users and technologies, mainly in regard to how an increase in value from a user perspective can contribute to increasing the longevity of computational artefacts (Blevis & Stolterman, 2007; Odom et al., 2009). Contributing to this research space, I am presenting a body of work in which I have studied preciousness for interaction design. Designing for preciousness is here understood as designing computational artefacts that have particular qualities, which contribute to such artefacts being considered as valuable from a user perspective. The particular way I have done so, is through studio craft, as a practice and concept, focusing on materials and design considerations when it comes to giving form to computational artefacts. In studio crafts according to Shiner (2012) and Koplos and Metcalf (2010), the designer and maker is the same person and there is a high degree of skill and experience involved.

Specifically, I have engaged in practice-based and exploratory design...
research (Koskinen et al., 2013; Redström, 2017) at the intersection of contemporary studio craft practices and interaction design, and specifically in leather, silversmith and textile crafting. My aim in this dissertation has been to study how notions of preciousness emerging through studio craft were concretely informing the way that materials and making were approached and treated at each intersection. Especially, in regard to how aspects of materials and how a making process unfolds can influence the user experience and consequently, potentially also the long-term use and adoption of technology. And, through that, to extract, at a higher level, which aspects of preciousness that were emerging through studio craft practices could be of relevance to interaction design and which can subsequently inform design research in this domain. This allowed me to articulate the quality of making preciousness for interaction design through studio crafts. Therefore, my dissertation has been driven by the urge to explore what studio crafts as a particular approach can contribute to exploring preciousness for interaction design, from a perspective of how we could design computational artefacts beyond practical use, to consider also aspects of materials and culture, and what that would be entailed in terms of approaching a design space, but also in terms of relationships between people and artefacts more broadly.

Craft has caught the attention of several researchers in the HCI community, e.g. (Bean & Rosner, 2012; Benford et al., 2017; Buechley & Perner-Wilson, 2012; Golsteijn et al., 2014). Research studies at the intersection of crafts and interaction design have mainly focused on exploring a particular craft material such as glass, ceramics or textile (Meese et al., 2013; Perner-Wilson et al., 2011; Persson, 2013; Rosner et al., 2015; Schmid et al., 2013), or a craft practice such as knitting, pottery, carving or sewing (Buechley & Perner-Wilson, 2012; Rosner et al., 2015; Rosner & Ryokai, 2009; Zheng & Nitsche, 2017). In these contexts, craft was approached as an inspiration, or as actively designing tangible interactive things that integrate particular craft materials, or from the perspective of how it can inform concrete aspects of making computational things. Additionally, an extensive body of work at the intersection of crafts and interaction design, concerns the exploration of digital fabrication technology, such as a laser cutter, for crafting artefacts, which has previously been referred to as hybrid fabrication or digital craftsmanship (Devendorf & Ryokai, 2014; Jacobs et al., 2016; Jacobs & Zoran, 2015; Zoran, 2015; Zoran & Buechley, 2013).

I consider studying the quality of preciousness for interaction design through studio crafts to be important for two main reasons. The first is because studio craft as a practice shares a number of common characteristics with interaction design as a practice of giving form to computational things. But, at the same time, these differ substantially, and studio
craft has been described previously as contributing to preciousness from a material perspective, but also in regard to how a craftsperson approaches a making process, which ascribes certain qualities to a crafted artefact (Adamson, 2010; Shiner, 2012). This is reflected in the fact that outcomes of a studio craft practice are often related to words such as “authentic” or “unique” apart from “precious”, for example due to the use of rare or expensive materials, professional craftsmanship, but also due to the authorship a studio craftsperson has over their artefacts. Therefore, studying studio crafts for interaction design can offer new insights into and perspectives on the design of interactive artefacts, in regard to preciousness ranging from material considerations to aspects of the actual making process, and to aspects of value, more broadly.

The second reason why I consider studying preciousness for interaction design through studio crafts to be important is related to the ongoing interest in experience-centered design in the domain of interaction design (Benford et al., 2009; Buxton, 2007; McCarthy & Wright, 2004; Wright et al., 2008). Several researchers are studying the various possibilities that technology can offer in providing people with more playful, ludic, pleasurable, aesthetic, or hedonic experiences to people (Bardzell & Bardzell, 2011; Benford et al., 2005; Bertelsen & Petersen, 2004; Ferreira, 2015; Höök et al., 2016; Lim et al., 2007). In this research space, apart from aspects of usability, efficiency or functionality, which are core design goals, the importance of also considering also the full experience of interacting with technology has been emphasized, and how this can contribute to engaging user experiences. According to previous research in this domain, this can include aspects such as the felt and aesthetic user experience (Höök, 2016; Schiphorst, 2009), enchantment through technology (McCarthy et al., 2006), or value-sensitive aspects (Friedman, 1996). Such topics in regard to the relationships between people and artefacts have also been discussed from a broader philosophical perspective that expands to the morality we inscribe to things we design, but also to design ethics and the politics of artefacts (Ihde, 1995; Latour, 1992; Verbeek, 2010, 2011; Winner, 1980). Such philosophical perspectives have been influential to the interaction design community within HCI that studies relationships between people and artefacts grounded in everyday practices.

1.1 The Design Aspects in Interaction Design Research

This dissertation aims to contribute to the research domain of interaction design (IxD) and to the broader domain of Human-Computer Interaction (HCI). In interaction design, there is a growing research community that is engaging in design-driven research approaches, which is important to consider in order to understand the motivation for my research, and especially why I studied preciousness for interaction design.
through studio crafts, but also why I approached studio crafts through interaction design.

HCI is the research domain that studies the many facets of how people engage with new types of computational things, from perspectives that include how to develop new technologies for people, how to study those, but also how to solve particular problems through the development of new computational artefacts or environments (Sharp et al., 2007). In order to study the relationship between people and computation from such a varied perspective, HCI draws on a vast spectrum of disciplines such as on psychology, engineering, computer science, social and technological studies (STS), and design, to name just a few. In this context, interaction design can be considered as the discipline, or the sub-community that focuses more on the actual process and outcomes of designing technologies. In contrast to other design practices such as industrial or graphic design, interaction design has previously been described as a practice of giving form to computational things (Hallnäs & Redström, 2002; Vallgårda, 2013), for example by investigating “new ways of designing computers, in addition to new ways of designing with computers” (Vallgårda, 2013).

Considering interaction design as a “making” practice, the spectrum of materiality includes, apart from physical materials, also code written on a programming platform (Lindell, 2013), media, for example in the form of photos or videos (Golsteijn et al., 2014; McCullough, 1998), and also various combinations of physical with computational materials. Therefore, an interaction designer is often engaging practically or “designerly” with materials and tools in order to develop artefacts, systems, or environments, for a particular research context or use-case scenario (Djajadiningrat et al., 2004; Gaver & Bowers, 2012; Odom et al., 2016; Wensveen & Matthews, 2014). Thus, metaphorically, an interaction designer could be seen as a crafts-person, developing and practicing ways and methods of skilfully giving form and shape to a varied material spectrum, for designing systems, interactive artefacts or environments. A central part to this practice is the design of the interaction gestalt or behaviour of a computational artefact, meaning how the artefact will respond based on the way a user will interact with it (Löwgren, 2006; Vallgårda, 2013).

1.2 My Background and the Context of PhD Studies

My personal background played an important role in how I approached the above research space, but also how the actual research process evolved. I am originally trained as a design practitioner, but at the same time I have been engaging in physical crafts for more than a decade. First of all, I have been educated as a Product and Systems Design Engineer at the University of the Aegean, in Greece, with a specialization in interaction design. This was a five-year Diploma in a very multidisciplinary educational environment, including courses and studio-based design work ranging from product and interaction design to material science, design management, and free drawing courses, to name just a few. While studying there, I spent one year as an
exchange student in Germany, six months at the Köln International School of Design in Cologne and another six months at the Weissensee School of the Arts in Berlin, at the Department of Textile and Surface Design. This year was very influential for my design practice, since I engaged in fashion design projects and started exploring practices of crafting electronics from soft and textile materials, but also developing further a strong interest in materials and crafting at the Weissensee School of the Arts.

While studying in Greece, apart from doing exchange studies, I have also completed an exchange internship at the Elena Poka Company in London the UK, where my role was to design and construct several costumes and accessories for an artistic performance. This was a three-month experience that allowed me to develop my skills in practice-based craft and design work. After completing my studies, and before starting my PhD at KTH, I worked for six months as a design assistant at the motoco project, which was initiated and running at the HyperWerk Institute for Post-industrial Design, which belongs to the University of Northwest Switzerland (HGK FHNW), located in Basel, Switzerland. During these months, I was engaged in practical design work, building mobile furniture and exhibition constructions, which were used for the needs of the project. At the same time, I gained experience in using personal fabrication machines, and especially a laser cutter, which was a main tool in our design work. The main materials I worked with at HyperWerk were leather, wood and metal, which were used for the design work conducted as part of the motoco project.

I started my PhD in 2012, as part of the interaction design research group at the Media Technology and Interaction design department, at KTH, doing 80% research and teaching 20% on various interaction design courses. My PhD position was also partly funded by the Mobile Life VINN Excellence Centre, which was a ten-year research centre that closed in March 2017. The Centre operated as a joint venture between its research partners, industrial partners and public-sector partners with funding from the Swedish governmental funding agency VINNOVA. Its research focus was on the design-led exploration of novel technology, by envisioning a society in which enjoyment, happiness, pleasure and playfulness would be key factors. My research evolved in the Arts & Crafts project running at Mobile Life, which was a project aiming to explore the artistic and craft perspectives of interactive artefacts on a spectrum that spans from popular culture and folk art, to how crafted interactivity takes form in public exhibitions and on the contemporary art scene. In this context, I was exploring the “crafts” angle of the project, from a practice-based and design-centric research perspective, aiming at contributing to the domain of interaction design within the broader field of HCI. As part of my PhD studies, I have also been involved in the Precious Materials of Interaction project, which was funded
by Innovativ Kultur, an organization that was run by the City of Stock-holm, aiming at supporting innovative ideas in the cultural and artistic sector. This project was focusing on exploring wearable technology from the perspective of jewellery crafting, and was run in collaboration with the Stockholm-based silversmith artist Emma Rapp.

1.3 Research Questions and Objectives

The main focus of my research has been to study preciousness for interaction design through studio crafts, both practically and from a conceptual perspective. I consider the main research questions driving my work as being the following three:

**Main Research Question:**
1. How can we conceptualise preciousness for practices of making interactive artefacts?

**Second Research Question:**
2. How could theoretical concepts from craft knowledge contribute to further understand preciousness in interaction design?

**Third Research Question:**
3. What particular challenges and insights emerge in regard to techniques, tools and materials at the intersections of interaction design and studio craft practices?

These research questions were approached through my engagement in three distinct studies focusing on the studio craft domains of leather, silversmith and textile crafting (Papers 1-4). Each study focused on the practical engagement with materials, tools and processes of working in the intersection of studio crafts and interaction design, in order to arrive at the development of design research artefacts (Pierce, 2014), together with the craftspersons involved. The aim was to gain insights through observing, documenting and reflecting on each process and their outcomes, on how each studio craft practice was contributing to revealing notions of preciousness. Additionally, studying contemporary studio craft practices close to experienced craftspersons in each domain allowed me to better understand studio craft as a practice and concept, in regard to its attributes and values.

During the second study focusing on silversmith crafting, we started exploring preciousness through a rather theoretical account of crafts, beyond the concrete design work and explorations. At this stage, the second research question emerged. In order to arrive at a more conceptual understanding, we explored crafts theoretically, in particular through the Japanese philosophy of Wabi-Sabi (Juniper, 2011). There-
fore, another approach of studying preciousness for interaction design was through the three intermediate-level knowledge concepts of impermanence, incompleteness and imperfection, which are embedded in Wabi-Sabi and in studio craft practices. This research question has been approached by engaging in the fourth study, which is an analytical and reflective one presented in Paper 6.

Finally, since I have engaged in concrete design work and explorations focusing on materials, tools and techniques at the intersection of three particular contemporary studio craft practices and interaction design, my research has been also driven by the third research question stated above. This question has been answered in the detailed material and process accounts included in Papers 1–5.

1.4 Research Approach and Method
I have approached the above research questions primarily through practice-based explorative design research. I have engaged in three long term-studies, to which I will refer as interaction crafting studies, in order to stress the presence of studio craft and interaction design. The studies were initiated from an interaction design perspective and lasted between six months and one year. During each study, experienced crafts people were involved, in the domains of leather, silversmith and textile crafting. The process of engaging in the interaction crafting studies can be understood as engaging in a Research through Design (RtD) methodological approach, which has previously been described as a process in which doing design work is part of doing research (Stappers & Giaccardi, 2017; Zimmerman et al., 2010). Looking at the overall research approach including all four studies, it can be seen as a research program (Binder & Redström, 2006; Redström, 2017) of which the title and main research direction was “exploring preciousness for interaction design through studio crafts”. The different studies comprise the various “experiments”, a core part of a research program, according to Binder and Redström (2006).

1.5 Summary of Main Contributions
I consider that there are three main contributions of my research. These can be seen as expanding on a spectrum of more generalizable and high-level knowledge contributions, or intermediate-level knowledge contributions (Höök & Löwgren, 2012), to very specific and concrete contributions or ultimate particulars (Gaver, 2012; Stolterman, 2008), as I will describe below:

1. The first and main contribution of my work answers the first research question. It is the articulation of making preciousness as a quality for interaction design through the three-sub qualities of resourceful composition, material sensuality and mattering artefacts. This articulation can be considered as an intermediate-level knowledge contribution,
since these three qualities consist of an abstraction of particular insights that were extracted from the four studies included in this dissertation. They emerged through the three interaction crafting studies in addition to the theoretical one. The three sub-qualities emerged, and consequently are acting on a level of materials, on a level of a making process, on a level of user experience, and, through those, potentially on a level of long-term adoption of computational artefacts. Additionally, they are closely related to the attributes and values of studio crafts, and for that reason, they provide a resource for transferring some of the craft attributes and values to the domain of interaction design. In Chapter 6 of this dissertation I articulate and discuss the quality of making preciousness as it emerged in my work through the three sub-qualities, from a perspective of how and why they can be of relevance and value to interaction design and HCI, more broadly. Additionally, I discuss how these sub-qualities could be used in interaction design for guiding a process of giving form to computational things in regard to aspects of materials and making. But also how they could be used for reflecting on how computational things are designed, valued and lived with, over time.

2. The second contribution answers the second research question. It is a theoretical elaboration on how the philosophical principles of Wabi-Sabi could be applied to HCI. Specifically, in Paper 6 we articulated how the three high-level craft qualities of impermanence, incompleteness and imperfection that are embedded in the Japanese philosophy of Wabi-Sabi, firstly are of relevance to interaction design research. Additionally, we articulated three design principles, in the form of paradoxes, which they could be used for guiding a process of designing computational artefacts based on impermanence, incompleteness and imperfection, and through that contribute to designing for preciousness in interaction design.

3. The third contribution, which responds to the third research question, consists of the concrete design exemplars of how to use leather, metals or textile in combination with computational materials for designing artefacts in interaction design contexts. In Paper 1, a number of insights and reflections are presented on how to use leather and e-textile materials for making a touch-sensitive input surface and how to use a laser cutter for crafting leather. In Papers 2 and 3 concrete examples are presented of how to utilize the conductive properties of metals for designing input sensors. Additionally, there are reflections on how to explore materials, making processes and interaction qualities when designing wearable technology in the form of accessories, by having jewellery as a lens for exploring aspects of preciousness. Finally, in Paper 4, a particular design exemplar is presented of how to design an interactive garment that responds to the movements of the wearer with an intricate soundscape, designed for implicit, rather than for explicit modes of
interaction, by combining metallic studs, copper thread, textile, electronic components and sound computing.

These contributions are mainly of relevance to interaction design researchers, who are studying the space of designing computational artefacts from a perspective of how aspects on a level of materials and making processes can influence and affect the way computational things are experienced in interaction, and lived with. But, also to the interaction design research community that studies how to design computational artefacts that would be meaningful and valuable to people, from a broader perspective beyond practical use. Finally, the third contribution could provide useful examples for interaction design researchers working with new types of computational and physical materials.

1.6 Limitations
The research conducted and presented in this dissertation is far from a complete investigation of the research space and has a number of obvious limitations. The most important of these is that I studied craft for interaction design only through studio crafts, and in particular three very specific studio craft practices. This choice has confined my design space and consequently my results and contributions. Another limitation is the methodological approach and the fact that my research explorations focused almost exclusively on making and material aspects, and much less on evaluating the design research artefacts in realistic use contexts, as they were only presented and experienced, for example when exhibited or demonstrated at conference venues. This allowed me only to gather some reflections from trying the artefacts myself, or when colleagues or other people in my surroundings where briefly experiencing their computational and physical qualities. Additionally, I have approached this research space and the topic of preciousness through practice-based research, instead of studying how people experience and value computational artefacts in real use settings and everyday practices, for a longer period of time, as previously studied by for example (Odom et al., 2012; Wakkary et al., 2017). Another limitation is the fact that I am offering insights only from a perspective of interaction design, and not from a crafts perspective. Specifically, I present only how the interaction crafting studies influenced my understanding of interaction design in regard to what studio crafts can contribute to exploring preciousness, but not how the practice of the studio craftperson involved in the studies was influenced by our collaboration, or what they learned from interaction design, for their craft practice.

1.7 Colleagues Involved in the Research Studies
It is important to mention my colleagues, who have been involved in and contributed to the research studies included in this dissertation. Espe-
cially since here I am offering my personal viewpoint, and involvement in the research process, while other researchers and designers who have participated in my studies also have authorship of the work. In the first interaction crafting study focusing on leather material, the main people involved in the practical work were the leather craftsperson Isla Bayer, and Mischa Schaub who was at the time the director of HyperWerk Institute of Post Industrial Design, which belongs to the HGK FHNW University, located in Basel, Switzerland. But apart from these two people, a number of design students and design practitioners contributed especially to the conception of the Sound Box, as this artefact was finalized during a collaborative workshop that took place at Yildiz Technical University in Istanbul, Turkey. Especially Frank Fietzek, who helped with the development of the software. In transforming the data of this study into a research paper, Ylva Fernaeus, my main supervisor and Associate Professor at KTH Royal Institute of Technology, contributed significantly.

In the second study focusing on silversmith crafting, other people involved were the silversmith artist Emma Rapp, who is based in Stockholm, Ylva Fernaeus, Martin Jonsson, Associate Professor at Södertörn University located in Stockholm, Sweden, and Jordi Solsona-Belenguer, who was at the time a PhD student at my research group. Martin Jonsson was involved in organizing some of the workshops and reflecting on the process and outcomes of the study, and Jordi Solsona-Belenguer was supporting me with the technical and computational aspects of the project.

In the third interaction crafting study focusing on textile crafting, my colleague Vincent Lewandowski was also involved as an experienced textile craftsperson in addition to his expertise as an interaction designer. An important member of the project has been Ludvig Elblaus, who is a PhD student at the same department that I am also part of, that of Media Technology and Interaction design at KTH. Ludvig Elblaus has been the sound computing crafts expert, who programmed and developed the sound computing output of the Nebula interactive garment. At the same time, he was a crucial member of the collaborative crafting process that led to the final conception and design of the Nebula interactive garment. Additionally, Roberto Bresin, Professor at the Department of Media Technology and Interaction design at KTH, was also involved in the reflective and theoretical parts of the process. Finally, Ylva Fernaeus was involved in the initial stages that included brainstorming sessions and the exploration of the design space. In the fourth study, Ylva Fernaeus contributed significantly to the reflective and analytical process.

1.8 Thesis Outline
The format of this dissertation is a compilation thesis in which this introductory part is called *kappa* in Swedish, translated as “coat” or “cover”.
It should be read in conjunction with the collection of research articles included in this book. For this reason, the aim of this text is to combine the research publications into a cohesive whole, and to present the aim of the overall research program, of which the individual studies and consequently publications are part.

The Introduction (Chapter 1) aims at providing an overview of the research topic and the methodological approach, but also the main research questions and contributions of this work. In Chapter 2, I provide a theoretical background to studio crafts, as a practice and concept. I focus on presenting the main attributes and values of studio crafts, based on historical accounts and on the three contemporary studio craft practices I studied. Chapter 3 gives an overview of craft-related research in interaction design and HCI. Chapter 4 outlines the methodological approach that I pursued for conducting this research, by offering an overview of the research studies included. Chapter 5 includes a reflection on my overall methodological approach. In Chapter 6 I am presenting the main contribution of my work, which is the articulation of the quality of making preciousness for interaction design. Chapter 7 includes a discussion, in which I place my work in a broader context, raise issues in regard to the limitations of this research, its relevance for interaction design, and suggestions for future work. Finally, in Chapter 8 I conclude by revisiting my research questions and contributions.

1.9 Overview of Papers Included

Apart from the *kappa*, this dissertation consists of six papers, which have already been published. Below I will summarize each paper and briefly present the main contributions and outcomes of each one.

**Paper 1:**
*Nominated for Best Paper Award*

This paper is based on two research explorations at the intersection of leather crafting and interaction design in which a professional leather craftsperson was also involved. The first exploration is focused on how to combine leather with electronic components for making a touch-sensitive input surface, and the second on how to craft leather both with specialized leather-crafting hand tools and with a laser cutter. This work resulted in the design of the Sound Box, a table that has a leather touch sensitive input surface that responds to touch by playing different recorded sound files. The second exploration resulted in a series of
physical leather artefacts that have been used for exhibition constructions. The main contribution of this paper concerns the articulation of the affordances and crafting properties of leather through the detailed account of both design explorations, which can guide the design of new interactive artefacts.

**Paper 2:**

The focus of this paper is a series of design explorations on the topic of wearable technology, and specifically on interactive accessories, through the lens of jewellery crafting. We studied this design space both from a conceptual angle in regard to meaning and personal significance, but also from an angle of making, by looking at the properties of jewellery in terms of material considerations and crafting. The first contribution of the paper concerns what we call “material preciousness”, which refers to utilizing the conductive properties of metals resourcefully, for making input controls by using copper or silver as an input interface. The second contribution concerns a broader critique in regard to aspects of the longevity and obsolescence of interactive accessories, when designed to look more like jewellery and less like gadgets. The final topic discussed in this paper is related to the positive and problematic aspects of making precious interactive accessories by leveraging crafting and material aspects. The topics addressed range from aesthetics, user experience when interacting with craft materials, and exclusiveness related to expensive materials or crafting methods.

**Paper 3:**

This paper presents the main insights and results deriving from a one-year practice-based and exploratory collaboration with a professional silversmith craftsperson. The aim of this study was to explore the intersection of silversmithing and interaction design at a fundamental level of materials, tools and making. The topics addressed in this paper include basic combinations of materials from both practices, which we called “hiding or surfacing the electronics”, the design of simple sensors such as buttons or switches, and ways of shaping and forming the mate-
rials involved based on the tools used in silversmithing and interaction design. The contributions of this paper concern high-level reflections at the intersection of both practices. The first reflection was that, due to the fact that the silversmith practice demanded a hands-on and tangible approach to the materials and tools involved, this led to the design of sensors with a tangible interaction gestalt, instead of actuators. The second reflection concerns how the values of material preciousness, slowness in regard to crafting and the professional aspect embedded in silversmithing offered a lens for reflecting on agile making processes in interaction design and material qualities of electronics. The final reflection concerns the fact that the “hybrid” crafting at the intersection of both practices had the character of explorative tinkering or material exploration instead of crafting, due to the lack of tools and the clashes on values.

**Paper 4:**

The focus of this paper is the Nebula interactive garment, which was the outcome of exploring the intersection of interaction design, sound computing and textile crafting. Nebula is a wireless studded cloak made of fabric, metallic studs, conductive thread and electronic components that reacts to the movements of the wearer and responds with an ethereal soundscape. In this paper, we present the main aspects of the design, implementation and interaction with the Nebula. We use the concept of *functional aesthetics* to present how the design process and the goal of designing for implicit interaction, led us to the use of metallic studs both as the main visual and at the same time interactive material, due to the conductive properties of metal.

**Paper 5:**

This paper is focused on the use of craft materials for designing interactive artefacts. We reflect on what types of experiential properties the craft materials leather, metals, wood and textile can evoke in interaction. The paper is based on Giaccardi and Karana’s framework on
materials experience (Giaccardi & Karana, 2015), and also the action-centric perspective on tangible interaction of Fernaeus et al. (2008). We distinguish between three experiential properties that we want to draw attention to: sensory experience, physical manipulation and interaction behaviour, and especially how those can implicitly be guided by the physical surface of things. This is the main contribution of the paper, in regard to craft practices and materials, and how they can guide the design of the interaction gestalt. By sensory experience, we refer to the way craft materials allow certain unique sensual experiences, which as such can guide interaction, but also user experience. We provide as an example the leather touch-sensitive input surface of the Sound Box presented in Paper 1. The physical manipulation refers to the crafting properties of materials and the fact that those properties can imply particular manipulation and interactions. For this, we provide as an example a speaker made of textile and wool that provides a personal and intimate interaction with the speaker. Finally, the interactive behaviour refers to the inherent properties of craft materials to conduct, to resist or to trigger, and how this can be used actively as a resource when designing interactive artefact with such materials. We provide as an example the copper and silver buttons presented in Papers 2 and 3.

Paper 6:

In this paper, we use the Japanese philosophy of Wabi-Sabi as a resource for discussing the material foundations of interactive products and systems, from a crafts perspective. Firstly, we provide an overview of how the three principles of impermanence, incompleteness and imperfection, which are embedded in Wabi-Sabi, at the same time constituting high-level qualities of studio crafts, have previously been addressed in HCI and interaction design. Then we do an interaction critique of four interactive artefacts based on those three realities, focusing on their design gestalt, their materiality, but also on terms of use practices. The main contribution of this paper is the articulation of three paradoxes, which highlight the intersection of crafts, through the philosophy of Wabi-Sabi and interaction design, and which can contribute to designing for preciousness in interaction design, or be used for reflecting on existing interactive artefacts. Those are: a) designing for long-term interaction through conscious use of impermanent materials and media, b) approaching perfection through explicitly unfinished designs, and c) engaging with the richness of interactive expressions.
by embracing limitations in current technology. Finally, we discuss how these principles could be understood and applied to the broad context of HCI.

1.10 Related Publications not Included in the Thesis

Below is a list of publications not included in this thesis, but which have contributed to my research process, in different ways.


CHAPTER 2

Theoretical Background: Understanding Studio Craft as a Concept and Practice
Chapter 2

Theoretical Background: Understanding Studio Craft as a Concept and Practice
2. Theoretical Background: Understanding Studio Craft as a Concept and Practice

“Craft practice has endlessly redefined itself and developed new forms in new media as a response to fine art, design modernism, postmodernism, education, patterns of consumption, class, politics and all sorts of currents in social and cultural history. The identity of craft is very fragile, but its practices have continued to command respect. Debates over its meaning and definition continue, and it is precisely this protean and fragile quality that also makes it so interesting.”

(MacDonald, 2005, p.48)

Craft is a very rich and complex concept to unpack. On the one hand it refers to a variety of disciplines characterized either by a set of materials, or techniques or by the names of functional products (Shiner, 2012), but at the same time it can refer to a practice of making. As a making practice, craft is the skilful process of giving form and shape to materials in order to transform these into a new entity, being an artefact or a new configuration of matter. A craft process involves the use of tools and revolves around a material space, based on the aims, the experience and the personal judgment of the craftsperson (Sennett, 2008). As a particular approach to making physical artefacts, crafting is characterized by the reflection or “dialogue” with a particular type of material being in focus (Schön, 1983). Therefore, at the core of what craft represents as a process of making is the close interplay among the craftsperson, materials and tools, all grounded in experience and skill (Hung & Magliaro, 2006).

Apart from a making practice, craft is also a concept embedded with a set of values and cultural significance (Attfield, 2000; Shiner, 2001). As a concept, crafts have a rich historical tradition and, according to McDonald (2005), craft agendas and practices have always questioned and responded to social and cultural issues throughout history. The complexity of craft is also attributed to its long history and to a shift in its meaning throughout the years. Craft as a making practice can be traced back to the beginnings of human civilization, when people started to use those materials available around them, such as stone, wood, or straw, for making utility products ranging from clothes to household equipment or decorations (Ingold, 2013).
Throughout the centuries, craft has always been associated with actions of making, similar to art or design, but the ontology of the word in regard to what it represents and stands for today has gone through several changes. As pointed out by Shiner (2012), “craft as a category has been relational from the beginning, positioned between industrial production on one side, and fine art on the other” (p. 233). From that quote we can understand better where craft stands in relation to design and art, since industrial production is used to refer to (industrial) design practices and fine art to refer to art practices. In between those two disciplines, craft has been constantly struggling to gain value and significance compared to art or design, since most often craft has been considered as a “lesser” practice, associated with decorative or applied, instead of fine arts, but also with handicraft or small-scale production of artefacts, instead of industrial production (Attfield, 2000). The devaluation of craft is also related to the fact that craft, and especially handicraft, has consistently been seen as an inherently feminine pursuit linked to the sphere of domestic life (Attfield, 2000) and, therefore, seen as being of less importance compared to the more “masculine” practices of art, as mentioned by McDonald (2005), or to the quest for technological rationality and mass production of artefacts embedded in industrial design.

It is beyond the scope of this dissertation to provide an extensive and complete definition or historical account of craft. But, what is important is to gain an adequate understanding of what craft, and in particular studio craft, represents as a concept and a practice, and what values it brings, when there is a craft attitude towards making. Therefore, I will firstly provide a brief historical account of craft by presenting two significant traditions, the Arts & Crafts movement and the Bauhaus school. These are used as theoretical underpinnings for unpacking studio craft as a concept, and for understanding some of the cultural grounding of where it comes from, and what it still represents. The reason for choosing those traditions is because they offer a strong theoretical background to understanding crafts more broadly, since their relationship with craft has been extensively articulated before. But, at the same time, these two traditions have influenced design practices in general, but also design practices within interaction design. They provide two available but also complementary theoretical perspectives on both craft practices and craft ideology. Finally, they offer a vocabulary and concrete examples of what we would recognize as craft in relation to design, before moving on to actually studying studio craft as a making practice, in regard to its core attributes, as I will do later in this chapter.

Apart from the two historical traditions of craft, I will also present a third historical perspective on which I draw for unpacking studio crafts. This is the Japanese philosophy of Wabi-Sabi, which has previously been summarized by Powell (2005) through the three realities of “nothing
lasts”, “nothing is finished”, and “nothing is perfect”. Wabi-Sabi has previously been used as an aesthetic concept in craft and product design mainly in regard to the materiality of products (Koren, 1994; Mente, 2006; Tierney, 1999), and also as a particular style in architecture characterized by minimalism and imperfection (Juniper, 2011). The reason why I use Wabi-Sabi as a third perspective to look into studio crafts is because it is embedded with the craft qualities of impermanence, incompleteness and imperfection, which are also embedded in studio craft as a practice and concept. To me, Wabi-Sabi offers a more pragmatic perspective on what craft is, through the three realities of impermanence, incompleteness and imperfection embedded in this philosophy. These three high-level craft qualities bring a rather honest or pragmatic view in regard to materials, crafting practices, but also in regard to the adoption of artefacts.

After drawing on the historical and theoretical accounts on craft, it is deemed important to see which aspects of craft are still relevant today, grounded on a pragmatic approach of how craftspersons work. In order to do this, I will provide a brief overview of three studio craft practices I studied as I was introduced to each one of them. These are leather, silversmith and textile crafting. After briefly presenting each one, I will expand on the main attributes of a studio craft practice based on related work and on what was present in the practical work conducted in collaboration with the craftspersons in each studio crafts domain.

2.1. The Arts & Crafts Movement

The Arts & Crafts movement began in Britain and flourished in Europe and North America between about 1880 and 1920, but it also emerged in Japan in the 1920s. William Morris, who was mainly a textile designer, was a pioneer and strong supporter of that movement in England. The movement emerged as an economic and political answer to the industrial mass production of goods that was focussing predominantly on making profit, as discussed by Stankiewicz (1992). Craft was the central component of the movement, reflecting its core ideals. It advocated small-scale production of utility objects and stood for traditional craftsmanship, in which decorative arts applied in the production of utility products was a way of challenging ideals of mass production and the industrialization of products. During that time, crafts became a unified concept. According to Greenhalgh (2010), it would not be an exaggeration to say that craft emerged as an actual concept at that time, since there came into being a generally recognized sense of craft as a thing in itself. Of course, craft existed before the Arts & Crafts movement, but it was then that it became recognized as a broader concept, and the political values of the movement became the values of craft itself.

Craft acquired a strong political dimension, which emerged during
Figure 1a. A typical example of an Arts & Crafts ceramic vase. Made at the Paul Revere pottery, in 1915, at Boston, Massachusetts, United States. Image: Obniski (2008).

Figure 1b. A textile pattern designed by William Morris, who was the pioneer of the Arts & Crafts movement. Figure taken from (Clarke, 2011).
this time and has continued to be a strong ideological attribute of craft since then. Additionally, craft became associated with the added value attributed to the skill and personal judgment of the craftsperson, since the individual was the one responsible for the making process instead of the factory machines, in an industrial system of mass production.

Another core ideal of the Arts & Crafts was that the creative practice of art was an inseparable part of the physical process of making. This was mainly manifested by bringing back the creative work of making to the people, through which the craftsperson was seen as an empowering figure that had the authority and autonomy of the making process. During that time, the boundaries between what was considered to be arts or crafts became blurred and craft became associated with decorative arts. Decorative arts were considered a central concept of craft during the Arts & Crafts movement, and were used to describe utility objects that also had decorative elements and were both functional and aesthetic (Figure 1). This concept emerged as a need to tie together functionality with ornamentation.

The return to ideals strongly associated with anti-mass production attributed to craft a vernacular aspect, embedded in values related to ideals of pre-industrial society (MacDonald, 2005). Vernacular in this context refers to the cultural production of a community, the things that are collectively made, spoken and performed (Greenhalgh, 2010; MacDonald, 2005;). In the context of the Arts & Crafts movement, the vernacular aspect of crafts refers to the fact that craft was considered as bringing back the “authentic” and “original” ideals of making, constituting that as a nostalgic space in which to escape from the fear of modernization, represented by industrialization. However, even though the Arts & Crafts movement started with a strong political focus against mass production for the benefit of both craftspersons and customers, it evolved as an elitist movement, promoting the production of expensive products that only a few rich people could afford. William Morris’ vision of producing things that were made to last instead of being cheap disposable objects faced the inevitable problems of costs in terms of expensive production of handmade products using expensive materials (van Helvert et al., 2017).

In the domain of interaction design, one can trace influences from aspects that are embedded in the Arts & Crafts movement, even though not directly related to that, especially in research approaches that are focused on craft and making practices. This is mainly in regard to leveraging craft practices and materials, which bring values of “authenticity” or handicraft aesthetics to the domain of designing computational things (Golsteijn et al., 2014; Ikemiya & Rosner, 2013; Robbins, et al., 2016). Additionally, the excessive craft ornamentation in addition to the strong ideological aspects that were central in the movement can also
be seen in the contemporary design practices of DIY making and appropriation followed in the Steampunk movement, for example, which has been studied from an HCI perspective (Tanenbaum et al., 2012). Traces of the ideological values embedded in the Arts & Crafts in regard to the empowerment of the maker, can be also traced in interaction design. In this domain, it expands to the empowerment of the user as the one being able to alter, personalize or modify a piece of technology based on their personal needs and desires (Höök et al., 2008; Nielsen, 2003).

2.2. The Bauhaus School
Contrary to the Arts & Crafts movement that saw the advantage of moving away from the industrialization and mass production of artefacts in craft, the Bauhaus school praised the new era of modernity by claiming the unification of the arts through craft for designing utility products. It was established in Weimar, Germany in 1919, and combined arts and design education with a strong focus on crafts, through a number of workshops that were running at the Bauhaus, such as the textile, the typography and cabinetmaking workshops focusing on the making of furniture. It laid the foundations of industrial design, as we know it today, by leveraging the combination of design and arts, through crafts. In that way, craft became part of industrial design, technological rationality and modernity, without being romanticized and related to small-scale and handicraft manufacturing, which happened through the Arts & Crafts movement.

According to Griffith Winton (2007), “the Bauhaus could be described as a utopian craft guild combining architecture, sculpture, and painting into a single creative expression”. In contrast to the elitist view of the Arts & Crafts movement in regard to handicraft, and expensive and exclusive production of artefacts, the Bauhaus was the socialist response to mass production through the combination of arts, crafts, and design for the public good instead of private luxury. In that way, functionality and aesthetics were leveraged through crafting practices, even when the Bauhaus was shifted more towards the mass production of artefacts, and the school adopted the slogan “Art into Industry” (Griffith Winton, 2007). The philosophy of the Bauhaus was political and ideological, and craft was a central aspect of that. Its educational focus was to attack the class of fine arts and instead combine it with craft, by leveraging craft as a political movement, without its vernacular aspect (Droste, 2002).

In the ideological background of the Bauhaus, craft was central, but the emphasis on handicraft appeared to be anti-progress and the vernacular politically reactionary (Volkmann & de Cock, 2006). Craft was rather seen as an empowering way to leverage arts for the good of everyday life, i.e. through the industrial manufacture of artefacts which would constitute those cheaper and thus more affordable things
Figure 2a. A typical example of a Bauhaus furniture. Marcel Breuer, wood-slat chair, second version, 1923. Stained maple with horse-hair fabric. Image taken by (Droste, 2002).

Figure 2b. An example of a textile made at the Bauhaus school. Gunta Stoltz, Jacquard Wall Hanging - “Damast” 1930 / 130 x 73.5 cm. Image: “Bauhaus-Archiv”.

for people to buy. The craft-based curriculum at the Bauhaus was aimed at educating artisans and designers that would create useful and good-looking objects for serving the demands of the modern era. Additionally, the Bauhaus praised modernism and the experimentation with new media, machines and materials, such as cellophane, fiberglass, or metal weaved together with yarns, at the textile workshop (Griffith Winton, 2007).

The fact that the Bauhaus considered crafts as inseparable from the arts set the scene for different product aesthetics, which were a result of the crafting properties of materials in combination with courses in art theory such as colour theory, taught at the Bauhaus. But even more importantly, the design philosophy of the school was characterized by values such as efficiency, spatial logic and functionality, which set the foundations for modernist aesthetics (Figure 2). To conclude, the craft aspect in this movement was mostly associated with the techniques and practices of crafting, in regard to the specialized treatment of a particular material and the use of specialized tools. Therefore, craft represented skilful making through the engagement with modern technologies, rather than tradition, nostalgia or ideals of ruralism (MacDonald, 2005).

The philosophy of the Bauhaus school has influenced modern design disciplines to a great extent, including design-driven approaches in the domains of interaction design and HCI. For example, considering both aspects of form and function while designing an artefact was central in the educational programme of the Bauhaus, and still has a great impact on contemporary industrial design as well as on interaction design practices (Baskinger & Gross, 2010; Djajadiningrat et al., 2004; Frens et al., 2003). In addition, colour theory and the gestalt principles that were developed at the Bauhaus, which relate the physical aspects of objects or images in regard to colour, form, or material to our cognitive perceptions (Behrens et al., 2012), have also been of great influence on contemporary design practices. Especially on graphic design and on the educational curriculums that teach graphical interfaces. Finally, the Bauhaus ideals can be seen as inscribed to contemporary movements that relate to the democratization of technology, which have also caught the attention of the HCI community (Ames et al., 2014; Tanenbaum et al., 2013).

From the 20th century and onwards craft and design followed different paths and became two distinct disciplines. This was mainly due to the division of labour imposed by the industrialization of manufacture and the invention of new materials such as plastic composites (Attfield, 2000). Industrial design emerged as a contemporary form of design practice for mass-produced and industrialized products. Therefore, design as a practice has mainly been related to industrial design, and to
ideals of technological rationalism, engineering and functionalism, summarized in the principle of “form follows function”. According to Greenhalgh (2010), design became tied exclusively to the idea of industry, and consequently designers became clearly distinguished from artists and craftspersons. Industrial design has mainly served the consumerism society, of which a main target has been to design and sell products to people for making profit, by creating new user needs and desires (Forty, 1986). This imposed on industrial design specific practices in terms of materials and methods of working with those, but also product aesthetics and values. For example, in industrial practices and processes the stages of design and production are separated, where design refers to the process of conceiving and developing an idea up to the production stage (Attfield, 2000).

On the other hand, crafts became associated with small-scale and local production of artefacts by a single person or by members of a guild, as opposed to industrialized mass production (Sennett, 2008). Industry and design practices became clearly distinguished from artists and craftspersons, and crafts followed their own path, in a space that expands in between arts and design (Adamson, 2010; Greenhalgh, 2010). In craft practices, and especially in studio crafts, the stages of design and making are not clearly separated, since a crafted artefact takes shape through the constant negotiations and judgments between a craftsperson and the available material space. This approach to making often results in products that are often considered of being of value, or characterized as “unique” or “authentic”. This can be attributed to particular properties that craft materials have, to the central role the judgment and decisions of the craftsperson play in the actual making process, but also due to the contextually-dependent process of crafting, which does not often lead to uniform results.

Interaction design emerged as a practice that was mainly influenced by industrial design, engineering and computer science, and not from craft traditions. However, the tension between craft and design, as articulated through the two traditions of Arts & Crafts and the Bauhaus school, is also relevant today in the context of interaction design. It can be traced, for example, in research that has been conducted on the topic of sustainable interaction design (SID), within HCI (Blevis, 2007), but also in highlighting values such as culture and aesthetics in HCI, as well as materiality (Rosner et al., 2012). Several researchers have been studying how to design technologies that, apart from being functional and complying to usability rules, should also be valuable to users from a broader perspective, and would thus have the potential of being kept longer (Blevis, 2007; Blevis et al., 2007; Blevis & Stolterman, 2007; Odom, 2009; Odom, 2015). In this body of work, a number of aspects have been highlighted which concern values and attributes embedded both in craft
and design. For example, aspects related to the materiality of computational artefacts, the quality of how something is made and thus the possibility it might have of being durable, but also aspects of meaning and significance ascribed to artefacts from a user perspective (Verbeek, 2010; Wallace et al., 2007).

2.3 Craft Qualities Embedded in the Japanese Philosophy of Wabi-Sabi

Wabi-Sabi is a very old and broad philosophical concept that has its roots in Japan and in the Zen philosophy. The core idea behind Wabi-Sabi is the transience of the world and the fact that the things that surround us are impermanent and prone to decay and inevitable death (Koren, 1994). It is strongly associated with Japanese aesthetics (Tanizaki, 2001), and with customs such as the Japanese tea ceremony, gardening, as well as with nature itself. The word Wabi-Sabi consists of two parts: Wabi refers to the essence of simplification, of cutting down the things to what is important, whereas Sabi refers to the passage of time, and more specifically to the fact that the core of something remains the same, even though the façade or surface may change over time. While Wabi resonates directly with principles of product and interface design, such as the Bauhaus ideals of minimalism, Sabi has a less straightforward counterpart in (post) modern ideals of predominantly western design thinking. Wabi-Sabi is embedded with a sense of melancholy, since the word Wabi refers also to loneliness, and the word Sabi to something that is withered or decayed.

Wabi-Sabi has evolved over the centuries as an aesthetic concept in crafts, which today refers to a “wabi-sabi” craft style, mainly in regard to particular form factors or physical materials used in a craft practice. But, apart from crafts, it has been extensively used in product design and architecture, as a particular way of approaching a material and design space (Mente, 2006; Tierney, 1999). The artefacts or interior spaces that are usually referred to as being “wabi-sabi” are characterized by simplicity, murkiness, irregular or imperfect surfaces, and they are most often made of craft materials, such as ceramics, wood or stone (Figure 3). For this reason, the physical form of the artefacts that are described as being “wabi-sabi” is not perfect, and these objects reflect signs of decay and it seems as if the presence of time and usage has inscribed signs on their surface (Mente, 2006). The Wabi-Sabi craft aesthetics point to the value and the degree of preciousness that is emerging through actively taking into account and utilizing the impermanent properties of materials.

In the case of this dissertation, I am using Wabi-Sabi in a rather pragmatic way, based on how it has been interpreted and summarized by a number of predominantly western scholars and from a perspective.
Figure 3. Two examples of what has been described as being Wabi-Sabi craft and interior design. **Top:** Wabi-Sabi interior aesthetics characterized by minimalism, murky colours and imperfection (“Wabi-Sabi Interior Style: The Beauty Of Imperfection | Jiji.ng Blog,” 2016). **Left:** A ceramic bowl that has an imperfect shape and patina on its surface (Margaret Penney, 2017).
of design and craft qualities (Juniper, 2011; Koren, 1994). Wabi-Sabi has been extensively re-appropriated and used by various scholars internationally. For example, it has been summarized by Powell (2005) in the three realities of “nothing lasts”, “nothing is finished” and “nothing is perfect”, as mentioned earlier. These three realities can be considered as high-level craft qualities that refer to attributes of studio craft as a practice, but also to its core values. And for this reason, Wabi-Sabi has been used as a concept in craft, design and architecture practices, to highlight the impermanent, incomplete and imperfect aspects in regard to material and making processes.

Any material, such as wood, leather or ceramics is impermanent. It ages and degrades over time, which is something manifested, for example, as patina on its surface. In studio craft practices, this is often something accepted and expected, and it can be considered as being part of the overall gestalt of a crafted artefact. When taking into account the material wear and tear as part of a design process and design actively for that, a crafted artefact would have the potential of gaining more value as it ages, since it will not be expected to remain intact and look new later in its lifetime. Often, this is reflected in what is considered “good craftsmanship” or a quality object, for example due to what has been described as the graceful aging of craft materials (Karana et al., 2016; Rognoli & Karana, 2014; Verbeek & Kockelkoren, 1998). Therefore, the impermanence of the material circumstances is a quality embedded in studio crafts.

Similarly, imperfection and incompleteness are two qualities embedded in studio crafts. A craftsperson can always work on an artefact even after it is “finished” – and this is something craftspersons usually do. A crafted artefact is expected to be adjusted, repaired or modified over time, and through this it can gain new value over time. Incompleteness is also embedded in the practice of melting down or re-using parts of damaged, old or broken artefacts for new designs. Incompleteness can be seen as a state of “always evolving”, as a transient state, instead of a “finished” situation. Finally, imperfection is a quality embedded in studio crafts, since there is often a positive value placed on variations or flaws as results from a crafting process (Salvia et al., 2011). A crafted artefact has signs of the making process inscribed into it, and this is something accepted and expected, but which often gives to crafted artefacts the attribute of “uniqueness”.

Therefore, the way craft is manifested through the philosophy of Wabi-Sabi has to do with accepting and embracing the realities of impermanence, incompleteness and imperfection, in regard to the materiality of crafted artefacts, but also in regard to the process of making and the overall life cycle of materials and artefacts. And through that to design things that have the potential to live longer, which attributes to
Wabi-Sabi artefacts a degree of preciousness. The three high-level craft qualities of impermanence, incompleteness and imperfection point to a particular worldview of crafting and making, which could be considered as philosophical to some extent, by reflecting how things actually are, instead of assuming how things ought to be, for example lasting, complete or perfect.

In the interaction design and HCI domains, Wabi-Sabi has previously been explored from a perspective of the manifestation of wear and tear among digital things (Ikemiya & Rosner, 2013). Additionally, Haimes et al. (2016; 2017) have explored the design of Internet of Things (IoT) devices inspired by Japanese Wabi-Sabi aesthetics.

2.4 Three Contemporary Studio Craft Practices

After presenting the Arts & Crafts movement and the Bauhaus school as two distinct historical traditions of which craft was a central component, I have articulated craft through the Japanese philosophy of Wabi-Sabi, which provides a more theoretical and philosophical perspective on studio craft, as a practice and concept. Moving forwards from drawing on the theoretical and historical accounts of craft, I will concentrate more in the specifics, in regard to what craft as a distinct practice and process entails, by presenting the core attributes of craft practices that are called studio crafts. Studio crafts, according to Shiner (2012) and to Kopplos and Metcalf (2009) are “the professional crafts in which designer and maker are one and there is an aesthetic intent” (p.241). Studio craft is different to amateur, DIY, ethnic or trade craft (Shiner, 2012), and for this reason it has very different characteristics compared to either of those. Therefore, when talking about studio crafts, the crafts-person is usually the one who designs something, i.e. has an idea of what to make, but at the same time they are the one also implementing this idea. But, in studio crafts it is also common that crafts-persons are working for commissions, which means to receive an order for what to make, instead of deciding completely by themselves.

Another particular characteristic of studio crafts is the professional aspect mentioned in the definition provided, which stresses the high level of skill and experience the crafts-person possesses. The skill and experience are accordingly closely related to the personal judgment and craft repertoire of the crafts-person, which unfold during a crafting process. The distinct and highly subjective approach to exploring a material space and giving form to materials, results in the distinct craft aesthetics reflected by the outcomes of a crafts-person. However, if we consider skill represented on a linear scale from the amateur to the fully professional, the craft practitioners practicing studio crafts could be rather considered as artisans, meaning that they have practiced a particular craft skill for many years.
Below, I will present the main characteristics of what could be considered as a practice of studio crafts by providing a brief overview of the three craft practices I have studied, which were leather, silversmith and textile crafting. Through that, I will provide a general context for each of the three interaction crafting studies included in this dissertation, in regard to how craft is present and represented. This perspective also allows discovering which aspects of crafts are still relevant today, grounded on a pragmatic approach of how craftspersons work, but also bringing craft as a practice closer to interaction design.

### 2.4.1 Leather Crafting

Leather refers to animal skin, which is one of the first materials to have been used in ancient history for crafting a variety of utility artefacts, ranging from clothes to housing equipment. The type of leather that is mainly used today has gone through tanning processes in order to become durable and waterproof. Leather crafting refers to the art of making artefacts out of this material, by utilizing techniques such as cutting, stitching or gluing. But, apart from making leather artefacts, a leather craftsperson also deals with repairing leather artefacts. The outcomes of a leather crafting process can include accessories such as bags or belts, furnishings, parts of tools or musical instruments, to name just a few. Leather is a material that has many similarities with textile, mainly due to the fact that it comes in a similar form, i.e. as flexible, flat surfaces. Therefore, the process of crafting leather has similarities with textile crafting; for example, a shape can be measured and cut out of a bigger surface, out of which a three-dimensional object, such as a bag, can be made. But, at the same time, leather is much sturdier than textile, and often thicker, which makes it slightly harder to work with, but also provides the possibility of making more robust artefacts, such as a horse saddle or a skin for a drum.

The leather craftsman with whom I collaborated and through whom I was introduced to the practice of leather crafting is called Isla Bayer, and has his own workshop and shop in the city of Basel, in Switzerland. Isla has worked as a leather craftsman for more than fifteen years, and he is specialized mainly in repairing leather furnishing (Figure 4a). Here it is important to mention that Isla mainly works with leather from cattle. During our collaboration and since the nature of the project in which both of us were involved was such, the leather artefacts that we made were bags, iPad holders, glass holders and similar utility artefacts, apart from making computational artefacts combining leather with interactive technology, and leather connectors for expandable exhibition constructions, as the one depicted in Figure 4b.
Figure 4a. The leather craftsman Isla Bayer, who was involved in the first interaction crafting study, is stitching a leather piece.

Figure 4b. A leather connector for expandable exhibition constructions. This is one example of leather artefacts that were made during the first interaction crafting study.
2.4.2 Silversmith Crafting

Silversmithing is the practice of shaping and giving form to metals by means of hammers, stakes and other tools in order to transform them into (utility) objects (Finegold & Seitz, 1983). Craftspersons in the area of silversmithing can approach their artistry in very different and often highly specialised ways. A practitioner in this field may, for instance, focus on the fabrication of standardised objects by the extensive use of high-tech tools, or making fine design of utilitarian objects such as bowls or cutlery, or specialise in restoration or alteration of existing objects, e.g. adjusting the size of rings or repairing broken necklaces.

Emma Rapp, the silversmith craftsperson with whom I collaborated, is renting a small studio space, which is shared with other artists and craftspersons in Stockholm, Sweden (Figure 5a). She has a creative training in fine arts and silversmith crafting from the early 2000s. Since her exchange studies in Japan, her craft practice is strongly influenced by the philosophy of Wabi-Sabi. Much of her recent work has taken inspiration from simple objects found in nature, both as jewellery items and as contemporary artworks presented in exhibition settings. During our collaborative interaction crafting study, we explored combinations of silversmith materials with electronic components, and we made several small devices focusing on input modalities. An example of our explorations is shown in Figure 5b in which a series of casings for hosting electronic components is depicted. They were made of silver and provided the possibility of allowing access to the electronics hosted inside for supporting practices of repair.

2.4.3 Textile Crafting

Textile crafting refers to the practice of making a piece of cloth by weaving yarns spun from artificial and/or natural fibres, also called textile design (Clarke, 2011). But, it also refers to the practice of making an artefact by using textile as the main material. Textile crafting is primarily the practice of making clothing or furnishing. The practice of textile crafting can vary, depending on the type of textiles to be used and the textile techniques that can be utilized. There are many different techniques for handling yarns or textiles, such as embroidery, weaving or knitting, to name just a few. When crafting clothing, it is important to know the techniques of patternmaking, sewing and stitching.

In my study focused on textile crafting, the textile craftspersons were myself and my colleague at KTH Vincent Lewandowski. Textile crafting is a practice that I have been personally engaged in for at least ten years. In the past, I was trained as a seamstress/dressmaker by my aunt who is a professional seamstress, and in order to learn this practice I made a number of clothes under her guidance. More recently, I have practiced textile crafting during my exchange studies at Weissensee School of the
**Figure 5a.** Emma Rapp, the silversmith craftswoman involved in the second interaction crafting study, working in her studio.

**Figure 5b.** A series of casings for electronic components that have been developed during our collaboration.
Arts in Berlin, where I learned the techniques of industrial weaving and knitting (Figure 6a,b). I was also involved in courses on garment design at Köln International School of Design in Cologne, Germany (Figure 6c), and recently I have been exploring the making of wearable technology with various combinations of physical and computational materials (Figure 6d). My colleague Vincent Lewandowski has been making clothes and been engaged in various fibre arts for over a decade. Our main activities in regard to textile crafting included picking fabrics, pattern making, stitching and sewing and throughout the project we designed and crafted two versions of an interactive garment, apart from other prototypes and material explorations that supported our process (Figure 7).

2.5 Main Attributes of a Studio Craft Practice

In this section, I will present and expand on the main attributes of a studio craft practice, based on related work and on the three studio craft practices I studied. In particular, I want to draw attention firstly to the central role that materials, tools and the workshop space play, and then to the topics of skill, experience, and aesthetics that come through skill.

2.5.1 Materials, Tools and Workshop Space

A studio craft practice is most often defined by a material or set of materials, which is reflected in the fact that the practice is named after the particular material in focus. For example, leather crafting defines the studio craft that is focused on leather material, in silversmithing the focal materials are various types of metals, such as copper or silver, and the main material in textile crafting is fabric. Or as described by Adamson (2010) “craft always entails an encounter with the properties of a specific materials, be it wood, glass, clay, metal, plastic, paper etc”. By having a particular type of material and its properties at the core, the craft practice unfolds around the material and very close to it. Often, craft materials are expensive or even exclusive in the case of gold, precious gems or real, instead of fake, leather. And this is something that adds a degree of value to artefacts that are the outcomes of a studio craft practice.

The very unique properties of materials guide the way they can be treated, by deploying a number of different techniques and by using a set of specialized tools, as the means for treating materials. For example, in a process of making a garment, the textile craftsperson needs to have some type of fabric and thread which will be given shape and form. Those materials will be combined and transformed into a garment by using a needle or a sewing machine, scissors and other tools for handling fabric materials. And, most importantly, the maker needs to know what particular techniques and methods to use for transforming a fabric into a garment. As Ingold (2010, 2013) argues, this is a process of following the force and flows of materials instead of imposing form
Figures 6a,b. Textile samples I wove with a loom while studying Textile and Surface Design at Weissensee School of the Arts in Berlin.

Figures 6c. The Isolation garment, which I made while studying at Köln International School of Design, as part of the course “1m2 of clothing means fabric”.

Figures 6d. The Speaker Scarf is an example of my practical craft explorations with combinations of physical and computational materials.
Figure 7. Testing a version of the Nebula interactive garment, during the second study focusing on textile crafting. In this study my colleague Vincent Lewandowski and I were involved as the textile crafting experts.
on the material world. The relationship between craft as a practice and materials should be understood from such as perspective.

The specialized tools that can be used for treating a particular material can vary substantially, and different skills might be needed in order to learn how to use them to their fullest potential (Figure 8). Even though craft has predominantly been associated with handicraft, for example with the use of handheld tools instead of machines, the relationship contemporary studio craftspersons have with hand-work can be reflected in the following quote from Pye (1968): “Handicraft or handheld are predominantly historical or social terms, not technical ones” (p.26). Contemporary studio craftspersons do not consider their work to be a traditional handicraft practice, which is reflected in the fact that they may be using various types of machines and tools in their work, such as a laser cutter or even a 3D printer. And, more broadly, contemporary craft practices are disrupting established notions of “traditional” craft, and craftspersons “are challenging long-term clichés concerning craft, gender, materials function and utility” (McDonald, 2005, p.41).

An example of this shift can be seen in the works by Elin Johannesson and Linda Ottosson, two Swedish crafts women that graduated from the Bachelor’s silversmith crafting programme at Konstfack University College of Arts, Crafts and Design located in Stockholm, Sweden. As depicted in two crafted objects exhibited at their Bachelor’s graduate show at Konstfack, their silversmith crafted artefacts are characterized by experimentation in terms of materials and form (Figure 9). The materials of which they are made consist of a combination of plaster, copper, cotton and latex, instead of metals representing silversmith crafting. Often, it becomes difficult to distinguish the crafting practice behind a particular crafted artefact in contemporary studio crafts.

Another typical characteristic of studio crafts is that the craftsperson is practicing their craft in a specific space, the studio or the workshop. In the workshop, all the necessary equipment, tools and materials are stored and can easily be accessed and used. But, apart from serving only functional purposes of convenience, as stated by Sennet (2008), the craftsperson’s workshop is where autonomy and authority play out, meaning that it is the space where they feel “at home” and have the authority of the work they are conducting (Adamson, 2010). However, it is possible to practice studio crafts outside the studio, since depending on the craft practice, a smaller set of tools can be carried to a different place, and used as a type of mobile studio.

2.5.2 Skill and Experience

Skill is considered to be one of the core attributes of craft as a process and practice of making (McCullough, 1998; Sennett, 2008). It is by applying the skill and previous experience that has been accumulated
through practice that a craft process unfolds. The skills a craftsperson develops over time and the experience they gain by practicing craft allow them to make decisions on the spot, in regard to how particular materials need to be treated with specialized tools and crafting techniques. In that way a crafting process usually evolves around the material space, without necessarily making a clear distinction between steps of action and reflection during the process. According to Sennett (2008), all skills begin as bodily practices and those bodily practices are the thousand little everyday moves that add up to a whole, and which become a matter of habit or become what has been described before as tacit knowledge.

Tacit knowledge in this context can be understood as a process that is happening while crafting, but which is hard to verbalize. In a craft context, this might mean that it is hard to explain why the craftsperson decides to proceed in one or another way at any moment, even though they often have a clear idea of how to proceed. And this is because particular actions during a craft process are guided by previous experience and knowledge, which has become embodied through repetition and practice, exactly because particular movements, gestures or ways of handling tools have been repeated many times previously. Such embodied movement can include the careful handling of particular tools such as pliers, tweezers or a soldering iron in a silversmithing practice (Figure 11a), the way the fingers should slide and turn around a mass of plaster, placed on a potter’s wheel, or the way a textile craftsperson handles sewing tools and textile materials, in order to give form and shape to them (Figure 11b).

This could also be understood as the hyper-reflection described by Kozel (2008), which in this case can be used as a way of discussing the reflection on the materials, but also of discussing the tacit knowledge and embodiment of a process. As she mentions, “the circle of hyper-reflection can be so finely grained, in such tiny loops that it can be done in the midst of experience” (Kozel, 2008, p.22). The pre-reflective and the hyper reflective “can open a way for understanding the deep entanglement between reflection and experience, between thinking and making, which is so important to many arts and sciences” (Kozel, 2008, p.23). The interplay between tacit and explicit knowledge, which is the active judgment that leads to decisions on how to proceed, in regard to how skill unfolds and is expressed while crafting, is similar to what Schön (1983) has described as a reflection in action when referring to how professional people work. Similarly, a craftsperson is constantly reflecting on the actual process, and for this reason, a crafting process is characterized by decisions made ‘on the spot’. Similarly, Nimkulrat (2012) stressed the importance reflection plays in crafts mentioning that “it [craft] is understood [...] as a way of thinking through the hand manipulating a material” (p.64).

This constant dialogue the craftsperson has with the materials while
Figure 8. In every craft practice there are specialized tools that are used for crafting particular materials. Shown here is the set of leather crafting tools used by Isla Bayer, the craftsperson involved in the first interaction crafting study.

Figure 9. Two examples of artefacts as outcomes of a contemporary practice focusing on silversmith crafting. Both from the graduate show of the Konstfack University of Arts, Crafts and Design, Stockholm, Sweden. 2013 and 2014, CRAFT! Bachelor’s silversmith crafting program.

Figure 10. The workshop is the space, where the craftsperson is practicing crafting. It has all the specialized tools and machines that are needed for manipulating materials. Imaged: The workshop of the silversmith artist Emma Rapp, based in Stockholm.
crafting could be considered as one important aspect that distinguishes craft from design, more broadly. While the craft process unfolds, the craftsperson always reflects back to the material being handled and decides how to proceed. On the contrary, most often in design, the stages of “implementation” and “reflection” have more clear-cut boundaries. This is related to the fact that, even though materials are central to design practice, they are even more central to a craft practice, since they are the core element driving the craft process.

2.5.3 Personal Judgment and Craft Aesthetics

As mentioned above, skill refers to a complicated repertoire of processes, or the interplay between tacit knowledge and self-conscious awareness, which is grounded in experience. The tacit knowledge on how to craft or give form to a material serves as an anchor, and the explicit awareness serves as a critique, or judgment, and therefore corrective force during the making process (Sennett, 2008). However, a clear distinction between tacit and explicit knowledge would be difficult and probably not even necessary to make since both are present when crafting is practiced, and they feed back to one another.

But the judgment could be understood as the aspect that connects craft with what I will refer to as the craft aesthetics. By that, I mean that the particular skill and experience of a craftperson, which are actively transcribed in a set of decisions and actions taken during making, is what gives to an outcome of a craft process aesthetic qualities. The aesthetic attribute that is embedded in craft is related to how a crafting process unfolds and how crafting is practiced, in regard, for example, to the unique ways each person approaches the material space, treats materials and utilizes techniques and tools according to their repertoire of skills, experience and personal preferences. All those aspects will somehow be transferred through the crafting process to the final artefact, based on the tacit knowledge and the active judgments and decisions taken. Every craftsperson applies a set of techniques on the same material in a slightly different way, or the maker leaves a personal mark of her presence on the object (Sennett, 2008). This is also one aspect that distinguishes small-scale crafted artefacts from mass-produced ones; the fact that they are personalized, have slight imperfections that reveal steps of the making process, or the way materials have responded to a particular treatment, or even reflect a very distinct crafting style of a specific craftsperson. As pointed by Dormer (1997) “[contemporary] craft is still an opposition, just as it was more than a century ago: Craft still stands against the anonymity of mass-production, and for the personalized object”. The attribute of personalization that characterizes the outcomes of a craft process is tightly related to the investment of time in the making process, and to the value that is inscribed in personal work and skill. Therefore the way a material and craft space is approached
According to Sennett (2008), all skills begin as bodily practices, which are the thousand little everyday moves that add up to a whole and which become a matter of habit or become what has been described before as tacit knowledge.

**Figure 11.** According to Sennett (2008), all skills begin as bodily practices, which are the thousand little everyday moves that add up to a whole and which become a matter of habit or become what has been described before as tacit knowledge.

**Top:** Silversmithing practice,

**Left:** Textile crafting

(Photograph: Vygandas Simbelis).
while making, adds a degree of preciousness to the final outcome of such a process. Additionally, since craft implies a particular type of person, environment or genre, gives to craft the attribute of being contextually and culturally situated (Greenhalgh, 2010).

From this perspective, craft aesthetics compared to industrial design aesthetics, for example, could be understood as emerging through the crafting repertoire developed and practiced by a crafts person, which brings also craft closer to the practice of art. However, this does not necessarily refer to “crafty” things that remind of folklore-styled artefacts. As described by Attfield (2000), apart from the main goal of craft process, which is to arrive to an artefact by giving form and shape to a set of materials, crafting is also an artistic endeavor. Especially when referring to studio crafts, apart from function, the development of a personal artistic practice through crafts is deemed necessary for the crafts people. For example, this was characteristic in the way the silversmith artist who was involved in the second study approached her craft practice. As seen in Figure 12, apart from jewellery she is crafting silversmith artefacts that she exhibits in galleries in Stockholm. Her personal approach to crafting being strongly influenced by the Japanese philosophy of Wabi-Sabi, as mentioned earlier, is reflected in her craft practice and consequently outcomes. She is utilizing material and craft properties in a way that the craft qualities embedded in this philosophy could be surfaced and reflected on her crafted objects. Finally, the relationship between craft and art can be better summarized in the following quote by McCullough (1998, p.20): “There may be an element of art in craft, or an element of craft in art”.
Figure 12. A decorative artefact, and a necklace made by the silversmith craftsperson Emma Rapp, who was involved in the second interaction crafting study. Her craft practice is very much influenced by the Japanese philosophy of Wabi-Sabi, characterized by simplicity, imperfection and inspiration from nature. This becomes the central element in how she approaches materials and making, which is also reflected in the identity of her crafted artefacts.
Chapter 3

Related Work: Crafts in Interaction Design
3. Related Work: Crafts in Interaction Design

This chapter aims at providing an overview of how others have previously studied various intersections of craft and interaction design. I will do this by offering some perspectives on craft-related research in these domains, and by doing so I will contextualize my work. I will focus on the elements of craft that have been of relevance to interaction design, and provide an overview of craft materials and practices that researchers explored previously for the design space of developing computational artefacts. But before I present related work, it is important to get an understanding of where interaction design stands as a practice, compared to craft practices.

3.1 Interaction Design as a Practice of Making Computational Artefacts

Interaction design is very different from contemporary studio crafts, and their main differences can be attributed to their different traditions. Interaction design draws mainly on traditions of industrial design, engineering and computer science (Fallman, 2008; Nelson & Stolterman, 2003; Stolterman, 2008), while the contemporary studio crafts, as discussed in the previous chapter, evolved as a counter to industrialization and mass production of artefacts. But, apart from their different traditions, which attribute to crafts and interaction design quite different practices, aesthetics, and consequently values, interaction design, and especially design research in this domain, has many elements that bring it closer to craft as a making practice.

Interaction design is the field that studies the way people interact with products and services, and is consequently focused on designing the interactions and behaviours of technologies that people will use in particular contexts (Buxton, 2007; Sharp et al., 2007). But, apart from designing the “interactions” and “behaviours”, interaction design also focuses on the actual shaping of artefacts, systems and environments. Several researchers have contributed to developing interaction design as a practice of giving form to computational artefacts or environments, e.g. (Benford et al., 2015; Bousseau et al., 2016; Koskinen et al., 2013; Redström, 2001; Vallgårda, 2013; Wakkary et al., 2017). But what distinguishes interaction design from other form-giving practices, one of which is studio crafts, is firstly the fact that materials in interaction design extend beyond physical, to include also computational ones. Specif-
ically, the practice of giving form to a computational artefact or environment demands the active consideration, exploration and consequently utilization of a material space that goes beyond the physical, to what has been described as “digital technology as a material for interaction design” (Jung & Stolterman, 2012).

Focusing on the material properties of computation and arguing that “materials matter” (Fernaeus & Sundström, 2012) in interaction design and HCI had a strong impact in the research community of interaction design already a decade ago, and this has been defined as the material turn in HCI (Robles & Wiberg, 2010; Wiberg, 2013). According to Vallgårda (2013), when designing computational artefacts there is a need to “design” apart from the physical form, also to the temporal form and to the interaction gestalt. She describes the temporal form as the coupling between inputs and outputs of computation, and how this unfolds over time. Additionally, she describes the interaction gestalt as the actions that users will do in relation to the artefact, in order to trigger an event. Therefore, when talking about giving form to materials in interaction design, this also includes computational components such as sensors, actuators, circuit boards or cables, as well as software, code or media (Bergström & Blackwell, 2016; Dourish & Mazmanian, 2011; Fuchsberger et al., 2013; Hansen et al., 2014; Lindell, 2013), or information (Dourish, 2017). Such types of intangible or immaterial materials (Belenguer et al., 2012) are explored similar to physical ones and are considered as having their own, unique properties, such as computed causality and connectability in the case of the computer as a material, previously discussed by Vallgårda and Sokoler (2010). Similarly, Löwgren (2007a, 2007b) discussed pliability and fluency as two experiential qualities of the “digital” material, and Isbister and Höök (2009) introduced suppleness as a particular affordance of digital materials. Finally, others have looked at the material properties of energy as a material (Lundström, 2016; Pierce, 2009; Pierce & Paulos, 2012).

A strong influence in regard to considering and treating computation as a material in interaction design, similar to any other physical material, has been the work of Vallgårda and Redström (2007) on computational composites. Ten years later, this is still of relevance and importance to the field, since this work highlights how computers share important characteristics with other materials used in design and architecture. An example of a computational composite is the PLANKS, which is a panel of wooden planks that each can be bent outward, when “touched” by sound and straightened, when in silence (Vallgårda, 2008). According to Vallgårda (2008), this is a physical manifestation of the concept of computational composites, with an emphasis on the expression, instead of on a particular use context. Another relevant work in regard to the properties of intangible materials has been conducted by Sundström
et al. (2011), who proposed the concept of *Inspirational Bits* as a way of exposing and becoming familiar with “*the dynamic properties of a digital material*”. They elaborate on their approach by exploring the dynamic properties of Bluetooth technology, as a material for interaction designers. This approach could be seen similar to the way a craftsperson approaches their available physical materials as, in order to explore their qualities and utilize those in the best possible way for a particular craft context or goal.

On a very basic level, the common characteristics shared between interaction design and studio crafts, as the practices and processes of making tangible artefacts, can be traced to the central role that materials and tools play in how the process of making evolves, but also the skill and experience an interaction designer and a studio craftsperson need to possess and apply while engaging in making artefacts, being computational or not.

### 3.2 Emerging DIY and Digital Fabrication Making Practices

An emergent cultural phenomenon that has also caught the attention and interest of interaction design researchers has been the popularization of making practices associated with Do-It-Yourself (DIY) making (Buechley et al., 2009; Desjardins et al., 2017; Wakkary et al., 2015), but also of making practices that involve the use of digital fabrication tools such as laser cutters or 3D printers, which has been supported by open source hardware and software communities (Morreale et al., 2016). DIY making can be seen as an everyday design practice in which people adapt and appropriate their belongings based on their needs (Wakkary & Maestri, 2008; Wakkary & Tanenbaum, 2009). On the other hand, making that involves the use of personal fabrication tools can be seen as a contemporary form of crafting, since this approach highlights the central role that materials and tools play in a making process, by leveraging on the latest technological advancements.

In interaction design, making approaches that include the use of personal fabrication tools to give form to materials are sometimes referred to as *hybrid fabrication* (Devendorf & Ryokai, 2014; Jacobs & Zoran, 2015; Zoran, 2015; Zoran & Buechley, 2013). An example includes the work by Efrat et al. (2016), who explored parametric design that can be used by textile craftspersons for making bags, through a custom Computer-Aided Smocking (CAS) design software (Figure 13). A number of researchers have been exploring the possibilities that personal fabrication tools such as a laser cutters or a 3D printer can offer in design practices within interaction design and HCI (Baudisch & Mueller, 2016; Mueller et al., 2014; Peng et al., 2015). Fabrication refers to the concrete manufacturing of artefacts using various techniques and rapid prototyping processes, and, until recently, the fabrication process primarily referred to mass
Figure 13. The work by Efrat et al. (2016) is an example of hybrid crafting. They have developed a custom Computer-Aided Smocking (CAS) design software for craftspersons, which utilizes algorithmic modularity for the design of textile bags.

Figure 14. The work by Devendorf and Ryokai (2014) explores agency and control between the maker and the machine, through human-assisted 3D printing that shows to the maker how to build a physical version of a digital model.
production of goods within factories. This has changed due to various technical and social developments, which have also drawn attention to local, small scale, and personal fabrication.

Related to this is the rapid spread of Fab Labs the last years, in several cities worldwide, described by Gershenfeld (2008) as “the combination of commercially available machines and parts, linked by specific developed software and processes, for making things” (p.15). Fab Labs opened a new design space for small-scale production, since expensive tools became available for people to use, either free of charge, or at a lower cost. Easy and quick access to personal fabrication equipment has now enabled designers, as well as amateur makers, to explore new materials and tools for the construction of artefacts, both interactive and physical, while producing more prototypes in less time. This approach to personal fabrication of artefacts, including practices of DIY making more broadly (Fischer et al., 2008; Mellis, 2013; Tanenbaum et al., 2013), has also been supported by several online communities that allow for the extensive sharing of instructions and advice. The maker movement and maker culture (Oehlb erg et al., 2015) that emerged from those strands has provoked recent discussions within HCI and interaction design in regard to the social, material, and economic implications of tangible and ubiquitous computing based on a DIY and open source scene (Fuchsberger et al., 2016; Lindtner et al., 2014; 2016;).

An interesting angle on this domain concerns the work of Mueller and her colleagues (Mueller et al., 2013a; 2013b), who have studied various ways of hacking personal fabrication tools to increase the authority of the maker, over the machine. One example includes their prototype constructable (Mueller et al., 2013), which is a system that “produces simple, yet functional mechanics that cannot be created with traditional interactive fabrication tools” (p.605). It is based on a laser cutter that has been enhanced with a hand-held laser pointer, through which the user can define the sketch lines on the material to be cut, and thus can have direct feedback on the making process. They call this approach to appropriating personal fabrication tools interactive construction. Another example of this approach is the LaserOrigami, which is a rapid prototyping system that produces 3D objects using a laser cutter (Mueller et al., 2013). Other research that highlights the use of personal fabrication technology for interaction design includes, for example, the work of Saegusa et al., (2016), who have explored the integration of digital fabrication tools in ceramics production through the development of a computer numerical controlled (CNC) engraving tool for ceramics. This was an investigation into the enhancement of traditional forms of craft with new technology.

Another example is the work by Rosner et al. (2015), who have combined ceramics with sound through the Sound Bowl, “a vessel designed
to record an audio message through surface undulations, much like a vinyl record” (p.181). They describe this work as an exploration of emerging fabrication technologies in the domain of ceramics. Finally, the work of Devendorf and Ryokai (2014) has pointed to new perspectives in which personal fabrication tools can be studied focusing on the maker and the performativity of the process of making, in regard to agency and control between the maker and the machine. They present an exploration in human-assisted 3D printing, which consists of a laser guide that shows the maker how to build a physical version of a digital model following the exact instructions typically given to a 3D printer (Figure 14). This perspective connects crafts back to contemporary forms of making, based on personal fabrication technology.

3.3 Craft Practices and Materials
In interaction design and HCI the words “making” or “crafting” appear sometimes interchangeably, and on such occasions those words are used to replace “design”. In these contexts the authors most often refer to a making process in interaction design, often by applying design-driven methodological approaches (Mellis et al., 2013; Tomico et al., 2013). Additionally, the term digital craftsmanship is often used when referring to hands-on making approaches that combine physical with computational tools or materials (Nitsche et al., 2014; Wallace, 2014), but also when designing with digital technology as an expressive medium more broadly (Jacobs et al., 2016). Therefore, craft in interaction design is not always used in the same way as presented in the physical studio craft practices outlined in the previous chapter. But, apart from such occasions, several scholars have been investigating the potential that craft can offer in regard to new possibilities of making or interacting with technology (Bardzell et al., 2012; Benford et al., 2017; Buechley & Perner-Wilson, 2012; Gross et al. 2013; Zheng & Nitsche, 2017). When the word craft is used in such contexts, it can refer to a process of making by skilfully engaging with the combination of physical and computational materials or tools (Schoemann & Nitsche, 2017), but also to the active involvement of craft artisans (Benford et al., 2017).

Several craft practices have been studied mainly from a perspective of how they can inform and contribute, in different ways, to further developing interaction design. For example, it has been argued that the affordances of craft practices such as carving, sewing or painting, can inform the physical and mental experience of building electronics by hand (Buechley & Perner-Wilson, 2012; Perner-Wilson et al., 2011). Fernaeus et al. (2012), who studied the Jacquard loom and the practice of weaving with this historical machine, reflect on its complex mechanical structure, its rich materiality and whole-body interaction gestalt, from an interaction design perspective. By conceptualizing the making practice of the
ArtBot artistic community as a craft, the study Jacobsson et al. (2013) conducted in which they interviewed artists who make robotic-oriented artworks, reveals interesting insights. Especially insights on how these artists approach their practice against the predominant culture around robots, reflected on material properties and making aspects. Another example of approaching a practice of developing artefacts in interaction design as a crafting process, can be found in the work by Elblaus (2015). He has been developing artefacts for performance contexts by working with code and software as craft materials for artistic creation, through which he highlights aspects of expressivity and empowerment of the maker/programmer.

Additionally, the outcome of engaging in a craft process can reflect particular steps or hidden qualities of how the process unfolds, as in the case of bookbinding described by Rosner and Taylor (2011), where “sensitivities to delicacy, flexibility and delay emerge through detailed engagement with the book” (p.1155). Another example in regard to the close interplay between craft practices, materials and interaction includes the work of Benford et al. (2015) on the making and deployment of the Carolan acoustic guitar. Here wood was explored in combination with decorative inlays, which contain embedded codes, as part of the guitar’s surface. The process of applying interactive decoration on the wood surface has made them become “intimately familiar with the material properties arising from the quality and nature of wood and of techniques for etching, cutting, and inlaying it” (Benford et al., 2015, p.66). Others have studied how DIY craft practices such as knitting, in combination with technology, can enhance everyday activities (Rosner & Ryokai, 2009).

When referring to a making practice in which both physical and computational materials and tools are present for designing interactive artefacts, this process is often referred to as hybrid crafting. The definition of hybrid crafting provided by Golsteijn et al. (2014a) is: “[the] everyday creative practices of using combinations of physical and digital materials, techniques or tools, to make interactive physical-digital creations” (p.594). In their work they focus on everyday making practices by combining physical materials and media content, such as photos, which can be seen as related more to amateur crafting, and through that they reflect on craft research through and for interaction design (Golsteijn et al., 2014b).


Apart from studying how several craft practices can inform research within interaction design, others have been actively exploring the use
of physical craft materials such as wood, ceramics, glass or textile, for designing computational artefacts (Forsslund et al., 2015; Giaccardi et al., 2014; Rosner et al., 2015; Schmid et al., 2013; Tomico et al., 2013). Materials that are central to a particular studio craft practice such as wood crafting or textile crafting most often come with a long tradition in terms of techniques for giving form to them. The fact that such materials are mostly associated with physical craft practices and not with computation or interaction design can be seen as providing an interesting juxtaposition, when these materials are brought into the contexts of interaction design.

Previous research on what craft materials can contribute to interaction design includes, for example, the work of Schmid et al. (2013), who explored the possibilities of making curved interactive surfaces using hand-blown glass in order to explore expanded possibilities in the field of in-car interfaces. Ceramics is another material that has been explored in interaction design. Meese et al. (2013) involved ceramic designers and illustrators to explore novel uses and techniques of visual pattern recognition for enhancing a dining experience. Another material is paper (Buechley et al., 2009; Gardiner & Gardiner, 2012; Mackay, 2015; Mellis, 2013), which is predominantly related to eastern craft practices such as Chinese paper cutting or Japanese origami. For example, MacKay (2015) has been involved in several studies focusing on the exploration of interactive paper as a form of physical computing for musical performances, and Mellis (2013) has explored the possibilities of crafting electronic circuits with paper and conductive ink.

From a perspective of complex craft materiality and interactive qualities, Fernaeus and Vallgårda (2014) present and discuss Ajna, which is an interactive musical cabinet that interacts with a live orchestra using a variety of setups. It has been made by the art and music collective Iskogen ibland, from a rich variety of materials, such as leather, feathers, wood and electronic components, in addition to old and re-used objects (Figure 15). They analyse the process of how Ajna was made through an interaction design lens, by focusing on the negotiations between physical form, temporal form, and its interactive gestalt.

Textile is the craft material that has been most extensively explored for interaction design (Devendorf et al., 2016; Perner-Wilson et al., 2011; Persson, 2013; Poole & Poole, 2016; Poupyrev et al., 2016). Textile materials gained ground in interaction design since they opened up a space for making “soft” electronics, such as various types of input or output sensors and actuators out of conductive or resistive yarns and other types of electronic textiles, usually referred to as e-textile materials. This has been also supported by the popularization of the LilyPad Arduino (Buechley et al., 2008) and similar microcontrollers that have been developed for contexts of crafting computational textiles. Hannah-Perner
Wilson in collaboration with Leah Buechley and Mika Satomi have been the first to introduce and popularize the idea of handcrafted electronics, by presenting the Kit-of-No-Parts approach to building electronics (Perner-Wilson et al., 2011). This approach is about utilizing everyday crafting practices such as knitting, stitching, sewing or felting for making sensors, actuators and circuits from soft and textile materials (Figure 16). Through their extensive explorations of textile sensors, they argue that the main benefits of such an approach to making electronics can be summarized in three topics: a) The possibilities of allowing for personalization, b) the transparency that handcrafted sensors offer, in regard to determining the function of an artefact from its form, and c) the utilization of skills transfer, in regard to “using craft materials to connect existing knowledge and skills to technology creation and customization” (Buechley et al., 2011, p.61). E-textiles and textile crafting more broadly have been of great relevance to research application domains that are focusing on the making of interactive clothes or accessories, known as wearable technology (Tomico & Wilde, 2016; Wilde, 2012), or fashionable wearables (Seymour, 2008), but also for interior design and architecture (Mazé, 2007; Poupyrev et al., 2016).

3.4 From Materials and Making Practices to User Experience

In an attempt to understand the intersection of interaction design and crafts, it is important to look at the properties of interactive artefacts beyond materials and making, as artefacts that evoke particular experiences in interaction and use. From an interaction design research perspective, this has been mainly discussed from a perspective of user experience (Buxton, 2007; Lowgren, 2009). At the core of interaction design as a practice lies how a computational artefact will be experienced in interaction, but also how it can become part of people’s everyday practices and use contexts, which extend beyond a making process (Odom et al., 2016; Redström, 2001; Wakkary & Maestri, 2008).

As it has been previously argued, the material properties of computational things greatly influence aspects of interaction and use, beyond merely influencing their form factors (Ylva Fernæus & Sundström, 2012; Hornecker, 2011). Several researchers have studied how the design of interactive systems is physically tied to the material foundations that define possible interactions and media expressions (Blanchette, 2011; Dourish & Mazamanian, 2011; Vallgårda & Sokoler, 2010). Other studies focused on material and design considerations in relation to user experience, stress the fact that materials also shape social and cultural practices around an interactive product (Giaccardi & Karana, 2015; Rosner et al., 2012; Wakkary et al., 2017). Giaccardi and Karana (2015) developed the Materials Experience framework for HCI, through which they discuss how “materials shape ways of doing and ultimately, practice, and
Figure 15. Ajna is an interactive musical cabinet made from a combination of craft materials and computation and which interact and perform with a live orchestra, designed by the art and music based collective *Iskogen ibland*. Fernæus and Vallgårda (2014) present and discuss the process of how Ajna was made, in regard to its interactive and physical properties.

Figure 16. A collection of input sensors in the form of pushbuttons, potentiometers, squeeze and stretch sensors, made from conductive and resistive e-textile and soft materials. This approach to handcrafting electronics has been extensively explored by Perner-Wilson et al. (2011).

Image taken from the blog that Mika Satomi and Perner-Wilson have developed as a resource for supporting wearable technology documentation (http://www.kobakant.at/DIY/).
how this is rooted in the experience of those materials” (p.2447). Similarly, Landwehr-Sydow et al. (2017) use the notion of Material Literacy to point to how the unfolding experiences around physical and digital materials have to be understood as a situated interplay between certain qualities of the material, and the subjective abilities to interpret and “read” these qualities.

In the domains of interaction design and HCI, experience-centred design has been considered very influential (Buxton, 2007; Löwgren, 2006; McCarthy & Wright, 2004). It has been stressed that the experience of interacting with technologies is deeply felt and grounded in bodily aspects, and this should be taken into account together with considerations of usability and function when designing computational things for people to use (Höök, 2012; Hornecker & Buur, 2006; Wright et al., 2008). A number of research studies focusing on experience and interaction have been inspired and influenced by Dewey’s (2005) pragmatism philosophy and more recently by Shusterman’s (1992) philosophy of somaesthetics, as the cultivation of someone’s attention to their own body as an aesthetic and sensory appreciation (Höök et al., 2016a; Jonsson et al., 2016; Lim et al., 2007; Schiphorst, 2009).

But, apart from the direct experience that is evoked while interacting with computational artefacts and in which material aspects have been considered to play a significant role, when technology becomes part of a person’s everyday use contexts, there are additional qualities that emerge, such as meaning and personal attachment with technologies (Broms, 2014; Gulotta et al., 2013). Wakkary et al. (2017) and Odom & Wakkary (2015) have been engaged in several studies of the long-term deployment and use of technology, looking at how people live with, and experience computational artefacts and Internet of Things (IoT) products that are part of everyday use contexts. Additionally, aspects related to the longevity or the obsolescence of technology from a perspective of meaning inscribed on artefacts through use and design considerations have previously been studied in interaction design. For example, this has been discussed from a perspective of how increasing the quality of a product or increasing the psychological attachment to a product, can be a possible way of increasing its lifetime (Blevis & Stolterman, 2007).

On the other hand, Verbeek and Kockelkoren (1998) have discussed aspects of the longevity of artefacts in regard to very specific material qualities. For example, they mentioned that leather material might have the potential to create longevity, due to its positive aging properties, in relation to the patina it develops on its surface (Verbeek & Kockelkoren, 1998). Considering material properties, Giaccardi et al. (2014) and Robbins et al. (2016) studied how design and materials aspects could play a significant role in increasing the value of interactive artefacts and, therefore, extend their lifetime, in different ways. Finally, user experience has
been approached from a perspective of cultural aspects of materials in relation to aesthetic consideration, when designing technologies that will be worn directly on the body (Wallace et al., 2007). McCarthy et al. (2006) presented the concept of *enchantment* for studying relationships between people and technology, by drawing on examples of digital jewellery.

All these diverse research perspectives point to a promising research space at the intersection of craft and interaction design, especially when it comes to material and making considerations, but also when it comes to aspects of interaction and use. But, at the same time, they provide a basis for further exploring how studies of craft can contribute to interaction design, when it comes to the overall experience of interacting with technology, including culture, values and personal meaning.
Chapter 4

Methodological Approach: The Studies
4. Methodological Approach: The Studies

The main research approach I have followed has been design research at the intersection of studio crafts and interaction design. Below I will provide a brief context in regard to what design research entails, as a particular methodological approach in interaction design. Then I will provide an overview of the methodological approach I followed by presenting my research studies, focusing on the main parts of the process and the main outcomes of each study. In the next chapter, I will reflect on my methodological approach from a higher-level perspective, by describing my research program.

4.1 Design Research in Interaction Design

What I here refer to as design research in the field of interaction design can be understood as an exploratory and process-oriented approach of studying a particular design space (Westerlund, 2009), mainly driven by curiosity and aiming at producing new knowledge within a field. The specific approach to conducting design research that I have chosen is often referred to as a Research through Design (RtD) methodological approach (Fallman, 2008; Nelson & Stolterman, 2003; Zimmerman et al., 2007). This term was first proposed by Frayling (1993), and has been used in diverse ways ever since. More recently, Zimmerman et al. (2010) described it as “a research approach that employs methods and processes from design practice as a legitimate method of inquiry” (p.310). Research through design can be also seen as related to what Fernaeus et al. (2008b), and later Kuutti and Bannon (2014) have referred to as the turn to practice in interaction design and HCI.

Referring to RtD methods, but expanding further on what such a research process in interaction design would entail, Koskinen et al. (2013) used the term Constructive Design Research (CDR). They define CDR as “design research in which construction–be it product, system, space or media–takes central place and becomes the key means in constructing knowledge” (p.5). They propose it as a general method of conducting design research, of which the main body of work typically consists of a research program, based on constructive studies reported in journals, conferences, or exhibitions. Binder and Redström (2006) and Redström (2005) articulated design research program, as a framework of conducting research based on design explorations and studies that share a central idea that shapes and structures the conducted research.
Research through design as a methodological approach has been described as a process in which doing design work is part of doing research (Mäkelä, 2007; Stappers & Giaccardi, 2017). It is practice-based, meaning that it has a process of practical work at its centre (Fallman, 2008), which can result in artefacts as concrete outcomes, most often in the form of prototypes. This is a common approach in design research methods within interaction design (Djajadiningrat et al., 2004; Gaver & Bowers, 2012; Odom et al., 2016; Redström, 2001; Wensveen & Matthews, 2014; Wiberg & Stolterman, 2014).

Research prototypes play a central role in the production of knowledge in the area of HCI, since they allow for observations and insights that it would not be possible to reach otherwise (Gaver & Bowers, 2012; Koskinen et al., 2013). At the same time, empirical data from the real world can become observable through prototypes (Stappers & Giaccardi, 2017) and they can serve as an impetus to discussion, for showing new possibilities in a design space instead of necessarily aiming at resolving a particular problem, or for critical inquiry (Blythe et al., 2008; Boer & Donovan, 2012; Pierce & Paulos, 2014; Wakkary et al., 2015). Pierce (2014) used the term design research artefacts, which he defines as “artefacts produced in a research context and living in it, instead of being commercially available products” (p.735). More recently Odom et al. (2016) proposed the term research product as an extension and evolution of the notion of research prototype, in order to cater for the more complex relationships that emerge between prototypes and users, when deploying a prototype for a user study as part of people’s everyday practices. Design research artefacts often serve the purpose of extracting and abstracting knowledge on a higher level of research contributions (Gaver & Bowers, 2012; Löwgren, 2013; Redström, 2017). Wakkary et al. (2016) proposed the concept of material speculation that utilizes actual and situated design artefacts in the everyday world as a site of critical inquiry, as a way of critically exploring and questioning possible, and preferable futures.

During the past decade, a growing community of interaction design researchers has been engaging in design-driven methodological approaches for conducting practice-based design research. Today, it is already a rather well-established approach as a legitimate way of conducting research and in that way producing new knowledge (Gaver, 2012; Höök et al., 2015; Höök & Löwgren, 2012; Koskinen et al., 2013; Stolterman, 2008; Wiberg, 2013; Zimmerman et al., 2010). But, at the same time, the academic community is still discussing and debating what type of knowledge contributions can be extracted from design research, or what type of design theory can be made through design research (Redström, 2017). Examples of how to communicate knowledge contributions and validity when applying a design research methodolog-
ical approach include speculative possibilities (Dunne & Raby, 2013), annotated portfolios (Gaver & Bowers, 2012), strong concepts (Höök & Löwgren, 2012), or experiential qualities (Löwgren, 2006), to name just a few. These approaches include outcomes of a design research process on a higher-level of knowledge abstraction, beyond the process of designing and testing a prototype. Additionally, they aim at extracting and generalizing the knowledge that is embedded in a process of making, or in an actual prototype, for example by abstracting the qualities of a research prototype into generalizable knowledge that would be of relevance to the field of interaction design, so that other scholars could take this extracted knowledge and use it in their research (Gaver & Bowers, 2012).

4.2 My Design Space
The work conducted in this dissertation was motivated by exploring new possibilities through processes of making and reflecting on a particular design space, which is a common approach in design research conducted in the domain of interaction design. A design research approach is not necessarily about finding what is universally true, which is the case for research conducted, for example, in the natural sciences. Instead, it is about finding what is ideal to a particular design context and situation, or what Nelson and Stolterman (2003b) refer to as the particular, or the ultimate particular of a specific design situation. According to Cross (1982), when “designerly ways of knowing” are deployed, the sources of developing, articulating and communicating design knowledge could be found in people, processes or products.

Following this line of thought, the aim of my research has not been to solve a particular problem, to find what is true, or to give one single answer to my research questions. On the contrary, the aim was rather to explore a particular design space, which was defined by the material practices that were investigated, and by doing so, to contribute new insights and knowledge in the domain of interaction design research. Thus, what could be framed as “the problem” was for me a rather broad question of how we could explore and conceptualise preciousness for interaction design through actively engaging with contemporary studio craft practices, and in particular the three studio craft practices of leather, silversmith and textile crafting, but also what more general insights from these studies would be of relevance to interaction design research, and why.

Therefore, at the intersection of studio crafts and interaction design a hands-on and explorative research approach was deemed necessary in order to gain a better understanding of studio craft, as a practice and a concept. In each study, apart from the main craft materials being in focus –leather, metals, textiles– interactive technology was involved, in
Chapter 4

the form of electronic components, software, sensors and actuators. The way in which I approached my design space allowed me to explore closely the materials and making processes, which has been previously considered as being central when conducting practice-based research in interaction design (Fernaeus & Sundström, 2012b; Jacobsson, 2013; Jung & Stolterman, 2012; Sundström et al., 2011; Vallgårda & Fernaeus, 2015).

4.3 Overview of the Research Approach through my Research Studies

Below, I will provide a brief summary of each of the four studies included in this dissertation. I will present information on the context in which they were initiated in addition to important steps in the research process and the main outcomes in the form of design research artefacts. But, I will also highlight the notions of preciousness that were emerging in each study. The combination of the studies and how they evolved over a time span of five years, can be described as a research program (Redström, 2005). From this perspective, my overall research approach and process can be considered as a research program titled “exploring preciousness for interaction design through studio crafts”. The studies that are part of a research program aimed at providing new knowledge and reflections that were feeding back to the initial formulation of the design program.

4.3.1 First Study: Leather Crafting and Interaction Design

The first study included in this dissertation is focused on the intersection of leather crafting and interaction design and is presented in detail in Paper 1. The interaction crafting work took place between February and September 2012, when I was working as a design assistant on the moto-co collaborative project at HyperWerk Institute for Post Industrial design in Basel. As I described in the Introduction chapter, this was, just before I moved to Stockholm to start my PhD studies.

The main goal of the project was to explore different ways of constructing mobile workshop and exhibition spaces that could quickly be assembled and disassembled, packaged and transported to different countries for organizing collaborative workshops between design universities. Leather was one of the main materials we used for making mobile structures and furniture, in combination with wood, metal and other materials. The design team of which I was part was collaborating with the leather craftsman Isla Bayer, who is based in Basel. This was located close to HyperWerk, where our (interaction) design workshop was based. As the project evolved, I became the leather crafting “expert” on our design team, and the one who was working close to the leather craftsman. I often visited him at his leather crafting workshop to work there, or he would visit me at HyperWerk, where we would work togeth-
er. My role in the *motoco* project was also that of the “interaction design expert”, since I had graduated from the department of Product and Systems Design Engineering at the Aegean University in Greece with a specialization in interaction design.

Here it is important to mention that, during the six months of the practical work, a research perspective on the exploratory design work was present, but it was not the only objective. That became the objective later, when I looked back at the data I had gathered during those six months and the designed artefacts which were the concrete outcomes of the exploratory interaction design research process. The data, apart from the designed artefacts were in the form of photos, notes and sketches, in which I have been documenting the practical explorations of the project. Having a strong lens of interaction design research, since I had already started my PhD studies, I looked at the overall process and the data and reflected on those from an interaction design perspective based on related work in this domain.

The core aspects of this study in regard to the intersection of craft and interaction design concern the practical design work, which was conducted in collaboration with the leather craftsman. Isla was involved in two main design explorations presented in Paper 1, during which we explored the material of leather in combination with electronic components for making a touch-sensitive input surface on the one hand, and possible ways of using a laser cutter for crafting leather, apart from using specialized hand tools on the other. Using leather in interaction design was a new design territory, for which there was no previous available knowledge before this research process was initiated. For this reason, the design process evolved as being highly exploratory and aiming at trying out and testing different possibilities. The design research process evolved by making probes to quickly test ideas, by reflecting on the actual making process and its outcomes, and then by proceeding to another design iteration. In Paper 1, apart from offering concrete insights and reflections based on the two distinct explorations focusing on leather material and interaction design, we present two types of artefacts, which were the tangible outcomes of this study in the form of design research artefacts.

The first one was the Sound Box (Figure 17), which is an interactive sound table that responds to touch by playing different recorded sound files. This table was the outcome of studying how leather can be combined with electronic components and how leather material can be used for making a touch-sensitive input surface. A part of the top surface of the box is covered with leather cut in an asymmetrical pattern, and divided into five press-sensitive areas functioning as “pushbuttons”, each triggering a recorded sound file to play. The sound files were audio snippets that have been recorded during a project trip, where we
tried out our mobile equipment and organized design workshops with students at the Academy of the Arts in Belgrade, Serbia, at the Academy of Fine Arts, in the University of Zagreb, in Croatia, and with students enrolled in the Media Programme at Yildiz Technical University, in Istanbul, Turkey. The reason why we chose simple tactile input to trigger the audio was in order to explore how leather could be used as a material for tactile interaction, through gestures such as pushing, slight touching or stroking a leather surface. Another “pushbutton” area in the shape of a circle functioned as a stop button. Two conductive fabric pieces were used for each pressure-sensitive area, one placed on the reverse of the leather surface and the other placed on a thick cardboard surface facing the leather, which was added just for this purpose. In order to process the sound files and control the input and output, we used Arduino and Processing open software. The hardware used for the interactive part was placed inside the box, consisting of a laptop, an Arduino Uno microcontroller, and a pair of speakers.

The second design exploration that was part of this study resulted in a series of leather corners and connectors, which were functional parts of spatially expanding support structures for the mobile equipment we have been developing (Figure 18). These were used, for example, to support a number of wooden poles held together with tightly knotted rope, which were expanding in space. In order to craft the leather corners and connectors, we followed two different approaches. The first was to assemble such an artefact by using only our hands and leather crafting hand tools, by following a leather crafting process guided by Isla. In the second approach, we made use of a laser cutter, which is a digital fabrication tool often used for making physical prototypes in interaction design. We used this machine to cut the exact shape of the corners or connectors. In this case compared to the previous exploration, there was a need to know in advance exactly how much material was needed, but also the exact shape and dimensions of the final three-dimensional artefact, in order to design, sketch and then send the two-dimensional drawing to the laser cutter, where it would then be cut and assembled.

The quality of preciousness emerged during this study firstly on a level of the actual materials used, and especially the specific properties of the material of leather. The fact that it was “real”, instead of fake leather, also attributed particular qualities to how a crafting process was approached. For example, while Isla was making the leather corners and connectors using specialized leather hand tools, he was using leather resourcefully, through practices of mending and repair, instead of throwing away a leather artefact and starting a craft process from the beginning, in case he made a mistake.
Figure 17. The Sound Box was one of the design research artefacts resulting from the first interaction crafting study. It was made of leather, wood and electronic components, and it triggers recorded sound files, when interacting with the leather touch-sensitive input surface.
Figure 18. Leather corners and connectors for expandable mobile exhibition structures. They are made of leather material in order to explore processes of crafting leather with specialised leather-crafting tools and with a laser cutter.
4.3.2 Second Study: Silversmith Crafting and Interaction Design

The second interaction crafting study was at the intersection of silversmith crafting and interaction design. It was in collaboration with the silversmith artist Emma Rapp, who is based in Stockholm, and was initiated in 2014, lasting for about one year. This study started as a research exploration on how interactive accessories could be conceptualized or actively designed as jewellery items. Interactive accessories was the term we used for describing wearable technology in the form of accessories instead of clothes, such as electronic devices worn as bracelets that can track the bodily activity of the wearer, such as the Fitbit (2007), which is a commercial product. The motivation behind this research study was based on the fact that there are many similarities between such wearable devices and jewellery; for example, they are worn very close to the body; they are put on public display and they are both elaborately made. But, at the same time, there are core differences between them: for example, fine crafted jewellery has more varied designs and is considered a valuable item that is worn and kept for a long time. On the other hand, interactive accessories are often considered “gadgets”, instead of precious items, while at the same time they can quickly break and be thrown away since they cannot easily be repaired. Based on such motivations, we started exploring both practically and theoretically the intersection of jewellery and interactive accessories, in regard to aspects of design, materials, but also aspects of wearing and interacting with such artefacts. It was at that time that we also received funding from Innovativ Kultur, and our project called Precious Materials of Interaction, intended to explore and study further the above research directions.

In terms of the research approach followed and the outcomes produced, this study consists of two parts. The first, presented in Paper 2, consists of reflective accounts that emerged from two main workshops organized, in addition to interaction crafting explorations in collaboration with the silversmith artist. The first workshop was organized at the TEI’14 Conference, which took place in Munich, Germany (Fernaeus et al., 2013). The focus of this workshop was to explore hands-on how to craft electronic components such as simple input sensors or potentiometers in combination with fragile materials picked directly from nature, such as dried leaves, pinecones or seashells. Such types of “raw” materials were combined with copper or silver coatings and other materials used in interaction design, based on their conductive and resistive properties. Such types of “fragile” sensors were then connected to the rFlea microcontroller (Solsona Belenguer, 2015) and integrated in lo-fi prototypes of interactive accessories or jewellery items. This particular direction emerged from exploring whether fragility could be one quality that could be utilized while making computational artefacts, and consequently contribute to a degree of preciousness in interaction. For
example, by inviting a user to handle the artefact with care, but also by explicitly reflecting, and taking to the extreme the impermanent aspect of materials.

The second workshop took place at the Mobile Life Research Centre in December 2014 and was a full day workshop with invited interaction design researchers and product designers, targeted at exploring and discussing interactive accessories by having jewellery design as a conceptual framework. The activities of this workshop foregrounded both practical and theoretical explorations, and resulted in several conceptual ideas based on the qualities of preciousness, ephemerality, fragility and craftedness. In Paper 2, we articulate craftedness as the way in which particular materials can be given form, based on their material qualities, and how this can potentially affect aspects of interaction and use practices emerging in relationships between artefacts and users.

From this workshop, the concept of the “copper and silver button” emerged, which would be fully implemented later in collaboration with the silversmith artist. It was based on the idea of using the conductive properties of metals as a resource for interaction, in combination with the resistive properties of bare skin, and through that designing simple input controls that would be worn as jewellery, and also look like “jewellery items”, instead of “sensors”. Apart from the workshops, together with the silversmith artist we explored possible intersections of jewellery and interactive accessories, through a series of small-scale artefacts that we developed by combining silversmith materials with materials used in interaction design, in the form of sensors, actuators and circuit boards.

Additionally, in this research study, a number of master’s students from the Media Technology and Interaction Design programme at KTH were involved. Since I was teaching various interaction design courses as part of my PhD studies, I often combined my teaching activities with my design research, for example by studying further insights and reflections emerging through my research studies, as part of the curriculum of an interaction design course. An example has been my involvement in the Physical Interaction Design and Realization course in 2014, and the fact that the course theme, and consequently the design work conducted by the students, was aligned to the research space of this interaction crafting study. Specifically, the theme was to design a mobile interactive artefact from a crafts perspective, interpreted mainly as using craft materials, in order to explore practically and reflect on qualities such as fragility, preciousness and craftedness. One of the student projects, the Memonile (Turesson, et al., 2015), which is a wireless device worn as a necklace for taking quick notes or making doodles, was one of the interactive artefacts that was analysed through impermanence, incompleteness and imperfection, during the fourth study, which I will present later.
The second part of this interaction crafting study, which is presented in Paper 3, is a more detailed account in regard to the intersection of silversmith crafting and interaction design, focusing on how the collaborative and practice-based design research process evolved in the craft studio. For about one year, I was visiting Emma at her silversmith studio located in the downtown area of Stockholm, and together we would engage in practical and exploratory research. Those visits were on an average twice per week, during which practical work was conducted for between three and eight hours. Starting from the fact that metals are highly conductive and for this reason central in interaction design practices, for example for building electronic circuits or connecting electronic components, and that they are also the central material in silversmith crafting, we explored the conductive properties of metals as a material quality for interaction. As presented in Paper 3, the main aspect of this study concerns how we approached the material space on a fundamental level, in which concrete challenges and insights emerged. These were on a level of the combination of materials, tools, techniques and ways of approaching each practice, but also clashes in values between silversmith crafting and interaction design, which influenced our design process.

This study resulted in a number of small-scale probes, lo-fi prototypes, and conceptual designs. However, I consider two artefacts as being the main design research artefacts that resulted from the collaborative work with the silversmith craftsperson. The first one is the Seaweed Speaker, which is a speaker designed as a necklace made from copper, leather, silver and hacked and re-used electronic components, which is described in detail in Papers 2 and 6 (Figure 19). It connects to a device such as a mobile phone or a laptop, and can either be worn as a necklace or placed on a surface leaving an increased openness or ambiguity in terms of where it can be placed, and accordingly, how it can be used or experienced as a device. In the case of wearing the Seaweed speaker as a necklace, the user can bring the copper seashell, where the speaker is placed, close to the ear, in order to listen to the music. It reads as a commentary on the short-lived reality of most electronic gadgets, since in contrast to most such devices, all of the electronic parts, which will likely be damaged at some point, have been made accessible in order to be replaced.

The second design research artefact from this study is a series of small input controls in the form of buttons or switches, which are made from wood, copper, silver, conductive thread and Bluetooth Low Energy (BLE) modules (Figure 20). They are described in detail in Papers 2 and 4. Each of these buttons can communicate wirelessly with a remote device, such as a mobile phone or a laptop, and they can be programmed through the Processing software platform. We imagined such buttons
Figure 19. The Seaweed Speaker is a speaker made of leather, copper and hacked and re-used electronics. It was one of the design research artefacts that resulted from the second interaction crafting study, focusing on silversmithing.
to be worn as bracelets or brooches and to be programmed in order to control various functions on a user’s remote device, ranging from answering a phone call to changing the background colour of a mobile screen, for example.

**4.3.3 Third Study: Textile Crafting and Interaction Design**

The third interaction crafting study, which was at the intersection of interaction design and textile crafting, was initiated in 2014 at KTH as an interdisciplinary project called Sound Clothes. This project was part of the initiative called *Small Visionary Projects*, focused on supporting the collaboration between different departments at KTH that had not previously collaborated. In that context two other colleagues from the Media Technology and Interaction Design department, Ylva Fernaeus and Vincent Lewandowski, and I, collaborated with two researchers from the Speech, Music and Hearing department at KTH, Ludvig Elblaus and Roberto Bresin, who are both at the same department as me today. As mentioned in Chapter 2, my colleague Vincent Lewandowski and I were involved as textile crafts experts but also as interaction designers. Overall, the study lasted for a little more than a year and aimed at combining the domains of textile crafting, interaction design and sound and music computing. The main goal was to study the design space at the intersection of these domains, by exploring possible ways of sonifying body gestures and movements through a garment that would be designed mainly for performative settings, for example to be used in a dance performance.

During this study, an exploratory and research through design approach was followed, starting from the material space at this intersection. The design research process evolved through bi-weekly meetings, which were organized in the form of lab sessions in which each research group brought designed probes so that they could be combined and tested together. As the design process evolved, these sessions took the form of collaborative crafting sessions in which the research group worked together on the development of one interactive garment. What was different in this study compared to the two previous studies presented above, was a different process that was followed since there was a clear aim for a particular design direction from the beginning, which was to design a garment by utilizing the performativity of the body and to combine this with sound as output.

As the project moved forwards, the overall explorations became more specific and crystallized into what was about to become the Nebula interactive garment (Paper 4). In order to reach this goal and arrive at the final version of the garment, several material explorations and design iterations were foregrounded in the form of prototypes in order to arrive at the final version. An important aspect of this study was the
Figure 20. Three versions of the copper and silver buttons, exhibited at Konstfack University College of Arts, Crafts and Design, as part of the Nordes’15 Conference. They are made of metals, wood and BLE modules and can be triggered by utilizing the conductive properties of metal and the resistive properties of bare skin. They can communicate wirelessly with a remote device.
explorations that were conducted, focusing on various types of materials and their combinations, in order to understand their qualities and decide how to use materials for the particular design context in the best possible way. This became feasible through the actual evolution of the garment, including the crafting of the soundscape and the crafting of the interaction gestalt between the bodily movements and the sound that was created through the garment, which brought together the different disciplines and practices involved.

After a series of prototypes and design iterations the main design research artefact was the Nebula interactive garment (Figure 21). This garment is a wireless studded cloak that reacts to the movements of the wearer and responds with an ethereal soundscape. The opening and closing of the folds and the many studs that clash, apart from being the main visual element of the Nebula garment, are also the mechanics by which the garment is made interactive. The large folds of fabric that follow the movements of the wearer in a lagging, pendulum-like fashion are translated into sounds, in real time, through the studs. Some of the clusters of metallic studs in the front are connected with copper thread to the analogue inputs of an x-OSC I/O circuit board, and some to the positive voltage output. The transmitted OSC-messages from the x-OSC board are received on a laptop by custom software written in the SuperCollider programming language. The circuit board, together with a small battery that powers it, are placed inside a pocket stitched on the inside of the first layer, at the back of the garment.

The quality of preciousness emerged in this study through the material qualities of the textile we chose for the Nebula garment, which is heavy, thick and elegant, in addition to the use of metallic studs as both the visual elements of the garment and the interactive component that triggers the sound. These material qualities in combination with the tight coupling between the movements of the wearer and the activity of the metallic studs that result in the sound output, contribute to material sensuality of both wearing and interacting with the garment. Additionally, preciousness emerged by the actual crafting process, mainly at a level of spending much time in investigating closely the material space, but also crafting the garment and the sound output.

4.3.4 Fourth Study: Reflecting on Computational Artefacts Through the Craft Qualities Embedded in Wabi-Sabi

The fourth study included in the dissertation is an analytical and reflective one compared to the previous three, and the aim was to look at the design space of interactive artefacts from a crafts perspective, through the Japanese philosophy of Wabi-Sabi (Paper 6). It was initiated together with my main supervisor, Ylva Fernaues, in 2015. In this study, impermanence, incompleteness and imperfection offered a basis for reflecting
Figure 21. The Nebula Interactive garment was the main outcome of the third hybrid crafting study focusing on textile crafting. It is an interactive garment that reacts to the movements of the wearer and responds with an ethereal soundscape, by utilizing the conductive properties of metallic studs, that are also the main visual element of the garment.
and discussing how crafts through Wabi-Sabi can be of relevance to interaction design and HCI.

The focus of this study was firstly to explore theoretically how the themes of impermanence, incompleteness and imperfection have previously been addressed in HCI with another vocabulary and without Wabi-Sabi as a basic framework. It was found that they relate to previous research on topics such as temporality, longevity and obsolescence (Blevis, 2007; Cohn, 2016; Odom, 2015; Odom & Pierce, 2009; Rosner & Taylor, 2011), but also on repair and appropriation (Maestri & Wakkary, 2011; Rosner et al. 2013; Wakkary & Tanenbaum, 2009). As a next step, we performed an interaction critique (Bardzell, 2009) on four interactive artefacts through the lens of impermanence, incompleteness and imperfection, focusing on their design gestalt, their materiality but also in terms of their interactive behaviour and use practices they invite for. The four artefacts were the Memonile, a note-taking device based on DIY aesthetics (Turesson, et al., 2015) (Figure 22a), Ajna, a complex musical cabinet, created in a bricolage fashion by the art- and music based collective I Skogen Ibland (Figure 22b), Woody, an open-source haptic manipulation device (Forsslund et al., 2015) (Figure 22c), and the Seaweed speaker, which was one of the design research artefacts resulting from the second interaction crafting study, described previously (Figure 22d).

The reason why we chose these particular four artefacts was because they resonated with our initial understanding of Wabi-Sabi by presenting physical as well as interactive gestalts that emphasise aspects of repair and customisation. We also found them intriguing, since their overall appearances depart in different ways from common norms in the design of interactive things. Furthermore, these artefacts were physically accessible to us, as we were able to experience their interactive qualities hands-on, and discuss them with their makers. Finally, they cover a range of interactive arenas (design, performance, haptics, art), which allowed a discussion across different types of use settings.

The interaction critique allowed for a closer investigation of the three high-level craft qualities embedded in Wabi-Sabi in regard to concrete aspects of materials, making and interaction gestalt of the four artefacts. By reflecting and analysing the results from the interaction critique led to the articulation of three meta-reflections, formulated as paradoxes, since they are proposing ways in which the seemingly negative craft qualities embedded in Wabi-Sabi could be used positively, as a design resource in interaction design. These three paradoxes, which are discussed in detail in Paper 6, are: 1) Designing for long-term interaction through conscious use of imperfect materials and media, 2) Approaching perfection through explicitly unfinished designs, and 3) Engaging with the richness of interactive expressions by embracing limita-
**Figure 22.** The four computation artefacts on which we performed an interaction critique in the fourth study (clockwise): a) The Memonile, a note-taking device based on DIY aesthetics (Turesson, et al., 2015); B) Ajna, a complex musical cabinet, created in a bricolage fashion, designed by the art- and music based collective *I Skogen Ibland*; C) Woody, an open-source haptic manipulation device (Forsslund et al., 2015); D) The Seaweed speaker, which was one of the design research artefacts resulting from my second interaction crafting.
tions in current technology. We end this study by discussing how these three paradoxes could possibly be used as a resource for designing for preciousness in interaction design and HCI, by taking into account the impermanent, incomplete and imperfect reality of technology. What was important in this study was that it offered a theoretical and reflective perspective on the intersection of studio crafts and interaction design, and allowed us to discuss preciousness for interaction design beyond the small-scale making activities involved in the three interaction crafting studies.
Chapter 5

Methodological Reflections
5. Methodological Reflections

In this chapter I will reflect on the overall methodological approach by presenting the main parts of my research program and through that provide a reflective account on the overall research process I followed. I will do this through a high-level perspective of how my methodological approach allowed me to extract my research contributions, and how these constitute knowledge contributions in the domain of interaction design. Looking at the overall research program, it can be summarized in my main research question.

As argued by Binder and Redström (2006), a research program consists of a variety of activities ranging from individual case studies to methodology and theory building. Based on this framing, the account of the research program that I will present below responds to the particular way in which I approached my research questions. From this perspective, the role of each study was to contribute to the program with new knowledge and insights, which resulted in the evolution of the program over time, and allowed me to extract theoretical knowledge from the practical design work.

5.1 The Three Interaction Crafting Studies: Design “Experiments” and Exemplars

According to Binder and Redström (2006), a design research program consists of studies or experiments, which are “exploratory probes into what the program may entail and how it can be expanded and sharpened to account for how the experiments unfold” (p.5). In my research process, the three interaction crafting studies could be considered as three design “experiments” of my research program. They contributed to exploring the design space at the intersection of studio crafts and interaction design through design explorations, as described by Fallman (2008). Design explorations are motivated by curiosity, with a main driving force to produce new knowledge within an unexplored field.

Since the three interaction crafting studies were initiated in different contexts, their methodological approaches differed slightly. The first study focusing on leather and the second focusing on silversmith crafting were more exploratory and open-ended in nature, compared to the third study focusing on textile, which started with a clearer goal of what to make. However, the process of exploring through making was central in the three studies and this was done mainly through practical work.
involving materials, tools, making processes and techniques. A central aim was to explore the “hybrid” space between studio crafts and interaction design on a fundamental level, to observe and report the results of such an exploratory research approach, and to reflect on the concrete insights and challenges that were emerging. Apart from a number of design research artefacts, the studies resulted in small-scale probes, in the form of material explorations and theoretical reflections, and these have been documented with photos, occasionally videos, sketches and field notes.

The design research artefacts that were the outcomes of each study consist a number of exemplars in the form of particulars or ultimate particulars (Nelson & Stolterman, 2003). As previously discussed by e.g. (Benford et al., 2015; Gaver, 2012; Pierce & Paulos, 2014), a design-driven methodological approach in interaction design, results in artefacts that may in and of themselves carry knowledge about the process and can be considered as a form of research contribution. The types of artefacts that serve research purposes are also central in design research programs and in Constructive Design Research aiming at designing for producing new knowledge, rather than designing commercial products (Koskinen et al., 2013). As mentioned by Cross (1982), design knowledge produced through a design research process is embodied both in the actual process and in the products produced from such a process. The design research artefacts resulting from my work can be considered as being “conceptual and material design studies and experiments” (Pierce, 2014). This is because they were mainly developed in order to serve the purpose of communicating particular insights that emerged during the interaction crafting studies, related to practices and values. For this reason they should not be considered as “finished” artefacts or products. Instead of being developed for user studies of deployment, they became “conversation objects” between the people involved, through which we reflected on aspects of material considerations and making. Additionally, they played a crucial role in providing a space for reflecting on how the presence of craft as a practice and concept, and specifically a particular studio craft practice represented in each study, influenced the making process and its design outcomes. Finally, they played a central role in extracting which notions of preciousness were highlighted in the explorations.

From a higher methodological perspective, the research approach when conducting practical work during the three interaction crafting studies could be considered close to what Redström (2017) has described as the tactic of parallels between design theory and design practice. He refers to parallels as a tactic of conducting design research in interaction design, in which there is a clear distinction between the designing/making on the one hand, and more theoretical accounts on
the other. In my case, when I was engaged in the practical design work during the interaction crafting studies, there was a clear distinction between craftwork and theoretical accounts of craft, which were taking place parallel to the practical work.

5.2 Studying Preciousness Through Craft Theory: Sequencing Theory and Practice

The aim of being an active participant myself in all three interaction crafting studies and working close to the crafts people involved was twofold: on the one hand it was to observe, document and reflect on how each studio craft practice was influencing both the process and the outcomes of each process, especially for interaction design research practice. On the other hand, studying contemporary studio craft practices close to experienced crafts people in each domain allowed me to better understand studio craft and its core attributes as a practice of giving form to materials. But also, to understand which values of craft are still present and part of the way that contemporary studio craftpersons practice craft.

Approaching studio crafts through and for interaction design by engaging in collaborative explorations with experienced craftspersons in their studios provided a space for bringing to the fore craft qualities, not only at a level of materials, tools, the actual making processes, but also at a higher level of craft qualities and consequently craft knowledge. The research activities that were followed at this stage of my research process could be described, from a methodological perspective, as what Redström (2017) refers to as the tactic of sequencing between practice and theory. He defines sequencing as the research tactic that aims to bring together making and theorizing, and in particular “it aims to make theoretical notions influence designing in sometimes fundamental ways” (p.17). In my case, I started to explore crafts theory from a perspective of how crafts knowledge can support and influence my design research process from a conceptual perspective. This is also where the second research question was addressed.

While working with Emma Rapp, the silversmith artist involved in the second study, impermanence, incompleteness and imperfection were highlighted as three intermediate-level concepts of craft theory, embedded in the Wabi-Sabi philosophy. As described in Chapter 2, these also reflect notions of preciousness embedded in studio craft practices more broadly, beyond my studies. Partly because the approach Emma has towards her practical craftwork was influenced by this philosophy and artistic design style, these three high-level craft qualities became a natural basis, where our design practice was informed by crafts theory. We started exploring preciousness through these three high-level craft qualities, from a perspective of how they could be used for designing
computational artefacts that would embody qualities of preciousness.

The use of craft theory was also feeding back to the overall direction of the research program and offered a new perspective on studying *making preciousness* for interaction design. The methodological tactic of sequencing was also foregrounded in Paper 5. In that work, we reflected on the experiential properties of the use of craft materials as surface materials of interactive artefacts. Specifically, we reflected on some of our design research artefacts, in addition to material explorations foregrounded during the interaction crafting studies, from a perspective of how the strong presence of studio crafts, as a practice and a concept, influenced materials, making and user experience. We used design theory based on two frameworks that have previously been elaborated by other researchers. The first is the *materials experience* framework by Giaccardi and Karana (2015), and the second what Fernaeus *et al.* (2008) referred to as *action-centric tangible interaction*. Based on these two frameworks on a theoretical level, we extracted three experiential properties that were highlighted by the use of the craft materials of leather, silver, copper, textile and wood. These are: sensory experience, physical manipulation and interactive behaviour. In Paper 5, we discuss how they highlight aspects of material sensuality in tactile interaction, but also the resourceful use of materials, based on the crafting properties of these particular materials.

5.3 Articulating *Making Preciousness*: Intermediate Level-Knowledge Abstraction

An important part of this work was to extract and articulate which qualities of preciousness emerging through studio crafts would be of relevance to interaction design. Löwgren (2009; 2006) has previously defined experiential qualities as the properties or traits that characterize the experience of interacting with a product or service, from a user perspective. However, when I refer to the quality of *making preciousness* and its sub-qualities that were extracted from my studies, they refer to qualities on a level of materials and making, as I will describe in the next chapter. The extraction of qualities from my studies could be understood as a knowledge abstraction, or what has been defined as intermediate-level knowledge contribution (Höök & Löwgren, 2012). According to Höök and Löwgren (2012) “design-oriented research practices create opportunities for constructing knowledge that is more abstracted than particular instances, yet does not aspire to the generality of a theory. We call this middle territory intermediate-level knowledge” [...], which is generative, that is, knowledge that plays a direct role in the creation of new designs” (p.23:3).

Collaborating with experienced crafts people in three distinct studio craft domains and engaging in explorative design research at the intersection of studio crafts and interaction design offered a unique setting
for bringing to the fore some of the attributes and values that are embedded in studio crafts that relate to the quality of preciousness, and more specifically to making preciousness. Reflecting on the three interaction crafting studies, preciousness as a quality was observed as emerging on how materials and making were approached, explored and combined, including interaction design materials and practices. But also, on how the making process evolved and what decisions were taken during the process, as well as how the material space and the making process were eventually shaping aspects related to interactive behaviour or the overall experience with the crafted artefacts from each study.

Reflecting on all four studies, it became possible to articulate three qualities of making preciousness, which are: resourceful composition, material sensuality and mattering artefacts. These are closely interrelated with the attributes and values that are embedded in studio crafts, and which were present in the three interaction crafting studies. But, they are also closely interrelated with the three high-level craft qualities embedded in the Japanese philosophy of Wabi-Sabi. They can be considered as three intermediate level-knowledge abstractions, which can be used to guide a design process in interaction design, but also to reflect on already designed computational artefacts in regard to the quality of making preciousness.

5.4 Research Validation: Contestable, Defensible, and Substantive

According to Höök and Löwgren (2012), in order for a contribution resulting from a design research methodological approach to become research knowledge, it has to be contestable, defensible and substantive. Based on these three criteria of research validation, a research contribution has to be new and novel to the academic community, it has to be grounded empirically and be rigorous and criticisable, and finally it has to be generative, meaning that others can use it as part of their research. From that perspective, my work is contestable, since the novelty of my research can be reflected in the peer-reviewed articles I published, but also in how I place my overall work and my contributions, among related research studies in the domain of interaction design and HCI. This has been described in Chapter 3, which focuses on related work, in Chapter 6, in which I present and discuss my main contribution, and in Chapter 7, where I discuss the relevance of my work from a broader perspective.

Additionally, the fact that I collaborated with experienced craftspeople in three distinct studio craft domains, in addition to being an interaction designer and a craftsperson myself, and as such being an active participant in all the research studies, supports the fact that my research contributions have been grounded empirically, analytically and
theoretically. This has happened through the design judgements (Nelson & Stolterman, 2003), but also through the design and craft repertoire (Schön, 1983) of the crafts people in addition to my own design repertoire and expert judgments during each design study.

The design research artefacts (presented in Chapter 4) resulting from the three interaction crafting studies, apart from being concrete outcomes of the exploratory process that carried information and knowledge in regard to the making process, they also served another purpose. They were exhibited and demonstrated at conference venues and in other contexts, tried out and tested by different people, and consequently were open to critique. In that context, the Sound Box, the interactive sound table designed during the first study focusing on leather, was exhibited at the DMY International Design Festival in Berlin, in 2012, where the visitors to the exhibition had the possibility of interacting with it. By observing and documenting how the visitors to the exhibition approached the table and reacted to it, but also how they explored the interactive properties of the table, and in particular the leather touch-sensitive input surface, provided important insights and reflections regarding the use of leather as a material for interaction. Similarly, the leather corners and connectors crafted both with hand tools and laser cutter, which were also outcomes of the first interaction crafting study, were tested in real settings, since they were used for actually constructing expandable exhibition structures. Another example is the Seaweed Speaker, developed during the second study focusing on silversmith crafting. This was exhibited at the craft studio of the silversmith artist involved in the study, during an exhibition we organized as part of our research process, but also at public events at the Mobile Life Research Centre. Several versions of the copper and silver buttons that have been developed during the same study have been exhibited at Konstfack University College of Arts, Crafts and Design, located in Stockholm, Sweden, as part of the parallel exhibition of the Nordes’15 Conference, Design Ecologies. Finally, the Nebula interactive garment, which was the design research artefact developed during the third study focusing on textile crafting, was demonstrated on several occasions, for example in public events at KTH and Mobile Life Research Centre. But most importantly, it was demonstrated at the CHI’15 Conference in Seoul, South Korea on the Interactivity track (Elblaus et al., 2015). The fact that several researchers tried it and explored the interactive qualities of the Nebula gave us new insights based on its crafting and interactive properties.

As previously argued by e.g. (Gaver, 2012; Zimmerman et al., 2007), design research is not about generalizing a contribution, since the design space consists of ultimate particulars, but it is rather about extending design knowledge. Reflecting on the relevance and transferability of
my research contributions, through the research program I articulated the quality of making preciousness for interaction design, through the three sub-qualities of resourceful composition, material sensuality and mattering artefacts. In Chapter 6, I present how they could be used in interaction design research contexts and developed further. Other designers in the domain of interaction design can take these three sub-qualities and use them in their practice of designing computational artefacts. By so doing, qualities of preciousness would be present at a level of materials, making and user experience. This can be seen as an extension of knowledge, since it is about the transferability of design research results. Finally, the three detailed accounts of how to use the materials of leather, copper, silver and textile for designing computational artefacts, in combination with the insights and challenges described in detail in Papers 1–4, constitute detailed descriptions and examples of working at the intersection of interaction design and studio crafts. Other researchers can gain insights in regard to how to integrate such craft materials in their practice, or how to study studio crafts and interaction design, more broadly.
Chapter 6

Making Preciousness for Interaction Design
6. Making Preciousness for Interaction Design

In this chapter I will present and discuss the main contribution of my work, which is the articulation of making preciousness through three qualities that emerged as part of my interaction crafting studies, namely resourceful composition, material sensuality and mattering artefacts. Making preciousness can be understood as a broader quality of a making process that includes a set of sub-qualities among which are the ones that I will focus on. These sub-qualities emerged and were extracted from studying preciousness for interaction design through studio crafts, and through craft theory. They can be seen as providing a level of knowledge abstraction, since they are bridging the “particular”, i.e. the design exemplars of my design research studies, and the “general”, i.e. the extraction of more generalized knowledge and theory from the particulars (Redström, 2017). Or as described by Höök and Löwgren (2012) they can be considered as intermediate level knowledge abstraction from practice-based design research studies, in the form of design qualities and experiential qualities (Löwgren, 2006).

On a broader level, the articulation of the quality of making preciousness that I am presenting in this chapter, can be seen as contributing to previous research conducted in the broader HCI domain on the topic of value and meaning of things, concerning relationships that can be developed between people and computational artefacts through use and interaction (Blevis et al., 2007; Broms, 2014; Odom et al., 2009; Odom & Wakkary, 2015; Wakkary et al., 2017). But more specifically, I have explored how preciousness could emerge through a making process and through material considerations that are present in practices of studio crafts. Therefore, I am offering a particular perspective of preciousness for interaction design, which is focusing on a degree of value that can emerge through materials and making, and would have the potential to influence relationships between people and technology, in regard to culture, aesthetics, material qualities and sensuality, when interacting with computational artefacts.

Preciousness as an explicit word, emerged in my work for the first time during the second interaction crafting study in collaboration with the silversmith artist, and in particular when we used jewellery as a metaphor to explore the design space of interactive accessories (Paper 2). During this particular study, preciousness became an active design goal for us, or a broader craft quality, which we were trying to achieve through practical work. For example, one particular question that guided our explorations was: how could we re-design very simple input sensors such as a button or a switch as a piece of jewellery using “pre-
cious” metals? And how would such a button evoke experiences in inter-
action, similar to experiences evoked by a fine crafted piece of jewellery?
Having preciousness as a guiding quality for our explorations explicitly,
as in the case of the silversmith interaction crafting study, or implicitly,
as in the study focusing on textile crafting, resulted in design research
artefacts that highlighted notions of preciousness. And by doing so,
they provided a basis for de-familiarizing already existing computational
artefacts, as it was the case with the copper and silver buttons (Paper 3),
or with the sound table made from leather and wood (Paper 1). Addition-
ally, preciousness allowed us to reflect, question and speculate at a
higher-level beyond a making process, how it could possibly contribute
to increased meaning and value of an artefact, from a user perspective,
based on qualities beyond practical use, such as efficiency of interac-
tion. But at the same time to critically reflect on how electronic products
and computational things are normally designed, but also on how they
are valued and lived with, based on their material and crafting qualities
(Papers 5 and 6). This includes artefacts designed as part of an interac-
tion design research context beyond the ones we made ourselves, but
also things that are designed as commercial products, such as wearable
sensors or other electronic devices.

6.1 Resourceful Composition

The first quality of making preciousness that I want to draw attention
to is what I refer to as resourceful composition. This is related to notions
of preciousness emerging during a design process. Specifically, it can
be considered as emerging and acting at a level of materials and mak-
ing regarding how a making process will be approached, including the
investment of time in exploring a material space, and how materials
will be treated. The quality of resourceful composition has the potential
of contributing to preciousness also at a level of user experience, by
inscribing particular qualities to the outcomes of the making process.
In the practice of studio crafts, preciousness on a level of materials
and making is achieved through the attributes embedded in this craft
category, as described in Chapter 2. Thus, metaphorically, the quality of
resourceful composition could be considered as referring to a particular
approach and attitude to materials and making in interaction design,
similar to that followed by a crafts person, who is engaging in a studio
craft practice.

From such a perspective, the quality of resourceful composition is
firstly about how a designer is exploring materials in order to utilize
their qualities for a particular design context, in a resourceful way. It is
not tied to a particular type of material, such as craft materials used in
our studies or to a “handicraft” process of giving form to something, but
it is rather related to the way materials could be given form in interac-
tion design, using tools, techniques and processes that are predominant in this domain. Here, by materials I am referring to the whole spectrum of materiality, as previously discussed and studied within HCI, ranging from physical materials to computational, code, media, software, and the possible combinations of those in various compositions between input and output modalities (Belenguer et al., 2012; Dourish & Mazmanian, 2011; Vallgårda & Redström, 2007). Resourceful composition is about investing time in engaging practically with the material space in order to reveal the set of qualities that are important for a particular context and design goal, and through that allowing materials to occur (Ingold, 2010), through a dynamic process of making. This dynamic aspect of revealing the qualities of materials while making is what the word *composition* implies. Additionally, it is through the experience and skills of the craftsperson that a resourceful composition of materials can be achieved, instead of an ad-hoc process of combining materials for arriving to any outcome. As mentioned by Ingold (2010) who is referencing Pye (1968), the deep knowledge about materials comes not only from a sensory perception of their materiality, i.e. the rather static material properties, but even more from the skilful practical engagement with materials in order to reveal their qualities.

When utilizing this sub-quality of making preciousness for guiding a making process in interaction design, it would firstly entail the very close investigation of the material space. This would mean spending substantial time and effort on exploring and getting to know the physical and computational materials and composites, as good as possible, before proceeding to the actual making. In HCI this has been explored, for example, by Sundström *et al.* (2011), who investigated the qualities of Bluetooth radio as a design material. But, apart from spending time on exploring the material space *in advance*, the quality of resourceful composition entails, even more, that materials should be the core of the making process *in situ*, around which actions of reflecting, judging, adjusting and continuing the making process could be initiated.

By engaging in a close exploration of the material space, it would be possible to investigate which material qualities should be brought to the fore for the particular context, and consequently used for a particular design goal in a resourceful way. By this, I mean that there should be an honest use of materials, when it comes to where they are needed according to their qualities, instead of just using particular materials without a reason, or for purposes they are not good for. An example of resourceful use of materials from my work includes the fact that, in the second study focused on silversmith crafting, silver or copper were not used in the artefacts for decorative purposes, but instead we used the conductive properties of such metals, in combination with the resistive properties of bare skin, to make input sensors (Papers 2 and 3). In that
way, a metallic surface became both part of the visual identity of an artefact and at the same time it was used as a resource for interaction.

Resourceful composition could be considered as being closely related to the notion of imperfection. As described in Chapter 2, “perfection” in a craft process is achieved through constant negotiations among the craftsperson, the materials, and the context in which crafting unfolds, which demand an investment of personal time, but also skill. The exploration of material qualities is closely related to the way in which they can be treated and given form. But at the same time, it is based on the skills and experience of the craftsperson, or of the interaction designer, since it is through practice built over time that they can develop their individual repertoire of (interaction design) craft skills for specific materials. A studio craftsperson utilizes their personal judgment and tacit knowledge while the making process unfolds around the material space, and decides how to proceed. Therefore, there is not a “perfect” or specific recipe on how to become a good craftsperson or how to make a “perfect” or good-looking artefact. For this reason, the quality of resourceful composition can also be considered as a subjective quality, but at the same time a quality that attributes to the maker the authorship of their creations.

In interaction design, a process of programming a shape-changing behaviour on an interactive wall for example, could be approached in similar way to a physical crafting process in which there is constant interplay and dialogue with the materials involved. From such a perspective using the quality of resourceful composition would entail the close investigation and exploration of the interactive behaviour and material expressions of the shape-change material of which the wall consists, in order to be composed resourcefully for a particular context of use. In this design space, this could be understood as designing resourcefully the temporality of the interactive behaviour (Redström, 2001), or the composition of the temporal form (Vallgårda, 2013). Similarly, Fernaeus and Sundström (2012) talked about three distinct layers in which the different material forms of how systems are crafted from and together with properties of digital materials could be explored. These are: 1) affordances of hardware and casings, 2) experiential properties of different software solution, and 3) material properties of sensors, radio-signals, and electricity (Fernaeus & Sundström, 2012). In designing the interactive behaviour of a computational artefact, an example of how resourceful composition could be used while exploring the properties of a materials space, is what Vallgårda et al. (2017) propose as Material Programming. This is a speculative idea of how a set of hand-manipulated digital tools could be used to explore the qualities of the temporal form of various types of input and output computational composites, in order to investigate, understand and consequently use their properties in the
best possible way for designing interactive compositions.

By using the property of resourceful composition, the maker could also learn new things about the material space such as exploring new material qualities or combinations of materials. And by doing so, they can decide what types of materials could fit best into a particular context, instead of designing “one size fits all” solutions, such as making use of predetermined materials for a particular context. In our interaction crafting studies, the close investigation of the material space resulted in surfacing particular material qualities in each case. Specifically, we explored how the qualities different craft materials have to conduct, resist or trigger could be used as a resource in interaction (Papers 2, 3 and 5). Providing a concrete example from our studies, in the third study that resulted in the Nebula interactive garment, we started by testing different types of e-textiles as input modalities, since this is a common approach when designing wearable technology. But, since we were aiming for a rather implicit, instead of an explicit mode of interaction with the garment, the process of exploring the material space led us to making use of metallic studs as input “sensors” instead. Metallic studs had to be used resourcefully due to their physical properties, weight, cost, as well as their conductive properties, both as the main visual element of the garment and at the same time as the main interactive element. The process of resourceful composition in this context allowed us to find a “new” type of material for the particular context and interaction gestalt we were aiming for, but also to succeed in designing for an implicit mode of interaction.

Resourceful composition could also provide a way of exploring and consequently knowing the limitations of the materials of which a design space consists, in order to use those in the best possible way. For example, the material properties of digital media being inherently limited in terms of storage space, battery life, or connectivity, could be actively used as rather “positive” properties, and through a resourceful composition, to arrive at more honest, and possibly richer designs. This can be understood as designing for “perfection” in interaction design, through the quality of resourceful composition, by taking into account notions of imperfection in a design process. As we described in Paper 6, in a context of interaction design, imperfection could be understood as related to the fact that technology is constantly evolving and dependent on cultural and social contexts. For this reason, it is through the particular intentions and skills of the designer, craftsperson, or programmer, through the tools available at any given moment, and finally through the cultural and historical grounding, that a negotiation of perfection could potentially be achieved.
6.2 Material Sensuality

The second quality of making preciousness that I will present and discuss is that of material sensuality. This is both a design and an experiential quality (Lowgren, 2009), referring to the experience of interacting with a computational artefact or environment. Specifically, how that experience can be designed in a way that would evoke strong physical sensory experiential qualities in interaction, similar to those evoked by crafted artefacts, and through that contribute to preciousness from a user perspective. I am using the word sensual instead of sensory, in order to stress the qualities that can be evoked in interaction, through bodily experiences that are both sensory and aesthetic (Shusterman, 1992). Material sensuality could be understood as expanding on a spectrum of mainly pleasurable experiences arising through our senses, and from this perspective, it could be considered as a quality that can guide the design of expressive interactions (Schiphorst, 2009) with technology. Therefore, material sensuality should be understood as being related to previous research on the topic of the aesthetics of interaction in the domain of HCI, as previously studied by e.g. (Bardzell, 2009; Höök et al., 2016; Jonsson et al., 2016; Wright et al., 2008).

In studio craft practices, the artefacts that are outcomes of a crafting process most often evoke strong sensory experiences in interaction and use, which range from tactile to visual, olfactory but also auditory. In the interaction design research domain, tactile interaction especially, has been a very prominent research sub-domain, and several researchers have studied aspects of design and interaction with tangible or graspable user interfaces, as for example (Döring et al., 2012; Ylva Fernaeus et al., 2008a; Hornecker & Buur, 2006; Ishii & Hiroshi, 2008). The strong sensory experiences evoked by crafted artefacts can be attributed to the actual craft materials that hold particular and strong sensory qualities, for example, in terms of texture or smell in the case of the materials of leather or wood. As described in the previous section, an experienced craftsperson has the skills to surface and utilize the very unique qualities of a material during a crafting process, and to make such qualities a core element of the crafted composition, meaning the outcome of a crafting process. Therefore, the quality of material sensuality could be seen as being related to the quality of resourceful composition. In order to design for evoking experiences in interaction, through materials, the interaction designer needs to possess a high degree of skill and experience. Through skill and experience the material space will be approached and explored in a way that would allow material qualities to occur, or slowly be revealed (Ingold, 2010; Pye, 1968), as I explained in the previous section. And consequently, it will be possible to “extract” and bring to the fore the material qualities that could contribute to sensual experiences in interaction, through a process of using materials
resourcefully for a particular design context. The resourceful approach of how particular material qualities could best be utilized for a particular context and purpose in order to compose the physical form and the interactive behaviour of a computational artefact will have an impact on the interactions and, consequently, on the experiences that designed artefact will evoke in use.

In that way, there is a degree of preciousness that is emerging on a level of enjoyment, satisfaction or pleasure when interacting with an artefact that evokes strong sensual physical experiences through materials. Some people might be familiar with the everyday experience of appreciating the use of a crafted ceramic coffee cup, which, beyond being merely visually appealing, can possess a texture that is central in how it can be experienced and appreciated in physical interaction. Adamson (2010) discusses the experiential properties of craft artefacts, and stresses the fact that they do not only appeal visually, but they also have to be experienced through our senses, for example through touch. In his view, referring to one of Anni Alber’s weavings, “to see it is not enough; one feels the need to rub it between one’s fingers to fully appreciate its design” (Adamson, 2010, p.5). By that, he is pointing to the property of craft artefacts to evoke strong tactile experiences in physical interaction, beyond the visual ones. Such strong sensual experiences evoked by craft materials or artefacts could also be discussed from a perspective of fetishism of craft materials or artefacts to embody and reflect values of authenticity or credibility (Attfield, 2000).

Similar to the strong sensual qualities that craft materials and crafted artefacts can evoke in interaction and use, for example when one strokes a leather or a wooden surface, the particular qualities of computational materials, code but also the dynamic and interactive behaviour, could also be explored and used from a perspective of designing for sensual experiences in our everyday use of technology. For example, Lim et al. (2007) studied how to design aesthetic interactions by paying attention to the material qualities of the interaction gestalt of a computational environment. In terms of tactile interaction with computational artefacts, Schipholst (2009) explored tactile interaction as a sensory modality that can evoke rich, poetic and somaesthetic experiences through the material qualities of the soft(n) installation which, with sound or light as output, reacts to various types of tactile input, such as squeezing parts of its surface. More recently, Boer et al. (2017) explored vibration as a modality that could contribute to rich vibrotactile sensations to a person wearing the Hedonic Haptics Player.

Since new types of materials or combinations of materials are entering the interaction design arena, and since computation, media and code are considered to be materials with their own unique qualities (Belenguer et al., 2012; Dourish & Mazmanian, 2011; Vallgårda & Sokol-
er, 2010), it would be interesting to explore how the qualities of computational materials could be designed from a perspective of evoking sensual experiences in interaction. For example how the qualities of pliability or fluency of the digital material, as previously discussed by Löwgren (2007a, 2007b), could be “given form” in a particular design context, aiming at sensual experiences, and contribute to preciousness, as I am approaching and discussing it in this dissertation.

Material sensuality should not be understood as a “static” quality, that either exists or not, especially since it is related to the passage of time, to the impermanence of materials and to the evolution of technology. One way of designing for sensual experiences through materials could be to take into account this impermanent aspect manifested as patina, for example, on a level of physical and computational materials or even media. And through that to design for material sensuality in interaction that would evolve and adapt to new circumstances, such as user needs or preferences, by allowing for a dynamic inscription of patina from a user perspective.

Material sensuality in the artefacts developed in the three interaction crafting studies was mainly manifested through the explicit use of the craft materials of leather, silver, copper, textile, wood and different combinations of these. That was mainly from a perspective of “surfacing the electronics” (Paper 3), in order to trigger interactions with the computational artefacts through tactile interaction with craft materials. And by so doing, to design “precious interactions”, through sensual and felt tactile interaction with artefacts. For example, that was in the case of the Sound Box, in which gestures of stroking of pushing a leather surface were mapped to triggering different sound files (Paper 1). Similarly, in the case of the copper and silver buttons developed during the second study, gestures of stroking, touching of fiddling with copper or silver surfaces was the “input” of triggering the buttons (Papers 2 and 3). The sensual experience through materials evoked when interacting with the Nebula interactive garment was a result of the combination of sound being closely linked to the subtle contacts created among the metallic studs, in combination with the very particular properties of the garment. Being enclosing and heavy, it evokes a very particular experience when wearing it and interacting with it, especially with regard to how the wearer can “feel” how the soundscape is created through the clashes of studs (Paper 4). Finally, the material sensuality evoked when using the Seaweed Speaker was on a level of the acoustics of sound coming out of the speaker. Since the speaker was hosted inside a copper shape that was given the form of a seashell, the sound coming out of it was deep and distant, and consequently gave particular qualities to the experience of listening to the music from this artefact (Papers 2 and 6). Additionally, the Seaweed Speaker evoked a sensual experience of listening to the
music, when worn as a necklace, since the wearer needed to place the copper shape in which the speaker is hosted, close to their ear. This creates a personal and almost intimate relationship between user and artefact, focused on material sensualities.

6.3 Mattering Artefacts
The third quality of making preciousness that I am presenting is that of mattering artefacts. The name of this quality has been inspired by Karen Barad’s work (2003), and it refers to how computational things can be designed from a “mattering” perspective, i.e. a perspective in which the work by the maker, the artefact and the user would be something that matters to all these agents, having as a connecting bond materials (matter). Preciousness through the quality of mattering artefacts would be achieved through a constant negotiation between the designer, the artefact, and the user, and it will be manifested as a degree, or a notion of preciousness, or not. This quality could be understood as bridging materials, making, and user experience with the long-term adoption of things, concerning relationships that can be developed between an artefact and its user, over time.

From a making perspective, this quality could be considered as linking the designer, the artefact and the user through material considerations. Specifically, it is about inviting for social engagement and for cultural and social participation by supporting the practices of caretaking and maintenance throughout the overall lifetime of a computational artefact. In my work, this can be read as being dependent on the three high-level craft qualities of impermanence, incompleteness and imperfection, in terms of how they could be used by an interaction designer during a process of designing computational things, on a level of materials and making. But, at the same time, this will be dependent on an ongoing negotiation between the user and the artefact, based on impermanence, incompleteness and imperfection, since the artefact will be designed in a way that will make its user aware that it has such qualities, that it is a “living” artefact, even after it leaves the hands of its maker.

Mattering artefacts is a quality embedded in craft practices to some extent, since their outcomes are most often considered as being “alive”, loaded with cultural significance, and on a more concrete level, they often need some caretaking over time. This is mainly due to the impermanent attribute of all physical materials and the fact that a material surface changes over time and through usage, for example manifests as patina. When considering physically crafted artefacts, this is something that can become a part of an artefact, and even contribute to its vintage value, or create meaning and personal attachment from a user perspective (Karana et al., 2016). Additionally, outcomes of studio craft practices are often expected to be repaired or modified over time, and a common
practice within studio crafts is to repair or re-use parts of damaged, old or broken artefacts for new designs, or to melt down metallic parts for new silversmith designs, for example. This can be seen as crafted artefacts having some inherent value, or even increasing in preciousness later on their lifetime, by a re-negotiation of (in)completeness and consequently (im)perfection between artefact, user and maker.

Utilizing the quality of mattering artefacts when designing computational things would entail to accept impermanence, and design for incompleteness and notions of imperfection. Therefore, mattering artefacts are closely related to the other two qualities of resourceful composition and material sensuality. A suggestion of how this could be achieved was provided in Paper 6, in which we proposed three design principles, in the form of paradoxes, for HCI. The first one is about designing for long-term interaction through a conscious use of impermanent materials and media. The second is about approaching perfection through explicitly unfinished designs, so that they have the potential to become “perfect”, based on user needs and desires. The third design principle is about engaging with the richness of interactive expressions by embracing limitations in current technology. On a higher level, using these design principles would entail that the interaction designer would invite potential users to take action and engage in the process of designing or appropriating the artefact through use and over time, i.e. “completing” the artefact by having a sense of ownership and authorship. And, in that way, to allow for use practices, as well as design orientation that treat design objects as alive.

Therefore, beyond a making process and on a level of the artefact-user relationship, the quality of mattering artefacts contributes to preciousness by allowing for the relationship between a computational artefact and a user to evolve over time. Rather than taking responsibilities away from the judgments of designers, designing for mattering artefacts would mean shifting these to further acknowledge the potential re-designs that may occur within use and after deployment. By accepting and actively using the impermanent property of computational materials, media or code, this can be a way of designing interactive technology that allows for having the possibility not just of recycling the physical components after something breaks, but also of adjusting to new circumstances and consequently being kept for longer, as already discussed by e.g. (Jackson & Kang, 2014; Maestri & Wakkary, 2011; Rosner & Ames, 2014). This view of materials, making and use, in relation to the factor of time, based on impermanence, incompleteness and imperfection, can be seen as related to what Ingold (2013) described as to foresee. In his view, a craftsperson has the possibility to see into the future, instead of projecting a future state of affairs in the present, or fix an end point, which, in his view, is a core difference between craft and
design practices.

A central aspect of the quality of mattering artefacts is the reality that materials are impermanent and, therefore, they age, decay or patinate, which has to do with on the one hand due to natural aging, and on the other hand it can be the result of interacting with materials, including extensive use, or misuse. Apart from physical materials, computational technologies degrade and age over time as well, either from a perspective of hardware’s material decay or software’s forms of obsolescence (Cohn, 2016; Dourish & Mazmanian, 2011; Fuchsberger et al., 2013). According to Cohn (2016) digital media, just as any media, are in a sense impermanent, however much we fight against this, and impermanence and obsolescence in some senses seems inevitable. This is because media are interdependent on physical platforms for storing, accessing and retrieving data, which are prone to aging, decay and degradation. The fact that materials and media age and decay and can become loaded with different meaning and significance over time should be considered as a reality and a material property that could be actively taken into account during a making process, but also during the overall lifetime of a computational artefact. In that way, the designer and later the users, could take into account this material property and design for long-term interaction based on the aging, decay or degradation of materials and media, and through that contribute to a sense of preciousness.

However, the impermanence of physical materials is much more straightforward compared to what impermanence in terms of decay, patina or degradation might mean for data, code or software. And similarly, the material meaning of artefacts resulting from a studio craft practice is much more straightforward, compared to the material meaning of computational artefacts. Craft materials such as wood, copper, leather or ceramics are more prone to changing their surface appearance over time, such as changing color, texture or develop a patina on their surface. In crafting practices, this is often used as a design resource rather than as something that should be avoided or not taken into account during a process of giving form to materials. Additionally, such materials have developed traditions of caretaking, for example polishing silver artefacts or waxing a wooden floor. In interaction design, the impermanence of physical materials in the form of traces and patina, and meaning-making practices around that, have been explored from a design perspective (Robbins et al., 2016; Rosner, et al., 2013), especially from a perpspective of how physical traces can be combined with digital traces of use and interaction with an artefact, which could be retrieved at a later stage (Giaccardi, et al., 2014). Concerning values inscribed on digital data, Gullota et al. (2013) investigated how digital materials might be passed down in the future, from a perspective of how digital systems and information can become a meaningful part of people’s everyday
and social relationships.

If we accept impermanence as a reality, then longevity and durability might not even necessarily be a design target per se. The fragility and impermanence that are inherent properties of various material forms might instead inspire new design directions and practices that treasure the ephemeral. One example here is the application *Snapchat* (2012), which has been designed for sharing media content between users in the form of photos or videos that would only have a short lifetime. This content will be lost after a specific timespan, which is not something that is common, when we consider media content such as personal videos or photos.

Mattering artefacts should not be understood only as being related to material properties, but could be considered as being a largely cultural quality. This quality of making preciousness is also referring to how taste, style, personal preferences and user needs are changing over time. Other researchers have discussed how computational artefacts could be designed in such a way that they would gain value through use, and thereby become meaningful for users, and consequently be kept longer. This has been discussed from a perspective of how increasing the quality of a product or by increasing the psychological attachment to a product can be a possible way of increasing its lifetime (Blevis, 2007; Blevis & Stolterman, 2007).

Looking at the artefacts that were outcomes of the interaction crafting studies, the quality of mattering artefacts emerged through utilizing impermanence, incompleteness and imperfection as craft qualities during the interaction crafting processes. In that way, preciousness emerged on a level of materials and user experience as the artefacts were asking to be handled with care, since they made the user aware of their impermanent and to some extent fragile properties, on a level of materials. Additionally, it can be observed that incompleteness is present as an attribute of those artefacts, both highlighting aspects of the crafting process, but also of the intended use and interaction with artefacts over time. An example is the copper and silver buttons, which have been made in such a way that allows for replacing either the two metallic surfaces or the wooden body of the button with others, if they are worn out due to extensive usage. But, most importantly, those buttons were designed so that they can be used both as interactive controls for a remote device such as a mobile phone or a laptop and also as jewellery, since they can be worn as necklaces, bracelets or pins. In that way, their design is from a user perspective incomplete, since the user can decide whether to use them as jewellery, as buttons, or both. Additionally, those buttons have been designed with a very open interaction in mind, since the user can decide to which action specific gestures can be mapped; for example, tapping or stroking the surface could
be mapped to answering a phone call and registering a specific moment in time, respectively. However, it is hard to draw conclusions about how in the long-term users would engage and value the artefacts of the three interaction crafting studies, since that is something that would need further studies in order to be firmly supported. And even more, in order to study this quality there would be a need to engage in long-term user studies, since this quality is explicitly addressing the long-term use, interaction and experience with computational technology.

6.4 Interrelations Among the Three Qualities of Making Preciousness

There are three levels on which making preciousness, through the three qualities presented above, could emerge and consequently act, with regard to the possible relationships that can be developed between the interaction designer, the artefact and the user. The first level is that of materials and making, including the available material space for a particular design context, how materials will be approached, and how they will be treated during a process of giving form to them, when having as a goal the design of a computational artefact. The second is the level of user experience, in which a potential user also becomes involved, beyond the interaction designer and the artefact. This includes aspects of interactive qualities and interactive behaviour of the artefact and use practices. Finally, the third level concerns the relationships between artefact and user over time, and includes aspects such as ownership, durability, but also values beyond practical use, such as attachment and meaning, cultural values and aesthetics. These three levels cannot be considered as being strictly separated from each other, since one influences the other, and all combined constitute the overall lifecycle of an artefact from a user perspective.

If we take into account these three levels, the quality of resourceful composition could be considered as emerging on the first level, that of materials and making. But, it can contribute to notions of preciousness emerging on the second and third levels. If materials and the design space are to be approached and composed resourcefully, meaning that a degree of making preciousness will be present on the first level as I described earlier, this would affect aspects related to interaction gestalt, and probably even the long-term adoption of computational artefacts. The quality of material sensuality is both a design and an experiential quality emerging mainly on the second level. However, it is dependent on resourceful composition, such as how materials and making will be approached, but at the same time it can influence preciousness emerging on the third level. For example, a computational artefact designed in a way that would evoke aesthetic and engage sensual experiences in interaction with materials might contribute to a sense of additional value.
from a user perspective, which could potentially contribute to stronger relationships between artefact and user.

Finally, the quality of mattering artefacts refers to notions of preciousness emerging on the third level, which is related to aspects of ownership and use over time. It does so by connecting the other two levels, through impermanence, incompleteness and imperfection. This means that, if an interaction designer were to use impermanence, incompleteness and imperfection as qualities on a first and second level to guide a design process, and design for engaging user experiences, that might lead to artefacts that would matter for users over time, and thus contribute to preciousness from a user perspective.
Chapter 7

Discussion
7. Discussion

In this chapter I will elaborate further on some topics that emerge when reflecting and speculating back on my research process and contributions. Firstly, I will discuss what were the upsides and the downsides of studying preciousness for interaction design through studio crafts. Continuing, I will elaborate on the contradictory aspects that are embedded in exploring making preciousness through the three high-level craft qualities of impermanence, incompleteness and imperfection. The third topic I will discuss will be what values craft brings to interaction design on a broader level. And finally, I will reflect on the attribute of the authorship the craftsperson has over their work.

7.1 Reflections on Studying Preciousness through Studio Crafts

In this work, I have explored preciousness for interaction design from a practice-based research perspective through contemporary studio craft practices, concerning attributes and values embedded in this particular category of craft. Focusing on studio, instead of other craft categories, such as DIY crafts, and exploring the intersection of studio crafts and interaction design is a research approach within interaction design that has not been extensively followed before, especially for studying notions of preciousness for interaction design. Exploring combinations of studio craft practices and interaction design is quite different than exploring intersections of interaction design and DIY crafts, or from exploring how to leverage new technologies and personal fabrication tools for developing further digital crafts for example, which have been two prevalent research strands in HCI, e.g. (Zoran & Buechley, 2013; Golsteijn, et al., 2014b). However, as reviewed in the related work section, a number of researchers in the domain of HCI have previously collaborated with craftspersons or artisans in developing computational artefacts, or in studying particular aspects that emerge in the design space that expands at the intersection of craft, design and interaction design. This includes, for example, the development of interactive decoration for everyday artefacts (Benford et al., 2017), exploring co-design processes between a ceramic artist and an interaction designer (Zheng & Nitsche, 2017), or exploring the integration of digital fabrication tools and techniques in the practice of “traditional” ceramic crafting (Rosner et al., 2015).

The fact that I studied making preciousness for interaction design through studio crafts allowed me to explore particular aspects of this quality, which would not have been possible to study otherwise. As I
presented in Chapter 2, studio craft practices have previously been associated with “preciousness”, which is present in some of the attributes and values embedded in this craft category. One example being the fact that studio crafts, compared to DIY crafts, often include “precious” materials, which was also the case in the first and second studio craft practices focusing on leather and silversmith materials in my interaction crafting studies. By “precious” I am not referring only to the monetary value and cost of buying leather, silver or copper, for example, compared to the cost of buying other types of cheap materials such as clay or cardboard. The material preciousness embedded in studio craft practices is even more related to the way materials are treated during a craft process, which is reflected in the practices of resourceful use of materials followed by studio crafts people also observed in our studies (Papers 1, 2, 3). The quality of preciousness is also embedded in the authorship the craftsperson has over their work, based on their previous experience and skill, in addition to the personal judgment and decisions taken on the spot, as the crafting process evolves.

Apart from the quality of preciousness embedded in studio crafts, which was a core motivation for studying preciousness through studio crafts, and studio crafts through interaction design, studio crafts and interaction design as practices of giving form to things share some characteristics, which brings them closer. As outlined in Chapters 2 and 3, in both practices there is a high degree of skill and experience involved, which attributes to a studio crafts person and to an interaction designer the identity of being experienced, instead of being an amateur in a practice domain. This allowed for particular observations during the research process of working close to the experienced craftspeople. An example here is that, reflecting on the intersection of interaction design and studio crafts on the same level of experience involved, allowed us to observe and articulate emerging clashes of values seen in the slow process of engaging with materials and making in silversmith practice, which collided with our ideals of agile and quick prototyping cycles often applied in a design process within interaction design (Paper 3).

On the other hand, the fact that I studied preciousness through crafts, and focused only on studio craft practices posed particular limitations on my research. In particular, because preciousness is also very much related to social and emotional aspects, beyond aspects on a level of design considerations including materials and making processes, in which I have mainly focused. By social and emotional aspects, I mean for example, the value and significance a computational artefact might have for a user as a result of the inscription of memories from loved ones, or due to social aspects, as previously studied, for example, in the case of music-sharing between friends (Håkansson et al., 2007).

But even only from a crafts perspective, taking my research further,
other aspects could be explored, or could have been studied from a different angle, for example how studying preciousness for interaction design through other studio craft practices, such as glass or wood crafting, would provide new or different perspectives in this research domain. Similarly, another approach could have been to study what complementary or contradictory values and attributes other craft disciplines such as DIY or amateur craft could bring to understanding and studying preciousness for the making of computational artefacts.

7.2 The Contradictory Aspects of Preciousness Through Impermanence, Incompleteness and Imperfection

Reflecting on the way that I have approached and studied preciousness, it becomes obvious that there is a contradictory or even paradoxical aspect embedded in this quality, and which I wanted to highlight through my work. Specifically, in my work this contradictory aspect is mainly embedded in the fact that I also studied preciousness through the three high-level craft qualities of impermanence, incompleteness and imperfection. At first glance, impermanence, incompleteness and imperfection could be seen as contributing to a decrease in value. Impermanence refers to things not lasting and being vulnerable and prone to decay, ageing and degradation. Similarly, incompleteness refers to something being unfinished, and imperfection as a word brings to mind something that might not meet high standards. Therefore, on a first level, these three high-level craft qualities could be considered as negative or at least problematic, especially when transferred to design contexts in which contrary values are predominant, such as in industrial design or engineering contexts, but also in contexts of interaction design. Especially since the engineering discourse of technology tends to promote values of designs being finished, lasting and perfect.

However, my intention in looking at what preciousness can contribute to interaction design from such a perspective, and by bringing these craft qualities into the domain of HCI and discussing their relevance to the field, was pursued for the following reason. It is because apart from high-level craft qualities, they also constitute realities of how things are, and consequently also offer a rather pragmatic and honest perspective regarding the design, use and long-term adoption of computational things. From such a perspective, preciousness can emerge when designing through and for these three realities. This approach is embedded in the quality of mattering artefacts, as I described in the previous chapter. Thus impermanence, incompleteness and imperfection can allow computational things to reflect their “real” qualities over time to their potential users, and in that way to contribute to the development of honest relationships between users and artefacts.

The contradictory aspect of preciousness that is embedded in design-
ing through and for impermanence, incompleteness and imperfection could be seen as also being related to the melancholic aspects that are embedded in the Japanese philosophy of Wabi-Sabi, and consequently in Wabi-Sabi crafts (Juniper, 2011). As mentioned in Chapter 2, the way melancholia is manifested in Wabi-Sabi is through the reality that there is an inevitable decay and death of all things that surround us, which is also tied to the ascetic and humble values embedded in this philosophy. In my work, I have not actively studied this melancholic perspective of Wabi-Sabi crafts for interaction design, but at the same time, this aspect is already embedded in impermanence, incompleteness and imperfection. Therefore, designing for preciousness in interaction design through notions borrowed from Wabi-Sabi could be seen as being embedded with and carrying this melancholic attribute. From an interaction design perspective, this can be seen as being manifested in material and design considerations of computational artefacts that reflect a pragmatic and honest account of how technology is designed, experienced and lived with, which might not be lasting, perfect or flawless.

The three design principles, presented and discussed in Paper 6, can be seen as an attempt to find a way out of these contradictory aspects by showing how to actively design for preciousness in interaction design, through these seemingly “negative” qualities. And, this is because they offer three distinct suggestions in regard to how the seemingly “negative” craft qualities embedded in Wabi-Sabi could be used “positively” in interaction design, on the levels of materials, making and interactive behaviour. Impermanence stresses the fact that technologies can be seen as a “live” material that is impermanent and changes over time, and with particular circumstances. Accepting and actively utilizing this attribute might be a way of designing interactive technology that provides a space for improvements, adjustments, or repair over time. Incompleteness stresses the importance of designing in a way that would provide the opportunity to users to personalize a device or a system, add their content, adapt it to their needs. In this way perfection can be approached, meaning perfection for each person, based on their needs and personal taste.

It was beyond the scope of this dissertation to study more in-depth each one the three themes and the paradoxical design principles. However, I have started to explore the theme of impermanence more in depth, having as a first research step a workshop that I co-organized at the NordiCHI’16 Conference in Gothenburg, Sweden (Tsaknaki et al., 2016). In terms of future work, the relationship between preciousness and impermanence, incompleteness and imperfection could be further studied and explored, both practically and theoretically, for interaction design. For example, from a perspective of what tensions could emerge between these in terms of computation, in the case of actively designing with data or code as materials.
7.3 What Values Does Craft Bring to Interaction Design?

By exploring the practices and values of studio crafts in combination with the practices of interaction design, my intention was also to open a space for further discussing and reflecting on existing values and norms that are prevalent in the domains of interaction design and HCI. This has been my intention in bringing impermanence, incompleteness and imperfection to these domains, but also by articulating making preciousness through resourceful composition, material sensuality and mattering artefacts. My aim has been to explore the material and making considerations of computational artefacts from a perspective of questioning existing norms and values, such as efficiency, robustness, “finishness” or perfection. Challenging predominant norms in interaction design is a research approach that has been pursued by various researchers before. Selective examples of previous research in this direction includes the exploration of ambiguity as a resource for design (Gaver et al., 2003), studies on counterfunctional things (Pierce & Paulos, 2014), and studies on slow technology (Odom, 2015).

Reflecting on the design research artefacts resulting from my work, they were all made from a perspective of de-familiarizing existing electronic or interactive artefacts, in different ways, and thereby they open a space for critique and reflection concerning materials, making aspects and user experience. In particular, they stress aspects of culture, craft aesthetics and more varied felt and sensual user experiences. Moreover, they were not developed in order to solve a particular problem, but rather to offer unique experiences, while at the same time to evoke desires and to trigger someone's imagination as artefacts that would be nice to have, similar to a crafted artefact decorating someone's house, or as a piece of jewellery that would be worn for enchantment. Specifically, they are challenging norms in regard to material and making preciousness.

However, my research approach could, as well, be wrongly understood and interpreted as arguing for designing fragile technologies, or systems and artefacts that are not robust or do not comply to usability rules. Especially since the design research artefacts presented in this work are on a level of small-scale probes that communicate aspects of exploring preciousness through making. They are not fully robust artefacts, and in addition to the fact that I have not conducted user studies, it becomes difficult to argue on a broader scale of everyday use practices, or real use contexts how the particular research artefacts could be valued or adopted in the long term. And, speaking more broadly, thinking of the transition from an interaction design research context, in which my work has evolved, and in which one is rather “safe” to make bigger claims to reality and the actual manufacturing and production of such computational artefacts, there are many questions that emerge.
On the other hand, a personal drive during my overall research process has been to re-value crafts, especially for contemporary, digital and post-industrial contexts of making, and in particular making in interaction design. Since the industrial revolution, crafts have been devalued compared to design (Attfield, 2000). Even this is not exactly the case nowadays, since crafts have re-gained value and importance as, for example, reflected in the fact that art colleges and universities have integrated craft in their educational curriculum (Shiner, 2012), it still remains a marginal practice for more technical, engineering or computer science related disciplines and domains. One reason for that is that crafts have been related to DIY crafts and hobbyism (McDonald, 2005). Especially “handicrafts” is often considered a female activity to be conducted in a domestic setting, compared to the more masculine professions that may traditionally lie closer to interaction design, such as engineering or computer science. By studying intersections of studio crafts and interaction design, I aimed at bringing some aspects of contemporary studio craft practices in the domain of interaction design. And, in that way, to open a space for further discussions and reflections on which attributes and values of crafts could be of relevance to design practices and approaches to designing for, and with computation.

7.4 Reflections on the Authorship of the Maker in Studio Crafts

Another reflection from my work is related to the value that is embedded in the authorship the maker in studio craft practices has over their work, which attributes particular qualities both to the making process and to its outcomes. This can be discussed from a broader perspective including tensions that emerge between values embedded in making, as approached through studio crafts, compared to industrial design manufacturing processes. Authorship is very central in practices of studio crafting, since the craftsperson is the one being responsible for what to make, and has the authority and autonomy to take decisions during a making process, based on their skills and experience. As described in Chapter 2, this particular characteristic of studio craft practices attributes an added value both to the process and to its outcome, which is related to skill, personal judgments and craft repertoire that unfolds during a making process. At the same time, it is also related to the aspect of “imperfection” embedded in a studio crafts process, which contributes to craft aesthetics created through a craft process, as described in the same chapter. Therefore, an artefact made by a single craftsperson in a studio is embedded with a different set of values, compared to one made through industrial production processes.

According to Dormer (1997), this is the tension between the “anonymity” of mass-production, in contrast to the “personalised” object that results from a small-scale crafts process, since it has the personal
“stamp” or signature of its maker. The authorship of the maker in studio crafts and the fact that this is considered as something that adds value to the outcomes of a studio craft process, distinguishes craft practices from mass-production or the industrial manufacturing of products. Most often studio crafts are associated with “personalised” or “unique” products, compared to unified ones that result from a factory chain, for example. This tension can also be traced back to the ideals embedded in the Arts & Crafts movement, compared to those embedded in the Bauhaus. On the one hand, small-scale crafting by a single person, or by the members of a guild, can result in more “authentic” objects that could probably be of more value to people, as claimed by the supporters of the Arts & Crafts movement. But, at the same time, the aspect of the authorship of a craft process is also embedded with the problematic aspect of expensive or exclusive one-off artefacts that result from a craft process, which probably not many people can afford to buy. This contradicts values of the democratization of technology, which is about cheap products that would be available for many people to buy, instead of expensive or exclusive ones. Therefore, compared to crafts, making processes that are based on industrial and mass production, speak to a different value system, which is related to socialist or democratic ideals of inclusiveness. However, one can still question the values of mass production, since there are problematic issues with planned obsolescence, for example. Since companies often aim at making profit by selling many products, instead of necessarily looking for the benefit to the people. A particular example of the problematic aspects of mass production is that the work of people assembling or repairing electronic products in factories or sweatshops is highly devalued, even though their work has many characteristics of a studio craft practice.

This tension has been underlying my work only at the level of exploring, understanding and consequently discussing the values that are embedded in studio crafts. Especially from a perspective of how my research could be placed in a more pragmatic context related to the reality of production and manufacturing of technological artefacts. Since studying the values and processes that are embedded in studio crafts could be read as romanticizing crafts and small-scale crafting over industrial production, my aim was also to understand and discuss the different value systems on a broader level, instead of arguing that one is “better” than the other.

Broadly speaking, the tension between the different value systems embedded in crafts and the manufacturing of products is much more complex and related to historical and political aspects. For example, this tension brings another issue to the fore, which is related to the uniformity of products that result from mass-production, which speaks to a particular style, inherited by the Bauhaus ideals and related to the “form
follows function” design ideals of the 20th century. On the contrary, craft has been sustaining a space that supports culture and ornamentation, which can be seen as a different style or product ideal, compared to minimalism that has been prevailing as a design style since the Bauhaus movement. This has been an aspect underlying the interaction crafting studies that I was involved in, especially in regard to how exploring the making of computational artefacts through crafts, could allow for bringing values such as culture, variation and personalisation into interaction design.

An interesting observation is the fact that there has been a resurgence of craft lately, which speaks to the need for more varied, local or small-scale production of things. This can be seen as related to sustainability issues, and consequently to trends such as “eco-design” which have been supported by several (sub) cultural groups emerging in various cities worldwide. From such as perspective, craft seems to sustain a space parallel to the mass production of goods and supported by cultural groups who are interested in making their own products, cultivating their own food, or adjusting already made products to their needs. I see this emerging trend or tendency as a way of transferring some degree of the authorship of the maker to the end user, especially in a social sphere of production in which uniformity is predominant, but at the same time there is a deeper need for individuality. Especially when it comes to uniform products, the user can take action and personalize those based on their needs and personal preferences.

From such a perspective, the authorship the crafts person in studio crafts has over their work and consequently over the outcomes of such a process, can also be discussed in relation to contemporary practices of DIY making, appropriation and open source making, which blur the boundaries between maker and user, and thus highlight different values. Such practices attribute to the user to some extent the role of the designer, and consequently a degree of authorship of their work. This could be further explored in relation to research directions in HCI on the topics of democratization of technology, the maker movement, or hacking and open source practices, as previously studied by e.g. (Ames et al., 2014; Tanenbaum et al., 2013; Wakkary & Tanenbaum, 2009).

The quality of making preciousness through mattering artefacts that I discussed in the previous chapter, can be seen as a way to transfer some of the authorship of the maker to the user, by taking into account impermanence, incompleteness and imperfection, not only through making, but also through living with an artefact. However, it is important to note here that designing computational artefacts that would invite the user also to become a maker, to some extent, could probably speak to a particular cultural group, who would treasure and consider as “precious” such possibilities of being able to modify, adjust or repair
something. And most likely not everyone would like to take action and “complete” an artefact themselves, and over time.

Finally, through my research studies, it was interesting to observe the aspect of the authorship of the craftsperson in relation to the collaborative work conducted during the interaction crafting studies. Especially since studio crafting is a highly individualistic practice compared to interaction design, in which it is common to collaborate with other people and often contribute to a small part of the overall process. This perspective would be interesting to explore further, concerning the degree of the authorship of the craftsperson, in contexts of collaborating with other parties, as it was the case in my studies. For example, how and to what extent, the practice and values of studio craft practices would shift if interaction designers more often collaborated with experienced studio craftspeople, and how this might result in new types of “hybrid” making practices, that would blur the boundaries between studio craft and interaction design.
CHAPTER 8

Conclusions
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In this dissertation, I presented a body of work in which I studied preciousness for interaction design focusing on design consideration on a level of materials and making, what I refer to as making preciousness. The particular way in which I studied this topic was through contemporary studio craft, as a concept and practice. The six publications included in this dissertation do all, in different ways, address this research space. This was from a perspective of how making computational artefacts could be approached as making things that would be of value to people beyond practical use, but also beyond a level of luxury or monetary cost. But, mainly considering value created through craftmanship, through the way materials and making are approached, value related to the experience of physically interacting with materials, and value created through the aesthetic intentions of the maker. This is a research topic that has been of importance and relevance to the interaction design research community within HCI over recent decades. Especially when it comes to studying how design considerations can influence the relationship between people and computational artefacts, how to design for richer interactive experiences, but also in regard to sustainable interaction design and how material qualities can contribute to increasing the value of things, which would potentially affect the artefact-user relationship over time.

My research was driven by my three research questions. The first research question concerns how to conceptualise preciousness for practices of making interactive artefacts? The answer to this question is the articulation of the quality of making preciousness for interaction design, and specifically for the practices of making computational artefacts. I articulated making preciousness through the three qualities of resourceful composition, material sensuality and mattering artefacts, which I consider to be of relevance to interaction design.

The first quality of resourceful composition refers to the attitude of approaching a design space in interaction design resourcefully, similar to how crafts people approach their craft practice. This could be understood as spending time and effort exploring the available material space in depth, both in advance and while the making process evolves, in order to allow the qualities of materials to be revealed for a particular design context and goal. And consequently, to be used for what they are good for, through a resourceful composition of materials, based on the skill and experience and intentions of the interaction designer.

The second quality of material sensuality is about notions of preciousness emerging through physically interacting with materials, due to
particular sensual and sensory experiences that are evoked by material qualities. It is about valuing the material experience of computational artefacts, beyond the physical shape, but also in terms of sensorial properties such as texture, temperature, weight and smell, as well as interactive qualities.

Finally, the third quality of *mattering artefacts* is about aiming for designing computational things that would “matter” firstly for the designer, and most importantly for the user, over time. I propose that it can be achieved by making use of the three craft qualities of impermanence, incompleteness and imperfection during a design process, and thereby design for allowing relationships between people and technology to evolve over time and adapt to new user needs and circumstances.

These three qualities that can be seen as different aspects of the broader quality of making preciousness. They highlight attributes and values embedded in studio crafts, and because of that they can be seen as transferring some of those to interaction design practices. And more broadly, they are covering a spectrum of material knowledge, craftsmanship and aesthetic intentions of the maker. They can be used as design qualities, or as a design intention during a process of making computational artefacts. Apart from guiding a design process, the three qualities of making preciousness can be used for reflecting on already designed artefacts, based on notions of preciousness on the levels of materials, making, user experiences and long-term adoption of things. And this is because they are emerging and consequently “acting” on these levels. Additionally, they can be considered as intermediate-level knowledge abstraction (Höök & Löwgren, 2012), from design practice to theory. This perspective on value created by the way a making process can be approached, and how this can contribute to value-creation of computational artefacts, has not been previously articulated in interaction design.

The empirical studies included in this dissertation, and the various insights that came with them, could be seen as constituting a design research program (Binder & Redström, 2006). In that context, each can be seen as a distinct design cases, or “experiments” of the research program. These were three *interaction crafting* studies at the intersection of studio crafts and interaction design, in the three distinct studio craft domains of leather, silversmith and textile crafting, in which experienced craftspeople were involved. Each study was exploratory in nature following a Research through Design methodological approach, and the aim was to observe, and articulate particular aspects concerning materials, making techniques and tools involved in each exploration. During each study, a number of design research artefacts were developed. These reflect insights and challenges that emerged during our work related to the “hybrid” crafting contexts, but most importantly, they reflect notions
of preciousness that were surfaced in each study.

Parallel to the practical work, I studied how craft represented in the Japanese philosophy of Wabi-Sabi can contribute to further understand and study preciousness for interaction design, on a theoretical level. This consists the fourth study included in this dissertation and summarizes the approach I took for answering my second research question, which concerns how could theoretical concepts from craft knowledge contribute to further understand preciousness in interaction design? Therefore, apart from the main contribution of my work, which was answered by the first research question, a second contribution consists the theoretical elaboration on how the craft theory of Wabi-Sabi could be applied to HCI. Specifically, I articulated how the three high-level craft qualities of impermanence, incompleteness and imperfection can be used for guiding a process of designing computational artefacts, and through that contribute to designing for preciousness. This second contribution can be summarized in the three design principles presented in Paper 6: 1) Design for long-term interaction through conscious use of impermanent materials and media, 2) Approach perfection through explicitly unfinished designs, and 3) Engage with the richness of interactive expressions by embracing limitations in current technology. The three high-level craft qualities of impermanence, incompleteness and imperfection are closely related to resourceful composition, material sensuality and mattering artefacts.

Finally, a third contribution of my work consists the particulars from each interaction crafting study, related to concrete ways of how to integrate the craft materials of leather, silver, copper and textile in interaction design contexts of making computational artefacts, in addition to the articulation of insights and challenges that emerged from each study. These can provide useful guidance for other interaction design researchers who are interested in integrating any of these materials in their design practices, or studying further the intersections between interaction design and leather, silversmith or textile crafting. This contribution answers the third research question of my work, which concerns what particular challenges and insights emerge in regard to techniques, tools and materials at the intersections of interaction design and studio craft practices?

Beyond the studies conducted as part of this dissertation, I have also discussed my work from a broader angle, by reflecting on and questioning the values that studio crafts might bring to interaction design research, but also, how my work could be discussed in a broader context of making and manufacturing of interactive or electronic devices. Moving from the studies presented here to other application domains in interaction design, the perspective in which I have studied making preciousness through studio crafts could be further explored. For example,
one could study further how to design more complex computational artefacts or systems with rich data, by using the qualities of resourceful composition, material sensuality and mattering artefacts as a guidance during a design process, scaling up the small-scale design explorations presented in this dissertation.

As a final remark, it is important to note that the quality of making preciousness that I have been offering throughout this work could be seen as a particular approach or attitude to a design space. And consequently, preciousness should be considered as embedded in, but also emerging through such an attitude, and inscribing subtle and hidden qualities to physical as well as computational things; qualities that invite us to touch, smell, interact, admire and acquire those, due to a complex but rich entanglement of elements that make them artefacts that evoke feelings and memories. I hope that my research will inspire others to further study and to explore the design space of computational things, environments and systems from a perspective that would account for more cultural, aesthetic, rich and sensual relationships between people and technology.
References


Design. In *IASDR07*, Hong Kong Polytechnic University (pp. 1–23).


University Press.


Fuchsberger, V., Murer, M., & Tscheligi, M. (2013). Materials, materiality,


Tanenbaum, J., Tanenbaum, K., & Wakkary, R. (2012). Steampunk as


