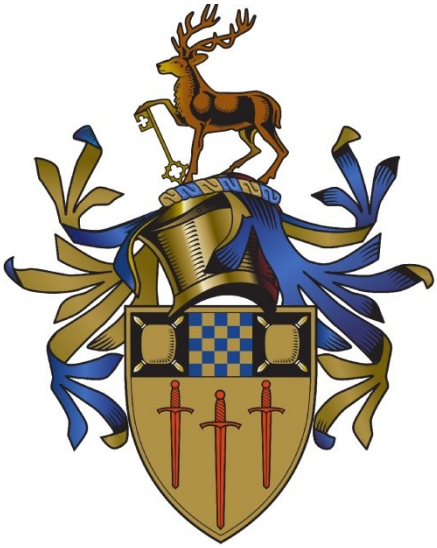
HYBRID CRAFT:

TOWARDS AN INTEGRATED PHYSICAL-DIGITAL CRAFT PRACTICE

CONNIE GOLSTEIJN



Submitted for the degree of Doctor of Philosophy

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Faculty of Arts and Human Sciences
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June 2014

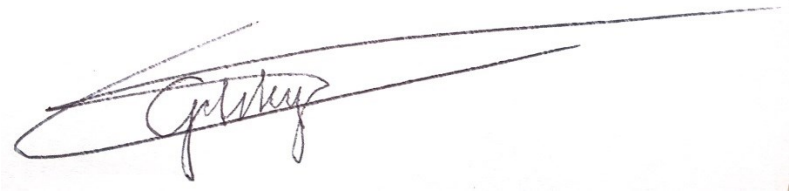
97,894 words

Abstract

Nowadays, people engage in a diverse range of craft practices in their everyday lives, which take place in physical and digital realms, such as creating decorations for their homes, modifying IKEA furniture, making digital photo collages, or creating their own personal websites. Within this increasingly hybrid age, in which people engage with physical and digital artefacts alongside each other and simultaneously, the research presented in this thesis poses that there are opportunities for new forms of making and creativity at the intersection of physical and digital realms. In other words, it introduces *hybrid craft* as a new everyday craft practice. Using an interaction design research methodology that consists of research *for* design (interviewing physical and digital crafters about their current practices) and research *through* design (designing, prototyping, and evaluating a novel toolkit for hybrid craft, called Materialise), this thesis explores what forms hybrid craft practice may take in everyday life, and what new systems or tools could be designed that facilitate this practice. Employing a comparison of physical and digital craft practices, and findings from design work, design guidelines are formulated for effective combination of physical and digital materials, tools, and techniques, and the realisation of interactive hybrid craft results in interaction design, for example by implementing surprising material behaviour within physical-digital combinations, and by realising techniques to work with physical and digital materials in the same materiality realm. Through empirical and theoretical grounding and reflection, this thesis establishes hybrid craft as a novel concept within design research and craft communities that has a wide range of possibilities in everyday life, both in offering ways to do more with digital media, and in encouraging new forms of making and creativity.

Statement of Originality

This thesis and the work to which it refers are the results of my own efforts. Any ideas, data, images or text resulting from the work of others (whether published or unpublished) are fully identified as such within the work and attributed to their originator in the text, bibliography or in footnotes. This thesis has not been submitted in whole or in part for any other academic degree or professional qualification. I agree that the University has the right to submit my work to the plagiarism detection service TurnitinUK for originality checks. Whether or not drafts have been so-assessed, the University reserves the right to require an electronic version of the final document (as submitted) for assessment as above.



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June 2014

Acknowledgements

I would first like to thank everyone who participated in this research in the initial focus groups, interview studies, and creative workshops – without your valuable insights this research would not have been possible. In addition, my deepest gratitude goes to my supervisors, who always made the time to read and discuss my work and never failed to give valuable suggestions. To David, the sweetest supervisor one could ever have, on whose door I could always knock if I had questions or doubts. To Elise, who has known me since I was a scared undergraduate student, and without whom I never would have started this journey. And to Abi, who freed up so much time in her busy schedule for me, and always asked those difficult questions that made this research better.

My thanks also goes out to my colleagues at the University of Surrey, Eindhoven University of Technology, and Microsoft Research Cambridge, who supported my research by giving comments and helping me realise my prototype. Special thanks go out to Nicolas Villar and John Helmes for their help with Gadgeteer and Solidworks, respectively. I also want to thank Microsoft Research for sponsoring this research through their PhD Scholarship Programme – without this financial support and unique opportunity, I would not have been able to do this research, and go to conferences to present my work and meet other researchers.

Further thanks goes out to all the friends I met on my journey, inside and outside the university, not in the least the people of the Digital World Research Centre who made me feel right at home when I shakily set my first steps into a completely new world, especially the 'daily' crew: Kristen, Chris, Kristina, Phil,

and of course Jocelyn – my twin, my office mate, who has been there with me since the first day; for standing by me in many a crisis and many a dance of joy, for chats on the sofa, for grammatical advice and teaching me so many great new words and expressions. Thanks also to my fellow PhD students, especially Elio, Sarah, Mauricio, Eva, Melina, Peter, Linnéa, Fiona, Serena, and Richard, for valuable comments and discussions, but also for the necessary social events; and mostly to David, my cinema buddy and oasis, who showed me to take it easy sometimes and be more relaxed – thanks man.

And last but not least, thanks to my family. In particular to my mum and dad, for being there in my lowest lows and at my highest highs, for loving me and supporting me, both in their own distinctive ways. To Laura, my sister and fellow PhD-pursuer, for her unique combination of sensibility and sweetness, and for good chats and pieces of advice. To Robin, for being such extremely pleasant company, in person and remotely, and for showing interest. And most importantly, to my mupke Donna, whose optimism and enthusiasm has turned my life around. Thank you for always being interested in my research, for lauding my academic achievements (even minor ones), and for supporting me every step of the way.

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1 Introduction

Putting down her favourite magazine, Ally is inspired and determined[1]. She has just read an article about Dutch designer Piet Hein Eek, who makes beautiful furniture out of scrap wood. After hours of browsing home catalogues and furniture stores in vain for something that is not too sleek and fits her interior, Ally has now decided she will make her own table from scrap wood. In the next few weeks she spends some time going to lumberyards, strolling down the beach for drift wood, and picking out bits and pieces from friends who have a fire place, until she has gathered enough material for her table. Having grown up with a father who was keen to teach her some DIY, Ally knows how to handle a hammer. In the evenings following her workdays, she enthusiastically and skilfully puts together her masterpiece, after carefully measuring how big the table should be, and roughly planning which piece of wood can go where. Some days later, the table is finished and Ally sits down with a cup of tea, enjoying her handiwork at a table that also looks great in her living room.

A few houses down the road, Jake shuts down his computer: enough for today. At the moment, he spends most of his free time building a portfolio website for his photography hobby. He has always enjoyed taking photographs and often shows them to friends and family, or posts them on Facebook. However, his friends have repeatedly told him he should consider doing more with his photography; he is good enough to be a professional, they say. Jake is not

[1] This chapter draws on material previously published in Golsteijn et al. (2012) and Golsteijn et al. (2014).

convinced but figures it cannot hurt to build up some web presence for himself in the form of a website dedicated to his photography. He has done some basic web programming years ago but now technology has changed, and Jake has spent a fair bit of time researching different scripting languages and browser compatibility solutions. After coming up with an idea for structure and content of his website, and sketching out some styling features, he decided to just start. Slowly getting a feel for web design as he worked, and through much trial and error, the end is now near. Some might say the website is already finished but, being a perfectionist, Jake still wants to put in some finishing touches… tomorrow.

Consider these two scenarios. Both Ally and Jake are making something; Ally creates a physical table, while Jake builds a digital website. Physical and digital making seem two worlds apart; and yet there are common features of these two practices, such as the personal motivation to make something; the research and gathering of resources; and the design and planning of the work before execution. Both scenarios further highlight other characteristics often associated with making or 'craft', such as skill in working; enjoyment; learning by doing; and perfectionism. When looking carefully, Ally's and Jake's practices are not that different after all. Both these physical and digital activities are examples of the everyday craft practices many people nowadays engage in; they create decorations for their homes, hack IKEA furniture, make photo collages, or create their own personal websites.

'Craft' is a discipline-dependent, contentious term, and a universal definition of craft, if this is feasible at all, has yet to be found. The term has, as art and craft researcher Peter Greenhalgh says, 'a plurality of meanings' but can also be seen as 'the epitome of confusion' (in: Dormer, 1997, p.ix). Shiner (2012), for example, distinguishes between craft as a *set of disciplines* – often defined based on materials used (e.g. wood, glass, clay) or techniques (e.g. weaving, throwing, blowing) – and craft as a *process and practice*, which can be found for example in bricklaying, surgery, cooking, but also in teaching and parenting (Sennett, 2008).

This thesis focuses on the latter interpretation – craft as a practice that can be found in everyday life – as in the examples above. This view on craft resonates primarily with the theoretical stances of sociologists Richard Sennett and David Gauntlett. Sennett uses an analysis of crafters, craft and craftsmanship to illustrate that craftsmanship 'names an enduring, basic human impulse, the desire to do a job well for its own sake' (2008, p.9). He continues to state that craftsmanship goes beyond manual labour, as craft is sometimes viewed: 'it serves the computer programmer, the doctor, and the artist; parenting improves when it is practiced as a skilled craft, as does citizenship' (2008, p.9). This view concurs with Adamson's (2007, 2010) arguments for the analysis of craft as 'a process, an approach, an attitude, or a habit of action' (2007, p.4) and his view on craft as 'a way of doing things, not a classification of objects, institutions or people' (2007, p.4). Importantly, this broad, practice-focused view on craft leaves room for the inclusion of new forms of making in the craft realm. Although the term 'craft' may evoke images of dark workshops, stern masters, and strenuous work with physical materials and tools, according to the views addressed above craft may just as easily apply to *everyday practices in both physical* (e.g. cooking, scrapbooking) *as well as digital realms* (e.g. blogging, photo editing).

Gauntlett (2011) writes about the power of making in current times, and includes digital technologies, by drawing on examples ranging from physical making (such as DIY and knitting) to digital making (such as game avatars and YouTube videos). Gauntlett focuses on making practices that result in something novel – as opposed to, for example, making the same chair from one drawing over and over again – and thus he closely links making to creativity. Gauntlett draws on Csikszentmihalyi's (2010) definition of creativity to define 'everyday creativity' as follows:

> 'Everyday creativity refers to a process which brings together at least one active human mind, and the material or digital world, in the activity of making something which is novel in that context, and is a process which evokes a feeling of joy' (Gauntlett, 2011, p.76).

Note that activities that are not novel, e.g. creating objects that are reproduced, can still be considered craft, but are not included in Gauntlett's interpretation of everyday creativity. Questions further arise around the differences between physical and digital practices and how notions about physical making can be carried over to the digital realm, e.g. digital objects can more easily be reproduced; is this still craft? This thesis explores such issues and reflects on differences between physical and digital making. Gauntlett adds the 'everyday' to the notion of creativity to reject addressing only the 'certified public genius' and instead talk about 'a friend or colleague who seems to like making things or solving problems in everyday life' (p.75). Sennett and Gauntlett share the view that crafting and making can be found in everyday practices. In this line, the interpretation of craft as a process and practice in everyday life, which is held central for this thesis, will be referred to as 'everyday craft' and is defined as:

> 'Everyday craft refers to the everyday creative physical and/or digital making practices people engage in, arising from a personal desire to do so.'

Thus, everyday craft can take place in the physical as well as the digital realm (More about this in the next section). Moreover, technologies such as tablets and software applications have given people new means to express their creativity. This thesis in Interaction Design Research studies these everyday physical and digital craft practices of everyday people. Specifically, drawing on the notion that both physical and digital means have their strengths, it focuses on the integration of craft in physical and digital realms into *'hybrid'* forms of making, for example creating physical objects that incorporate digital media, such as a home-made digital photo frame that displays a slideshow. These integrated physical-digital craft forms will be referred to as *'hybrid craft'*.

While this Introduction further defines hybrid craft later, and shows that certain craft activities in our everyday lives may have a hybrid craft process or result, current practices are only scraping the surface of what hybrid craft can potentially be. Taking a design research approach to envision new practices, this thesis aims, first, to develop a comprehensive understanding of what hybrid craft

practice entails and, second, to explore the design of new interactive products or systems to support hybrid craft.

FRAMING EVERYDAY CRAFT

Taking a step back from hybridity, it is first necessary to frame the notion of everyday craft further – what is, and what is not, considered craft in the light of this thesis? There are some common – and again contentious – assumptions about craft, or boundaries around what may be considered craft, that can be found in literature and in common views on craft. When including everyday practices and digital materials in a view on craft practice, it becomes necessary to review – and challenge – these assumptions.

CRAFT IS DONE BY HAND

First, it is often assumed that *craft is done by hand.* As David Pye (1968) illustrates, this assumption and the notions of 'hand-work' or 'handicraft' are ambiguous: they can refer to work done by using only one's hands versus work done by using tools; to work done using hand-tools versus work done by machines; or to work done using hand-powered tools versus work done using power-driven machine tools. Pye argues that hand-work and handicraft are 'historical or social terms, not technical ones' (p.26). The idea of handicraft seems to refer to any type of workmanship as it was done before the Industrial Revolution, without the help of machines, and it became a protest carried forward by the Arts and Crafts Movement to oppose the workmanship common in the Industrial Revolution (Pye, 1968). However, William Morris, who stood at the base of the Arts and Craft Movement, did not see handwork as such; he saw handwork as work without the division of labour[2], which could also include the use of tools or machines (Pye, 1968). In current times, as new technologies, such as 3D printers and laser cutters, are becoming more readily available,

[2] In the division of labour one worker is set to do a specific simple task, for example within a production line, which he soon masters. After mastering this task his goal is merely to increase his speed in the production line (Morris, 1910-1915). Morris argued for forms of craft without this division of labour in which one worker was involved throughout the production of a complete object.

possibilities for everyday making expand, and new forms of crafting arise that may combine machine-aided activities – such as the creation of components through 3D printing–; work done by hand – such as the assembly of these components into a product–; and a blend of these, in which one interacts with a machine (e.g. a computer) through hand-guided input devices (e.g. a mouse or keyboard) in a new form of handwork (McCullough, 1996).

In agreement with Morris and McCullough, it seems that when studying the everyday making practices in current times, the assumption that craft is done by hand is hard to uphold if this implies that craft is done without the help of machines or tools. Machines and tools, especially new technologies, do not take away the craft element, but instead can support the novel forms of crafting that are of interest to this thesis, as also argued by McCullough (1996). The assumption that craft is done purely by hand is therefore rejected to take a broader stance: craft includes any form of making that employs regular manual input from people, for example in guiding a machine (e.g. a sanding machine) or providing input (e.g. creating the model for 3D printing). This excludes fully automated processes in which no user input is required, but includes those processes in which machines or tools are used to support the process, such as working with Photoshop to create a photo collage.

CRAFT IS PHYSICAL

Second, an assumption stemming from traditional views on craft guilds and trades is that *craft deals with physical materials*. As Risatti (2007) shows, traditionally craft is often categorised by the material that is used – e.g. ceramics, glass, fibre, metals, and wood –, or the process that is required to work with this material – e.g. weaving, quilting, and turning. However, others (e.g. Gauntlett, 2011, McCullough, 1996, Sennett, 2008) discuss digital technologies and media as new craft materials and argue for the inclusion of making practices with these digital materials in the definition of craft. Bean and Rosner further argue for expanding the notion of craft materials to include for example infrastructures, services, and technologies (2012). As these authors further show, not only can

the *materials* that are used to craft be non-physical, also the *result* of craft can be digital or immaterial, such as a website, YouTube video, or recital of a poem.

With the inclusion of these new, often digital materials, it becomes increasingly important to understand how we go about crafting with these materials and how non-physical craft results may manifest themselves. Therefore, this thesis includes in its definition of craft materials also digital media – such as people's photographs or videos – as well as code, text, websites, and other files such as CAD models, and, as addressed, craft results do not have to be physical. All these materials can be used to craft artefacts: digital photographs can be used to create photo collages, or code can be used to create software, just as clay can be used to make pots, or wood can be used to make furniture. Hybrid craft specifically looks at the integration of physical materials – traditionally considered craft materials – and digital materials – which can be considered new craft materials.

CRAFT IS FUNCTIONAL

Third, it is often assumed that *craft objects are functional*, e.g. a crafted pot, and craft is often contrasted with art, which is said to lack such a functional role. Strongly advocated by Howard Risatti in his taxonomy of craft based on applied function (Risatti, 2007), this view states that craft arises from a physiological need and craft objects have physical functions, which are either containers (e.g. cups or bowl), covers (e.g. blankets or clothing), or supports (e.g. beds or chairs). The author's further discussion of additional categories of shelters (e.g. architecture) and adornment (e.g. jewellery) indicates that the taxonomy does not cover everything that may be considered craft. Risatti separates craft from art; the latter does not have a physical function, but rather its function is communication and dealing with social conventions. However, boundaries between art and craft are blurring as crafters create objects that do not meet physical functions or that have decorative or creative elements, and as artists skilfully work towards mastery of their specific medium, their aims extending beyond creative expression and communication (e.g. Risatti, 2007, Shiner, 2012). Risatti's framework of utilitarian and fine arts and crafts shows that distinctions

between arts and craft based on function are not as clear-cut (2007). In current times, with more ways to express ourselves through digital means – while many of these still require the skilful manipulation of materials with manual user input – it becomes even more difficult to hold the claim that craft has a physical or physiological function. Consider the design and modelling of a ring that is then 3D printed and cast in silver – this ring does have a function, but this function lies in the realm of communication (traditionally assigned to art). However, based on its process of making it can easily be argued that the ring is a craft object. Therefore, following the blurred boundaries of art and craft, this thesis discards the assumption that all craft objects need to be functional in the traditional (physical) sense and it will include in its view on everyday craft the functions of art and new media, such as communication or expressing one's identity or values.

CRAFT IS NOT CREATIVE

Fourth, related to the discussion of art and craft, it is often assumed that *craft is not creative or innovative*. This assumption claims that art is the domain of creative expression and innovation, and craft is the domain of skill and mastery, which relies on existing principles and repetition (e.g. Risatti, 2007, Shiner, 2012). Instead – again drawing on the fading boundaries between art and craft, and artists and crafters crossing the boundaries of their fields – the view of craft in this thesis includes also, and foremost, those works and processes that are creative or innovative. McCullough states: 'In digital production craft refers to the condition where people apply standard technological means to unanticipated or indescribable ends' (McCullough, 1996, p.21). Ingold (2006) similarly argues that with the advance of technology, skill does not disappear but has shifted to the improvisation and creativity needed to disassemble technology and incorporate it into one's own practice. In these views creativity and innovation are needed to come up with new ways to use digital technologies or media. Similarly, being a novel practice, hybrid craft will inherently require creativity to come up with ways to integrate digital and physical materials into hybrid creations. Therefore the notion that craft is not creative is rejected within the

view on craft upheld in this thesis. Contrarily, a certain level of creativity is a requirement, in that the crafter comes up with ideas within the craft process, rather than merely executing others' ideas or repeating the same process.

CRAFT IS, OR IS NOT, UNIQUE

Fifth and final, contradictory assumptions about craft exist which claim that *craft objects are unique or one-off,* or that *craft objects can be made in endless series based on one design.* The first assumption looks at craft versus industrial production and sees craft objects as the individually made counterparts of mass-produced objects (e.g. Cardoso, 2010). The second separates designer and crafter and sees the designer as the one who comes up with an idea and the crafter as the one who merely executes the idea and who is thus in principle capable of making the same object endlessly (e.g. Pye, 1968). When considering digital media and technologies craft materials and tools, it is obvious that craft objects made from these materials can easily be reproduced once a design has been made, e.g. a digital image can be copied and each copy will be exactly the same. On the other hand, physical objects are unique even if they are made according to the same design or using the same mould, for example due to imperfections in the material. When integrating digital materials with physical materials, hybrid craft objects can have mixed attributes and can include both unique and reproducible elements. Uniqueness can, for example, be introduced through the inclusion of specific physical materials, or the specific integration of physical and digital materials, and through changes in the object caused by interaction with it, if the hybrid craft result is an interactive creation. Although digital means are inherently non-unique and reproducible, hybrid craft thus strikes an interesting balance between uniqueness and reproducibility, making both assumptions both true and untrue for this specific type of craft.

EVERYDAY HYBRID CRAFT

In sum, with its view of craft centred on everyday creative making practices and hybrid materiality, this thesis does not limit its interpretation of craft to focus on handwork, physical materials, objects with a physical function, or objects that

are non-creative and reproducible – assumptions that have often guided the boundaries of what may be considered craft. It will further not limit itself to considering craft those processes and materials that have traditionally been called craft in relation to trades or guilds, e.g. glass-making, or goldsmithing (e.g. Sennett, 2008), or to the views, resulting from the Arts and Crafts Movement, of craft as an amateur or hobby practice (e.g. Adamson, 2007, Pye, 1968). Rather it will take a broader view and include:

- new forms of handwork, which may consist of interaction with computer devices and other technologies, and the manipulation of digital data;
- new craft materials, which may include physical as well as digital materials and media;
- new functions, which may include functions beyond physiological needs, such as sharing with others, or communicating one's identity;
- creativity, which may include novel integrations of physical and digital materials;
- uniqueness, which may combine reproducible digital materials and digital craft objects with unique physical materials and interaction results.

Further, since craft is seen as a broad category of making practices, not limited to specific disciplines or materials, there will be no specific distinction made between 'crafting' and 'making'. Crafting is considered a 'careful form of making', similar to Sennett's requirement of 'doing a job well' (2008, p.9), which may be done by one person or collaboratively. While this may seem to imply that one has to be 'skilled' or good at something, this idea is rejected; instead, it is suggested that, in order to be considered craft, a making activity has to be done carefully – with thought, deliberation, and care – and well, within one's own abilities. The words 'crafting' and 'making' are used interchangeably throughout this thesis to avoid the tedium of repeating words. In addition, since everyday craft refers to everyday making practices instead of professional craft, this thesis assumes no specific requirements for crafters' skills or training in their craft; after all, novices may engage in creative practices based on a personal desire to do so and execute these practices to the best of their abilities, just as experts would. This

does not imply that if crafters have had training in their craft they cannot be an everyday crafter; they may still engage in practices that fit everyday craft.

Finally, there are still debates around the relationship between craft and design, and craft and art (e.g. Bean and Rosner, 2012, Cardoso, 2010, Collingwood, 2010, Dormer, 1997, Risatti, 2007, Shiner, 2012). Craft is traditionally seen as the executing arm of design, or the uncreative counterpart of art. However, this thesis follows Shiner's (2012) view that craft, design, and art should be thought of as three overlapping areas rather than exclusive practices, and that boundaries between these practices have not just blurred, but have all but completely disappeared. In everyday craft, this overlap may be even stronger than in disciplines, studios, or education because the drive for making is not creating something that fits an exhibition, studio ideal or course requirement, but creating something for oneself or for others. In its view on craft, this thesis therefore eliminates the distinctions between design, art and craft to include forms of making that may traditionally be classified in either of these domains; i.e. it includes woodwork, pottery, and painting, as well as Photoshop activities, and web design.

DEFINITIONS AND TERMINOLOGY AROUND HYBRID CRAFT

After having defined and framed what is considered everyday craft, it is important to further specify what *hybrid* craft entails. Regardless of materiality, a distinction that can be made when speaking about craft practices is between the *process* and *result* of these practices. Both process and result can be physical, digital, or both (hybrid), and the materiality of process and result do not have to be the same: a physical crafting process could also result in a digital craft result. To clarify what is meant by physical and digital, and with process and result, consider the following:

- A *physical craft process* is a process in which only physical *materials* (to make something *from*), physical *techniques* (to make something *through*), and physical *tools* (to make something *with)* are used, such as painting, working with wood, claying, or making jewellery.
- A *physical craft result* is a result that is purely physical in its materiality, e.g. a piece of jewellery, or a statue.
- A *digital craft process* is a process in which only digital *materials*, digital *techniques*, and digital *tools* are used, e.g. making digital photo collages, programming, or writing a blog. Here digital materials are considered to be digital files such as photos and music, but also text or code, and digital tools to be, for example, software packages required to work with digital materials.
- A *digital craft result* is a result that is purely digital in its materiality, e.g. digital photos, websites, or software.

Note that a digital process or result cannot truly be free of physicality, because one always needs one or more physical tools to work with digital materials, e.g. a computer or a tablet. Similarly, one needs a physical device to perceive a digital craft result. However, as opposed to a physical craft process or result, in digital craft these physical means are only used because we cannot interact with digital materials or tools without them. The physical means are merely ways to enable or frame the digital craft process or result. In the same way as a digital artwork may require a physical medium, a physical painting may require a physical frame to appropriately perceive the work. Because similar constructions of enabling and framing exist for physical craft, this physicality in digital craft does not define the practice – although it may influence it – and therefore digital craft will be referred to as purely digital.

Following these demarcations, a *hybrid craft process* is a process that includes both physical and digital materials, techniques, and/or tools (in which the physical contributes beyond being a medium to enable or frame the digital)[3]. A *hybrid craft result* is a result that consists of both physical and digital elements (where the digital elements are still digital as opposed to printed, for example). Incorporating the focus on everyday crafting addressed before, the definition for hybrid craft used in this thesis is as follows:

> 'Hybrid craft refers to everyday creative practices which use both physical and digital materials, techniques, and/or tools, to make physical-digital creations.'

Table 1.1 shows a classification of crafting practices based on materiality, and some everyday examples for each form. The most straightforward forms of crafting are purely (in process and result) physical (Cell C1) and purely digital forms of crafting (Cell C5), these forms shall be referred to as 'physical craft' and 'digital craft', respectively. Cells C2 and C4 combine physical and digital, but they are not hybrid as they do not include both physical and digital in either process or result, or both. Cell C2 is therefore referred to as digital-oriented craft and cell C4 as physical-oriented craft[4]. Following this logic, 'hybrid craft' involves *both* a hybrid process and a hybrid result (Cell C9). Cells C3, and C6-8 involve either a hybrid process or a hybrid result, but are not hybrid in both, and shall thus be referred to as 'semi-hybrid craft'. It can be seen from Table 1.1 that in the area of hybrid and semi-hybrid craft, a hybrid *process* enables more everyday craft

[3] Although all three aspects in the integration of physical and digital *materials*, *techniques*, and *tools* are important for an exploration of hybrid craft, it may be the case that not all hybrid craft processes will include integration in all three. For example, a hybrid craft process may include physical and digital materials, but may be realised using only physical techniques and physical tools. However, possibilities for realising this depend greatly on the systems or products that are designed to support hybrid craft, and more insight into (hybrid) craft practice is needed to assess which designs would best support hybrid craft practice. Therefore, it is envisioned for now that *one or more* of these aspects needs to include physical and digital elements and all three are explored in design work; Chapters 8 and 9 further address how materials, tools, and techniques can be physical-digital integrations. Since it is a requirement for hybrid craft *results*, it is envisioned that physical and digital *materials* always need to be integrated in process and result.
[4] Inspired by Fallman's (2003) naming convention for 'design-oriented research' and 'research-oriented design'.

examples, while hybrid craft *results* move more towards the realm of specific disciplines or skillsets, such as interaction design or hardware skills.

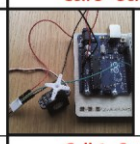
Process \ Result	Physical	Digital	Hybrid
Physical	 sculptures, paintings, jewellery, *woodwork*	 *Digital photo files*, scanned drawings or artwork	 *Live video footage at concerts* or sports games
	Cell 1 - Physical craft	Cell 2 - Digital-oriented craft	Cell 3 - Semi-hybrid craft
Digital	 printed photo collages, *printed documents*	 Digital photo collages, websites, *blogs*, software	 *Microprocessors programmed to control motors*, lights, displays.
	Cell 4 - Physical-oriented craft	Cell 5 - Digital craft	Cell 6 - Semi-hybrid craft
Hybrid	 *Assembled 3D-printed objects*	 Digitally edited images of physical creations, e.g. *drawings*	 *Self-made interactive photo cubes*
	Cell 7 - Semi-hybrid craft	Cell 8 - Semi-hybrid craft	Cell 9 - Hybrid craft

Table 1.1 Examples within a classification of craft practices based on materiality. In each cell the example in italics is illustrated[5].

Another distinction that is of particular interest to interaction design research is the *interactivity of craft*. Does a craft result react to someone interacting with it, can it evolve over time, can it be different in different situations – e.g. when different people are present in a room –, or can it be edited as new material becomes available or as someone's interests or preferences change? Note that all these examples of interactivity refer to the craft *result,* because a craft process inherently involves working with materials and tools, and constantly changing the craft piece through user actions in the process; as such, a craft piece is, in a way, interactive throughout the craft process. Craft results on the other hand, can be either static or interactive, in which 'interactive' is defined as being 'designed to respond to the actions, commands, etc., of a user'[6]. Note that user input can be

[5] The copyright for all images is held by the researcher. Images are: C1: creation of a wooden bench by a research participant (permission for use of photo granted); C2: digital photograph of a parrot; C3: screen that shows live footage alongside the stage at the 2012 New Orleans Jazz Fest; C4: photo of printed documents; C5: screenshot of the researcher's blog; C6: photos of a servo step motor attached to an Arduino microprocessor; C7: photo of the assembly of the 'Materialise' prototype; C8: digitally edited sketch of an early design idea; and C9: photo of the prototype of interactive photo cube design 'Cueb' (Golsteijn and Hoven, 2013).

[6] Definition from online dictionary Merriam Webster: http://www.merriam-webster.com (Accessed June 2014).

direct, e.g. the user presses a button or touches an object, or indirect, e.g. the user enters a room which is perceived by the object, or a user makes changes elsewhere that are processed by the object, e.g. updates on social networks. In either situation, the objects will typically react with a certain state change that may facilitate new input from the user. Table 1.2 shows some examples of static and interactive physical, digital, and hybrid craft results. Note that a physical craft result hereby refers to a result of *physical craft*, i.e. involving a physical process *and* result (Cell C1 in Table 1.1), and not to a physical result of any form of craft; similarly, a digital craft result is a result of digital craft (Cell C5 in Table 1.1), and a hybrid craft result is a result of hybrid craft (Cell C9 in Table 1.1).

	Physical	Digital	Hybrid
Static	Paintings, sculptures	Digital images, sound recordings, photo collages	Self-made digital photo frame that runs a slideshow
Interactive	Mechanical woodwork, jewellery that can be composed in different ways	Websites, software, blogs	Prototypes with microcontrollers, self-made tablet or smartphone devices

Table 1.2 Examples of static and interactive craft results.

Although the table shows that physical craft can be interactive, digital materials have the potential to provide interactivity that goes beyond the craft result itself. For example, interactivity can be provided by allowing change of an object remotely through online information – in which there is no direct interaction with the craft result – , or by changing media content or information on the object and/or on other devices – in which the result of interactivity goes beyond a simple state change of the craft result. As such, including digital materials into (digital or hybrid) craft practice opens up a new design space of highly interactive craft, which comes with its own set of design challenges and opportunities, e.g. how to successfully integrate physical and digital elements in interactive hybrid craft, how to interact with interactive hybrid craft results, and how hybrid craft results may change following interaction. In line with the interests of the field of interaction design research, this thesis focuses on interactive hybrid craft, rather than static hybrid craft. As such, it also concerns

itself with those questions posed above, within its aims of developing a notion of hybrid craft practice, and designing to support this practice.

HYBRID CRAFT: EMPLOYING STRICT AND LIBERAL DEFINITIONS

The previous section has defined a strongly focused interpretation of hybrid craft which is aimed for in the design of new systems that facilitate this practice. Although this strict definition leaves out certain practices that could be considered hybrid craft, it is beneficial to demarcate a strongly specified application area in order to focus the design brief for ideation activities. Within this strict definition, hybrid craft includes a hybrid process and result, and is interactive. In addition, the digital materials that are still present in their digital forms in a hybrid craft result are digital files, or collections of files, as opposed to more ephemeral representations such as displaying the time on a digital clock, or blinking an LED. As mentioned, a simple example of a hybrid craft result would be a physically decorated or enhanced digital photo frame that displays a selection of photographs or a self-made photo collage. Hybrid craft within this definition thus employs digital materials on a higher level: the file level, rather than the bit, electronics, or coding level. This excludes certain practices that are currently being done by technophiles, such as those who engage in the Maker culture[7]. Although these practices are hybrid in that they use both physical and digital materials, techniques, and/or tools to make physical-digital creations, craft results usually do not include digital materials at the file level, but instead focus on electronics. These practices thus have different foci and results, and as Table 1.1 has shown, hybrid craft within its strict definition lies more within the realm of interaction designers (who may or may not create prototypes that would be considered hybrid craft) than in the realm of everyday crafters. Thus, while hybrid craft *in the broader interpretation* does happen in everyday life (although solely done by those with a love for technology), few or no examples exist of hybrid craft *in the strict definition* within everyday craft practices, and there are no tools or platforms that facilitate this. This thesis' premise is that this form of 'everyday hybrid craft' can be a fruitful area for the use of people's

[7] A technology focussed DIY craft practice that includes the use of microprocessors, electronics, 3D printing and robotics. See: http://makezine.com (Accessed June 2014).

personal digital media alongside physical materials in new creative practices, which is why it aims for the design of systems that can facilitate these practices for everyday crafters, who are not necessarily technophiles or know how to code. While this strict definition of hybrid craft is used to focus the design brief, a more liberal interpretation is employed for studies that inform the design (e.g. interview studies into craft, which include physical, digital and semi-hybrid forms) and reflecting on hybrid craft more generally (Chapter 10). Here Maker practices and other currently existing hybrid practices are also considered. Taking a more liberal view outside the focused design brief is considered beneficial for developing a comprehensive understanding of hybrid craft and to open up the design space initially; after all, it cannot be anticipated beforehand where interesting opportunities for hybrid craft may lie.

MOTIVATION FOR THIS RESEARCH: WHY HYBRID CRAFT MATTERS

Making and crafting have been interwoven in people's lives for a long time; originally mostly within professions but later also recreationally, people have turned to making both for functional reasons and for the experience of making itself. In our current mass-production society, there appears to be a turn back towards making (Cardoso, 2010, Gauntlett, 2011) which becomes evident in the existence and popularity of maker fairs and online communities with how-to resources and blogs of makers' experiences, such as 'Instructables'[8] and 'Make Magazine'[9]. With the prominence of digital materials in our everyday lives, such as photographs, websites, and emails, there have been repeated findings that people also enjoy making and crafting with digital materials, and that self-made digital things can become 'cherished objects', objects of particular sentimental value to the owner (e.g. Golsteijn et al., 2012, Odom et al., 2011, Petrelli and Whittaker, 2010).

[8] http://www.instructables.com (Accessed June 2014).
[9] http://makezine.com/projects/ (Accessed June 2014).

Previously, studies looking at cherished objects (e.g. Golsteijn et al., 2012, Jung et al., 2011, Odom et al., 2009, Petrelli et al., 2008) have shown that digital objects are less likely to be cherished than physical objects, for example because of ephemerality, relative invisibility in the everyday landscape, and the existence of huge, unorganised collections. However, cherishing certain objects provides important selection mechanisms to decide what to keep and what to dispose of, which may be even more crucial for the overwhelming amount of digital things we own. It further supports our meaning-making by giving us focal points for understanding and communicating our identities, telling our stories, and reminiscing about our experiences (e.g. Dant, 1999, Miller, 1998, Woodward, 2007). It is thus important to understand and support the cherishing of, particularly a digital, but in fact any object. This thesis zooms in on one aspect that was found to be an important reason to cherish things: craft. Whether it is because we made an object from scratch, because someone else made it for us, or because we spent hours tweaking or augmenting it, craft appears to make an object more likely to be cherished (e.g. Jung et al., 2011, Odom et al., 2009, Odom et al., 2011, Golsteijn et al., 2012).

CHERISHING CRAFT

In 1981, Csikszentmihalyi and Rochberg-Halton published their study on cherished possessions, in which they discuss what objects were cherished and why. In this study 12% of all objects were cherished because they were crafted – defined as 'made by hand by either respondent, kin, friend, or someone known by the respondent' (1981, p.272). Similarly, in the study carried out within this doctoral research (Golsteijn et al., 2012) a focus group approach was used to study which objects people cherish, hereby explicitly including physical and digital objects (the ephemeral things on our devices, such as photos, emails, websites). While the data around the 41 selected cherished objects in this study confirmed the importance of craft for physical objects, for digital objects it appeared to be even more important: craft was the second most important reason for cherishing digital objects, after 'self' – a category indicating that the objects were important for the participants in relation to themselves. In addition,

24% of all objects were 'crafted', even if craft was not the reason participants mentioned for cherishing the object. It could thus be seen that craft formed a strong indicator for digital objects being cherished[10].

Other studies have sought to identify the objects we cherish and have included digital objects in this investigation (e.g. Jung et al., 2011, Kirk and Sellen, 2010, Odom et al., 2011, Petrelli and Whittaker, 2010, Bowen and Petrelli, 2011, Petrelli et al., 2008). These studies have found a similar appeal of craft, and have shown that digital objects that were cherished were often self-made, augmented, changed through use over time, or had been in other ways the focus of engagement for a longer time (Jung et al., 2011, Odom et al., 2009, Odom et al., 2011). Further, in their study about time capsules, Petrelli et al. (2009) found that participants were active in crafting new content for the sole purpose of preservation in the time capsules, and studies with digital scrapbooks (West et al., 2007) and technology heirlooms – technologies and digital media designed specifically to be passed on after an owner's death (Kirk and Banks, 2008) – have illustrated that self-created objects are often cherished. As gifts for life events, such as weddings, craft artefacts can further symbolise relationships, are often appreciated when received, and kept with care (Massimi and Rosner, 2013). Furthermore, the *process* of crafting such personal media objects is often a meaningful and cherished activity (Petrelli et al., 2009, Stevens et al., 2003, Massimi and Rosner, 2013), although craft practices around digital media are often confined and idiosyncratic as limited means exist for adjusting and personalising digital media in current archiving systems (Odom et al., 2011) and for displaying digital craft results in the home (Kirk and Sellen, 2010). Within the view that craft may help to select and create cherished objects, Gauntlett argues that craft and creativity may further offer a 'positive vision to making and reusing' and an alternative to accumulating more purchased products that do not positively contribute to well-being (2011, p.57). Gauntlett argues that craft has the potential to contribute to well-being on a personal and societal level, for

[10] This study was the prime motivation for studying craft after an initial investigation of cherished objects within the PhD research that identified craft as an important reason for cherishing objects. For more information on this study, see Golsteijn et al. (2012).

example because it allows us to choose our own activities and projects to work on, and to connect with others in engaged communities.
Therefore, the research presented in this thesis studies craft practice as a whole – including process and result – and focuses on enabling more creative and personal practices with digital materials, alongside physical materials. In sum, this is considered a valuable research goal based on the premise that craft practice can have beneficial effects on our digital media accumulation, consumption, and presentation; and our lives in general, for example in supporting our meaning making (e.g. Dant, 1999, Miller, 1998, Woodward, 2007), and increasing our well-being (Gauntlett, 2011, Sennett, 2008).

HYBRIDITY

Despite the fact that craft with digital media has been acknowledged as a reason for cherishing objects (e.g. Golsteijn et al., 2012, Jung et al., 2011, Odom et al., 2009, Odom et al., 2011) and that digital practices have been referred to as craft (e.g. McCullough, 1996, Sennett, 2008), because of long traditions of craft as a physical practice, the term still has strong physical connotations, which is illustrated by the foci of contemporary craft literature (e.g. Adamson, 2007, Adamson, 2010, Dormer, 1997, Risatti, 2007, Shiner, 2012). This is unsurprising because the domain of craft with the inclusion of digital materials is still relatively new. It does not, however, mean that physical craft practice is more valuable, or that the physical should be discarded in favour of new, digital forms of crafting. This thesis poses that what is particularly valuable to explore is where the two come together and new forms of craft practice can exist on the intersection of physical and digital. As mentioned, researchers within HCI have argued for the inclusion of digital materials in the notion of craft materials (e.g. Bean and Rosner, 2012). Since these digital technologies and materials are still embedded in our physical environments, it is not only considered interesting to study practices around digital crafting materials, but also the hybridity of these new forms of craft. Moreover, physical and digital materials, tools, and techniques have different strengths and advantages, which may be effectively

combined in hybrid practices[11]. Table 1.3 lists some examples of these advantages of physical and digital craft.

Physical	Digital
- Tangible feeling of working with materials. - More varied interaction with tools (compared to e.g. keyboard and mouse. - Craft can more easily be done co-located (in situations where peers can easily see each others' work). - Results can easily be displayed in the everyday environment and are thus more visible. - Results can be more unique. - Results can age (often considered an aesthetic feature).	- Craft materials are often 'unlimitedly' available and free, so exploration is not costly. - There are many possibilities to correct mistakes. - Others on online forums can offer support, sometimes even get involved in the process. - Tools can often be acquired remotely (e.g. software) and are sometimes free or can be tried for free. - Results can easily be reproduced and shared. - Meta-data about the process and result can automatically be captured.

Table 1.3 Examples of strengths of craft with physical and digital materials, tools, and techniques (this list is not meant to be exhaustive).

Furthermore, in design research there is a tradition of studying the integration of physical and digital materials – e.g. within Tangible Interaction research (e.g. Fitzmaurice et al., 1995, Ullmer and Ishii, 2000) – for example by using physical tools or actions to interact with digital materials, and more recently by showing digital information through changes in the physical appearance of an object (e.g. Alexander et al., 2012, Iwata et al., 2001). The study of hybrid craft practice follows this tradition and at the same time resonates with a recent increased interest in craft in design research (e.g. Bardzell et al., 2012, Bean and Rosner, 2012, Buechley et al., 2009, Rosner, 2010) and in everyday life, as in this era there is a shift from consumption to active participation in digital media and technology (Gauntlett, 2011). As such, this research brings together these two important research agendas and enters an *unexplored design and research space* of physical-digital integration in the area of craft, thus providing a valuable and topical contribution to design research.

[11] The term 'hybrid' was first used in the context of physical-digital integration by Kirk and Sellen, who defined hybrid objects as: 'physical instantiations of media content such as cassette tapes, video tapes, CDs and vinyl records.' (Kirk and Sellen, 2010, p.10:14).

RESEARCH QUESTIONS AND THESIS STRUCTURE

This thesis employs an interaction design research approach as its main methodology. Design research is inherently inventive, and typically aims beyond merely understanding a phenomenon, towards understanding it *for* something, e.g. in order to develop new designs or design principles for that phenomenon. Similarly, this thesis aims, first, to *develop a comprehensive notion of a hybrid craft practice,* i.e. how this may manifest itself in our everyday lives in the future; and second, to *explore the design of new interactive products or systems to facilitate hybrid craft, and formulate a set of design principles for hybrid craft*. As Chapter 3 addresses in detail, an integration of 'research for design' and 'research through design' approaches is used (Frayling, 1993). Because hybrid craft is a new practice that is currently mostly absent from our everyday lives, research for design is used to study existing *physical and digital craft practices* through interviews, which can theoretically inform hybrid craft practice and the design of new systems that facilitate this, by comparing physical and digital practices and considering how these may be combined into hybrid practices. Research through design is used to conceptually and empirically explore hybrid craft practice and design guidelines, through the design, prototyping, and evaluation of an interactive, technological product (e.g. Fallman, 2007, Gaver, 2012, Zimmerman et al., 2007), in this case a hybrid craft toolkit. As such, this thesis addresses the following research questions:

R1. What are the characteristics of everyday craft using physical materials, tools, and techniques?
R2. What are the characteristics of everyday craft using digital materials, tools, and techniques?
R3. What are the characteristics of everyday hybrid craft?

- I. Which characteristics of physical and digital craft can be maintained and combined for hybrid craft practice?
- II. What unique new characteristics does hybrid craft introduce?

R4. How can everyday hybrid craft be facilitated through the design of interactive products, tools or systems?

III. How can physical and digital materials, tools, and techniques be effectively combined in hybrid craft processes?

IV. What forms may interactive hybrid craft results take?

V. What design guidelines can be formulated for the design of interactive products or systems that support hybrid craft?

This thesis first presents a review of literature into related work and the identification of the gaps in this literature this thesis aims to address (Chapter 2). Next, it contains a chapter that explains the main research methodology, employed methods and thesis contributions (Chapter 3), followed by chapters addressing the empirical design research: interview studies into physical (Chapter 4) and digital (Chapter 7) craft practices; the design process and the development and prototyping of the hybrid craft toolkit (Chapter 5); and creative workshops to evaluate this toolkit and explore hybrid craft practice (Chapter 6). Chapter 8 is a synthesis chapter that compares physical and digital craft and formulates design guidelines for hybrid craft based on findings from the empirical work. Chapter 9 is a second design chapter that illustrates these design guidelines and evolves the design of the hybrid craft toolkit; and finally, Chapter 10 concludes the research by reflecting on the nature of hybrid craft.

2 Literature Review

CRAFT AND HYBRIDITY IN HCI AND DESIGN

With developments in digital technologies, the rise of maker communities, and the wider availability of technological maker facilities, a return towards making and crafting is currently taking place[12]. This is illustrated by numerous books by academics and avid crafters sprouting up, celebrating the joys of making in everyday life (e.g. Crawford, 2010, Frauenfelder, 2010, Gauntlett, 2011), and discussing craft from a multitude of angles. The topic has been addressed by different disciplines, and each discipline has its own interpretations and foci. As such, there is no 'grand theory' of craft that everyone agrees on and, as art and design historian and writer Christopher Frayling aptly puts it, what 'craft' means 'all depends on where you are coming from':

> 'To a sociologist, the word 'craft' is associated with 'skilled manual labour' or 'the aristocracy of labour.' To an economist, with a stage in economic development preceding capitalism (there are overlaps and fusions between the two stages). To an anthropologist, with the maker as user, with homo faber or the maker of things and homo ludens or the 'deep play' of everyday life. […] To an art critic, the word 'craft' is about the distinction between an 'art' – as in intellectual/conceptual – and a 'mere craft' – as in manual – a debased version of age-old debates about the social recognition of the artist which go way back to the Italian Renaissance, sharpened in England by Royal patronage of the 'fine artists'. […] To a designer, 'craft' is about the workmanship of risk and – most recently – the slow design movement.

[12] Sections of this chapter have previously been published in Golsteijn et al. (2014).

> Meanwhile, artist Damien Hirst has confessed that the word 'skill' always reminds him of macramé.' (Frayling, 2011, p.10-11)

Because of these major differences in interpretation and focus, it is important to consider which disciplines inform this thesis. This thesis engages, to some extent, with craft in a multidisciplinary fashion, and addresses works originating from material culture, psychology, art and craft critique, craft practice, sociology, human-computer interaction (HCI), and interaction design. Unsurprisingly, of particular relevance to this interaction design thesis is work done in the areas of HCI and interaction design[13], because these fields similarly engage with craft in an inventive manner, e.g. in the study of craft to inform design, or in the design of new systems that support craft. With its focus on HCI and design, a full literature review in each of the other disciplines lies outside the scope of this thesis. However, it should suffice to highlight some interests of these fields in their treatment of craft that are drawn on in this thesis, which is done in the next section. As such, this chapter does *not* include: comprehensive discussions on the societal view of craft (e.g. Frayling, 2011, Dormer, 1997), or the role of craft in education (e.g. Frayling, 2011); a review of craft history (e.g. Adamson, 2013, Greenhalgh, 1997, Valentine, 2010); or a multi-faceted treatment of the debates around the distinctions between art, craft, and design (e.g. Adamson, 2007, Dormer, 1997, Frayling, 2011, Risatti, 2007, Shiner, 2012, Veiteberg, 2010). Instead, it focuses on those literature sources that can inform the study of hybrid craft directly. As the Introduction has served to frame and define this term, these discussions are not repeated in this chapter. Instead, this chapter reviews relevant literature in HCI and interaction design in the areas of craft and physical-digital integration, in order to identify gaps in the literature, after highlighting the important insights gained from sources from other disciplines.

[13] Note that here HCI and design are used together, and research in both disciplines is addressed; Chapter 3 expands on these disciplines and addresses the approach taken for this thesis.

MULTIDISCIPLINARY TREATMENT OF CRAFT

MATERIAL CULTURE

First, the field of material culture, which concerns itself with the relationship between people and their material objects (e.g. Dant, 1999, Miller, 2008, Woodward, 2007) was drawn on in Chapter 1 to discuss the value and relevance of cherishing crafted physical and digital objects. In their treatment of craft, material cultures studies have typically concerned themselves with the specific *processes and materials* used by certain cultures or communities in making their utilitarian objects, for example Miller's study of Indian village pottery (2010). Recently, Miller has argued for an interpretation of craft that includes the use of modern manufacturing processes and technologies, such as 3D printing, as well as being good at everyday practices, such as putting on make-up (2011). This latter view is of particular relevance to this thesis as it resonates with this interpretation of craft. However, most material culture studies deal with in-depth observations of particular existing craft practices, and because this thesis looks across different craft disciplines in everyday practice in Western society, literature in this field was deemed of lesser importance.

PSYCHOLOGY

Second, similarly addressed in the discussion of cherished physical and digital objects, psychologists Csikszentmihalyi and Rochberg-Halton's work (1981) was drawn on in Chapter 1 to underpin the finding that *crafted objects can be of particular personal value*. This vision on craft concerns itself with mental connections and associations with craft, and is of importance because it offers insights into why people craft. This thesis further draws on Csikszenmihalyi's definitions of creativity and flow – 'an almost automatic, effortless, yet highly focused state of consciousness' (2010, p.110) often reached in craft – which are both used to understand *underlying mental processes of crafting and creativity.* These concepts can, at least partially, explain why the process of crafting is important to people, and again, why they craft. Along with Csikszenmihalyi and Rochberg-Halton's observation that crafted objects are important (1981), this

literature gives insight into why both process and result of craft are important, and is thus used to analyse and explain the study findings in this thesis.

ART AND CRAFT CRITIQUE

Third, art and craft critics have concerned themselves with *discussions around the role of craft within art* (e.g. Adamson, 2007, Dormer, 1997, Frayling, 2011, Risatti, 2007, Shiner, 2012, Veiteberg, 2010). While craft is here addressed as a separate entity, it is important to note that from the start it has been a relational category positioned between industrial production and fine arts (Shiner, 2012). In addition, design and the role of designers in craft practices are brought in. Needless to say, there has been a great deal of debate about the relationship between these categories (e.g. Bean and Rosner, 2012, Cardoso, 2010, Collingwood, 2010, Dormer, 1997, Risatti, 2007, Shiner, 2012, Veiteberg, 2010). While a lengthy discussion of the relationship between art and craft is beyond the scope of this chapter, it should be sufficient to say that art and craft have been considered to have an uneasy relationship, involving dichotomies such as: art as the domain for creative expression and meaning, and craft for skill and mastery; artists as intellectuals versus crafters as object makers; and art as lacking function where craft does not (Risatti, 2007, Shiner, 2012). Similarly, craft and industrial production have often been viewed as mortal enemies, and craft has been said to be superseded by industry (Lucie-Smith, 1981, Adamson, 2013, Woolley, 2010): 'mass production was the Goliath, and craft was a brave but insecure David' (Cardoso, 2010, p.330). Related to this is the relationship between design and craft. Pye (1968) identifies the designer as the person who comes up with an idea and the crafter as the one who merely executes the idea. The author argues that a closer cooperation of the two can support the process and result of craft. Ruskin (1997), however, believed that true craftsmanship should not be constrained by specifications and precision; he valued the imperfections in craftwork because they celebrate human imperfections. Today, this distinction between designer and crafter is no longer that clear-cut. There may still be separate people designing and executing ideas but it has been argued that design should be seen as a form of craft (Bean and Rosner, 2012) or that

craft and design go hand in hand, and both extend beyond initial creation into the use of a creation (Cardoso, 2010). Shiner (2012) argues that craft, design, and art should be thought of as three overlapping areas rather than exclusive practices, and that boundaries between these practices have not just blurred but have all but completely disappeared. This view is in resonance with Veiteberg (2010) who says that craft is 'expanding' to include new forms that were traditionally considered art, or that incorporate new technologies (McCullough, 1996, Myerson, 1997). For this thesis, the eliminated distinction between art, craft, and design is helpful because in everyday craft differences between disciplines are even less likely to be clear-cut. Therefore, this thesis employs a broad interpretation of craft (as addressed in Chapter 1) and the studies in this thesis will include practices that would traditionally be classified as craft, art, and design – and those practices that overlap these fields.

CRAFT PRACTICE

Fourth, in the literature examples can be found of craft practitioners *drawing on their own practices to discuss tenets of craft*. A well-known example is David Pye (1968), a woodworker and Professor of Furniture Design, who defined craftsmanship as: 'workmanship using any kind of technique or apparatus, in which the quality of the result is not predetermined, but depends on the judgment, dexterity, and care which the maker exercises as he works' (1968, p.4). Pye also developed the well-cited notion of the 'workmanship of risk', which is based on the premise that during the craft process, the work is constantly at risk. The author argues that this risk is an important characteristic of craft. More recent examples are books by Matthew Crawford (2010) and Mark Frauenfelder (2010). The first is a cultural researcher and mechanic, who draws on his own experience in repairing motorcycles to argue against the division between mind and handwork, and discusses the importance of manual labour for personal satisfaction and cognitive challenge, as well as for societies, in fostering pride and individual responsibilities. The second is a blogger, 'DIY-er' and the editor-in-chief of MAKE magazine. The author gives examples of his own DIY projects and concludes that using his hands gives him a richer, more meaningful life; it

has helped to take control of his life – in choosing to invent rather than buying mass-produced products – and engage more with the world around him. Such first-hand accounts are inspiring and insights from these studies, although some are idiosyncratic and not scientifically-based, help in developing a comprehensive notion of everyday craft. For this thesis particularly Pye's work (1968) is considered relevant as he discusses characteristics of craft, such as risk, precision, and the regulation of tools that can aid in understanding the process of craft, both in a technical and motivational way. Because first-hand accounts from craft practitioners are so inspirational and informative this thesis includes systematic interviews with physical and digital crafters to develop such insights further and give voice to the practitioners. Since these interviews address different craft disciplines in both more traditional, physical forms of craft, and newer, digital forms, this thesis makes a contribution to the craft community in providing new empirical data around these practices.

SOCIOLOGY AND MEDIA COMMUNICATION

Fifth, addressing craft and making from sociological and media communication perspectives, respectively, both Richard Sennett (2008) and David Gauntlett (2011) discuss *social aspects of craft*. Gauntlett addresses practices around online sharing of craft results, such as YouTube videos, and the author extensively writes about *the effects of making practices and attitudes* on personal happiness and successful, engaged social communities. Sennett addresses similar themes for current societies and draws on a discussion of guilds, workshops and apprenticeships in past times. The social side of craft was considered of importance to this PhD, because online platforms have provided many means for sharing craft knowledge, experience, and results that were previously impossible. This provides great potential for a new craft practice, especially when this practice is partly digital, e.g. in the sourcing of new media through social networks, and in the sharing of results with others. Furthermore, as addressed in the introduction, both Sennett and Gauntlett were drawn on heavily for this thesis' interpretation of craft. Sennett's process-focused view of craftsmanship as 'an enduring, basic human impulse, the desire to do a job well

for its own sake' (2008, p.9), and Gauntlett's inclusion of digital materials and notion of everyday creativity led to the definitions of everyday craft and hybrid craft upheld in this thesis.

INTERACTION DESIGN AND HUMAN-COMPUTER INTERACTION

Sixth and final, researchers in interaction design and human-computer interaction have recently gained interest in craft and over the past decade – and in increasing numbers every year – papers have been published that seek to *inform design through investigations of craft practice* (e.g. Bardzell et al., 2012, Buechley and Perner-Wilson, 2012, Yair and Schwarz, 2011) or that have *produced new designs to support craft practice* (e.g. Mellis et al., 2013b, Perner-Wilson et al., 2011, Rosner and Ryokai, 2010). Furthermore, research into the *integration of physical and digital materials* has been carried out, for example in the development of Tangible Interaction systems that support everyday life practices (e.g. Hoven and Eggen, 2003, Kirk et al., 2010, West et al., 2007, Hoven et al., 2007). Work in these fields is highly relevant for this thesis as it similarly addresses the study of contemporary craft practice, the design for, and development, of a novel craft practice, and the integration of physical and digital materials in hybrid practices. As such, it is crucial to carefully review what has been done in these areas and identify gaps in the literature where this thesis can contribute to the fields' knowledge.

CRAFT IN DESIGN RESEARCH AND HCI

Addressing craft from the perspective of cherished objects, Csikszentmihalyi and Rochberg-Halton take a broad perspective on the subject, defining it as everything that is made by someone rather than being a 'conveyor belt product' (1981). In HCI, this understanding of craft is taken up by Rosner and Ryokai who summarise craft to include a 'partnership between people and technology for the creation of personally meaningful things' (2009, p.195). Craft-oriented research has also been identified as a strand within materiality research, which brings the communicative dimensions of materiality into the discussion – for example in communicating traditions, material choices, and processes of making through the

material (Gross et al., 2014). While materiality, and the integration of physical techniques and materials with technology, come forward strongly in much of the reviewed literature, the next section focuses specifically on designing for the integration of physical and digital in the craft area. Crafting in everyday life, as addressed in this thesis, is further related to the DIY tradition, which has previously been defined as: 'an array of creative activities in which people use, repurpose and modify existing materials to produce something.' (Buechley et al., 2009, p.4824). Furthermore, crafting with digital materials or tools can also be seen in, for example, CAD design (e.g. McCullough, 1996) or rapid prototyping technologies (e.g. Mellis and Buechley, 2012a, Saul et al., 2011). While this section reviews some works in this area, the processes and/or results of these forms of making are often not hybrid and/or interactive, e.g. the craft process is digital and the result is physical or hybrid. This thesis focuses instead on interactive forms of hybrid craft, where both craft process and result consist of both physical and digital elements, and the craft result can react to user actions or changes over time. Therefore, this chapter does not give a comprehensive overview of work done in rapid prototyping, but instead focuses on works that lie closer to the thesis' interpretation of hybrid craft. All in all, craft has recently started to gain interest from the HCI community and over the past decade a number of studies have sought to inform design through the study of craft practice, have combined technology with traditional means of crafting, or have proposed craft-centred design guidelines for digital systems.

Informing Design Through the Study of Craft Practice

A great number of studies in HCI and design research have sought to investigate diverse craft practices in order to inform understanding of design or inform concrete design solutions. This section focuses on those investigations of existing craft practices, and is divided in sections addressing understanding and extending concepts of craft within design, DIY practices and learning craft, and the study of specific craft practices.

Understanding and extending craft in the context of design

A first category that was identified within this section contains studies that aim to understand craft better in the context of design, as well as identify where traditional notions of craft do not hold up within the realm of design, and extend these notions for the discipline. Kettley (2010) for example, argues that craft should be seen as something fluid that has the ability to shift between transparency and reflection and that looking at craft can thus provide a promising model for tangible interaction design that is both metaphorically meaningful as well as useful. Kolko (2011) introduces a new notion of craftsmanship centred on empathy through narrative, prototyping and public action, and inference, for situations in design in which the 'material' to work with is not a traditional material, such as paint or clay, but instead relates to service design or interaction design. Robles and Wiberg use the design and crafting of an Icehotel to introduce the term 'texture', 'a material property that signifies relations between surfaces, structures, and forms' (2010, p.137), to argue for a focus on the similarities and extensions of physical and digital rather than the differences, within and beyond the realm of crafting. Tanenbaum et al. (2012) look at the Steampunk movement and how, through the concepts of design fiction, DIY and appropriation, Steampunk maker practices can inform design. They argue that such practices introduce new models of values and meanings, and, as such, construct new models of craftsmanship, functionality, and aesthetics, in which creativity and resourcefulness are encouraged and designers act as 'bricoleurs'. Studying craft 'as-is', outside the design realm, Yair and Schwarz (2011) study the working lives of crafters in England and their contributions to the cultural sector of the country. Of particular interest for a design approach to understanding craft are the authors' proposed characteristics of craft: material knowledge, understanding of people and objects, and passion and reflections around materials and the material world.

Finally, addressing craft from a methodological perspective, future craft (Bonanni et al., 2008) introduces a design methodology to use digital tools and processes, such as digital fabrication and open-source communities, in the creation of designs that are socially and environmentally sustainable, through

the application of principles of public, local, and personal design. Nimkulrat uses her own practice-based research in textile craft to explore how craft can inform practice-based research and how research can inform craft practice (2009, 2012). Gross and Do (2007) discuss the relations between making and creativity in the context of design and computing, and highlight three characteristics that identify design and computing as forms of making: owning the problem, design and the play instinct, and building tools to make things.

Do-it-yourself practices and learning craft in the digital domain

Another category that is of particular interest to everyday craft looks at hacking and DIY practices. Where in the past products were designed by professionals and used by consumers, currently there is a trend towards the personalisation and appropriation of products by 'amateurs', hobbyists, and enthusiasts (Paulos, 2012). This trend is fuelled by the Maker movement, with its 'MAKE' magazine and Maker faires (Williams et al., 2012), although Bean and Rosner (2014) argue that 'making' may be better understood as a brand that appeals to certain types of consumers and triggers an ideological shift from consumption to production. Unsurprisingly, research in HCI and design has addressed such everyday making, DIY, hacking, and craft practices, which Tanenbaum et al. (2013) refer to as the 'democratization of design and manufacturing'. Wang and Kaye (2011), for example, study 'inventive leisure activities', such as hacking, tinkering, DIY, and crafts, and propose common characteristics of these practices, such as skill, reputation, and participation. Ely et al. (2009) coin the term 'digital DIY' to address the reconfiguration of domestic technology after life changes and conclude that these practices are social and resemble problem-solving behaviour in traditional DIY. Desjardins and Wakkary (2013) study the everyday making practices of families, hobbyist jewellers, and Steampunk enthusiasts, and argue that of the three aspects important to social practices – meanings, materials, and competences – meanings or goals are the main motivator for engaging in this practices. The authors distinguish between foundational (e.g. creating something in support of another goal, such as supporting an everyday activity), aesthetic (e.g. creating something beautiful and unique), and aspirational goals (e.g. creating something to belong to a certain subculture, or challenge oneself).

A recurring theme within DIY and hacking studies is that such practices may help to make the creation of technological products more accessible to everyday users. Williams et al. (2012) discuss DIY and hacking practices with technology in the light of Tangible Interaction, and reflect on the effect of the availability of open-source hardware on the public interest in interaction design. Kim (2013) uses the principles of DIY to develop a construction kit that allows children to build their own light source, and at the same time teaches them about technological components. And finally, Mellis' (2013a, 2013) on-going work studies digital fabrication – the use of digital files and technologies, such as 3D printers and laser cutters, to create electronic devices – in order to understand the implications for the production of electronic devices.

Closely related to every crafting practice is learning about craft. Nowadays, this is often done online, which has implications on the learning process and craft practice. Torrey et al. (2009) study how people seek craft knowledge online, and conclude that people search for creative inspiration as well as technical clarification; that keyword searches are often employed, although they are problematic; and that searching is often an iterative process with employing new knowledge in practice. Similarly, Rosner (2012) discusses digital apprenticeship and the loss of not only hands-on practice when learning from internet sources, but also embedded community values, such as secrecy, curiosity, and care. She argues for a careful investigation of apprenticeship to include visual as well as sensory details in digital apprenticeship.

Studying specific craft practice to inform design

As a common approach in design research, researchers in this field have studied specific craft practices in order to illustrate how the design of technological products may benefit from taking into account these forms of making. Measteri and Wakkary (2011), for example, look at the repair and reuse of objects in the home as a form of 'everyday design' and argue for the employment of a framework of resourcefulness, adaptation, and quality to overcome the barriers of repairing and adapting digital technologies. Also addressing repair, Rosner and Taylor (2011) study bookbinding practices, and use antiquarian book

restoration to illustrate the material practices of restoration for HCI. They highlight the making of authenticity through careful use of materiality, and designing for longevity by integration in social practice as means for designing more meaningful and lasting technological products. In a different study, Rosner and Ames (2014) address repair practices as 'negotiated endurance' that happens in everyday life throughout a product's lifecycle without being anticipated by designers beforehand, e.g. in identifying that something was broken and deciding it is worth fixing. Rosner (2011) further argues for designing technological products that allow for tracking provenance, for example by replaying traces of production, foregrounding traces of breaking, and extending traces of ownership. Similarly, Broken Probes aim to give new life to broken and worn down objects by digitally associating stories with marks of degradation (Ikemiya and Rosner, 2014). Relatedly, Zoran and Buechley (2013) explore intentionally broken craft objects and 3D printed restorations in order to explore the combination of digital fabrication (e.g. 3D printing) and craft. The authors argue that such a design process of destruction and reassembling can serve as a ritual process of mourning for crafters that is related to the risk involved in the craft process (Pye, 1968). These studies highlight interesting possibilities for the design of new systems that reside on the intersection of traditional craft and technology, similar to the aims of hybrid craft.

Bardzell et al. (2012) interview elite craft practitioners to enrich understanding of notions of quality and provide insights to interacting with integrity, self-expression through interaction with materials, and socio-cultural positioning of creative work, in light of designing products with socio-cultural relevance and value. Further, addressing a specific craft practice, Lindell studies the design processes of programmers and argues that code can be seen as a material and programming as a craft (2014). Lingel and Regan (2014) offer more insight in this area by discussing coding through a craft lens, and addressing craft as a process in coding (including selection of tools); as embodiment (including attachment to tools); and as a community of practice (including understanding of others outside that community).

Goodman and Rosner (2011) look at the practices of gardeners and knitters, and how they use information technologies, to argue for a framework of handwork to inform design that goes beyond the distinction of physical and digital, by focusing on extending, interrupting, and splitting up physical practices with digital technology. Wallace's work (e.g. Wallace and Press, 2004, Wright et al., 2008) uses examples of jewellery making to illustrate how aesthetics, beauty, and enchantment, can arise from the process of making, through empathy and sensibility towards felt life, and the relationships between maker and wearer, and maker and materials. Treadaway (2009) studies the use of the hands in a hybrid drawing practice – using graphic tablets, physical drawing and digital editing – and finds that the hands play an important role when creatively engaging with digital technologies: they translate memories and emotions into concrete art, and they provide the body with sensory experience of materials and tools. However, she concludes that digital tools are not yet satisfactory for the diversity of hand skills and Tangible Interaction mechanisms have great potential to the design of better systems. Ploderer et al. (2012) study the practice of photography and found that the craft elements present in photography (e.g. controlling the parameters of the camera or developing photos in a darkroom) can increase engagement with the process and enrich the experience. Mellis et al. (2013a) explore the possibilities of digital fabrication in human-computer interaction, and propose that supporting roles for such technologies include collaboration around physical objects, prototyping, and unique, personalised artefacts. Finally, Buechley and Perner-Wilson (2012) compare the making of electronics with carving, sewing, and painting practices, and discuss examples and opportunities for 'hybrid craft' in which these craft techniques are combined with electronics. The authors discuss five reoccurring themes: sharing, aesthetics, peacefulness, ideas, and personal use; and find that electronics making is more focused on personal use and functionality than the other craft forms. This may also be a characteristic of other digital or technological crafts.

INTEGRATING TECHNOLOGY WITH CRAFT THROUGH NEW DESIGNS

While the previous section addressed research that studied diverse forms of craft practice in order to inform new design solutions, most of these studies stopped at the formulation of craft characteristics or implications for design. In contrast, this section addresses studies that have developed, and often evaluated, concrete design solutions that integrate technology and craft. Categorising the research found in this area, this section addresses enhanced textile, paper, and other craft forms, as well as new technological craft practices, and the use of craft materials and tools as input or output for digital technologies.

Enhanced textile craft

A first group of enhanced or 'mediated crafts' (Rosner, 2010) are *textile-based crafts*. Buechley et al. designed new means to attach off-the-shelf electronics to textiles to make this so-called 'e-textile craft' available for crafters and hobbyists (Buechley and Eisenberg, 2009), and children (Buechley et al., 2006). Perner-Wilson et al. (2011) take the approach of a 'kit-of-no-parts' as a means for supporting the building of electronics from a variety of craft materials, illustrated by the development of a number of textile sensors, hereby bypassing the constraints that modular, pre-determined building blocks in traditional construction or electronics kits may have. Gowrishankar and Mikkonen (2013) test embroidered motifs with different resistance values and discuss the possibility of building a repository of these for textile electronics. Kassenaar et al. (2011) developed an interactive quilt that plays back audio recordings when it is folded, to explore design that encourages utilisation. Embroidered Confessions (Benedetti, 2012) is a collection of QR codes associated with digital confession stories from the internet embedded in a quilt. A well-known example is Rosner and Ryokai's Spyn (2010), a mobile phone software tool that allows needle-crafters to associate specific locations on physical garments with digital media to enrich the meaning of these garments as gifts and the relationships between maker/giver and receiver. Although this system is not completely hybrid in that the digital materials are not embedded in the physical form, Spyn offers a good example of combining physical and digital materials in craft. Finally, Movement Crafter (Pschetz et al., 2013) captures and visualises the practice of knitting in a

thread visualisation that grows as more knitting is done, in order to reward time knitting and respect the activity as a hobby one may do to slow down.

Enhanced paper craft

A second well-employed material for enhanced craft appears to be *paper*. Freed et al.'s I/O stickers (2011) provide children with a means to craft personalised remote communication interfaces by combining the crafting of greeting cards with the use of networked sensor and actuator stickers. Zhu (2012) looks at paper-craft, such as writing, drawing, folding, cutting, gluing, and presents two supporting technologies to allow the building of paper-computing systems around three themes: the ubiquity of paper-craft, the flexibility of paper-craft as a means to control digital data, and displaying digital information through changes in the paper. Cheng et al.'s Tessela (2012) is an interactive origami lamp that encourages creative, poetic interaction through changing light patterns. Gardiner and Gardiner (2012) explore the materials, interactions, and technological challenges around interactive paper artworks that fold and unfold. Qi and Buechley (2012) combine shape memory alloys – metals that change shape in response to heat – with paper craft in the creation of actuated origami cranes that move their wings. West et al. (2007) developed MEMENTO, a digital scrapbook that aims to integrate the advantages of both the physical and digital worlds by using dedicated paper and pen, with which information can be transferred to a computer for processing. And finally, Saul et al. (2010) propose a number of interactive devices made from paper; construction techniques (e.g. cutting, folding, gluing); materials (e.g. paper, copper tape, gold leaf foil); and a piece of software, which support a DIY design practice for users to build their own paper electronics.

Other enhanced traditional craft forms

Outside of textiles and paper, Zoran (2013) explores the concept of 'hybrid basketry' in which he combines 3D printing with the craft of basketry, and reflects on the role of craft within design and fabrication. He argues that craft, manual skill, and the preservation of art and culture have potential to 'reclaim a lost material identity' in design and fabrication. Further, Kazi (2013) proposes SandCanvas – a digital medium for sand animation –, and Vignette – a system for

the creation of textures in digital pen-and-ink drawings – as examples of novel digital art tools.

New technological craft practices

Apart from the integration of traditional forms of craft with technology, design research studies have also developed novel forms of technological practice with a craft-like character. Buechley and Perner-Wilson (2012) for example, show examples of how electronic components may be crafted by using techniques from carving, sewing, and painting. They conclude that such integrations may help to increase technological literacy, and develop new kinds of devices in diversifying the kinds of electronics that are created and the people who create them. DuMont (2012) and DuMont and Lee (2012) used a microprocessor platform to study how the design and creation of personal electronic pets could support under-achieving youths, and found that students took pride in their creation, and that this form of crafting could teach them about debugging and coding, although little collaboration between students was achieved. Finally, taking a more general stance in this area and addressing issues in the integration of craft with computational media, Blauvelt et al. (1999) argue that technological craft systems would benefit from dedicated craft languages for notation or object specific programming languages; distributed functionality in smaller sub-computer blocks; more sophisticated computer input and output devices, such as 3D printers or colour readers; and intelligent craft kits that know of how many components they are composed.

Craft materials and tools as input or output

Finally, some studies have looked at the use of craft materials and techniques as augmented input or metaphors for digital technologies, e.g. claying (Reed, 2009) or sketching (Woo et al., 2011). Shaper, Speaker, and Cutter are digital fabrication tools that explore the effect of direct user input in the process (Willis et al., 2011). These systems respectively allow to form foam objects, sculpt wire forms based on audio input, and create digital 3D models by hand-modelling foam with a hot wire. Using a craft-like approach, rather than an actual craft tool, Serim's 3D drawing tool (2013) allows for the indirect control of curves in a 3D drawing by moving virtual objects in the design space. This tool aims to explore

how emphasising on material and handwork, and making user actions explicit, may change the design of digital tools.

Others studies have used digital technology to guide physical craft tools as output. For example, Zoran and Paradiso (2013) and Zoran et al. (2013) propose FreeD – a handheld milling device that is guided by a computer and a predesigned 3D model to maintain an object's rough design features, while still allowing the user to have freedom to sculpt. Similarly, Enchanted Scissors are a digitally controlled pair of scissors that guide the user in cutting paper (Yamashita et al., 2013). Finally, Eisenberg et al. (2003) propose some output devices for craft materials that take printing a step further, in order to explore possibilities for children's craft activities. An example is the Pop-up Workshop, a software package that allows for designing and printing of templates for pop-up constructions.

CRAFT-CENTRED DESIGN GUIDELINES

Apart from studies that explicitly address craft, other research has identified the importance of craft for, among other things, designing for objects with stronger sentimental attachment, or supporting digital media archiving practices. This section addresses the craft-centred design guidelines, i.e. those guidelines that promote craft in technological applications, suggested by these studies. As such, this section serves to illustrate the relevance of craft within design and HCI, beyond studies that set out to study craft.

Addressing the archiving of physical and digital objects, Stevens et al (2003) argue that time spent archiving and managing media should be turned into a time of personal expression. Similarly, Petrelli and Whittaker (2010) pose that digital archiving technologies should try and support new practices similar to scrapbooking or making albums, and thus engage people in active and creative use of their digital media. This view is further advocated by Bowen and Petrelli (2011) in their design of digital mementos that make media archiving systems 'not like work', but instead afford personal time and space for remembering.

Petrelli et al. (2014) further analyse photographs as examples of personal memory objects and propose four design concepts for novel photo technology. They conclude that such technology should, among other things, focus on serendipitous exploration of photo collections through dynamically generated albums, consider materialising of digital belongings, and pay attention to material properties of 'containers' that integrate physical and digital. Inspired by Petrelli et al.'s earlier observations that participants dedicated time and effort in the creation of personal time capsules (2009), Thiry et al (2013) discuss the use of their Project Greenwich system – which allows people to make their own digital timelines – and zoom in on the importance of making for personal memory purposes. They conclude that it is important for the design of systems that aim at the creation of personal timelines to allow for: explicit authoring; reminiscing with, and involving others in the process; flexibility in manipulating pre-determined formats or constraints; and conveying the process of making in the final result. Massimi and Rosner (2013) look at objects crafted for major life events, such as weddings or births, and discuss that life events are opportunities to craft; crafting is used to personalise life events; craft artefacts symbolise relationships; and there is value in receiving and keeping crafted items. The authors conclude that to enable the creation of digital artefacts for life events, digital technology should be imbued with symbolic value and enable uniqueness; show the process of creation and the relationship between crafter and receiver; and allow for repurposing after the life event.

Identifying the effect of craft on to what extent objects are cherished, Jung et al. (2011) argue for creating a sense of rarity in objects as a means to make them more cherished, which can be reached by personalisation and customisation. The authors further find that objects with 'aficionado-appeal' are often cherished because their owners spent time acquiring knowledge or expertise about something. Meaning can be accumulated by supporting means for modifying, personalising or hacking objects to make them more unique. Odom et al.'s (2011) suggestion for supporting the accrual of metadata also ties in to augmentation of digital objects. Personalised metadata, added comments on social networks, or textual annotations can be powerful indicators of the extent to which digital

objects are representative of, and meaningful for, a group or individual. As such, meaning of these objects is developed though individual or collaborate augmentation of existing digital objects. Similarly, Odom et al. (2009) identified 'augmentation', or the reuse, renewal, modifications, alterations, or otherwise augmentation beyond original state as important, because the object comes to illustrate the resourcefulness and creativity of the owner. Similarly, Ahde (2007) discusses the importance of adornment and personalisation in the appropriation of products in everyday life. Studying teenagers' jewellery, she finds that personalised objects tend to be of great personal attachment. She proposes that gathering stories and material experiments are useful starting points for studying and designing for these personal creative practices. Desjardins and Wakkary (2013) highlight the importance of understanding how people go about adapting products and technologies, and propose that further research should address everyday making practices, and interaction design should aim to support the foundational, aesthetic and aspirational goals of 'everyday designers'.

Approaching craft more directly, Tanenbaum et al. (2013) who study the 'democratisation' of technology through craft and hacking, propose that products should be designed to enable creativity, to allow for pleasure, utility, and expressiveness, and to allow for mixed manufacture (e.g. combining mass- and batch production). And finally, De Roeck et al. (2012) present a manifesto that argues for new creation platforms for non-technical users in the context of the Internet-of-Things – linking and identifying objects and their virtual counterparts in an internet-like structure. Their manifesto includes the requirements for design to inspire to be creative, help people to create useful components, and support collaboration and the sharing of unfinished projects.

THE INTEGRATION OF PHYSICAL AND DIGITAL MATERIALS

After having addressed related work in the area of craft in the previous section, this chapter now turns to the hybrid element of this thesis; i.e. the integration of physical and digital (Kirk and Sellen, 2010). Alongside their collections of physical objects, people nowadays accumulate vast collections of digital objects, such as digital photos, videos, or work documents. The parallel existence of such physical and digital objects has sparked discussions on the importance of materiality and how the use of objects is different for physical and digital objects (e.g. Dijck, 2007). Furthermore, it has caused HCI research to explore the design of systems that integrate physical and digital objects and interaction mechanisms in order to better support our everyday lives, e.g. in archiving, reminiscing, or story-telling. Advantages of this integration include the closer accessibility and visibility of the digital in everyday life, and the employment of our well-trained physical skills in interaction with the digital (Hoven et al., 2007). This thesis' goal of developing a notion of a hybrid craft is closely related to these research aims. As such, this section addresses a common methodology, and examples within this methodology, to physical-digital integration – Tangible Interaction – after which it addresses craft platforms and construction kits that have been proposed within Tangible Interaction.

TANGIBLE INTERACTION: DESIGNING FOR THE INTEGRATION OF PHYSICAL AND DIGITAL

Tangible User Interfaces (TUIs) aim to provide physical interfaces to digital information. Hornecker and Buur (2006) propose that different views on Tangible Interaction exist within Computer Science and HCI: *data-centred* coupling of physical objects and digital information; Industrial and Product Design: *expressive-movement-centred* emphasis on meaningful bodily interactions with objects; and Arts and Architecture: *space-centred* emphasis on interactive spaces that combine physical spaces with display of digital information; although in practice these distinctions may not be so clear-cut. For

HCI, the advantages of TUIs lie in, for example, ease-of-use and the exploitation of rich human skills for handling physical tools and thus providing more direct manipulation (Dourish, 2001). A well-accepted view on Tangible Interaction is that of Ullmer and Ishii (2000). They state that Tangible Interaction eliminates the distinction between *representation* and *control* that is common in graphical user interfaces (GUIs). Rather than having separate output and input devices, TUIs use the same physical objects, called tangibles, as means for both representation and control. These tangibles, according to Ullmer and Ishii (2000), can be *iconic* or *symbolic.* Iconic tangibles share properties of their physical form with the digital objects they refer to, while symbolic tangibles do not share such references. A second axis to this dichotomy was added by Van den Hoven and Eggen (2004) who argue for the distinction between *generic* and *personal* objects. They add personal objects, such as holiday souvenirs or heirlooms, to the existing frameworks for Tangible Interaction (e.g. Hornecker and Buur, 2006, Ullmer and Ishii, 2000), based on the idea that users of tangible objects have existing mental models of the links between their personal objects and the associated digital information, e.g. because of past events known to the user in which these objects played a role.

Both personal and generic objects have been used in novel interaction mechanisms and systems developed by design researchers. While a comprehensive overview of these systems is beyond the scope of this chapter, the studies that can serve as relevant examples have integrated elements from the physical and digital realms in attempts to provide more meaningful ways of interacting with our everyday objects. Some existing systems provide physical interfaces for digital information, such as Shoebox: a physical shoebox for storing and accessing digital photos (Banks and Sellen, 2009); Memento: a physical pen and paper interface for a digital scrapbook (West et al., 2007); Cueb: a set of interactive physical photo cubes to explore and share stories about digital photographs (Golsteijn and Hoven, 2013) and 4Photos: a physical display for displaying Facebook photos during dinner time (Bhömer et al., 2010). Other systems create connections between tagged physical objects and digital information, allowing people to access digital information through physical

objects, such as Audiophoto Desk: an interactive desk that plays sounds associated to photographs placed on the desk (Frohlich and Fennell, 2007, Frohlich et al., 2004); Digital Photo Browser (Hoven and Eggen, 2003) and Souvenirs (Nunes et al., 2009): both are systems with which physical objects can be scanned to access associated digital photos. A third category aims to store and archive physical objects and associated stories digitally, such as Family Archive: a multi-user family archive for archiving and annotating physical and digital possessions (Kirk et al., 2010); Living Memory Box: a box for photographing, annotating and archiving physical objects (Stevens et al., 2003); and Memory Box: a box which allows for recording and attaching audio recordings to memorabilia (Frohlich and Murphy, 2000). Similarly, the TOTeM research project (Tales of Things and Electronic Memory) resulted in a platform with which people can record stories about their physical objects and tag these objects to access these stories online (Barthel et al., 2010).

TANGIBLE INTERACTION AND CRAFT PLATFORMS

The most relevant area of Tangible Interaction, which is here interpreted broadly as any integration of physical and digital, is that of platforms or construction kits that support various forms of making or crafting. Some of these have looked at *repurposing and employing existing means* to novels ends. Mellis and Buechley (2012b, 2011), for example, study the use of open-source hardware as a means to support creativity, and based on their findings they advertise the integration of physical and digital skill development. Another approach is the development of objects that can be used in home crafting projects, such as Rototack (Wrensch et al., 2000) and a programmable hinge (Wrensch and Eisenberg, 1998). Inspirational Bits (Sundström et al., 2011) further aim to expose material properties of technologies that can inform a design process and design sketches, although they are not intended as prototyping means.

A second category in research consists of *systems aimed at children.* These systems allow children to create their own toys, or tools for storytelling, such as Plushbot (Huang and Eisenberg, 2011), Craftopolis (Meyers et al., 2010), kidCAD

(Follmer and Ishii, 2012), and Telltable (Cao et al., 2010); encourage them to craft, e.g. e-textiles (Buechley et al., 2006); or teach them about programming, e.g. Electronic Blocks (Wyeth, 2008) and Tern (Horn and Jacob, 2007). Finally, Guler and Rule (2013) uncover gender stereotypes behind construction kits aimed at girls, and instead propose the Invent-abling kit as a girl-centred prototyping kit for wearable electronics with a gender-neutral presentation. Finally, other platforms are *prototyping tools* that allow for the quick assembly of electronics and physical prototypes in interaction design. While most of these tools are initially aimed at designers and researchers, their use can extend to creative practices of everyday users. Examples of such tools are: Voodoo I/O – a platform that enables the quick creation of electronic circuits by pricking components into a conductive surface (Villar et al., 2006, Villar et al., 2007); LittleBits (Bdeir and Rothman, 2012) – electronic components embedded in small circuits that can be snapped together with magnets; and .NET Gadgeteer (Villar et al., 2011) – an open-source hardware platform that includes a microprocessor and components embedded in concrete building blocks. Further, Mellis et al. (2013b) made embedded programming accessible through the development of an 'untoolkit' – a kit that does not consist of high-level building blocks but, in this case, of low-level electronics, a microcontroller, and conductive ink. Varesano's on-going work (2013) explores the development and use of LibreMote, a platform that allows researchers, artists, and hobbyists, to prototype wireless controllers. Gaye and Wright (2012) explore the use of plastic fuse beads as a prototyping material for simple switches, 3D shapes, and elements in electronic circuits. Hurst and Kane (2013) propose the Easy Make Oven, an interactive surface that enables users to scan, edit, and produce copies of physical objects, as an example of a tool to 'make "making" accessible' (p.635). TOPAOKO (Wu and Gross, 2010) is an interactive building kit consisting of electronic components embedded in laser-cut hardboard, which allows for the quick assembly of sensing and actuating circuits. Triangles (Gorbet and Orth, 1997) form a tangible interaction system that enables interaction with digital data by connecting magnetic triangular pieces of plastic. AutoGami (Zhu and Zhao, 2013) is a toolkit for the creation of automated moveable paper craft – e.g. paper characters for storytelling – through an integration of physical paper craft,

a digital model of the crafted object, and microprocessor technology. And finally, Codeable Objects (Jacobs and Buechley, 2013) is a programming environment that allows novices to quickly create objects, such as lamps and clothing, using digital fabrication techniques, such as laser-cutting and embroidery machines.

Some of these research projects were developed into commercially available platforms, such as littleBits[14], and .NET Gadgeteer[15]. Other platforms are also available to support everyday craft practices, such as MaKey MaKey[16], Raspberry Pi[17], Phidgets[18], and Arduino[19]. Furthermore, websites such as Ponoko[20] and Shapeways[21] offer 3D printing and laser cutting services and make the creation of physical products based on digital design accessible for everyday users.

RESEARCH AIMS

This literature review has highlighted some insights on craft from different disciplines, before zooming in on craft in design research and HCI. The review of this literature on related work has enabled the identification of gaps in knowledge this thesis aims to fulfil. First, several studies have looked at specific craft practices, e.g. DIY and hacking (Desjardins and Wakkary, 2013), Steampunk (Tanenbaum et al., 2012), book restoration (Rosner and Taylor, 2011), and gardening and knitting (Goodman and Rosner, 2011). Also a few studies have looked across specific crafts and tried to uncover common characteristics of craft, hereby focusing on professionals (e.g. Bardzell et al., 2012, Buechley and Perner-Wilson, 2012, Yair and Schwarz, 2011). Unsurprisingly, as these studies have shown, studying a particular craft is a successful way of furthering understanding of that craft practice. This thesis aims to similarly gain a comprehensive understanding of everyday hybrid craft in order to facilitate design for this practice. However, as addressed in Chapter 1, hybrid craft is

[14] http://littlebits.cc/ (Accessed June 2014).
[15] http://www.netmf.com/gadgeteer/ (Accessed June 2014).
[16] http://www.raspberrypi.org/ (Accessed June 2014).
[17] http://www.raspberrypi.org/ (Accessed June 2014).
[18] http://www.phidgets.com/ (Accessed June 2014).
[19] http://www.arduino.cc (Accessed June 2014).
[20] http://www.ponoko.com (Accessed June 2014).
[21] http://www.shapeways.com (Accessed June 2014).

hardly practiced by everyday crafters, which is why it is challenging to study these practices. Therefore, it is crucial to instead thoroughly understand characteristics of both physical and digital craft practice to theoretically inform hybrid craft. However, a comprehensive study of diverse forms of *everyday physical and digital craft practice* – which are analysed for common characteristics and differences based on a similar research method and analysis framework – has not been found in the literature. This thesis will therefore, first, provide this research and address relevant dimensions of physical and digital craft, such as materials and tools, across craft disciplines.

Second, the review of related design work has shown that although some authors use the term 'hybrid' (e.g. Buechley and Perner-Wilson, 2012, Zoran, 2013), this term does not have the same meaning as outlined in this thesis. Zoran (2013) uses hybrid craft to mean an integration of traditional craft and digital fabrication, while Buechley and Perner-Wilsen (2012) use the term to mean an integration of electronics with traditional craft. As addressed, for this thesis hybrid craft refers to everyday creative practices which integrate physical and digital materials, techniques and/or tools, to make physical-digital creations (with a focus on digital files as digital craft components). This view on hybrid craft is not found in literature, and many of the existing systems are only hybrid in process but not in result; or only integrate physical and digital through the inclusion of electronics or coding, but not files. As such, existing platforms and construction kits for craft miss certain elements that are crucial for this thesis' interpretation of hybrid craft, for example the possibility to include digital media in interactive hybrid craft results, the possibility to incorporate a diversity of physical craft materials, and accessibility to everyday people without any programming skills. Although the reviewed literature can provide inspiration in the design process and in the formulation of craft characteristics, it is considered important to start studying and designing for hybrid craft afresh within a dedicated empirical design process, simply because existing literature does not fully match this research's aims. This design process results in the design and evaluation of a system that facilitates hybrid craft, and a set of design guidelines, which are contributions to the literature. This research further aims to establish

hybrid craft as a 'strong concept' (Höök and Löwgren, 2012), an intermediate-level knowledge contribution that is an abstraction from a concrete design idea and is grounded in related design knowledge (see Chapter 3).

Finally, a gap in the literature is identified around methodological reflections on using design research to study craft. Moreover, while design research has created new designs that integrate craft with technology or that propose novel forms of technological craft, these designs all use craft instrumentally to achieve other goals, e.g. making craft accessible for everyday users (e.g. Perner-Wilson et al., 2011, Saul et al., 2010), making more meaningful or personalised objects (e.g. Freed et al., 2011, Rosner, 2010), supporting education (e.g. DuMont, 2012), or making it easier to build prototypes (e.g. Mellis et al., 2013b, Villar et al., 2011, Wu and Gross, 2010). However, none of these studies created new designs for craft merely *in order to understand a specific craft practice, or newly developed craft form*; this thesis provides a first design research example for this. It is thus unsurprising that earlier studies do not include reflections on the use of design research to study craft, as their reflections instead have focused on the main goal, e.g. making craft accessible for everyday users. On the other hand, reflections in HCI literature on the nature of art or craft (e.g. Kettley, 2010, Kolko, 2011, Nimkulrat, 2012) are based on studies of craft practice, but not on design research. There is thus a disparity between those craft studies and reflections that have been useful to understand the nature of craft within design, and those studies that have built new designs for craft practice. This thesis therefore includes a reflection on the use of a design research methodology (which includes the design of a new system) to study craft (see Chapter 10). This reflection uncovers relevant insights in the relations between design and craft that can provide new metaphors for addressing interaction design. After identifying gaps in the literature, the next chapter addresses the research methodology and methods through which the proposed research is carried out.

3 Methodology

AN INTERACTION DESIGN RESEARCH APPROACH TO STUDYING HYBRID CRAFT

As the literature review has shown, this thesis draws on literature from multiple disciplines[22]. Similarly, this chapter shows that the selection of methods employed in this research has a multidisciplinary character; it engages with methods originating from social sciences – narrative interviewing, portraiture, and thematic analysis – as well as from design – idea generation, annotated portfolios, prototyping, and creative workshops. The use of qualitative research methods originating from social sciences – for example, interviews, ethnography, and data coding – within design research is well established in Human-Computer Interaction (Dourish, 2006). Moving further beyond this tradition, the interdisciplinary method of 'idea generation through portraiture' that was developed as part of this research (Golsteijn and Wright, 2013) combines methods from social sciences and design, and illustrates how design research may benefit from closer appropriation of social science methods. However, despite these multidisciplinary influences, this thesis is primarily rooted within the broad field of Human-Computer Interaction (HCI).

HCI originates from psychology and concerns itself with the study of interactive products and systems, and people's interactions with these systems. Upon its emergence as a field in the early 1980s, Human-Computer Interaction focused on technology, information processing, man-machine coupling and cognitive psychology – this is now referred to as first-wave HCI (Bowers, 2012, Kaptelinin et al., 2003, Harrison et al., 2007). In the so-called 'second wave', attention shifted to include the social identity of the user and the use of technology in

[22] Sections of this chapter have previously been published in Golsteijn and Wright (2013).

context, e.g. the use of applications within groups, or within work contexts (Bødker, 2006, Bowers, 2012, Harrison et al., 2007). In the last decade, researchers have sought to add a 'third wave', which was most systematically argued for by Harrison et al. (2007) The authors state they had heard colleagues discuss a third paradigm but had not seen it introduced to the field as a 'legitimate frame or lens through which to view contributions' (2007, p.2), which they subsequently seek to do in their paper. In this third wave, focus has shifted again with the broadening of use contexts from workplaces to homes, and with the premise that the study of interaction should include elements such as culture, emotion and experience (e.g. Bardzell and Bardzell, 2011, Bødker, 2006, Gaver et al., 1999, McCarthy and Wright, 2004). As such, third-wave HCI has a contrasting focus: 'non-work, non-purposeful, non-rational, etc.' (Bødker, 2006, p.2). In short, the third wave takes a phenomenological viewpoint, in which interaction and knowledge are embodied in situation, real world, human action (Harrison et al., 2007).

In third-wave HCI in particular, and as design practitioners have become more and more integrated in the HCI research community (Gaver, 2012), it has become more common to combine design action and research in so-called 'design research'. After all, the third wave includes a broad range of technological issues and concerns of human experience which can be served with a design perspective (Bowers, 2012). Positioned within the HCI field, this thesis takes a design research approach as its methodology to study hybrid craft. Since it deals with interactive products and technologies, or interaction design, the overall methodology for this thesis is referred to interaction design research. This chapter now continues to introduce design research, and address different strategies to design research which are used complementary to study hybrid craft. After introducing the specific methods employed in this research, it finally discusses the contributions this thesis makes.

DESIGN RESEARCH METHODOLOGY

Within design research and HCI communities there is still plenty of discussion on the role of design in research and HCI. For example, it has been posed that there is a distinction between qualitative design-based and quantitative model-based HCI (Law, 2011), within which the former seems closely connected to third-wave HCI and the latter to first- and second-wave. Model-based HCI aims to reduce products, systems, or phenomena under study into measurable dimensions, and to evaluate designs based on repeatable and generalisable methods. In contrast, design-based HCI argues against this, and aims to holistically explore users, use contexts, and design solutions, while taking into account human factors, such as emotion and engagement. The success of such 'holistic design solutions' is often difficult to assess because attempts to measure or quantify certain elements of the design contradict the tenets of design-based HCI; after all, each user, each design, and each use instance is unique. Similarly, some authors have argued that design, or design research, needs to be formalised as a methodology in order to make contributions in theory, content, or methods (e.g. Forlizzi et al., 2011, Zimmerman et al., 2010). However, others (e.g. Fallman and Stolterman, 2010, Gaver, 2012, Stolterman, 2008) oppose this view and argue that the nature of design makes it difficult, and in fact counter-productive, to try and formalise a design methodology. Gaver argues that design research tends to be 'provisional, contingent and aspirational' (2012, p.938), which makes it unfalsifiable in nature. He offers some explanations on why there are so many different interpretations of what design research is and what it should be, for example because it is a 'pre-paradigmatic' field – a field where no dominant underlying theory or way of working has been established. However, the author's other explanations suggest that convergence may not be required or desired for the progression of the field; for example, because design research is a generative discipline it is able to create multiple worlds of design that may not overlap or be compatible. Gaver is further quick to point out that perhaps it is not such an undefined field after all; there are plenty of tenets most design researchers agree on, such as: a focus on some variation of user-centred research – keeping the potential target users in mind, and involved, throughout the design process –; the

exploration of a large range of design options; attention for detail in the work; and the belief that the practice of creating design artefacts will lead to richer understanding (Gaver, 2012). At the same time, methodologically, design has come to play a more important role in third-wave HCI as designers seek inspiration beyond pure user research, in more exploratory processes (Bødker, 2006), e.g. the use of cultural probes (Gaver et al., 1999).

DESIGN RESEARCH STRATEGIES

As a term 'design research' does not provide much clarity regarding the topic under study, methodology, and ultimate goal, which is why researchers have attempted to classify different types, or strategies, of design research. Frayling (1993), for example, names 'research into design' (research that studies the topic of design, e.g. design history, aesthetics, or theoretical perspectives); 'research through design' (research that uses design action as a tool or a method, e.g. materials research, (concept) development work, and action research where findings are communicated through a research diary); and 'research for design' (research that contributes to the creation of an artefact, which is the final goal). Similarly, Fallman (2003) makes a distinction between 'research-oriented design' (the ultimate goal of which is to create a new artefact), and 'design-oriented-research' (the ultimate goal of which is to generate knowledge, through the design of an artefact, specifically the kind of knowledge that would be difficult to gather without the designed artefact). Fallman's 'research-oriented design' is thus similar to Fraylings's 'research for design' (RfD), while his 'design-oriented research' resembles Frayling's 'research through design' (RtD).

In the design research community, as opposed to, for example, in product development companies, most researchers are concerned with gathering knowledge to contribute to existing knowledge of researcher or practitioner communities, and thus RtD appears to be the dominant form of design research. The use of design action – the development of design concepts and the creation of interactive prototypes – can be beneficial. RtD has been argued to produce several beneficial contributions to HCI, such as the identification of

opportunities; the creation of concrete artefacts that embody theory and technical opportunities; and the contribution of holistic research that includes the framing of the problems and the road towards a solution (Zimmerman et al., 2007). Furthermore, it allows for design solutions to be evaluated in real-life contexts; for designers to learn about the topic by doing design activities; and for design activities to lead to discussions and new insights and ideas (Hoven et al., 2007). RfD, on the other hand, typically gathers knowledge for the design of a product or system through methods such as interviews or focus groups and does not include design action in this research process. However, taking a slightly broader interpretation of RfD implies that the result does not need to be a 'final' product. RfD can also inform the design of a new artefact that can subsequently be used in further research through the formulation of design guidelines or knowledge around design context, user group, requirements, etc. In other words, *RfD can be used to inform RtD* (Figure 3.1). Similarly, RtD, in addition to providing knowledge on the research topic, can inform design guidelines, design specifications, new ideas, insights into gaps in existing knowledge, *which can inform further RfD* (Figure 3.1). RfD and RtD are thus not two isolated research strategies but can be used together (Fallman, 2007). The next section addresses how the use of both RfD and RtD strategies within this research complement each other.

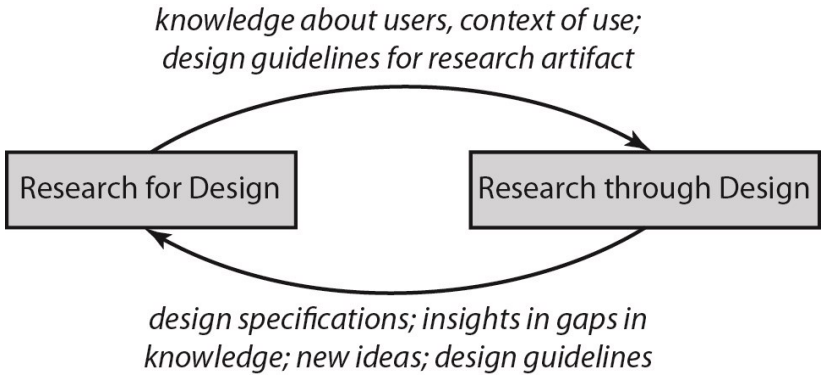


Fig. 3.1 Using RfD and RtD: findings from one activity can inform further work in the other.

RESEARCHING HYBRID CRAFT *THROUGH* AND *FOR* DESIGN

Design research is considered a particularly apt approach to researching hybrid craft. Craft, apart from having recently become of interest to the HCI community, is typically one of those topics that would benefit from a design-based, holistic, third-wave approach, because it is embedded in social and personal contexts, and it deals with people's personal interests and mental processes, which makes it very difficult to generalise. Further, the large diversity in craft practices – the diverse possibilities of crafting, the different practices people engage in, the different things they make, and the ways they do this – makes it difficult to break these practices up in measurable entities; a holistic design approach may thus serve better. Finally, studying craft *through* and *for* design may provide interesting opportunities for reflection on the relation between craft and design, and what it means, methodologically, to study craft by using design research. As addressed in Chapter 2, traditionally there was a clear-cut distinction between designers and crafters (Pye, 1968). Currently, however, these boundaries are fading due to novel processes of making and customisable products. More and more, designers are being considered crafters, and design is considered craft, or 'the crafting of connections rooted in the material world' (Bean and Rosner, 2012, p.87). If design is a form of craft, or at least an activity that shares many of the tenets of craft, it seems particularly apt to reflexively employ design research in the study of craft. To this end, Chapter 10 includes a reflection on the use of RfD and RtD to study craft.

As an overarching goal, this thesis aims to formulate a vision on hybrid craft practice, and design guidelines for new systems that can support this practice. Because it is often difficult for people to imagine how they would use a new system that is unlike anything they currently have, hybrid craft is typically an area in which it would be difficult to generate knowledge without the use of concrete designs or interactive prototypes that help users envision what is possible. RtD is therefore a pivotal part of this thesis. However, because hybrid craft as it is envisioned in this thesis is currently hardly practiced in everyday life, it is also difficult to envision what design may be realised that can give

insight into hybrid craft practice. Before carrying out RtD it is thus required to carry out RfD to be able to realise a meaningful design. Since hybrid craft cannot readily be studied through observations or interviews, an interview study into existing physical and digital craft practices is carried out, in order to compare these practices and identify how they may suitably be combined into hybrid practices. This interview study subsequently advises the design of a system (RtD), called Materialise, which facilitates and informs hybrid craft practice. From this RtD, design guidelines for hybrid craft are derived, which can in turn be considered RfD because they can inform the creation of further design artefacts (see Figure 3.2). The next section addresses the specific methods that are employed in this research within the RfD and RtD strategies.

Fig. 3.2 Visualisation of the design research process: RfD (the crafter interview study) informs RtD (the design and evaluation of Materialise), which subsequently informs further RfD (design guidelines for hybrid craft).

EMPLOYED METHODS

With interaction design research as the methodology, the concrete methods that are employed for this research follow a user-centred trajectory, which is the dominant preferred way of working within design research (Gaver, 2012). Although user-centred design approaches have been criticised (e.g. Cockton, 2013) for their limited potential in producing profitable innovative products, it has also been argued that design *research* sets itself apart from design *practice* through its focus on generating knowledge rather than creating products that can be successful on the market (e.g. Zimmerman et al., 2007). This thesis thus employs a user-centred, qualitative approach because it aims to generate rich understanding of existing and envisioned craft practices. Methods employed within this approach are: an explorative narrative interview method combined with portraiture and thematic analysis (to gain understanding of everyday

physical and digital craft practices); an idea generation method developed within this research that uses portraiture as an input for ideation (to generate ideas for hybrid craft); annotated portfolios (to illustrate the design journey); interaction design prototyping and creative workshops (to evaluate the hybrid craft design and inform a vision on hybrid craft and design guidelines). An overview of the research methodology, employed methods and corresponding chapters can be seen in Figure 3.3, and this section now introduces each method in turn.

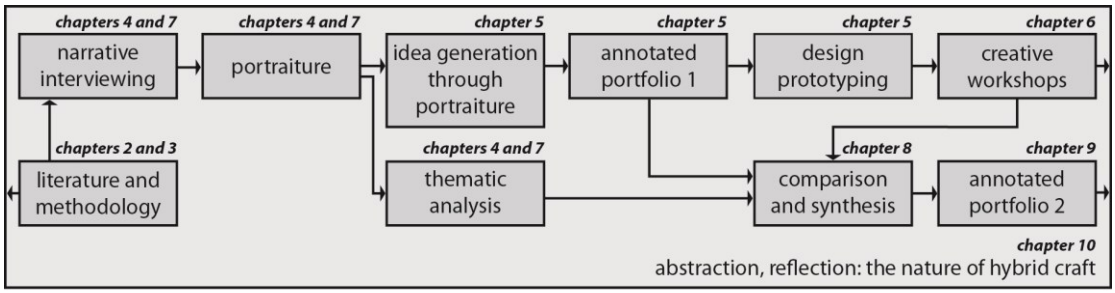


Fig. 3.3 Overview of the interaction design research methodology: employed methods, chapters in which they are addressed, and how each method informed consequently used methods. An overarching approach is the abstraction and reflection upon empirical work (arrows pointing outward) to reach an understanding of hybrid craft (Chapter 10). Similarly, Chapter 8 forms a pivotal chapter that compares physical and digital craft and derives design guidelines for hybrid craft from empirical and design findings, which are subsequently used in a second design chapter (Chapter 9). Apart from the whole illustration representing the research methodology, a literature and methodology block is included to represent the informing roles of the reviewed literature and methodology on the overall understanding of hybrid craft and its guidelines, through the use of design research and the explicit reflection on the research methodology.

NARRATIVE INTERVIEWING

Some twenty-five years ago, Bruner (1987) introduced the concept of 'life as narrative', arguing that human beings construct meaning, make sense, and engage in 'world making' (Bruner, 1987, p.11) through 'narrative' – that is, through creating, telling, recording, and reading stories. Relatedly, the field of narrative research seeks to engage analytically with the storied ways in which we make sense of our experiences, within the wider context of our social world and those social others within it (Bruner, 1987, Hollway and Jefferson, 2000). A

narrative approach to interviewing thus focuses on analysing those stories interviewees have to tell about a certain topic, and related background stories. Because a narrative interview leaves an interviewee relatively free – compared to a semi-structured interview, for example – it is particularly useful for exploratory research projects, in which it is not known which questions or answers may lead to interesting insights (Bruner, 1987, Hollway and Jefferson, 2000). Since the study of physical and digital craft practices is such an explorative endeavour, narrative interviewing is considered particularly suitable for holistically exploring craft practice and crafters' stories. It has been argued that seeing and doing, rather than talking about, craft are crucial to uncover tacit knowledge (e.g. Sennett, 2008, Ingold, 2006). However, since the goal is not to learn or understand a specific craft in great detail, but rather to gain multidisciplinary insights in personal accounts of everyday craft, it is considered more important in this study to get crafters' personal views on their practices. Because narrative interviewing allows individuals to tell their stories beyond the topic directly under study, and beyond that which would have been directly observable, it is expected that these interviews uncover a broad spectrum of aspects related to craft practice, varying from participants' actual practice to their more general backgrounds, motivations and beliefs. Moreover, interviews take, where possible, place in the locations where crafters usually work and include reference to materials, tools, and craft pieces in these locations so that observations are nevertheless possible.

Critical challenges that have been identified in relation to narrative research include: ethical difficulties, especially in maintaining anonymity of research participants because of the level of contextual and personal detail (Smythe and Murray, 2000); the impact of the research and in-depth personal inquiry on the participants (Stacey, 1991); and the perceived 'legitimacy' and 'validity' of the data produced (Bruner, 1987). Despite these challenges, narrative approaches to research have been utilised successfully across a range of subjects in the social sciences, including education (e.g. Sinclair Bell, 2002); health (e.g. Williams, 1984); the construction of 'everyday selves' (e.g. Pasupathi, 2006); and the storied experience of crime (e.g. Presser, 2010).

While the origin of narrative research lies in social sciences, it shares common ground with some HCI methods, e.g. contextual inquiry (Wixon et al., 1990); the use of digital storytelling, cultural probes and conversational interview techniques within experience-centred design (McCarthy and Wright, 2004); deep narratives (Jung et al., 2011); technology biographies (Blythe et al., 2002); and ethnographic approaches to design research (e.g. Dourish, 2006, Millen, 2000). However, these methods often have a smaller or different scope than narrative interviewing, e.g. contextual enquiry lacks attention to findings beyond the phenomenon of interest, such as a person's motivations and background, and deep narratives and technology biographies are centred on people's possessions and technology. Moreover, such methods in HCI have been criticised for reading interview data 'too narrowly' in over-emphasising 'implications for design' (Dourish, 2006). In contrast, by using narrative interviewing in combination with the portraiture and thematic analysis methods (both addressed later), the empirical interview data becomes more important because it is used both directly in ideation and thematic analysis.

A two-fold narrative interview study into physical and digital craft practice is conducted, which consists of eight interviews with physical crafters (Chapter 4) and eight interviews with digital crafters (Chapter 7). The need for this two-fold study was identified throughout the research process. After identifying a gap in the literature around craft studies (Chapter 2), an investigation of physical craft was done first. The findings from this study were subsequently used to inform design activities, and the development of a concept prototype (Chapter 5). During the design activities and prototype evaluation (Chapter 6), it came to light that more insight was needed into digital craft because design ideas were initially developed by extrapolating findings about physical craft to the digital and the hybrid, as will be addressed when introducing the idea generation through portraiture method later in this section. Acknowledging that people currently also engage in digital everyday craft, it was decided to conduct a second set of interviews that looked at digital practices. Findings from both sets of interviews are used to draw comparisons between physical and digital craft practices, and synthesise research findings into design guidelines for hybrid craft

(Chapter 8), and to inform further design work that implements these guidelines (Chapter 9). As a specification of Figure 3.3, the different roles of the physical and digital interview studies can thus be summarised as shown in Figure 3.4.

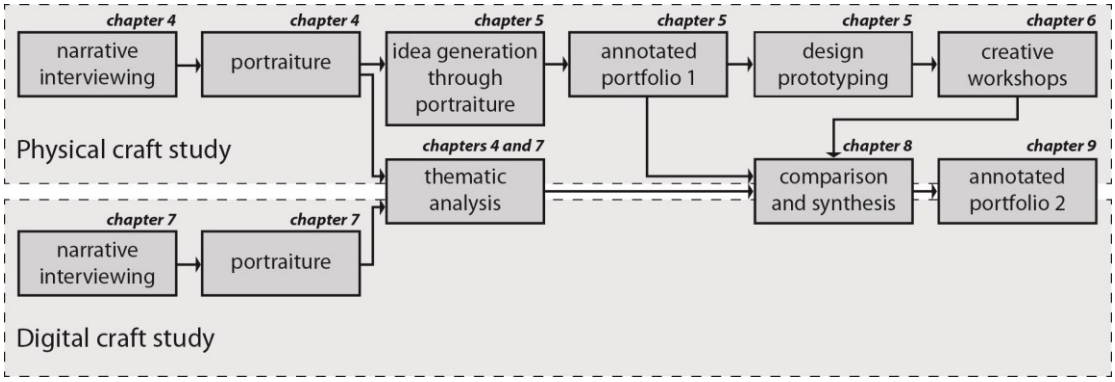


Fig. 3.4 The different roles the physical and digital craft interview studies play in the research: physical interviews inform idea generation through portraiture, interaction design prototyping, and creative workshops, as well as thematic analysis, while digital interviews informed thematic analysis. Both are included in a comparison and research synthesis that informed design guidelines and further design work.

PORTRAITURE

Portraiture is an analysis method for narrative research (e.g. English, 2000, Davis, 2003, Lawrence-Lightfoot, 2005) and is used in the analysis of crafter interviews. In portraiture, a written document, the research portrait, is created about an interview participant, which aims to capture a holistic image by describing the research context, participant, and the stories that represent answers to interview questions (Lawrence-Lightfoot and Davis, 1997). The purpose of this is to attend to 'the aesthetic whole' (Chapman, 2005, p.48) of the research participant, an idea central to both the narrative and portraiture approaches; in contrast to, for example, solely employing a data coding approach, which fragments the data (e.g. Hollway and Jefferson, 2000). As such, portraits combine 'first order' narratives (those of the participant), and 'second order' narratives (the stories the researcher is conveying) (Harling Stalker, 2009), such as observations of the research context and the researcher's interactions in that context, hereby thus engaging reflexively with interview data (Hill, 2005, Elliot,

2005). The use of portraiture methodologies is most dominant within the social sciences, primarily within the sociological study of education and educational leadership (e.g. Chapman, 2005), but its use extends to criminology (e.g. Hollway and Jefferson, 2000); psychology (e.g. Davis, 2003); and health research (e.g. Williams, 1984).

In this research, portraits are created about each interview participant in the two-fold interview study, which are subsequently used in thematic data analysis – by coding the data in the portraits – and ideation – by generating ideas around the individual crafters (Golsteijn and Wright, 2013). Craft practices are strongly specific to craft discipline and crafter. Therefore, it is important to attend to the holistic story around each participant's practice without breaking up the data, for which portraiture is deemed a particularly appropriate method. This approach minimizes the risks of stereotyping and oversimplifying individual people and their experiences, which is deemed beneficial in both the thematic data analysis and the ideation process. In HCI, similar methods to the research portrait have been employed, for example ethnographic vignettes (Orr, 1996), which are short descriptions of people in a setting that aim to capture the 'felt experience' of that setting (Wright and McCarthy, 2008, p.642), although these are primarily used for distilling and communicating ethnographic data, instead of holistically exploring data in thematic analysis and idea generation.

THEMATIC DATA ANALYSIS

Thematic analysis of interview data is conducted to uncover characteristics of physical and digital craft practice, and derive important insights into a potential hybrid craft practice. An 'open coding' approach – common in design research – is used, in which empirical data is clustered by affinity, and codes, or themes, are derived from the data, rather than coding the data within a predetermined coding scheme (Liamputtong and Ezzy, 2005). This approach is similar to – and represents a part of the methodological sequence of – sociology's Grounded Theory (Charmaz, 2006), which rejects the use of predetermined hypotheses or theoretical frameworks in favour of deriving categories and theoretical

constructs by categorising empirical data. This approach is useful for studying phenomena for which existing theory or literature is limited (Hsieh and Shannon, 2005). Because a comprehensive understanding of a diversity of everyday craft practices has not been established in the literature, this is deemed a useful method. This approach allows for the development of a scheme of codes that covers both anticipated and unanticipated themes in the data, which is desirable for understanding a broad spectrum of aspects related to existing craft practice; envisioning a new, hybrid practice; and opening up the design space. After all, because hybrid craft is a new practice it will be challenging to anticipate beforehand which themes can inform this practice.

Portraits of interview participants are used as input for the thematic analysis. While it can be argued that the portraits are an abstraction from the empirical data which may introduce researcher bias – and, alternatively, verbatim transcripts may have been coded in the analysis –, Hollway and Jefferson (2000) describe a similar approach to the analysis of their narrative data. Although the authors do not employ a formal thematic analysis, they use their created portraits as input for 'finding links' in their data; identifying relevant insights in the data that relate to other sections in the data from the same or other interviews, and which may help to explain or understanding these findings. The authors further argue for the use of portraits because they include researcher insights and observations that may not be apparent from interview transcripts; thus, the portraits can form a 'substitute "whole"' (Hollway and Jefferson, 2000, p.70) for the verbatim interview transcripts in further data analysis. Moreover, while researcher bias is inevitably introduced in any data analysis – e.g. in clustering and classifying data – the reflexivity embedded in the research portrait allows for the acknowledgement of this bias, and provides handles to make it explicit – e.g. by distinguishing between participant quotes and researcher interpretations in the portraits – thus making data analysis more transparent. Finally, portrait creation consists of selecting data for inclusion, omitting irrelevant information early in the process, where this usually would have been done at the coding stage. This limits the time needed for coding, because it can be assumed that all the information that is included in the

portraits is relevant to the analysis. It is important to note that in this research the 'irrelevant information' that is omitted in the portraits is kept to a minimum, and is limited to tangents and off-topic remarks, extensive examples, or repetitions that are not directly on-topic. Any disparate topics or stories are included in the portraits to allow for a diversity of themes to arise from the data. It is further attempted to retain the authenticity of the interview data by including large sections of verbatim transcripts, and by giving interview participants the chance to read and comment on their own portraits to be sure to question whether the researcher's interpretations are accurate. Findings from the thematic data analysis will be addressed in Chapters 4 and 7.

IDEA GENERATION THROUGH PORTRAITURE

Idea generation, ideation, or brainstorming (Osborn, 1953) is a key phase in any interaction design project as it serves to generate ideas that may be developed into design concepts. Idea generation methods can be seen as a form of designers' tacit knowledge, as designers tend to invent ad hoc approaches and personal adaptations of methods, and draw inspiration from 'unorthodox sources' (Gaver and Bowers, 2012, p.42). In this tradition, a new method for idea generation is developed as part of the research (Golsteijn and Wright, 2013), which is here referred to as 'idea generation through portraiture': research portraits resulting from the physical craft interviews are used as direct input in idea generation activities[23]. Portraits can provide a useful focus to ideation compared to using disparate empirical themes (Chen et al., 2011) because interview findings are broad and there is no predefined direction in which design ideas should be sought. In short, the method consists of a number of separate brainstorm sessions, each focused on one specific crafter, in which design ideas are generated by iteratively reading the crafter's portrait and thinking about what may be designed for that person if their craft included digital materials, tools, and techniques alongside the physical ones.

[23] As mentioned, digital craft interviews were done later in the research process after a need for them had been identified throughout ideation and concept development; digital crafter portraits were therefore not included in the idea generation through portraiture.

Although ideation based on character descriptions is not new in design research – it is for example used in personas (Cooper, 1999); pastiche scenarios; (Blythe, 2004), extreme characters (Djajadiningrat et al., 2000), design alter egos (Triantafyllakos et al., 2009); scenario-based design and character-driven scenarios (Nielsen, 2002) – the key difference with the idea generation through portraiture method is that in these methods the character descriptions are fictional. Where the use of portraiture brings the descriptions around actual, *real*, interviewees into the ideation, personas and related methods create composite, *fictitious*, descriptions of multiple users (e.g. Blomquist and Arvola, 2002, Chang et al., 2008). Such an approach potentially leads to superficial, and even erroneous, assumptions (Triantafyllakos et al., 2009), and may cause interesting insights to be lost before ideation has even begun. Moreover, it eschews the important reflexive question of the role of the researcher in producing the data generated (Lawrence-Lightfoot and Davis, 1997), which risks the dominance of the researcher's interpretation of the data, and the loss of what was originally important to the person being consulted; using portraits aims to limit this risk. Finally, using portraits directly in the ideation process ensures that attention remains focused on the diversity of the people in the target group throughout the process. Where personas are usually created between data collection and ideation phases – thus generalising and summarising data *before* ideation has begun – idea generation through portraiture only compares and combines interesting ideas for multiple participants *after* idea generation. A possible downside of using this approach is that it can result in bespoke design and that it can be time consuming. However, as seen in Chapter 5, the resulting set of design concepts is not only true to the interviewed crafters, but also forms a varied set that addresses multiple angles on craft (Golsteijn and Wright, 2013). Through a process of idea generation, selection and development, ideas can be generalised, categorised, summarised, and extended to larger target groups, making sure ideas are relevant beyond idiosyncratic individuals whilst retaining their unique relevance to an individual (Golsteijn and Wright, 2013, Blythe, 2004, Djajadiningrat et al., 2000).

ANNOTATED PORTFOLIOS

Annotated portfolios (Bowers, 2012, Gaver and Bowers, 2012) have been proposed as ways to communicate design theory, or intermediate level design knowledge (Löwgren, 2013), in order to map design spaces and inspire future work, while still being suitable for design practice; i.e. they provide a more general form of knowledge while not stifling the design process by posing too strict guidelines or frameworks. In short, annotated portfolios consist of 'families' of design concepts, often represented in design illustrations with annotations but they can take any shape or form, for example illustrations with short textual annotations (Gaver and Bowers, 2012) or textual accounts (Bowers, 2012). Annotations typically form a partial view on the collection of designs, in focusing on certain aspects of the designs, such as connections to the research topic or promising directions for future design work. The annotations and the designs are mutually informing, and neither would be as informative without the other; the designs are characterised and abstracted (Löwgren, 2013) by the annotations, and the annotations are illustrated by the designs.

The reasoning behind annotated portfolios lies at its core within the discussion around the role of theory in design research, and how design may contribute new theory. While design practice has been pressured to make theoretical contributions, theory often 'underdetermines' design choices and rationale, and vice versa (Gaver and Bowers, 2012); any number of designs can be developed for any given theory, and any number of theories can be derived from a particular design. Theory, in the traditional scientific sense of the word, 'promises generality and guidance but seems inadequate to capture the situated and multidimensional, and configurational nature of design, and moreover threatens to occlude the potency of unique, embodied artefacts in a cloud of words and diagrams' (Gaver and Bowers, 2012, p.42). Therefore in developing theoretical notions, designers instead often focus on deriving insights, or theories, from their designs that support future design work in a certain research area; and these insights are implicitly present in concrete designs (Gaver and Bowers, 2012). Designers have a privileged position in the perception of designs

as they are knowledgeable of this implicit information, and it is necessary to annotate designs in order to highlight features of the designs, as well as connections to the research at hand. Annotated portfolios give form to this practice in explicitly highlighting these implicit insights – using a collection of concrete, contextual ideas from the same designer or studio – and, as such, they respect both the multidimensionality of design and the need for generalizability. As such, annotated portfolios establish an 'area' in a design space, and by highlighting the relevant dimensions of that area, they can serve some of the same functions as design theory (Gaver and Bowers, 2012, p.44). Löwgren (2013) strongly advocates this form of design theory and the use of annotated portfolios. The author argues that the annotations can form abstractions from particular designs that reside in the 'in-between space' between general theory and particular artefacts; as such, they are an example of 'intermediate-level knowledge' that can be derived from design (p.32). Thus in short, as abstractions from concrete design examples, annotated portfolios aim to inspire novel work and map emerging design spaces; and annotations allow designs, and relations between them, to be discussed (Gaver and Bowers, 2012).

In this thesis, annotated portfolios are deemed a suitable method to structure, reflect on, and communicate the empirical design work, due to its overarching goal of abstracting knowledge around hybrid craft from design practice. Chapters 5 and 9 present annotated portfolios around hybrid craft design ideas, in which annotations are used to highlight similarities of ideas and emergent themes for further research and design work. These annotations further inform design guidelines and a vision on hybrid craft.

Interaction Design Prototyping

After creating a portfolio of design ideas, one idea, the 'Materialise' building set, is prototyped. Interaction design prototyping is used to create a working demonstrator that incorporates at least enough functionality to allow people to interact with the design, experience the intended use, and envision further functionality. While design ideas can also be communicated to users by using, for

example, sketches or scenarios, the creation of concrete artefacts in design research allows for design solutions to be evaluated, and for design activities to lead to discussions and new insights and ideas (Hoven et al., 2007, Stolterman, 2008). Furthermore, a prototype can serve to illustrate the research contribution and the knowledge obtained (Zimmerman et al., 2007, Zimmerman et al., 2010). In this research, it is deemed of particular importance to create a design prototype because hybrid craft is a new practice that is currently mostly unknown and unpractised. As such, it is likely to be difficult for users to envision how they may use a new system to craft in novel ways without actually being able to try it. Providing users with an interactive prototype can help them in this respect, and offer insight into potential use and the development of the design. The development of the 'Materialise' prototype will be addressed in Chapter 5.

CREATIVE WORKSHOPS

The Materialise prototype is used in a set of creative workshops to explore hybrid craft practice, evaluate the design concept, and explore what participants create using the system. By including hands-on interaction with a prototype and ideation activities, the creative workshop method is used as an alternative approach to traditional focus groups or group discussions. Creative workshops are considered an appropriate method for a number of reasons. First, because Materialise presents a conceptual idea, it is deemed most important to gather general insights around the design, as well as the overarching vision on hybrid craft it embodies, which can be done using prototype interaction in a controlled setting. Second, because Materialise is a conceptual design, and because of technical limitations, the prototype possibly required the researcher's aid with technical issues during use. Third, bringing participants together in small groups is believed to be beneficial to gain views on hybrid craft from a greater number of participants – while they still all have the chance to interact with the one-off prototype – and to introduce interactivity between participants that helps their involvement and participation in the sessions (e.g. Denzin and Lincoln, 2000). Finally, workshops or group discussions are common methods in HCI and seem to be a particularly favoured method to evaluate novel craft construction toolkits

(e.g. Bdeir and Rothman, 2012, Buechley et al., 2006, Gaye and Wright, 2012, Mellis et al., 2013b, Sundström et al., 2011, Villar et al., 2011). Workshops in these papers have typically included an explanation and demonstration of the toolkit, followed by hands-on trying it, design activities and group discussions, and have aided the designers in developing their concepts and envisioning potential use. In this thesis, four two-hour creative workshops with three to four participants each were organised that functioned as design concept and hybrid craft practice evaluation and development (see Chapter 6).

THESIS CONTRIBUTIONS

Having discussed the interaction design research methodology for this thesis, and the methods employed within, now enables addressing the methodological, empirical and design, and theoretical contributions.

METHODOLOGICAL CONTRIBUTIONS

First, this thesis introduces the narrative research and portraiture methods to the HCI and interaction design research fields (Golsteijn and Wright, 2013). Although these fields have engaged to some extent with the underlying principles of narrative research and portraiture (as addressed in the previous section), this thesis argues and shows that employing these methods from social sciences in design research can help researchers to holistically engage with their interview participants and retain attention to diversity and detail throughout data collection and analysis. This is an important endeavour for design researchers who seek to generate qualitative user-centred data to aid both the design process and the understanding of users. This thesis and the accompanying publication about this topic (Golsteijn and Wright, 2013) introduce these methods to those who do not have an extensive social science background, and can help researchers to employ them in their own research.

Second, this thesis contributes the 'idea generation through portraiture' method that was developed within this research (Golsteijn and Wright, 2013). This research shows that this method can help to generate diverse ideas that are

more likely to be relevant to users, as the portraits help to both open the design space, and focus the ideation. This method can be beneficial for anyone in design research who aims to generate user-centred ideas within a topic area that is broad (such as craft), and when there is no preferred direction where design solutions may be found.

Third, this thesis reflexively uses design research to study craft. It is hereby the first research example that creates new designs for craft merely *in order to understand a specific craft practice, or newly developed craft form*. Design research for craft, it seems, has thus far mostly been instrumental to other goals, e.g. making craft accessible for everyday users (e.g. Perner-Wilson et al., 2011, Saul et al., 2010), making more meaningful or personalised objects (e.g. Freed et al., 2011, Rosner, 2010), promoting craft activities (e.g. Pschetz et al., 2013), or supporting education (e.g. DuMont, 2012). In these studies, new craft forms and notions of craft arose but were not comprehensively described or reflected on. Conversely, this thesis employs a design research methodology with the ultimate goal to understand craft practice better, and understand how a hybrid craft practice may be facilitated through design. Because this has not been done before, there are also no existing reflections in the literature on the use of a design research methodology to study craft, or discussions around the roles of craft and design arising from a design practitioner's view. This thesis includes a reflection on the use of the RfD and RtD strategies and highlights the indispensable insights this has uncovered about the methodology, the research topic, and the relations between craft and design. Making such reflections transparent to the design research community can help other design researchers to select which strategy to use in future studies, and can aid design researchers who want to study craft, as it will give them more insight into their own design practices, how these practices influence findings, and how they may be exploited.

EMPIRICAL AND DESIGN CONTRIBUTIONS

This thesis, first, presents empirical findings of a broad multidisciplinary study into everyday craft practice that covers both physical practices and emerging

digital practices, which includes a comparison of these practices. As Chapter 2 has shown, such a comprehensive study of diverse forms of everyday physical and digital craft practice – which are analysed for common characteristics and differences based on a similar research method and analysis framework – is missing from existing literature. This research thus offers a valuable contribution to interaction design because it can inspire new research and design in craft that looks across different disciplines and across materiality realms. It further contributes new empirical knowledge to craft communities where accounts of craft practice have been inspirational and informative (e.g. Crawford, 2010, Frauenfelder, 2010).

Second, this thesis makes a design contribution in its presentation of numerous design ideas into hybrid craft; and the prototyped design of the Materialise craft set. Apart from providing the basis for theoretical contributions (addressed in the next section), these design ideas can be inspirational for further design for (hybrid) craft, toolkits for craft, and tangible interaction.

Third, in its evaluation of the Materialise craft set in a series of creative workshops, this thesis offers empirical data into the use of such a hybrid craft set, what applications it may serve, how hybrid craft practice may be supported using a toolkit, what content people would like to use and create, and how the design may be adjusted to better support hybrid craft (Golsteijn et al., 2014). This data forms a valuable contribution for design researchers who aim to design for hybrid craft or design a craft toolkit.

THEORETICAL CONTRIBUTIONS

It is often argued in design research that much theory and knowledge lies in the designed artefacts themselves (Cross, 2001, Frayling, 1993, Zimmerman et al., 2007), especially if statements about design are applied to multiple examples (Gaver, 2012). Gaver (2012) argues that there are different forms of theory that can be produced by design research, for example conceptual work that implicitly communicates the choices of the designers, or frameworks or guidelines for

design. This design work in this thesis offers such forms of theory that are strongly linked to design ideas, as well as the knowledge contributions of overarching characteristics of physical and digital craft, and hybrid craft as a 'strong concept' (Höök and Löwgren, 2012).

The first theoretical contribution is the presentation of annotated portfolios around hybrid craft. In annotating the similarities, differences, and promising future directions of a set of design ideas – which all embody important design decisions – an annotated portfolio provides theoretical notions that provide guidance to future designs within that design space without being too general to be useful for design practice (Gaver and Bowers, 2012). The annotated portfolios thus provide 'intermediate-level knowledge' – knowledge that resides between specific design concepts and general design theories (Löwgren, 2013) – into hybridity, craft, tangible interaction, and hybrid craft that is useful for designers who work in these areas.

Second, this thesis formulates design guidelines for hybrid craft that are closely coupled to concrete design ideas; they thus both inform design, and are informed by design. Design guidelines are a powerful form of design theory (Gaver, 2012) and they can help design researchers to build on the work of others, and develop more effective systems or research tools. As addressed in Chapter 2, hybrid craft is a new concept that was developed within this thesis and, as such, there are no existing design examples beyond those in this thesis. The design guidelines thus offer an important contribution in the communication of the design findings and in offering guidance to future design for hybrid craft and toolkits.

Third, the empirical study into physical and digital craft offers overarching characteristics of physical and digital craft that are linked to relevant theoretical notions in literature, which contributes to theoretical understanding of existing craft practice. This is important for designers and researchers who study craft, as well as for craft communities, who provide empirical accounts of craft practice and views on the value of craft in everyday society.

Fourth, this thesis establishes hybrid craft practice as a 'strong concept' (Höök and Löwgren, 2012). Strong concepts are abstractions from concrete design ideas that are grounded in related design knowledge, and are contestable (inventive and novel); defensible (empirically, analytically, and theoretically grounded); and substantive (relevant to the community, and expected to be generative for the design of new instances). An example of a strong concept posed by Höök and Löwgren is social navigation (making decisions based on the decisions of others). Chapter 10 carefully evaluates the criteria for strong concepts and concludes that hybrid craft can be established as a strong concept through its empirical, theoretical, and design grounding, and its documentation in a vision on potential practice and design guidelines. For the craft community, the integration of physical and digital materials may inspire new applications and hybrid practices. For the design research community, hybrid craft integrates the popular research area of tangible interaction and hybridity (e.g. Fitzmaurice et al., 1995, Ullmer and Ishii, 2000) and the emerging research area of craft (e.g. Bardzell et al., 2012, Bean and Rosner, 2012, Buechley et al., 2009, Rosner, 2010) and opens up an unexplored design space of craft research as a direction within materiality and hybridity research. It further offers new possibilities for the design of new craft toolkits and other designs that facilitate a hybrid craft practice. Finally, it offers new possibilities for personal digital media use in the crafting of physical-digital creations, which can offer an enjoyable and cherished craft process and craft result. As such, hybrid craft also contributes to research into personal digital media technology, and research into cherishing physical and digital artefacts and craft as a reason for cherishing (e.g. Jung et al., 2011, Odom et al., 2009, Odom et al., 2011, Golsteijn et al., 2012, Petrelli et al., 2009, Stevens et al., 2003), in confirming that craft is cherished, and showing why this is the case. Hybrid craft thus forms an inspirational new craft practice that can inform new designs and research for the design research community, as well as new applications and practices for the craft community. In sum, this chapter has introduced this thesis' interaction design research methodology and the methods employed within. It has finally outlined the contributions this research offers. The next chapters address empirical and design work, starting with the interview study into physical craft in Chapter 4.

4 Understanding Physical Craft

AN INTERVIEW STUDY INTO EVERYDAY CRAFT WITH PHYSICAL MATERIALS, TOOLS, AND TECHNIQUES

After identifying a lack of comprehensive studies of diverse physical and digital everyday craft practices in the literature, it was deemed important to carry out a multidisciplinary empirical study across these realms, in order to gain insight into processes, tools, materials, and techniques[24]. Suiting the aim of this thesis, the focus hereby lay on 'everyday crafters', or people who engage in everyday creative making practices, arising from a personal desire to do so. While some earlier studies have looked across specific physical crafts and tried to uncover common characteristics of craft (e.g. Bardzell et al., 2012, Buechley and Perner-Wilson, 2012, Yair and Schwarz, 2011), *everyday craft* has not extensively been studied across multiple craft disciplines, which is what this chapter addresses. This chapter is the first part of the two-fold interview study, which looks solely at physical craft. Interviews were conducted with eight participants who craft with *physical* materials. As defined in Chapter 1, a *physical craft process* is a process in which only physical materials (to make something *from*), techniques (to make something *through*), and tools (to make something *with)* are used; such as painting, working with wood, claying, making jewellery. The main method for data gathering was narrative interviewing, which focuses on the discovery of personal perspectives around a practice, through active engagement in the creation of personal narratives with the participants (Bruner, 1987, Hollway and Jefferson, 2000). This approach served to uncover habits and activities around craft, and underlying backgrounds and motivations. Employed data analysis methods were portraiture and thematic analysis.

[24] This chapter draws on work previously published in Golsteijn and Wright (2013).

The data gathered from the narrative interviews consisted of visual material (photos taken at the interview site), interviewer notes (for example on the site, the participant, and non-verbal elements of the interview), and the interview transcript. These materials combined were used to create a research portrait about each participant, using portraiture (Lawrence-Lightfoot and Davis, 1997). These portraits served the research in two ways. First, portraits were directly used in ideation activities, using the idea generation through portraiture method (Golsteijn and Wright, 2013) to generate design ideas for hybrid craft (See Chapter 5). Second, portraits from all eight interviews were used in a thematic analysis (Liamputtong and Ezzy, 2005), which allowed for the discovery of analytic themes that were of interest to understanding physical craft practice (addressed in this chapter), and later allowed for a comparison of physical and digital craft (Chapter 8). Figure 4.1 shows how the different methods introduced in Chapter 3 were used in this study, and what the outcomes were in each stage. Note that this figure shows the workflow around one single interview in the physical craft study; this process was repeated for each interview.

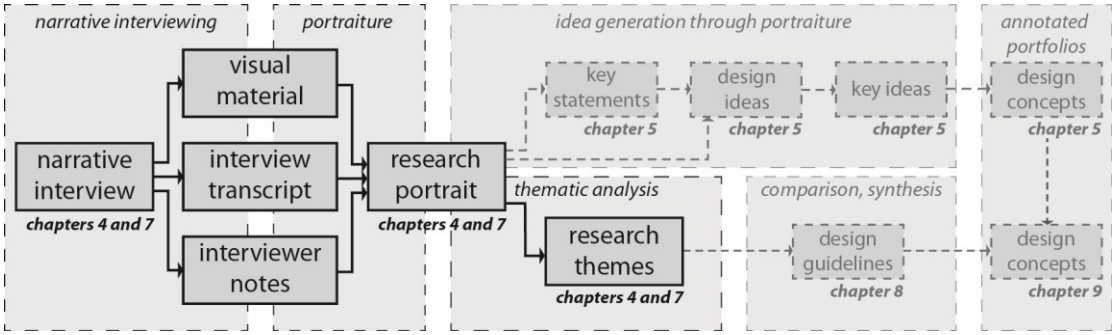


Fig. 4.1 This illustration shows the process from interview to thematic analysis and design concepts, with the creation of the research portrait as a key step. Light grey blocks with dashed outlines represent research activities, and darker grey blocks represent outcomes in each stage. This chapter addresses narrative interviewing (of which visual material, interview transcript, and interviewer notes were the outcomes); portraiture (with a research portrait as the outcome); and thematic analysis (resulting in research themes).

This chapter now introduces the participants and recruitment strategy, before addressing how narrative interviews, portraiture, and thematic analysis were conducted. Subsequently, findings from the thematic analysis are addressed, and this chapter concludes with a short discussion of methods and findings.

INTERVIEW PARTICIPANTS

This interview study aimed to uncover characteristics of physical craft practice, and see which characteristics extend beyond practices with specific materials or within specific disciplines, to form a broader understanding of physical craft practice. In order to achieve this, interview participants engaged in different disciplines to try to uncover a multidisciplinary view on craft, rather than a comprehensive understanding of a specific craft discipline. Furthermore, within the goal of understanding 'everyday craft' and within the broad definition of craft employed for this thesis, participants' practices included forms of making that may traditionally be classified in design, art, or craft, since, especially for everyday craft, boundaries between these domains are fading (e.g. Shiner, 2012). All participants are referred to as 'craft practitioners' or simply 'crafters'. Participants were recruited via personal communication, e-mail and telephone, and were mainly recruited from within the personal and professional networks of the researcher. In many cases, participants were recruited of whom the researcher was aware they crafted; in other cases, participants, friends, or colleagues would suggest crafters that may be interested in participating. In total, eight crafters were interviewed who worked with physical materials. This sample included both professionals and recreational crafters to get a wide range of views on craft practice. As mentioned in Chapter 1, there was no requirement of a certain skill level for everyday crafters, so interviewees had various levels of experience (years of experience ranged from 4 to 23 years) and the sample included both novices and experts. A requirement for the recruitment of professionals was that their interest in their craft extended beyond earning a living, meaning that the interviewed professionals were all so interested in their craft that they would engage in similar practices beyond their jobs; they thus qualified as everyday crafters as well as professionals. This criterion was used to safeguard the development of a view on everyday craft, in which people crafted because they wanted to. The division between professionals and recreational crafters was not clear-cut: some participants considered themselves at least semi-professional but their craft was not their main source of income. To simplify matters around self-classification, the following definitions were used:

for a 'professional' the craft he or she was interviewed about was their main source of income, or their job (although income was not their motivation for crafting); for a 'semi-professional' craft was not their main source of income or job, but they did make a small amount of money from it in one way or another; and finally, an 'amateur' did not make any money from their craft. Professionals and semi-professionals were expected (and observed) to have similar views on the professional side of their craft (e.g. making money), which is why both physical and digital interview groups contained equal numbers of professionals and semi-professionals versus amateurs.

Interviewed physical crafters were a hairdresser, wood and metal hobbyist, glass artist, mixed media artist, silk painter, jewellery designer, guitar builder, and paint artist. Participants included three males and five females; ages ranged from 38 to 68 (average age: 53). Participants were Dutch, English and North-American, and interviews took place in the Netherlands (the hairdresser, guitar builder, jewellery designer, paint artist, and wood and metal hobbyist) and in the UK (the silk painter, mixed media artist, and glass artist). Interviews with the Dutch participants were done in Dutch; the other interviews were done in English. All interviews were done by the author of this thesis, a native Dutch speaker who is also fluent in English. An overview of the participants can be seen in Table 4.1.

Crafter (pseudonym)	Craft	Pro/semi-pro/amateur	Age	Nationality
Jim	Hairdresser	Professional	38	Dutch
John	Wood and metal hobbyist	Amateur	54	Dutch
Mary	Glass artist	Semi-professional	56	English
Lucy	Mixed media artist	Amateur	42	North-American
Vicky	Silk painter	Semi-professional	54	English
Carol	Jewellery designer	Amateur	58	Dutch
Paul	Guitar builder	Semi-professional	68	Dutch
Tina	Paint artist	Semi-professional	52	Dutch

Table 4.1 Overview of pseudonyms, crafts, professional statuses, ages, and nationalities of the interview participants.

NARRATIVE INTERVIEW METHOD

As addressed in Chapter 3, a narrative interview approach focuses on uncovering and analysing participants' stories around a certain topic. This section discusses the interview schedule that was created to aid the narrative interviews, the style of interviewing, and the interview process and collected data.

INTERVIEW SCHEDULE

To guide the interviews, an interview schedule was designed to elicit stories (Hollway and Jefferson, 2000) from the participants; see Appendix A. To this end, the schedule was used loosely, and mostly to initiate conversation and trigger a new topic when a storyline was finished. Certain topics were aimed to be addressed in all interviews, while others were only elaborated on if they were brought up by the participant. All interviews were started by asking the participants: 'Can you tell me something about the kind of crafting you do?' to get a feel for the *general description* of the participant's craft, their processes (e.g. procedures, methods, techniques), and the results of their craft. All participants were further encouraged to talk about where and when they crafted, and whether they did this professionally or recreationally, which aimed to provide *contextual information* to the craft practice. Further detail into craft practice was gained by asking participants about the *materials and tools* they used; and in addition, participants were encouraged to talk about their craft history (e.g. when and why they started crafting, how they had learned their craft, what skills they needed) and why they crafted – these last two cues providing contextual understanding of the *motivations* behind craft practices.

The themes of questions, or cues, within the interview schedule can thus roughly be divided into Craft General; Starting and Learning; Materials; Tools; and Motivation. These themes correspond with Shiner's characteristics of craft (2012), which address both process and result of crafting, and resonate with themes addressed in other pivotal works (e.g. Adamson, 2007, McCullough, 1996, Pye, 1968, Risatti, 2007, Sennett, 2008, Ingold, 2006). Shiner (2012)

identifies Hand, Material, and Skill as characteristics often addressed in craft literature, and he broadens up these categories to Body, Medium, and Mastery, before expanding them with a fourth characteristic: Function. This extension of craft characteristics has the advantage that it can cover a variety of craft practices, including studio craft and amateur craft, and it extends beyond the realm of traditional making of physical objects, which is particularly useful for the overall goal of this research. The themes of questions in the interview schedule map to Shiner's characteristics as can be seen in Table 4.2. Apart from these themes that were addressed in all interviews, other themes were anticipated, inspired by the literature, and included as 'conversation prompts' in the interview schedule to be discussed and elaborated on if they were introduced by participants. These prompts included: perfectionism, challenges in the work, risks, identity as a crafter or artist, and social aspects. It is important to note that deviation from the schedule – manifested in the discussion of unanticipated topics brought up by the participant – was considered positive, since it may generate new, unanticipated ideas.

Theme in Interview Schedule	Characteristic in Shiner's framework (2012)
Craft General	Function (and Medium) *the goal of the work, be it aesthetic, functional, or other*
Starting and Learning	Mastery *skill and technique*
Materials	Medium *physical materials and immaterial actions, embedded crafting conventions*
Tools	Body *hand-work, as well as bodily involvement and tools*
Motivation	Absent from framework *But considered crucial for a comprehensive story around craft practices*

Table 4.2 The themes in the interview schedule all gave content to one or more of Shiner's craft characteristics (short explanations of these characteristics are in italics), with the exception of 'Motivation', which was added to the interview schedule to gain a comprehensive view on underlying backgrounds and beliefs around craft practices.

NARRATIVE INTERVIEWING

Next to creating an interview schedule appropriate for narrative interviewing, it was important to carefully consider the formulation of questions or prompts within the actual interview. Since the concept of narrative interviewing is

inherently bound up with that of storytelling, it is crucial that the interview techniques are capable of eliciting storied data. Hollway and Jefferson recommend that researchers 'narrativise topics'; that is, 'turn questions about given topics into story-telling invitations' (2000, p.35). For example, in a semi-structured interview the question 'How did you learn your craft?' may be asked, while in a narrative interview 'narrativising' this question would transform it into, for example: 'Could you explain to me the processes and people by which you learned your craft?' In this way, the likelihood of eliciting a personally relevant and detailed story about processes, experiences, and interactions with others is increased. Of course, the difference between 'narrativised' questions and semi-structured questions is not black and white as good researcher practice in qualitative interviewing would dictate asking participants to elaborate if short answers are given. Nonetheless, in this study, paying particular attention to how questions were formulated aimed to elicit more storied data and personal accounts around craft practice.

Interview Process and Collected Data

All interviews were done face-to-face, with the exception of the interview with Lucy, which was done over Skype. Where possible, in six cases, the interview took place in total or in part in the crafter's workplace, and interviews were complemented with observations of this workplace. In the other two cases this was not possible for logistic reasons (Mary, the glass artist), or because the artist had no specific workplace (Lucy, the mixed-media artist). It was considered beneficial to be in the crafter's workplace where possible; in the same way as it is beneficial for contextual inquiry and ethnographic research more broadly, it aided the narrative interview for a number of reasons. Firstly, it illustrated some of the topics participants were talking about, and allowed the interviewer to better understand and document (both through taking notes and photographs) the context of the crafting practice. Secondly, it gave both interviewer and interviewee handles for new topics to address, and thirdly – crucially – it benefitted the narrative character of the interview as participants naturally (without prompting) started telling stories about materials, tools, and examples

in the workshop. Apart from being in the workshop while the interview was conducted, Jim (the hairdresser) was further interviewed while he was working, and others (Paul, the guitar builder; Carol, the jewellery designer; and Vicky, the silk painter) made active use of examples of their work, materials, and tools during the interviews.

After the interviewer had introduced herself and the research, and the participant had read an information sheet and signed a consent form for data collection (both included in Appendix A), the interview was started by asking questions that would elicit storied responses, as addressed in the previous section. Examples of opening questions are 'Can you tell me something about the kind of crafting you do?', and 'Can you tell me how and when you started [participant's craft]?' During the interview, the participant was encouraged to draw on examples and stories of personal relevance to him or her, generating ideas previously unanticipated by the researcher. A new topic was only introduced by the interviewer when the participant had finished a story. Interviews lasted for approximately one hour and were audio recorded to allow the interviewer to more fully engage with the participant. The few written notes that were taken focused mainly on aspects the audio recording would not capture, such as the interviewer's observations and impressions during the interviews, e.g. on participants' use of examples, the mood and personality of the crafter, and the appearance of the workshop. In cases where the interview took place in the crafter's workshop, photos were taken of work, tools, and materials.

After interviews had been conducted, recordings were transcribed, and notes were taken on interesting comments and observations while listening to the audio recordings, reading notes, and looking at photos. For early interviews, only relevant sections of participants' stories that provided great detail were transcribed verbatim for time efficiency, e.g. participants' explanations of why they like their craft or descriptions of pieces they made; later interviews were transcribed verbatim in full to more easily create the portraits afterwards. At this point, quotes from interviews done in Dutch were carefully translated into English, while making sure the participants' intended meaning was preserved.

Before translated quotes were included in data analysis, these were in most cases checked by participants within the portraits created about them, which further safeguarded against translation errors.

RESEARCH PORTRAITS

Notes and transcripts, along with photographs and written interviewer notes were used to write research portraits about each participant, which were roughly half the length of the full interview transcripts. As mentioned, these portraits are written accounts that describe the context of the craft practice, participant, and the relevant stories that represent answers to interview questions, which include both researcher observations and interpretations and direct quotes from participants. This section addresses how the portraits were created and introduces the participants using excerpts from the portraits.

CREATING THE PORTRAITS

Portraits all roughly followed the same structure; that is, first introducing the craft, the crafter, and the context of the interview, before looking at when and how they started, and the materials and tools they used, followed by any other interesting themes from the interview. This meant that the portrait did not need to follow the sequence in which interview questions were asked. As such, portraits clustered around the key 'narratives', or storylines/plots that underpinned what the participant said (Hackmann, 2002). The portraits, in which participants were given pseudonyms, were rich descriptions supported with lengthy quotes from the interviews where this was considered useful, e.g. because of the level of detail or the relevance to the research aims. They detailed the setting in which the interview took place, and in many cases addressed the researcher's feelings about the setting and the individual participant. As mentioned, portraits also included important contextual observations by the researcher, or 'setting the site' (Lawrence-Lightfoot and Davis, 1997), e.g.:

'*As I enter the salon to get my dreadlocks tidied up and redone, I am greeted by Jim's ten year old daughter who later comes back to have a look as Jim is working. She wants dreadlocks too and Jim demonstrates to her the process of tidying up the dreadlocks to convince her to carefully think about this:* "Look, these two dreads have knotted together and I have to separate them. I want you to look at her face as I pull them apart: it really hurts." *But the child is adamant and keeps coming back from time to time to witness the progress and ask her father, and me, numerous questions. She and her younger brother are still on their Christmas break and come into the salon from time to time to ask their dad questions, cross through with bikes, show their new purchases, and generally pry. Such is the atmosphere in Jim's salon, and I get the feeling that this amicability, that almost gives the idea of witnessing a day, or an hour, in the life of the hairdresser's family, is part of the image and brand that makes customers come back.'* (Excerpt from the portrait about Jim, the hairdresser)

An important tenet of both narrative research and portraiture is that of reflexivity, which focuses on the importance of the researcher reflecting on the research scenario and their interaction within this context (Hill, 2005, Elliot, 2005). In the portraits which are 'shaped through dialogue between the portraitist and the subject' (Hackmann, 2002, p.51), further reflection was needed on how the background of the researcher (e.g. gender, age, social class, educational/employment status) impacted the interview. Such reflections can be seen, for example, in Jim's portrait (see excerpt above), where the researcher was at the same time the interviewer and the customer and thus the focus of Jim's craft; and in Paul's portrait, the guitar builder, who was visibly pleased with the interviewer's interest in his craft, being a guitar player:

'Throughout the interview I have gotten a strong feeling for Paul's […] appreciation of my interest in his craft. He explains to me that sometimes people come over who just have a glance at his workshop, ask him questions like: "So, how many guitars do you make a month?" *and they leave after 15 minutes.* "They should just stay away," *in Paul's opinion. Not me, however, being a guitar player myself I would have been unable to hide my enthusiasm and appreciation*

even beyond the scope of this interview, much to Paul's liking. As I prepare to leave he repeatedly thanks me for listening and chuckles: "In 30 years' time, when I've made my 200th guitar, come back and I can tell you much more."'

In other cases, participants felt intimidated at first to talk about their craft because they felt the interviewer (having a background in design) was 'very creative', and extra attention was needed to reassure participants that the aim was not to assess their skills but to hear their stories. Whilst these interactions can be problematic if one is unaware of them, the reflexive researcher acknowledges such phenomena, writes him or herself into the research in order to demonstrate this, and makes clear in writing up the point at which first-order narratives become second-order. Further, Miles and Huberman's advice was followed, who suggest that participants be allowed to read, and comment upon, their own portraits, being sure to question whether the researcher's interpretations are 'credible to the people we study' (in: Lawrence-Lightfoot and Davis, 1997, p.246). This also helped to ensure that portraits stayed true to the interview data, which was considered crucial for the use of portraits in thematic analysis. Nine of the sixteen participants from both the 'physical craft' and 'digital craft' studies made use of the opportunity to check their own portraits, of which only two proposed minor changes, which may serve to confirm the general thoroughness of the way in which portraits were created. In a similar way to providing interview transcripts to make data analysis more transparent, all portraits are included as a 'substitute "whole"' (Hollway and Jefferson, 2000, p.70) in Appendix B.

INTRODUCING THE PARTICIPANTS USING PORTRAITURE

This section briefly introduces the interview participants, by using excerpts from the portraits. This section mainly serves to illustrate the construction of portraits, and to give a background into what participants did; where and when they did it; and when, why and how they started, before going into data analysis.

Jim - Hairdresser

'Jim is a hairdresser who has his own salon in a city in the south of the Netherlands. In the salon four people are employed, including Jim and his wife, who are frequently complemented with interns from nearby teaching institutes, who need to work at a hairdressing salon as part of their training. […]'

'Jim's craft is working with hair. Although not all customers come in for extreme creations that require much creativity and design, Jim keeps up with the developments in the field and knows how to give his customers his professional advice. Specifically, I am talking to Jim about making dreadlocks. Jim has been making dreadlocks since 1994 when he joined a friend for a workshop in London after having been interested in the process long before. In this workshop he learned the basic techniques and he has developed his techniques into his own style by experimentation since.'

John – Wood and metal hobbyist

'John, a software engineer by profession, likes to tinker with wood and metal. He enjoys making tools, small machines, or furniture, such as garden benches and tables. […] John says he is always working on his projects; if he is not physically busy he is thinking about what to make. He used to be in his workshop daily, but now that he is older this has been reduced to a few times a week. He is more active in summer time, because it is too cold in his workshop for winter time tinkering.'

'John tells me he has always been interested in creating things: as a small child his dad had to keep him away from the tools and machinery in his workshop. His parents bought a construction kit for him about which he tells me: "the examples that came with the kit were not enough; I went in search for extensions and used all materials at hand: cigar boxes, bike lights, tea towels, ropes.' *Much in line with this John later followed a mechanical engineering education.'*

Mary – Glass artist

'Mary works with glass, which she sometimes combines with found materials, such as pieces of cable or copper wire. […] As her busy schedule got freed up recently, Mary has since a few weeks decided that she will try and spend two days per week

on her glass work, roughly one day for stained glass and one day for glass sculptures.'

'Mary tells me that she used to have a dedicated place, a spare room set up as a studio, […] but this has currently been repurposed. Because part of the work is quite messy she is currently setting up a place to work in a shed in the garden […]'

'Mary has always been interested in stained glass and […] took the opportunity to learn it in evening classes and has continued making stained glass since. […] As such, Mary has been doing glass work since 1980, but has been doing "craft things" *all her life.'*

Lucy – Mixed media artist

'Lucy, an academic by profession, creates mixed media art using a large variety of materials, such as fabric, images, and metal objects. Much of her mixed media work is based on traditional weaving: "I do a warp and a weft with fabric and from there I start to weave in, or incorporate into that, mixed media stuff."'

'Lucy has a background in art; she went to art school and initially had the ambition to become a professional artist. However, she had difficulties achieving this, which caused certain restlessness in other jobs: "I would be doing things and never really satisfy what I wanted to do. […] I never felt like it was enough." *After having worked after finishing her undergraduate studies […] she did a Master's in art in education, followed by a PhD.'*

Vicky – Silk painter

'My interview with Vicky takes place at her home. […] As Vicky apologises for the mess [crafting materials and art pieces] […] she verbalises what I was thinking: "the house is completely taken over by… art and craft and things."'

'Vicky's main craft media are hand-painted silk, e.g. scarfs and cards, and fused glass, e.g. coasters and plates, both from which she earns money. Further she does a diversity of activities "for fun", *such as patchwork, knitting, stamping, embroidery, photography. […] She mainly does her crafting in the evenings […] and she*

emphasises that she does something creative every day, even if it is just "some random painting."'

'Vicky first started silk painting in 2001 when she went to a big art and craft fair where small workshops for different crafts were run so that people could try. She recollects trying silk painting in such a workshop: "[…] I didn't think I could paint and I went on this workshop and discovered I could, and it was awesome!"'

Carol – Jewellery designer

'Carol has been designing and making jewellery for four years. This is something she had wanted to do for a long time and an opportunity arose when a jewellery designer moved into her neighbourhood and started up a course. With some encouragement from her partner, Carol followed the course and has been reapplying every year. At this course four to five course members work individually on their pieces while learning new techniques from the teacher. […] Once or twice a week Carol works on her jewellery for two to three hours in her own workplace in a spare bedroom. She explains that she likes making jewellery to "be out of [her] head" *and as a variation to everyday life; Carol works in health care.'*

Paul – Guitar builder

'Paul, a retired insurance officer, has found a love in building acoustic guitars. […] [He] has always been an avid guitarist and has always liked repairing broken stringed instruments he bought at second-hand markets. After Paul closed down his insurance business 12 years ago he […] followed a course and, with partly pre-manufactured parts, built his first acoustic guitar about which he "wasn't satisfied". *Looking for the next level of building Paul went in search for a book about building acoustic guitars and found a renowned training institute in Belgium that offered training courses for building guitars and other stringed instruments. Initially he asked them for the book he wanted, but they told him he could come and write it himself, which is exactly what Paul did. […] Paul spends four to five hours a day in his workshop working on his guitars. He makes it very clear that it* "shouldn't start to feel like working" *[…].'*

Tina – Paint artist

'Tina started painting twenty years ago after two years of drawing courses and activities. Nowadays, she paints once or twice a week for an hour or two. When I ask her why she started drawing and painting she tells me she has always liked to draw and found she was good at it when she tried drawing people as a teenager. She decided she wanted to do more with this: "then you follow a course and another one, and then you feel like: 'now I want to move on to the next level,'" *and that is when she moved from drawing to painting. She followed painting courses for years, in which she learned techniques, how to use light and shadow, how to blend colours, perspective, and what materials can be used together.'*

THEMATIC ANALYSIS

Portraits were used as input for a thematic analysis of the data. An open coding approach was used in which themes arose from the data as opposed to using a predetermined coding scheme.

ANALYTIC PROCESS

Using the open coding approach, the researcher read through the eight portraits and labelled excerpts of the data that represented important findings. Excerpts found elsewhere in the data that addressed the same topic were subsequently clustered together under one label, or 'code'. In this way, a multitude of codes, and sub-codes, of important findings arose from the data, which, as addressed, allowed for the discovery of unanticipated findings. After a first list of codes was derived, the overall categories of questions from the interview schedule – which were covered in all interviews – were used to broadly classify the codes emerging from the data. This served merely to further organise the emerging scheme of codes and data analysis write-up after codes had been derived from the data, and did not influence how coding was done, or which themes were found in the data. Because these categories resonate with craft characteristics found in the craft literature (e.g. Adamson, 2007, McCullough, 1996, Pye, 1968, Risatti, 2007, Sennett, 2008, Shiner, 2012), it was trusted that they would

provide a relevant categorisation of the data on a high level, in addition to being useful for the research aims of analysing craft practice.

In addition to these five broad categories from the interview schedule, throughout the data analysis three more broad categories emerged which could be used to classify large numbers of emergent codes, namely 'Social Aspects', 'Craft Process', and 'Craft Result'. Naturally, this was an organic process of moving codes around, and changing categories before settling on the final categories after the coding was completed. Finally, a last organising category was added for codes that did not fit any of the other categories. Codes in this last category were grouped under the heading 'Other Characteristics of Craft and Crafters'. Further, codes around about 'starting to craft' were moved from the category 'Starting and Learning' to 'Craft General', which was renamed 'Background and Introduction', and this category was used to introduce the participants and their backgrounds. Subsequently, the 'Starting and Learning' category was renamed to 'Learning and Skill' to instead group those codes that had to do with the learning process and skill development.

The data within each category was grouped under codes and sub-codes; for example, within the category 'Learning and Skills', the code 'how learned' could be found (which grouped data around how the participant had learned to craft), which in turn included, among others, the sub-codes 'books', 'courses', 'just doing/trial and error', 'specific people', and 'internet'. It is hereby important to note that because the aim was to derive themes around craft practices, and have elaborate accounts within these themes, data could be coded under more than one code; for example, consider the following excerpt:

> *'Further he tells me about two influential men in his life that have taught him a lot and provided him with a basis from which he could develop his skills: his father, a constructional fitter, who taught him how to work with metal, and his father-in-law, a carpenter, who taught him how to work with wood.'* (From wood and metal hobbyist John's portrait)

This was coded for 'specific people' within the 'Learning and Skill' category, as well as for 'learning from others' within the 'Social Aspects' category.

After this initial round of coding, codes were again revisited, and redefined where necessary. Larger categories that encompassed multiple references (excerpts from the data) that referred to disparate themes within the data were further subdivided into sub-codes to allow for a greater level of detail in the analysis and a better organisation of the data. Careful scrutiny of the data under each code allowed for the coding of references in other relevant categories for which these references were missed in the first round, for example because codes were only created after that part of the data had been analysed. After this process, a final coding scheme was derived consisting of 126 codes and sub-codes, which will be further addressed in the next section.

All coding was done using the NVivo data analysis software. In addition to easy categorisation and exploration of data, this software allowed for the creation of 'memos', which were overall notes, observations or important findings; or findings related to specific codes. This was done frequently throughout the analysis process to document important thoughts on coding and findings.

Overview of Developed Scheme of Codes

The final coding scheme consisted of a three level coding scheme. The highest level was formed by the nine general categories that were partly determined by the interview guide and partly arose from the data: 'Background & Introduction'; 'Learning & Skills'; 'Craft Process'; 'Craft Result'; 'Materials'; 'Tools'; 'Social Aspects'; 'Motivation & Interest'; 'Other Characteristics of Craft and Crafters'. As mentioned, these categories merely served to organise the data and analysis on a high level, without influencing the coding of the data. Within these categories codes were classified that arose from the data, which often consisted of sub-codes that provided a higher level of detail within the codes. There was no requirement for a minimum number of references in a code or sub-code, so any finding in the data that was disparate from other findings could make up a new

code. An overview with examples of codes and sub-codes within the categories can be found in Table 4.3, while the comprehensive coding scheme – including an overview of number of participants that addressed each code or sub-code, and number of references in each code or sub-code – can be found in Appendix C[25].

Category	Code, or selection of codes	Examples of sub-codes within a code
Background & Introduction	Description of craft practice Starting	Description craft practice; location; time How started; when started; why started
Learning & Skills	Continuing development How learned Participant's background general What can go wrong/risks/limits What skills are needed	Developing one's own style; making the next better Books; courses; just doing/trial and error; internet *(no subcodes)* Accidents/not paying attention; frustration Patience; fine motor skills
Craft Process	*(selection)* Doing research Enjoying the process Personal journey Surprise, ideas evolve in process	*(no subcodes)*
Craft Result	*(selection)* Earning money Giving it away, sharing, duplicating Functional result Selling the result	*(no subcodes)*
Materials	*(selection)* Exploring materials Know-how of materials Materiality of the process Tried out different things	*(no subcodes)*
Tools	Acquisition of tools Description of tools Handling tools Tools influence process, result, workflow Which tool to use	Getting affordable tools; making your own tools Digital tools; physical tools Feel or 'interaction' with tools Tools are remote or not owned by crafter Certain tools limit risks; using anything at hand
Social Aspects	Collaborating with others Competing with others, marketing Learning from others Others are involved with the result Presence of non-peers Teaching others	Collaborating on a piece; discussing with others Publicising oneself Learning from unknown peers; looking at others' work Reactions from others; sharing the results with others Distraction from others *(no subcodes)*
Motivation & Interest	*(selection)* Challenge Feeling with the materials Forgetting worries Seeing something come into existence	*(no subcodes)*
Other Characteristics of Craft & Crafters	Identity as a crafter or artist Perfectionism	*(no subcodes)* It doesn't have to be perfect; self critical/perfectionist

Table 4.3 Overview of the developed coding scheme, with the general organising Categories, Codes that emerged within these categories (where there is a large number of codes in a category, a selection of codes is given as example), and a selection of Sub-codes for the codes where these arose from the data.

[25] The coding scheme was later complemented with new codes in the data analysis of the digital craft interviews (see Chapter 7). To avoid duplication of similar material in the appendices, Appendix C contains the coding scheme for both physical and digital craft interviews.

RESULTS

For this result section the general categories will be used to structure the findings and the most relevant themes for understanding craft practice will be addressed. It is important to note that while this section sometimes mentions how large and how common coded themes were, it does address not quantitative facets of the data, such as number of references in each theme. This would be a futile effort; first, because data can fall into multiple themes and thus individual references do not form unique occurrences of either one theme or another; and second, because of the premise of narrative interviewing – letting the participants tell their own stories without the researcher using a fixed set of questions – each interview is so distinct in character that it cannot be determined if a theme that is not addressed in an interview is truly absent or irrelevant in this participant's account of their craft practice, or if it was merely not addressed in that specific narrative interview. As discussed before, while certain topics were aimed to be elicited in all interviews, other themes were only elicited when brought up by the participants. Therefore, this section presents a qualitative treatment of the themes in the data, while the number of references, or number of participants talking about a specific theme, were only used for researcher reflection on themes and to assure data analysis was done reliably.

Because coded references are excerpts from portraits, they contain both direct quotes from the participants and researcher descriptions; this may cause issues with clarity in reading the following sections if it is not made clear how these different instances are formatted. Longer excerpts from portraits will therefore be indented, while short ones may be used in the text. Excerpts will always be demarcated with single quotes, while direct quotes from the participants inside an excerpt will be demarcated with double quotes. For further clarification, researcher descriptions within excerpts will be in italics, while direct participant quotes will be in regular font, e.g.:

> *'This is an excerpt from a portrait, in which the participant said:* "direct quote"*'.*

LEARNING AND SKILLS

Participants talked about how they initially learned their craft, how they continued their development after this initial learning phase, and what skills are needed to do their craft. They further addressed things that can go wrong, risks in the process, mistakes, and limitations (of crafter, material, or tool). These themes were classified in this category because participants often spoke about how they learned from their mistakes, or how a lack of knowledge or skills had caused mistakes.

How did participants initially learn their craft?

Five of the participants mentioned 'learning by doing' or 'trial and error' as means to learn their craft, e.g.:

> *'Over the years, Jim has perfected his way of backcombing, e.g. the directions to hold to dreadlock and the comb, where to start, and how to twist the dread while working from all sides, and he has experimented with different methods of making and fixing dreads […].'* (From hairdresser Jim's portrait)

Also John, the wood and metal hobbyist, said: if you want to learn, '"just start"'; he was convinced: '"If you are interested, you can learn so much by just doing it."' Other larger themes were 'courses' – where participants did specific courses related to their craft, outside their main education, such as in evening classes – and 'looking at other people's work'. Tina, the painter, for example, followed drawing courses first and painting courses after:

> *'[…]* "Then you follow a course and another one, and then you feel like: 'now I want to move on to the next level'"*, and that is when [Tina] moved from drawing to painting. She followed painting courses for years, in which she learned techniques, how to use light and shadow, how to blend colours, perspective, and what materials can be used together.'*

Relatedly, looking at other people's work often happened within groups of peers who came together to do their craft together, where ideas, techniques, tips, and tricks were exchanged. John, however, learned bricklaying from watching the builders that were building his sister's house:

'"You build up background knowledge; knowledge you initially don't know how to place it or what to do with it, but it's still there, and all of a sudden that becomes useful."'

Other participants followed a formal education in their craft, or related to their craft, such as Lucy, who went to art school, and Mary who studied ceramics and glass in college for a year. Further sources for learning craft were books, the internet (both only mentioned once), and specific people, e.g.:

'Paul's philosophy ties in with that of an American guitar builder who teaches people how to build a guitar that sounds exactly like they want, starting from a sound in their minds and adjusting the construction of the guitar to match that sound.'

Finally, participants sometimes had other related experiences within their lives that may have helped them get a general feel for craft, creativity and making things, e.g.

'[Mary] tells me she had to learn how to make her own clothes when she was a child, and she was quite good at needlework. Her parents were further involved in setting up a local traditional crafts centre so Mary "had a go at silver-smithing and spinning and weaving and all those sort of traditional things." *This obviously provided a great opportunity for her to explore:* "most things I have been able to do… but you really have to decide to do one because you can't do all of those things; you'd never get anything finished."'

How did participants continue their development?

Most of the participants mentioned facets of continuing their development in one way or another, or challenging themselves to '"move on to the next level"' (Tina) or learn something new. John, for example says:

'"I'm eager to learn, so even if I had my own way of doing something, I would still try out a new method, because perhaps that is better than my own method."'

Mary has kept doing qualifications throughout the years, which she saw as illustrative of '"becoming an expert"', and similarly Vicky was following an arts and design course to broaden her skill base. Further, hairdresser Jim *'[kept] up with the developments in the field'*, and both Vicky, the silk painter and glass

artist, and Paul, the guitar builder, had created their own manuals to keep track of the way they had done things in the past. For Paul it was part of his guitar builders' course to document how he built his guitars (see Figure 4.2), while Vicky documented all her firing experiments with her kiln so that she could build up her knowledge. Participants further looked at existing solutions within their craft area and reused them or made them their own, such as Paul's creation of his own tools based on ideas he found in books and on the internet; building up background knowledge (John); and developing one's own style, such as Jim developing his own way of backcombing, or Vicky finding her own niche:

> '"The thing is, I've got to get myself a core range of stuff that is different to what everyone else does. So I think I'm still in the 'I'm experimenting and trying to find my niche' phase. I'm doing okay, but I've got a sideways portfolio rather than a focused one at the moment. Everything is so exciting. It's very difficult to have the discipline to reign yourself in to doing one thing."'

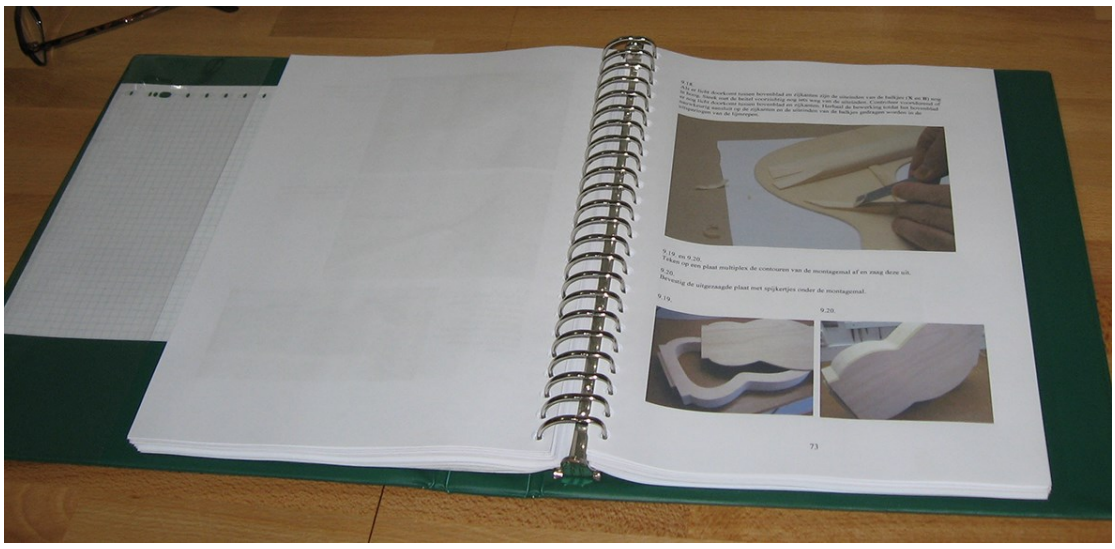


Fig. 4.2 Paul's manuals carefully document how he has made guitars in the past.

Participants further mentioned experimenting and wanting to make the next thing better:

> '*Paul is experimenting with different constructions of internal bracing, constructions of wooden struts inside the belly, which strengthen the panel and determine the sound. […] Paul is currently building two guitars with different bracing to see what sound he likes best and will then change the bracing on*

future models accordingly: "but I don't experiment with that much, because then you have to build something like 25 guitars and then you can gain that experience. All I can do is use renowned concepts and make some adjustments if I think for example: 'there's not enough bass, I'll make the box less deep.'"' (See Figure 4.3)

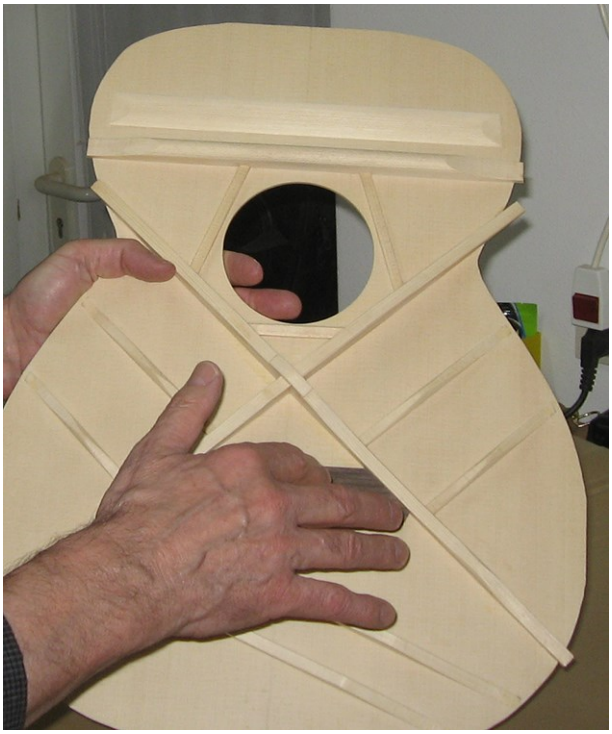


Fig. 4.3 Paul was experimenting with different bracing constructions for the back panel.

What skills are needed to be a good crafter?

Skills did not come up in all of the interviews, and even when probed participants seemed to struggle to pinpoint which skills were required to do their craft. The few skills that were mentioned would easily be classified as personal traits or characteristics, rather than something you can learn to *do.* One example is 'patience'; for example Carol, the jewellery designer, said you have to be patient and know when to stop:

'"Sometimes I think: 'well, let's leave that for now and try again later.' I am not someone who tries something in the same way a hundred times. I start and if it doesn't succeed in a few tries, I stop and try again later."'

John further said it helps him that he is 'precise', which also came forward in the interview with Paul; the process of building a guitar includes a lot of precision

work, which requires focus and concentration. Similarly, John added that 'fine motor skills' are a requisite for doing his wood and metal work.

What can go wrong, or cause limitations to the craft?

Participants mentioned that sometimes mistakes occurred because the crafter was not focused or paying attention, such as Paul's example of forgetting a step when putting together a guitar. Another cause may be a lack of know-how, for example in jewellery making:

> *'If the temperature is too high the material melts;* "then it's lost, there is nothing you can do." *This does not happen to Carol often though, because she has gained experience of how to handle the materials.'*

Other times mistakes can happen because the materials are fragile, for example in Mary's work with glass:

> '"With stained glass you can make a panel, hold it up, and as you look at it, the piece will crack. […] You know that it's a fragile thing, it has its own mind, it being a continuingly moving, living thing."'

Mary added that she does not get extra satisfaction from completing a piece without any errors because such risks with the materials are beyond her control:

> '"It's like a stubborn child. Sometimes the glass will just say 'I'm not going there' so you'll have to change the shape, or 'I'm going to break' so you're going have to do something else with it.'"

Sometimes mistakes were irreversible, such as Tina's example of a ripped canvas and Paul's example of a broken guitar panel, but Paul also illustrated during the interview how many mistakes can be corrected, by showing how to get a dent out of soft wood using a drop of water. Paul further tried to limit risks by using hand-tools instead of machines, such as using a chisel instead of a milling cutter when making the groove for the guitar's rosette; or by making specific tools for parts of the process that need to be done very precisely, such as measuring aids. Some participants expressed frustration when something went wrong, be it within their own power or not, often because it is a lot of work to solve the problem. Mary and Vicky, however, seemed quite relaxed about mistakes; Mary was '"philosophical about it"' and accepted that the piece '"wasn't meant to be"', and Vicky said:

> '"I've got things that went horrendously wrong, and it happens. And I keep them and I laugh at them sometimes. Or, the good thing is, you can cut it up and turn it into something else."'

Mary added: '"'the only disaster you can have is if you injure yourself; that would be catastrophic […]"'. Tina further saw mistakes as an opportunity to learn.

Apart from things that can go wrong and risks that exist in the crafting process, participants further mentioned occasions in which their own personal state of mind limited their crafting process. Tina, for example, said she found it very difficult to focus on a painting of her father-in-law because she knew he was dying of cancer at that time; *'she had to force herself at times to sit down and work on the painting.'* John explained that while craft is great to forget his worries,

> *'there needs to be a balance between what is going on in his mind and what he can try and put aside by tinkering:* […] "when you are very concerned about big issues, you can't really do anything else, because you can't focus [on craft]."'

When talking about the presence of other crafters while working, Mary highlighted that it is important that the other person is doing the same thing as her, and that it 'clicks':

> '*She tells me it's a* "very sensing, emotional thing" *and there has to be a connection with the people she is working with:* "it's not about being in the right mood, it's about the chemistry with people you're working with. […] The dynamics are important; if there's any negativity in it, it comes through in the work."

Finally, Lucy told the interviewer that she feels guilty when she crafts, which limits the times she actually engages in her making processes:

> '"I actually really, really miss making stuff, but part of me feels like it's kind of frivolous to indulge in that; that it's not meaningful enough. […] It feels juvenile… or I feel selfish, that you have that time as an individual artist to just work. It doesn't feel like it's giving anything."'

Discussion and summary

Unsurprisingly, and in line with the literature, most of the participants talked about *learning and developing their skills through experimentation and doing* or as Sennett calls it 'enlightenment through practice' (Sennett, 2008, p.96), which appeared to be the main way to learn to craft. However, participants also looked at other people's work for inspiration and to learn new skills or techniques. The combination of experimenting and doing, and seeing other people craft appeared a powerful source for learning to craft. While other sources, such as books and courses, sometimes helped participants, their main purpose was to get crafters started, to get in touch with peers, or to help them continue their development.

Interestingly, participants found it hard to pinpoint what skills they required for their craft, and when probed often come up with character traits. This may illustrate that *craft skills are either highly craft-specific, or so general* that participants did not think about them because they were considered straightforward, such as precision. It seems that skills are a good example of tacit knowledge that may be better studied by observing craftspeople (Sennett, 2008), which can uncover craft-specific skills. Further, it aligns with Pye's (1968)'s assertion that 'skill' is not a helpful term when talking about craftsmanship because it is different for each kind of craft, and is usually simply knowledge (or 'know-how'). Pye mentions 'dexterity' and 'judgement' as things that are learned, which make it easier to learn another craft after a crafter has learned one craft. These examples serve the same role as 'patience' and 'precision' mentioned by the participants in this study. Pye further wonders if skill may simply be 'the habit of taking care' (p.52), which comes very close to Sennett basic premise of what craft is (2008) – doing a job well and carefully. The results of this study seem to confirm Pye's thoughts that skill may not be a useful characteristic of craft, and that speaking about skill may indeed be a 'thought-preventer' (p.52).

In addition to learning through doing and developing tacit knowledge that was hard to pinpoint, it was also important to *keep developing and find a personal style* in one's craft and participants took deliberate action to keep progressing. Sometimes this was connected to external factors, such as the need to find a

niche in a competitive market (Vicky); keeping up with the developments in the field (Jim); and experimenting with techniques of others (Paul). However, often self-development was driven by the crafters themselves for their own personal reasons, for example the desire to make the next product better (John); become an expert (Mary) or move on to the next level in skills (Tina). Although external factors were a stronger drive for the professionals and semi-professionals – e.g. because they needed to make money, or be knowledgeable – self-development often appeared to be on participants' own initiative and own terms, and was pursued autonomously in their own personal ways; very similar to how they learned to craft in the first place.

Finally, according to Pye's notion of a 'workmanship of risk', in which the crafter overcomes risks through 'judgment, dexterity and care' (1968, p.4), *risk is an important element that makes craft so rewarding* because it allows crafters to show their skills and qualities. Participants in the interview study did not explicitly address that overcoming risk made them feel like better crafters because often mistakes were beyond their control. However, they did value learning from risks and mistakes, which indicates these still have an important role in the craft process. Paul's use of hand-tools instead of machines can further be seen as an example of using dexterity in regulating his process, rather than 'shape-determining systems', to limit risk, as addressed as different strategies by Pye (1968). More than limitations or risks caused by tools or abilities, it seemed that *the crafter's personal state of mind influenced how well one could craft*; worries, guilt, and the presence of others sometimes formed obstructions. Csikszentmihalyi describes a few conditions that are necessary for reaching 'flow'– 'an almost automatic, effortless, yet highly focused state of consciousness' (2010, p.110) – a state that is often reached in craft and is crucial to the enjoyment of craft. It is possible that worries on a crafter's mind or the presence of others that one does not 'click with' form distractions that prevent the crafter from reaching flow, as argued by Csikszentmihalyi, or prevent the crafter from successfully merging the action of the moment and the awareness of what one is doing (2010). Similarly, the author describes that in flow, self-consciousness disappears and one no longer worries about what others may think, which may

help to explain why Lucy sometimes has trouble reaching flow and enjoying her craft; she does not seem to be able to disconnect her self-consciousness, and feels guilty because she feels she needs to '"give"' more to the world. Thus, the difficulties encountered from a personal state of mind may serve to illustrate the importance of flow for being able to craft; this will be further addressed in the section on Motivation and Interest.

CRAFT PROCESS

Naturally the process of crafting is strongly specific to each crafter, both because certain materials dictate certain ways of working, but also because some of the participants had developed their own ways of doing things. Descriptions and observations of processes varied from Jim's detailed annotated demonstration of how he backcombed the hair to create dreadlocks, and Paul's experimentations of creating a guitar with a good sound, to Vicky's enthusiastic demonstration of various aspects of her silk painting, such as using an outliner to prevent the paint from running on the silk (Figure 4.4). Despite being craft- and crafter-specific, overall themes could be identified that were encountered across craft disciplines.

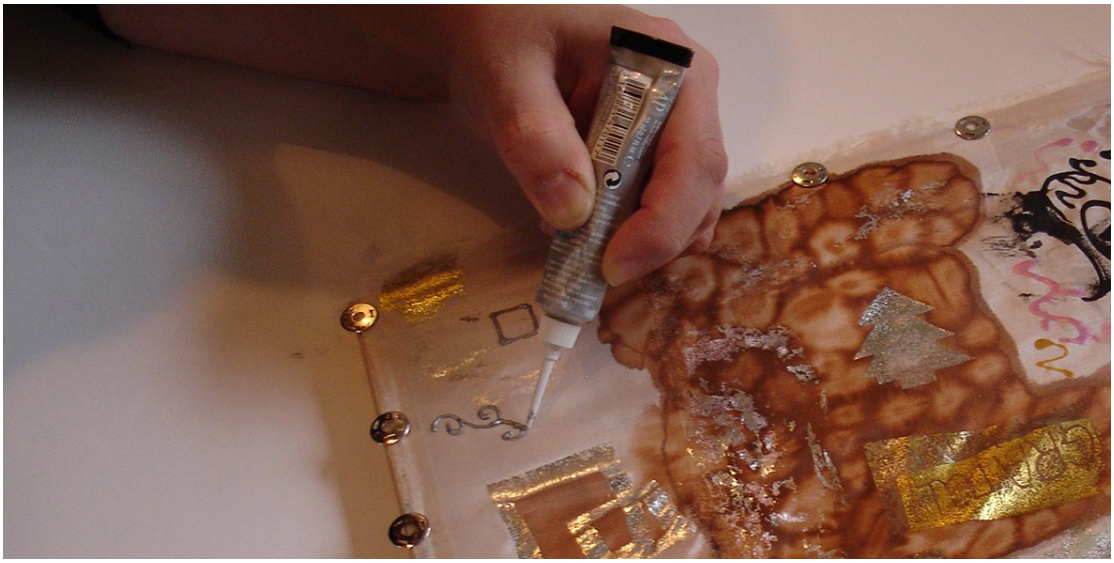


Fig. 4.4 Vicky demonstrates the use of an outliner, which prevents the paint running.

Surprise and unexpected outcomes

A frequently occurring theme within the 'Process' category was 'surprise', in which participants talked about how things may evolve differently than expected, and how ideas evolve during the crafting process (this was mentioned by five participants). Sometimes this surprise came from unexpected behaviour of materials, such as the aforementioned example of Mary's glass which behaves '"like a stubborn child"'. Vicky has similar experiences with glass and sees this as a major difference between her glass work and her silk painting:

> *'[Vicky] appreciates the fact that with glass you never know what happens when you put it in the kiln:* "I'm getting better at knowing what's going to come out, but sometimes things react in a way you don't expect that is really quite interesting."'

Carol showed the interviewer an example of a bracelet with a beautiful colour pattern that just appeared when she was heating the copper with a large flame. Other times, circumstances could cause interesting surprising results:

> *'[Tina] tells me how she once made a painting that came to exist because she had tried how certain colours go together by putting some paint on a piece of paper, and then folding the paper after she was done. This had such a nice effect when unfolding the paper that she used this technique in a painting;* "and that is one my best paintings."'

Vicky mentioned an example of a time when she was painting outside and while the paint was drying some leaves dropped on her work and left strange patterns on it. It could also be unpredictable how a piece would turn out because ideas developed in the process. Carol, for example, usually did not have anything specific in mind when she starts making a piece of jewellery out of copper: '"something arises. And then I am hammering and bending, and well... Something just comes into being."' Similarly, Lucy said: '"as I start doing the ideas starting flowing in. I'm not a big planner when it comes to this; it happens as a process."'

Research as part of the process

In other occasions, however, there was some research and planning involved and a piece got more or less designed before the making process started, for example for Mary, who told the interviewer she '"thinks an awful lot"' about her pieces

and had interviewed people for a piece '"because I want to have some sort of narrative of what people say and I write that actually on the glass."' Vicky showed a workbook she made for one of her silk paintings, which contained shape and pattern studies of pieces of broccoli to come up with a final design for her painting. She further mentioned how in a typical process she would create a design first and draw it on paper, edit it on the computer and print it real-size, before transferring this design onto the silk and painting it. In contrast, Lucy compared her process of making to doing academic research:

> '"Just like when you are making, you are not researching it like: 'oh, I need to look up all these things' but there is a process of going back and searching, so this researching, whether it is in your mind or whatever it is, it all happens as you're making it. […] You do a certain amount of planning, but at the same time, just as when you're writing, things start to happen."'

Inspiration

Related to the development of ideas in the process, is getting inspiration. Tina, for example, got inspiration from photographs, from which she then derived colours and shapes to incorporate in her abstract paintings. Vicky kept a book with ideas that came up in her head which she leafed through when she got stuck. Carol and Vicky both indicated they got inspired by the people around them; in Carol's case she looked at them and imagined what jewellery she could make for them, and in Vicky's case people often came up to her and asked her to do certain things, which triggered her to try something new. An overarching theme appears to be that inspiration could come from anything:

> *'[…] things [Vicky] thinks about in the middle of the night, something someone is wearing;* "it's there, all the time. You know, I can just look round my room and get an idea. That's one of the reasons I like… *[she looks round the room where a diversity of things are placed around her, such as a jar of jam on the window ledge]*, because if everything was away in cupboards, behind glass, whatever, there's be nothing for my brain to bounce off." *Inspiration can come from nice wrought iron gates, patterns, drain covers, the colour of bricks:* "you can take almost anything and turn it into something."'

Precision

Often there is variation in the process in terms of precision. Some participants, such as Tina, chose to work 'rougher' and on a larger scale sometimes to get some variation from more precise work, while for others this variation was embedded in the process, such as for Paul:

> *'Making the neck for example is rough work compared to the process of making the rosettes around the sound hole. These are made from tiny strips of wood that are glued together into small packages, which are then sawn into strips again, and composed into complex patterns around a round mould. Although these rosettes can be bought pre-manufactured, Paul likes the high precision work as a variation on the 'rougher' work.'* (See Figure 4.5)

Carol mentioned that sometimes she is simply not able to do very precise work, so she lets her work be guided by what she is able to do at that time.

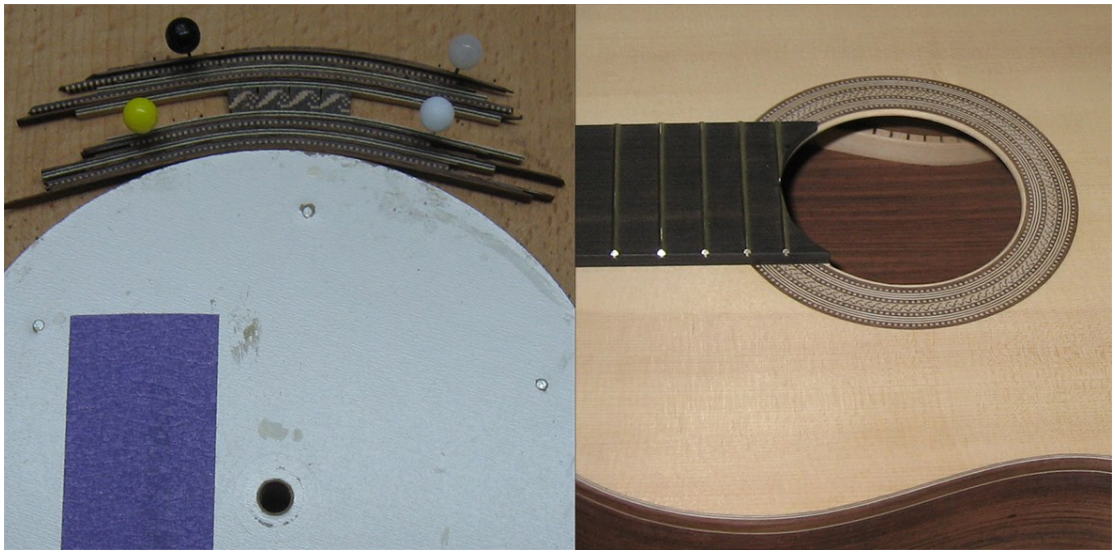


Fig. 4.5 Precision work: the rosette of a guitar (decoration around the sound hole) is made of thin strips of wood glued together and composed onto patterns around a round mould.

Staying true to traditional craft techniques

Both Lucy and Mary have had processes in which they tried to stay true to traditional forms of crafting, such as Mary's techniques for making stained glass panels, despite more '"modern gadgets"' (Mary) being available. Much of Lucy's mixed media work was based on traditional weaving:

‘“I do a warp and a weft with fabric and from there I start to weave in, or incorporate into that, mixed media stuff.” *She gives me an example of such a work the theme of which was gender and aging:* “I did a piece that was based on the traditional aspects of weaving and I was really interested in these kinds of female crafts.”’

Enjoying the process

Many of the participants expressed their enjoyment of various aspects of the process, or “‘the whole road, from A to Z”’ (Jim), for example because they could see their progress from non-existent to having a visible, tangible result. Lucy liked the materiality of the process, and she further described some of her making process as personal explorations and journeys:

‘Moving on from these weaving-based works Lucy has started creating other mixed media pieces, where she uses photographs of herself and cuts them up to “break through canvas and put them behind canvas so it is really about the process and reworking the surfaces.” *She calls these works* “explorations”, *not just of her own identity but also of the media she works with.* […] “What happens to media, I guess physically but also mentally when we have this really sort of juxtaposition of what I would say are disparate media, bringing them together in disparate form into one canvas?”’

Doing repairs

Since participants appeared to enjoy the whole process from coming up with an idea to seeing the actual result, it was unsurprising that in cases where they were not involved with the whole process, it could be less interesting. Mary, for example, had done repairs of stained glass panels and said: ‘“‘there is an element of ‘I didn’t design this, therefore I haven’t got a feeling for it.’ […] For me, if I haven’t designed it in the first place I’m not really interested in it.”’ She did not enjoy doing repairs:

‘“the only way you can properly repair a stained glass window is to take it apart and put it together again because it will always look… it’s like a darned sock... you know, it just looks... unless you’re really good at it…”’

Paul also had experience doing repairs of guitars, which he only did when he felt like it, and if the guitar was worth spending a large amount of time and money

on, for example when there was an emotional attachment. Jim, on the other hand, quite enjoyed repairing broken dreadlocks, and messy situations, which he saw as a challenge: '"Give me some time with that and see what I can do with it."' For him it did not seem to matter much if he had made those dreadlocks in the first place.

Discussion and summary

For most participants the *process of crafting was of equal or higher importance than the result*, and it gave them much enjoyment. This confirms the relevance of expressing craft as a process (e.g. Adamson, 2007, Sennett, 2008), rather than a specific discipline or perfected result, as this thesis' definition of craft has centred around. Many participants talked about *being surprised in the craft process*, which was caused by ideas evolving, materials reacting different than expected, and sometimes even external circumstances influencing the process. The first bears a relation with the 'trial and error' way of working identified in the previous section; some actions in the process can be planned beforehand (which also comes forward in the 'research' theme in this section) but there will always be surprises when one starts crafting, simply because not everything can be anticipated in advance or one's ideas develop. One may wonder if expert crafters will be better at anticipating the process than novices, and if they will encounter fewer occasions of unexpected material behaviour, simply because they are more knowledgeable of their materials. This is likely to be true, however even the more experienced crafters among the participants (Jim, John, Mary, Tina) still encountered plenty of surprises as for them ideas kept evolving and, as apparent from Mary's quote, it is still sometimes surprising how certain materials may react. A parallel can further be drawn with the participants' need for self-development; it is likely that more experienced crafters will try new techniques, materials, or tools because they continue to pursue surprise and discovery when they are getting more skilled (as apparent from John's quote in the previous section). Csikszentmihalyi (2010) also asserts that novelty and discovery – as often experienced when a participant was surprised in the craft process – are crucial aspects of flow, which further illustrates the importance of the element of surprise in a craft process, for both novices and experts.

Inspiration was brought up by a few of the participants, and appeared to be a more apparent topic for the art-focused crafters (Lucy, Tina, Vicky, Carol, Mary), who made pieces with primarily aesthetic or communicative functions (Risatti, 2007). Although certain aspects of John, Paul, or Jim's craft may be called inspiration – e.g. the ideas and choices around what piece of furniture to make for John – they did not refer to getting their ideas as inspiration. It is possible that the term is still strongly connected to people's associations with art, and that one would be less likely to think of inspiration in a more traditional craft. However, this was one of the few demarcations found between 'artists' and 'crafters', which shows confirms that boundaries between art and craft realms are fading (e.g. Shiner, 2012, Veiteberg, 2010).

A less prominent theme in the data was the *variation between rough and precise work*, which Pye has addressed as a close approximation (precise) and a more disparate approximation (rough) of a particular design (1968). Participants did not see this in the same way, as in many cases there was no design they were trying to approximate; for them it seemed to have more to do with the need of that stage in a project, and their abilities at a certain point in time. Finally, it appeared to take a particular kind of person and particular kind of project to engage in *repairs*; for some of the crafters it was more important to be involved in the whole project, and moreover sometimes it was just not worth it (e.g. to invest time or money in it) to do a repair. Crawford uncovers similar considerations in addressing motor cycle repair (2010). It could thus been seen that craft processes contained both deliberate actions (precision, choosing craft techniques, doing research) and reactions to circumstances (materials behaving unexpectedly, ideas evolving, new inspiration and discoveries, and a crafter's abilities at certain times).

CRAFT RESULT

Similar to craft processes, the results of craft were also strongly craft-specific. Again, participants gave examples of some of their results, such as John's large barn which he built by combining all his skills, Lucy's mixed media art piece

around age and gender, and Vicky's fused glass bowls and coasters. Participants further talked about what to do with the result once it is finished, and how to publicise or show one's results.

What to do with the result once it is finished

Participants did not always have a clear goal for what to do with the results of their craft and often the process was more important than the result; participants seemed to express more enjoyment when talking about the process than about the result, and most participants said that they liked the process better than the result, or that they liked both. For John the main goal for crafting was creating functional objects and he stated that an overarching theme for his work was that the '"creative element does not lie in it being beautiful or being art, but in the goal and function."' Most of his work was thus put to practical use after it is finished. The price-quality ratio was a strong motivator for John:

> '"If you buy a garden bench that is affordable, it is often not good quality, and if you buy the materials and make it yourself you have a much better bench for the same amount of money."'

Other participants, for example Vicky and Tina, occasionally sold their work, and for Vicky, selling scarf, pictures and cards was a way of earning money, alongside the workshops and lessons she organised. Paul also occasionally sold the guitars he made, and sometimes worked on commission. However, for many participants most creations remained stored in their homes, some on the walls, and some in the attic. Tina said: '"the idea is that I sell my paintings but if I don't, they stay with me"' and Vicky called the results of her craft '"awkward"' because she then had to sell it or store them. Another common theme among participants was giving their results away and sometimes objects were created for specific people, as Carol often did with her jewellery:

> *'[While showing me some of her work]* "Oh, these are the last ones I made; they were much fun too. [My partner] has a new grandchild and I made two kites, one for the youngest child, from silver, and one for the oldest, from copper. See, with some things dangling from it. That was much fun to do, I must say, with their names on it."'

Lucy did not sell her work either, and said she did not do much with it after it was finished. She had given some pieces to friends or family members who have put them up in their homes, about which Lucy felt a mix of pride and embarrassment. Interestingly, Vicky saw her creations as a '"record of life"':

> '"You put so much of yourself into it [while you are making something]. I look at some of these pieces and I can remember what I was doing when I did it, you know. Sometimes they can be a record of your life or your emotional state or whatever." [...] *This "record of life" is really explicit in a bedspread she is making from little squares of painted silk made in the birthday parties she runs:* "it will keep growing as I do the silk painting parties. So I'll have the kind of memories of all the parties I've been and run as a bedspread."'

How to publicise or show one's results

Apart from giving the results of their craft away, participants had various ways to show their creations to others. Tina, Mary, and Vicky, for example, all enjoyed exhibiting their work. While Tina was trying to find venues for a collection of her finished pieces (although it was a bit of a hurdle for her to approach people who may make this possible), Mary was more seasoned in doing exhibitions and made some pieces especially for certain exhibitions:

> *'Currently she is working on a panel for an exhibition and she says she challenges herself to do a piece like that every year:* "it's like doing a journal article; something you can put on your CV that is equivalent to a journal article."'

Vicky's weekends were usually filled with going to craft fairs, giving talks on silk painting, and organising silk painting birthday parties. Tina further had her own portfolio website on which she put her paintings, and Carol kept a photo book with pictures of her craft creations.

Discussion and summary

This section has shown as much as the previous one that craft mostly seems to happen because participants want to do the activity*; craft is 'autotelic' – it is 'an end in itself'*, which gives enjoyment merely from doing it (Csikszentmihalyi, 2010, p.113). With the exception of John, who is strongly driven by making functional objects, for most participants, the result of this activity is a 'by-

product' that has to be 'dealt with', either by storing it, selling it or giving it away. Some participants liked sharing or publicising their work, but if the craft result had not been made for anyone in particular, they sometimes appeared too shy to do this. Nevertheless, some of the participants seemed to actively work towards publicising themselves, even if it meant overcoming a personal threshold.

Interestingly, there were *few expressions of craft results being particularly cherished*; participants did not mention specific pieces that they would never discard, or that were particularly important to them. As a tangentially related study into cherished objects has shown, crafted objects have the potential to be cherished (Golsteijn et al., 2012), but it seems likely that this is a small percentage of all craft results that are created in the first place, especially for crafters who create a great quantity of objects, such as Vicky. Cherished craft results may be those things that are kept over a long time, or given to others, such as a painting of Tina's father-in-law. Participants liked the possibilities their craft results gave them to connect with others, e.g. sharing craft results or creating things for someone specific (half of the participants had occasionally crafted things for specific people). Crafted gifts were often considered more personal and more meaningful than purchased gifts, because of the time and effort invested in them. As shown, crafted objects may further be functional and have a good price-quality ratio (John), or provide participants with a 'record of life' because of all the memories attached to it (Vicky). Furthermore, even if no explicit references were made, or no specific reasons could be pinpointed, to why their craft results were important to them, participants appeared *undisposed to discard them*; Tina's statement that the work she does not sell '"stays with her"' was uttered with an affectionate tone, and Vicky stated she '"has to"' store her work, apparently unable to throw it away. This implies that craft results may always be important, if nothing else because of craft experiences behind them.

MATERIALS

Unsurprisingly, general descriptions and observations of the participants' craft materials were strongly craft-specific, for example Jim's use of human hair, Tina's oil and acrylic paints, and Vicky's silk and outliner material. Crafters further addressed the materiality of the process; know-how of materials; influences of materials on process and result; and exploring, mixing, and recycling materials.

The materiality of the process

Participants spoke enthusiastically about the materiality of the process, and the feeling of working with materials, which '"makes you physically tired"' (John), but which also was a great draw to crafting for many participants. Paul, for example, said he was glad that as part of his education he had to experience working by hand, e.g. sanding, because '"you get the feeling of the wood"'. Mary's response to the question why she likes glasswork was as follows:

> '"I like the feel of it. I like the fact that glass is a continuingly moving substance. I absolutely love glass blowing; the fact that you've got it in your hands, 650 degrees worth of stuff […] physically in your hands, well you've got a wad of wet newspaper between you and it, but when it's at the end of the blowing iron or whatever you're working with, this red hot glass is actually literally in your hands […]."'

Similarly, if it was not physical, it was not very interesting to Lucy:

> '"I do a lot of photography and stuff, and sometimes I get lost in that, but not as much as I can when I'm producing mixed media or sculpting or something like that. It's just too two-dimensional for me. I don't know. If I could actually grab bits of data or film or something like that… I probably would have enjoyed it more a long time ago before it was digitized […] when we were actually cutting film. Because then I could see it and lay it out, I don't know, and build something. It just feels like too much of an illusion. It bores me."'

Know-how of materials

Many of the participants brought up know-how of their materials and how to work with them. For Jim, for example, it was important to know how to work with different people's hair, and even on one person's head not all hair was the same:

> '"The hair at the back of the head knots more easily and it is therefore easier to backcomb. At the front and top of the head the hair is much smoother and I have to work on that harder. At the same time I'm also more perfectionistic for those parts because they are more in sight."'

Tina worked with oil and acrylic paints and knew that with these paints there was always time to correct mistakes by painting over them or erasing parts, while with aquarelle, which she had tried in the past, a painting was ruined if something went wrong. Carol, similarly, knew that when making a piece of jewellery from copper she needed to use higher temperatures than with working with silver: '"At the course we have small soldering devices but we also have a big flame with an oxygen tank, and that is very effective."' Paul took a great interest in his materials, and not only did he know how to work with the wood to make his guitars, he also knew where the wood was from and why it behaved in the way it did:

> *'Apart from the frets and the strings the whole guitar is made of wood, although Paul tells me there is great variation in the types of woods that are used, and each type has its own characteristics in working with it, and in how it sounds as material for a guitar. Most material variation lies in the back panel of the belly and as Paul leafs through sawn backs of guitar bellies standing against the wall he informs me:* "this is from Schwarzwald; it's from a walnut tree. It has a beautiful print so that will be on the back of the guitar. This is cypress; this is used for Flamenco guitars. This is Palisander, from India. This is Cocobolo, from Central America. This is Madagascar Palisander. Padauk, from Africa. And this is Santos Palisander, from America." *He appears to take an interest in the background of his materials and their qualities in functioning as a musical instrument:* "The top panels are usually made from spruce wood. […] This comes from Italy, Germany, Austria, or Czech Republic. There the trees grow on heights over 1000 meters, and because they grow so high they don't grow

much in width each year. And that is important because... look at the graining. The annual rings are really close to each other and that gives it its qualities as a sound wood." *He continues to tapping the wood while holding it up between two fingers to let me hear the high pitched tone it produces.'*

Influences of materials on process and result

Further, certain materials influenced how crafters could work with them and what they could make. Tina, for example, mentioned how making an oil painting is '"much more about the colour"' than a drawing, which influenced what she would produce. John talked about the differences between working with metal and wood, and when he would use which material:

'Wood and metal require different tools, such as different drills and files, and wood is more elastic than metal so if it does not fit together perfectly you can still put something together while this is not possible with metal. Also the ways of connecting separate pieces of material are different: "you wouldn't connect wood with nails or screws if it needs to be beautiful, because you will see those parts, but metal can be screwed and then a screw can be beautiful. Nowadays metal can be glued, but I usually don't use glue in metal constructions; I use welding, screwing, and riveting." *John adds that he likes the challenges of making difficult wood connections because the teeth have to be sawed very carefully.* "It is difficult to connect two pieces of wood in a perfect 90 degree angle. With metal this is dead easy. I make something out of metal because this is beautiful, not because it's a challenge […]."' (Figure 4.6)

Fig. 4.6 In John's garden bench the wood is connected with pins that slot into other pieces of wood, instead of with screws, because this gives a more beautiful result.

Exploring, mixing, and recycling materials.

Most of the participants had experience working with different materials, and they had developed their own preferences. Vicky's main crafts were hand-painting silk and fusing glass, but she did a variety of things on the side, or '"for fun"' as she called it, such as patchwork, knitting, stamping, embroidery, photography. Lucy also had had the opportunity to work in many different studios in art education, such as a steel studio and a painting studio, and she found that she always tended to mix her materials: '"even when I was painting I was always sticking pieces of wood on it […] so I couldn't just paint. […] I'm not interested in paint; it's just a bit flat."' Mixing materials appeared to be quite common, even for participants who did not call themselves explicitly 'mixed media artists', as Lucy did. Tina had done paintings *'by gluing different materials, such as sand, cloth, paper, or metal, on a panel and covering them with paint'* (See Figure 4.7). John had made '"complete machines"', consisting of materials such as wood or metal, electronics, and sometimes software. Mary also combined her glass work with '"found materials"', such as pieces of cable or copper wire; and mixed glass of different sources, and Lucy tried to bring together '"really sort of disparate objects, like, I made one for someone that had nails but it also used a lot of lace"':

'[Lucy] is always gathering materials to include in art works "so they are there at hand, whether it's just a bunch of scraps, [….] or on my table now is a set of photocopies of images I want to rework.' *In her old studio she similarly had boxes filled with a variety of materials:* 'buttons and zippers and feathers and leather, just everything."'

Lucy further enjoyed exploring materials and media:

'"I'm really interested in media. I'm really interested in how far we can push a canvas or how far we can… you know, in the materials themselves. So, what will happen with the photograph when we paint on top of it? And stick it to the back of something else and put glue on that and then on top of there put on… I don't know, human hair, and all this kind of stuff."'

Finally, John liked to recycle materials or reuse the materials of pieces of furniture he accumulated, both because he did not like to waste, and because it would have a better result:

'[John] likes it when a material is not disposed of but is reused, and the fact that a dirty piece of wood can become a beautiful new piece of furniture. "Often [used] material is also better: if you go to a store and buy wood, you have no idea how this will behave, but if you have used material you know that someone has already thought about this and has carefully selected this material. This [wood] should be a window frame, it has been a window frame, and has served its purpose as a window frame. So then you know: this is good material for a window frame."'

Fig. 4.7 One of Tina's works in progress: she is mixing materials by gluing pieces of cloth and wires on a wooden panel and painting around and on top of these.

Discussion and summary

Unsurprisingly, and in line with craft literature, *materials and materiality appear to be a big draw for making* for the participants, and the materiality of the process often gave them enjoyment. The reason for this seems to be, quite straight-forward, the sense of feeling a material, grabbing it, touching it, and re-working it with hands or tools. *Craft materials are thus, in the first place, malleable*. Participants further wanted to *understand their craft materials*; how they behave; what can be done with them; and how to work with them. This understanding was reached through trying out, and exploring the possibilities with, different materials, each with their own range of possibilities and characteristics. *Craft materials are thus also fathomable, and distinctive*. However, craft materials can also be unpredictable, for example Mary's glass. Furthermore, Paul's quote about the different types of wood illustrates that the origin of a craft material, and its 'life' before being a craft material, greatly determines what one can do with it. This also strongly comes across in John's example of recycling materials that had previously been used for a certain purpose. *Craft materials are thus also autonomous*; they exist separately from the crafter and cannot always easily be controlled. In a way, it can be said a crafter has to engage in a dialogue

with the craft material, in which understanding must be reached before results can be achieved.

TOOLS

Unsurprisingly, most tools that were addressed in the interview with physical crafters were physical; while two participants, John and Lucy, explicitly compared their physical crafts and tools to their digital practices (see Chapters 7 and 8). Physical tools included Jim's comb, Tina's different sizes of brushes, Mary's glass moulds, Vicky's kiln, and Paul's collection of chisels, files, electric saws and sanding machines. Participants also talked about how they acquired their tools, how they worked with them, and how they chose which tool to use.

Acquisition of tools

Many tools were bought at some point by the participants and accumulated over the years, such as paint brushes, saws, screwdrivers, files, and even more expensive devices such as Vicky's kiln. Paul further mentioned that he had to prioritize when he started guitar building '"as a hobby"'; he bought those things he could afford and made do for the rest of the process. More interestingly, several participants mentioned making their own tools, or someone else making tools for them. John, for example said:

> '"When you are working on repeated tasks and it is toilsome to do something and there's a certain repeated pattern, you start thinking: 'Can I do this differently, smarter, or so that it makes me less tired?' And then it can be a challenge to come up with something for that, and a challenge to make that. And that is very rewarding when you succeed and when it works as you had intended."'

He said that some things he made turned out to be even better than expected and were even suitable for other purposes. Paul also made his own tools:

> *'As I look around [Paul's] workshop I see, apart from an impressive collection of the obvious tool such as saws, chisels, and files, many devices and tools that are unknown to me. Paul explains to me that he makes these himself to support parts of the process:* "Most of the work involved in building a guitar is precision work and each time you have to measure something there is risk of

error, so you start looking for ways to limit this risk and create tools for this." *He modestly adds that the ideas for these tools do not all come from him, but also from colleagues, books and the internet. His self-made tools range from hand-powered tools, such as a large round, slightly hollow sanding disc for sanding the top panel of the guitar's belly, and a compass with a chisel to cut out a circular groove for the rosette around the sound hole, to advanced electronic devices, such as a sanding machine for sanding the large, thin wooden panels for the top and bottom of the belly, and an intricately looking device for bending the thin panels for the sides of the belly with the aid of a heating element.'* (See Figure 4.8)

Fig. 4.8 Paul's self-made electronic tool for bending the thin side panels of the guitar's belly with the aid of a heating element.

Paul enjoyed making his own tools, coming up with the idea to do something different and finding out that it works as intended; '"That is wonderful"'. Carol had some tools dedicated for jewellery making that her partner made for her after watching her work, *'such as several sizes of round sticks and blocks of wood covered with sanding paper.'* Finally, Vicky had composed her own silk painting

kit to use for the birthday parties she organised because she was unsatisfied with existing kits. Apart from deliberately making a tool to support the work, Jim's tools got perfected through use as they wore out:

> *'I notice that the comb Jim is using has half and full pins and I ask him if he buys his combs like this or if he tailors them himself:* "The pins just break off from the backcombing, but actually it works best when not all pins are of the same length; it knots up the hair better. We save up broken combs for backcombing."'

Handling tools

In a similar vein to the materiality of the process of crafting, some participants talked about the 'feeling' of working with a certain tool. As mentioned, Paul's self-made tools consisted of both hand-powered and machine-powered tools, and the same was true for the tools he bought. He talked about the difference in working with hand-powered and machine-powered tools:

> *'[...] [Paul] tells me that at his training he had to do everything by hand, for example using sanding paper, planes, and scrapers, but he now uses electronic devices where possible:* "I had to do it [working by hand] and I am glad I've had to do that, because you still get the feeling of the wood. When you're using a plane on wood or a sanding machine, that's a very different experience. So that has been good, but I think it's slavery."'

Similarly to Paul's last remark, Mary called polishing her glass pieces by hand '"'a bit arduous and tedious"'. Although hand-work gave a better feeling of the material, the process could be quite tiresome. As such, crafters often chose machine-powered tools where possible.

Choosing which tools to use

In contrast to the tools that were self-made to support specific parts of the process, most other tools used by participants were quite universal – they could be used for other crafts as well as for the participant's specific craft – such as the aforementioned saws, chisels, files, paint brushes, hammer, rulers, pliers, and Lucy's main tool: a glue gun. However, participants often owned a large variety of such universal tools, because which tool was used depended greatly on the desired result and the material one was working with:

'In his extensive workshop John has a large variety of tools, a combination of hand-powered and machine-powered tools. He explains that this is necessary because not only do wood and metal require different tools, "metal chisels are much harder than wood chisels; wood chisels need to be razor-sharp, but metal chisels don't have to be that sharp", *even different metals, such as stainless steel or aluminium, require different tools.* "I have saws, sanding machines, milling machines and drills in all sorts and sizes, because each job demands its own machine."' (See Figure 4.9)

At an even more universal level, both Lucy and Tina indicated to use anything they could find, anything that was available, both in terms of materials and tools:

'[Tina] further tells me about paintings she has made by gluing different materials, such as sand, cloth, paper, or metal, on a panel and covering them with paint. And in the process of creation everything is allowed to get a desired effect: "sometimes I use my fingers to make gradients, or a cloth, or I use a piece of paper to scrape paint off again. […] I use everything I have at hand."'

In contrast to these universal tools, a few participants had dedicated tools for their craft, such as Carol's *'measuring set for ring sizes, and a set of domed moulds for making spherical shapes'*, and Vicky's glass-cutter.

Fig. 4.9 John had a large variety of different tools (e.g. files and chisels) he used to work with different materials.

Sometimes the choice of tool was determined by the risks involved in that step of the process. Paul said he used hand-tools to limit risks for some precise parts of the process, *'such as using a chisel when making the groove for the rosette:* "some people do it with a milling cutter, but it's risky: it easily takes out chunks of wood."' Finally, Lucy mentioned she was limited in what she wanted to do

because she could not acquire and maintain the tools she needed within her lifestyle:

> *'[After] leaving the school environment [Lucy] found that it was hard to maintain these crafts [sculpture, steel sculpture and pottery]; due to travelling and moving place of residence often it was hard to set up a studio.'*

Discussion and summary

Similar to the previous section on materials, also craft tools require a *certain level of knowledge*, in choosing which tool to use for which task. Interestingly, participants did not talk much about the physical skills needed to work with a particular tool, and many of the actual actions that were done with tools, e.g. backcombing, painting, putting glass in a mould, sanding wood, seemed quite repetitive and straight-forward. Although undoubtedly these actions require fine motor skills and practise, participants seemed to take this for granted and instead focused the discussion on the selection of tools. *Tool use, just like craft-specific skills, thus appears to be another aspect of crafters' tacit knowledge*.

When looking at the difference between *hand-tools and machines*, Mary and Paul expressed that working by hand can limit risks, but can also be tedious. While handwork is sometimes highlighted as a characteristic of craft, Pye says: '"handicraft" and "hand-made" are historical or social terms, not technical ones.' (1968, p.10). It is not about which tools are used, if these are hand-driven, or the quantity of produced objects; instead, it centres on an inaccurate portrayal of the ideals of the Arts and Craft movement that states that before the Industrial Revolution everything was made without machines (Pye, 1968). For the participants, just like for Pye, it did not seem to matter much if their tools were hand-powered or machine-powered; as apparent from Paul's opinion: it is great to have had the experience of working by hand, but there is no shame in using machines where this is more efficient.

Interestingly, there seems to be a *scale of universality of tools*. On the most universal level, participants used anything at hand, which may not even be tools, such as Tina's use of her fingers, and Lucy and Tina's use of anything they could

find. Moving along the scale, next are universal craft tools that can be used for multiple different crafts, such as saws, chisels, pliers, brushes. One step further along the scale are material or craft-specific tools, such as John's dedicated iron files and Carol's domed moulds. And finally, the most specific level of tools are those crafter-specific tools that are made by the crafter to suit his or her specific needs, or that are worn out by the crafter in ways that make the tools more effective, such as Paul's homemade tools and Jim's comb. Although making one's own tools requires more dedication and creativity than wearing out tools, there was still a conscious process behind Jim's dedicated tools because broken combs were kept especially for backcombing; this indicates an awareness of specific craft tool requirements and an ingenuity in acquiring those tools while they could not readily be bought. As shown, both examples in the last category arose from certain needs in the craft process, e.g. the need for precision and limiting risks (Paul) or efficiency (Jim). It could thus be argued that the use of dedicated tools supports a more goal-driven process, while the use of universal tools may encourage more experimentation, as can be seen from Tina and Lucy's examples. As a middle ground, universal tools often seemed to encourage experimentation but also left room for improvement, such as Carol's partner identifying a need for more dedicated tools, and John's gradual acquisition of more dedicated wood and metal tools. Whichever the needs and goals of the craft process, craft tools seem to occupy a space on the universality scale, and it seems to be a *craft-specific requirement, as well as personal preference* if more universal or more dedicated tools are used.

SOCIAL ASPECTS

Social aspects emerged as one of the larger themes in the data (after Learning & Skills, and Motivation & Interest), despite the fact that it was not an anticipated topic in the interview schedule. Participants talked about how they learned, taught, and collaborated with others in the craft process, and involved others with the craft result.

Learning from others

Some of the participants had had the opportunity to learn from others in an educational setting, such as Lucy in art school, albeit in quite a free format:

> '"We just hang out in the studio and whatever we wanted to do we did, so we had a steel studio, and a painting studio, so all of our classes were very hands-on. If you wanted to be with a professor you hang out with them and they'd help you."'

Other participants learned a great deal from influential people in their lives outside of education, such as John who learned to work with steel from his father, a constructional fitter, and with wood from his father-in-law, a carpenter. In a few occasions participants also mentioned learning from unknown peers, such as Paul who found ideas for the tools he made in books and on the internet, and who was inspired by the philosophy of an American guitar builder. Most common, however, was learning from others by looking at their work and exchanging ideas, techniques, tips and tricks. Jim, for example, had visited other hair salons and workshops to see which techniques others use for creating dreadlocks: '"To fix a dread some use candle-grease, or honey, it's a mess!"' Others, such as Tina and Carol, got together with peers who did the same craft, which gave them an opportunity to be inspired and develop their own styles:

> *'Once a week Tina gets together with a group of friends and they paint together. In these* "classes", *as she calls them, everyone works on their own paintings and there is large variety in use of materials, techniques, and what they paint. Some people make realistic paintings, some mix realism with surrealism, and some recreate paintings they see in magazines, which Tina* "personally [doesn't] consider art."'

Tina further mentioned receiving advice from her painting instructor and recalls being too stubborn to take this advice in the past: '"sometimes someone told me not to do something, but I was stubborn and did it anyway, and now I think: 'they were right, I shouldn't have done that.'"' John did not mind receiving, or even asking for advice:

> '"When I really didn't know how to do something I would go to a professional and say: 'this is what I'm doing and this is what I want; what am I doing wrong?' And then I would get advice about the materials, tools or procedure."'

Teaching others

Five participants had experience teaching others aspects of their craft in one form or another. During the interview with Jim, he was teaching his colleague how to help him with the backcombing:

> *'Jim shows [his colleague] again how to do the backcombing and observes his 'student's' work carefully. Eager to learn, and probably aware of Jim's quality demands, the colleague asks for Jim's opinion after finishing his first dread, and from time to time he asks Jim for advice when he is in doubt of the way to proceed. Jim patiently demonstrates and gives advice based on his observations. On a few occasions Jim's colleague starts to follow Jim's instructions during his demonstration and Jim urges him to watch carefully first.'*

However, Jim was also a bit wary of teaching others the whole process of making dreadlocks, and his personal techniques:

> '"I don't go around just teaching anyone. It has taken me a long time to perfect my technique and skill and to gain the experience that I have, and I don't want to teach just anybody who just walks out the next day with that new know-how obtained for free. I need to have a good feeling about someone before I teach them."'

John passed on his knowledge more freely and wherever possible:

> *'Friends and family will ask him how to do certain things, such as putting in a water pipe,* "but not everybody is equally interested; I am sometimes too enthusiastic in my explanations." *It also happens that someone asks him to explain something without showing them, for example in an email or over the phone;* "then I will make a drawing, for example, or try to explain, but I prefer to just demonstrate it; that is most fun."

Further, Paul started teaching small groups of students how to build guitars, after realising that there was much interest from others. Although he was hesitant to teach at first, he now enjoyed '"sharing his hobby"' with others. Tina had run a few workshops in the past, while for Vicky workshops, fairs, running courses from her home, and birthday parties were not only a way to make money, but also a source of enjoyment and satisfaction:

> '"It's showing them something new. It seeing them go from 'can't paint, won't paint' to 'maybe I can'. And that is the other thing I love: it's actually helping

people to achieve their potential. This is the thing with the teaching; I teach adults as well as kiddies, I've got 6 year olds and I've got people who are retired who come to me for lessons. […] And it's getting them into that 'maybe I can' frame of mind, which then frees them and allows them to then go off and make mistakes.'"

Collaborating with others

The largest category of collaboration with peers consisted of discussions with peers. Sometimes these discussions took place within organised group meetings where peers came together to craft, such as the ones Tina and Carol went to. However, Mary also kept in touch with others who did glass work, with whom she met up in evening classes and at exhibitions. Vicky mentioned she met up with a silk painters' guild once a month, in which they considered new techniques or materials, and exchanged knowledge and interests. Being with others while crafting could be beneficial; Tina said her painting group provided an '"inspiring environment"', in which she actually got around to painting, and in which she was among equals. Although she got easily distracted in the presence of others who did not craft, being with peers was encouraging:

'"I really like [painting], I can completely lose myself in it. […] I want to do it when I'm completely alone, I can't do it when my family is around, because I don't want to be distracted. But in that group I can work, as if I feel they are more knowledgeable [than my family]. […] The solidarity with fellow painters is very encouraging."'

For the same reason Mary joined her friend once a week in her fully equipped glass studio:

'"Sometimes it is quite nice to work with someone else; it can be quite lonely if you're just on your own the whole time." *When being co-located Mary and her friend can chat while working and exchange advice and even spare glass. She adds:* "there can be long moments of silence, when you're working away and concentrating, but it's quite good to have someone else around you can sort of bounce off."'

Mary added that it was important to her that the person she was with was doing the same thing, because if there was any negativity, or a mismatch in

appreciation of the craft, coming through in the dynamics between the people present, she could not work effectively.

In only two occasions crafters mentioned actually collaborating on a piece. In Jim's case, him and his colleague worked together to backcomb one person's hair, although Jim was clearly 'the leader and master' in this craft process. Vicky mentioned that they sometimes did collaborative pieces within their silk painters' guild, *'such as an undersea-themed kimono for an art festival'*, for which everyone painted a small part. As a final form of collaborating with others, Mary described a process in which she interviewed people to include their narratives in a glasswork piece.

Involvement of others with the result

As addressed earlier, results of craft were often given away or shared with others. Often pieces were created specifically for one person, sometimes on the crafter's own initiative, such as the jewellery Carol made for her partner's grandchildren; because someone asked for it, such as the pieces of furniture John made; or because they were created on 'commission', such as any of Jim's hairdos, and some of Paul's guitars. Paul said that in guitar building, working on commission can be a problem:

> *'When you get a new guitar there has to be some sort of connection. In a store you can try a few, but when you build one, that is the result you have to be satisfied with. The sound is very subjective and that is a risk:* "what I like, someone else doesn't necessarily like as well."'

Mary did not like working on commission:

> '"I don't like making [stained glass] windows for people, at all. […] Because they'd say: 'oh, I want this, I want that' and I'd think 'oh come on.'" *When people ask her to make something for them she'll ask:* "why do you ask me?" *If they just want a window she'll refer them to her friends who do like working on commission, but it has happened that people said that they like her work specifically,* "so I couldn't really say no, which is very nice as well."'

Other times, a result was given to someone else after it was finished, such as the painting of Tina's father-in-law, which she gave to his widow, most of Carol's

jewellery, and Lucy's artwork. For Tina, Vicky, and Mary others were also involved with the result because craft results were shared with others through exhibitions; and finally sometimes it was just nice to "'get compliments"' (John) from others on craft results.

Discussion and summary

In line with Gauntlett's (2011) vision that making and crafting brings people together, the interview findings show that *craft is strongly social*. Often crafters learned from others, taught others, exchanged knowledge and ideas with peers, or showed or gave their craft results to others. While craft may be envisioned as a sole activity, in which an individual focuses on the task at hand to achieve a 'master piece', it seems that the opposite is quite true. Even though the activity itself was mostly done individually – i.e. a crafter worked independently on his or her own piece, even in the presence of others; and indeed, participants did not mention many cases of collaborating on a single piece – craft practice does not seem to exist in its current form without interactions with others. This is not completely surprising as traditionally there have been social structures around craft in the form of co-located crafting (in workshops and guilds); teaching and learning (in the relations between masters and apprentices); and collaboration (in the practice of apprentices working on the master's or guild's pieces) (e.g. Adamson, 2013, Sennett, 2008). Further, learning from others by uncovering tacit knowledge that may not have been documented; social presence of others; collaboration; and motivation to share have been identified as factors in a successful 'community of practice' (e.g. Lave and Wenger, 1991) – a group that share a craft or profession – which further highlights social dynamics and learning tactics within craft practice. Similar themes came up in the data and Jim's tutoring, and his reluctance to teach just anyone, can be seen as a form of modern apprenticeship, in which an employee has to gain the trust of the master to be enlightened with the secrets of the workshop (Sennett, 2008). Finally, others were *often involved with the craft result*, although the level of involvement varied. A parallel may be drawn to a user-centred design process: where a crafter is working on commission, or creating something because someone asks for it, the strongest level of 'user involvement' can be seen; followed by the case

of creating something for someone specific on the crafter's initiative. At a lower level of user involvement a crafter may give one of his or her craft results to someone without having specifically made it for that person. At the lowest level, a crafter may share craft results with a larger audience, for example at an exhibition. Interestingly, in this study, where craft results were shared, this mostly seemed to be done in organised settings, such as exhibitions, while crafters were often a bit shy when it came to 'just showing' others their work in informal settings.

MOTIVATION & INTEREST

When interviewing the participants about their craft, it was not difficult to see the love for their craft shining through in the way they talked about it, showed examples, demonstrated techniques and tricks on the spot, and visibly enjoyed the chance to tell everything they wanted to share. It is not surprising that the 'Motivation & Interest' category was the second largest category, after 'Learning & Skills', being coded with both participants' answers to the explicit question that asked what they liked about their craft, but also all those expressions of enjoyment that came forward in other parts of the interview. Half of the participants explicitly mentioned that they had always been interested in art or craft, for example:

> *'John tells me he has always been interested in creating things: as a small child his dad had to keep him away from the tools and machinery in his workshop. His parents bought a construction kit for him about which he tells me:* "the examples that came with the kit were not enough; I went in search for extensions and used all materials at hand: cigar boxes, bike lights, tea towels, ropes."'

Participants also pointed to a 'drive to make': Vicky was quick and determined and said '"I can't *not* do it"', while Lucy said she had struggled with her 'urges':

> *She tells me she has always had a strong drive to make things, which has not always been easy for her:* "Even when I was young I always painted and I was always making things. [….] I remember writing in my journals that the fact that I wanted to do this [making things] was almost… I almost felt cursed in

the sense that I couldn't not do it. […] It was something I could never stop. […] I felt like I couldn't do anything else; nothing else satisfied me. So I felt like I was stuck with this… it wasn't even a talent, it was a real desire to produce, to make things.'"

Another frequent theme in the Motivation & Interest category is 'seeing something come into existence', while participants also enjoyed making something functional. Addressed themes are: material aspects; social factors; learning from craft; and personal rewards and emotions associated with craft.

Seeing something come into existence & making something functional

Over half of the participants said they liked to 'see something come into existence' while they were crafting, for example:

'"if you build something, you see something growing and then there is a product and it is very satisfying that you have built something yourself. That provides much motivation to go on and make it better next time."' (John)

Similarly, Paul mentioned that the students he teaches guitar building, just like him '"don't want a cheap guitar; they want the adventure of building it. They want the experience of the development of that thing and feeling what happens with the wood."' Vicky enjoyed '"having a physical product"' as a contrast to '"working in an office where you are, for instance, creating virtual things the whole time."' Lucy compared her making practices to her process of doing a PhD, and said that as soon as she realised that the PhD was about making something and seeing it come together, she started to enjoy it more:

'"When I was doing my PhD I felt like I was too cerebral, I felt like I was too much in my head, and there wasn't enough… I don't know, maybe creativity, or maybe it was a process of making art that I can't put my finger on… it's both physical and cerebral…' *However, Lucy finally had the realisation that her research can be seen as a piece of art and the process of making art and doing research are very similar:* 'what I finally saw when I was writing and pulling the pieces together and doing fieldwork was that it was like a really big piece of art, a slowly produced, agonizing piece of art, where there was all these bits involved. And it was almost like working on a huge canvas or making a big

installation […]. Once I started to see it that way, it just sort of came to me, it changed the way I look at research now; it's a very similar process. […]'"

Another motivator, mainly for Paul and John, was making something functional, which for John was further related to the price-quality aspect of having a better product for a lower price. Paul said about making his own functional tools:

'"When you make something that really works. You are working and you're thinking: that could easily be done like this, would that work? And damn, it works. That's fun."'

Material aspects

Half of the participants brought up material aspects of crafting, such as the feeling of working with a physical material, and for some participants, such as Mary and Lucy, this was clearly the main, if not the sole, reason they enjoy making. As mentioned earlier, Mary liked the feeling of having the glass practically physically in her hands, and the tactile nature of crafting with glass:

'"It's not this sharp, jagged, scary thing that can cut you; it's a colourful, moving thing that you can shape and form, but at the same time it still fights back. So that's probably why I like it."'

Lucy called herself '"a haptic artist, you know, a touch person"', and explained:

'"My really big draw is making, is actual hands-on… when I do ceramics it's about the feeling of the clay and it's about pushing media… So there's a lot of embodiment in it and tactileness, and this connection between me and media. It's very physical."'

For Vicky it was satisfying to have a physical thing, but also to be physical in the making process:

'"I like getting my hand dirty. It's the same with gardening. I like gardening, because it's the whole process of getting in there, making a difference and then something happens."'

Finally, John pointed to the actual physical activity involved in crafting based on his experience of being in a rehabilitation centre where they used crafting activities to encourage people to make certain movements. While being there, crafting helped him with his rheumatic complaints.

Social factors

As addressed in the previous section, social factors sometimes played a role in crafting. Craft being appreciated by others was something that participants enjoyed greatly. Tina, for example, said about the painting she made of her father-in-law, which she later gave to his widow:

> '"At some point [my mother-in-law] said to me, and that touched me: 'I took a photo of [the painting] and when I go on a holiday I put that photo in my purse and then he's always with me.'"'

John said he liked '"getting compliments"', and Paul was visibly pleased by the interviewer's interest in his craft. John further liked making things for others, '"which people use and enjoy using"'. He added: '"that's in [both] software engineering and in furniture making."'

Learning from craft

Mary also liked the fact that she gained new knowledge from working with glass, and that she could then incorporate this new knowledge into new practices:

> '"[There] is something about shaping and forming that and then transferring that sense of contact with it into that knowledge you have of how the glass behaves, how the different colours behave: how when you add purple it distorts it because the purple is stronger, and if you add pink or yellow… it moves the glass in different ways. And then you can transfer that knowledge into when you're making something in a mould: how you place the glass in the mould, how you place the colours, how to position it." *She tells me you don't learn how the glass behaves in technical or chemical sense in the classes; that is something you need to pick up by trying and exploring.* "Passion is not the right word for it," *she tells me,* "but it's a deepening understanding of the behaviour of this material and just increasing the depth of knowledge."'

Personal rewards and emotions associated with craft

The final, and largest, category of themes includes all the personal rewards and emotions associated with craft brought up by the participants. Participants indicated to like challenges, such as Jim who *'sees great challenges in home-made dreads and really messy situations'* and thus really enjoyed doing these. In many references in this theme, challenge was connected with satisfaction; where there

was a big challenge, it was very rewarding to get something done. As has come forward in many quotes in this chapter, many participants mentioned that crafting is 'satisfying' or 'rewarding'; Mary goes as far as to say: '"if you were going to call [a finished piece] 'perfection' it would be in the satisfaction and the professional excellence as a final piece of work."' Unsurprisingly, participants also expressed pride about their craft, or about being good at what they do. Sometimes the realisation of being good motivated crafters to do more with their newfound skills, such as Tina who took up drawing lessons after she realised as a teenager that she could draw people quite well. Now painting makes her feel good about herself: '"Look, this is what I can do."'

Craft was sometimes used to explore oneself, and get to know oneself better, such as in Lucy's example of making a mixed media pieces using photographs of herself; she called these pieces explorations of the media and of her own identity. Vicky further appreciated the freedom and time she had to craft:

> '"It's also the having the time to make things you are happy with. Because so often you are working towards a deadline and you're thinking: 'oh I could have done it like that, if I had the time'. So I think it's the satisfaction of being able to work to your own… you know, march to your own drum, I guess."'

Some participants mentioned being 'in the flow', referring to a state of completely focused motivation, introduced by Csikszentmihalyi as 'an almost automatic, effortless, yet highly focused state of consciousness' (Csikszentmihalyi, 2010, p.110). For example, for Jim this meant that he '"just gets focused on the dreads and getting everything tidy again"*; he gets into the routine, listening to music at the same time, and* "just really getting into it"'; and Tina said: '"'I really like [painting], I can completely lose myself in it."' Lucy described how this feels:

> '"I think that one of the reasons I feel so good when I'm creating something is that you're in the moment. It's completely consuming […] because you're moving somewhere and pulling things together, and you're thinking and you're doing; I find it very therapeutic, I guess. […] It's all consuming in that you can't be bogged down, at least I'm not, when I'm making things I'm not thinking: 'oh, I have to do this, this, and this', at all, you know 'oh, I have to do

this tomorrow; I have to call that person', I'm actually in the moment […] You're completely caught up in the present."'

From Lucy's quote another motivator for crafting, related to the flow-feeling came forward, namely forgetting worries or other things on your mind for a moment. For many participants crafting was a therapeutic activity, '"a way to switch off, a reset function"' (John):

'"It gives you a chance to switch off. Worries you may have are forgotten, because you are focused on hand craft. There is no room for other worries. You are so focused on trying to get the chisel to take away the right amount of wood that there is no room for psychological worries or puzzles; that is all gone."' (John)

Tina had had similar experience with craft:

'"The moment I start painting [all my worries] are gone. Nothing counts except that shaded part, that coloured patch, that colour transition. I am completely gone for two hours, in my own little world, and only from the moment I get in my car to go home things start coming back. So, that's nice."'

For Tina this became very obvious when she was working on a painting of her father-in-law who was dying of cancer at the time. Her painting instructor urged her to continue the painting because it would help her to deal with the situation and vent her frustration; Tina says it was an exhausting process because of the emotions, while painting provided great support in a difficult time: '"When I was painting I forgot he was dying. When I stopped the lump in my throat returned."'

Discussion and summary

Gauntlett identifies the 'drive to make' as a characteristic of makers (2011, p. 222). The author states that not all people have this drive, but for the ones who do, *craft is an activity they do without the need for external rewards*. This is prominent in the findings of this study, as the recruitment of crafters naturally selected those with 'the drive'; many of the participants mentioned they had always been interested in craft. As discussed earlier, craft appears to be autotelic (Csikszentmihalyi, 2010), and while some motivators had to do with craft results (e.g. making something functional or getting compliments), the data suggested that, moreover, craft was enjoyable as an activity.

One theme in the data is the desire for '"the adventure of building it"' and *seeing something being created step by step*; relatedly Csikszentmihalyi (2010) describes clear goals at every step of the way, and immediate feedback to actions (in this case in seeing something develop) as characteristics of feeling flow, which helps to explain why craft is enjoyable. Similar sentiments are uttered by Frauenfelder in his manifest for craft as a way to take control of your life, and inventing as an alternative to buying mass-produced products (2010), much in the same way as Paul's students want to create guitars rather than buying cheap ones. Further, *material aspects* made craft enjoyable. *Social factors* formed a relatively small theme; instead, crafters were mostly intrinsically motivated to craft.

Intrinsic motivation came from a range of *personal rewards and emotions*, many of which can be traced back to Csikszentmihalyi's concept of flow (2010), a heightened, focused state of consciousness that can be reached in craft, and is strongly linked to enjoyment (Csikszentmihalyi calls flow 'the optimal experience' [of enjoyment] (p.110)). Some participants explicitly mentioned they liked the feeling of 'being in the flow', which they closely connected with forgetting time and worries; forgetting time, surroundings, and self are also identified by Csikszentmihalyi as a core element of flow. Interestingly, participants mentioned a limit to how much of their worries they could overcome with craft, and distractions caused by worries, or self-consciousness could sometimes form obstructions to experiencing flow and to being able to craft. Other participants expressed satisfaction in working on challenges, while a balance between skills and challenges has been identified as a requisite for flow (Csikszentmihalyi, 2010). It thus appears that as an overarching term flow is the most important motivator for crafting.

Other Characteristics of Craft and Crafters

Two themes remain to be discussed, which were classified in this category because they did not easily fit any of the other categories, namely 'perfectionism', and 'identity as a crafter or artist and professionalism'. Both themes were only

elaborated on when brought up by a participant, but were still addressed by over half of the participants.

Perfectionism

Some of the participants explicitly mentioned that they considered themselves perfectionists, for others this was more implicit in the way they talked about their craft. Jim was one of those people who admitted to be a perfectionist and this could be witnessed as he carefully executed each step of his process. It can also be seen from the following excerpt from his portrait:

> *'Jim explains that it is also an unwritten policy in his salon that wherever possible every employee gets to do whatever hairdos they like doing most* "because then you can guarantee that bit of extra quality and inspiration customers come here for."'

John was also a perfectionist; this sometimes caused him to plan things badly, but for him it was more important that things were done well, than that they were done quickly:

> '"It's important for me that it is done decently. I can't make myself call something done when it is crooked or loose or knocked together. Those are demands I put on myself. I have noticed that when I make something for other people they will easily say 'oh, that's good and finished' but I will say: 'no, I just have to do this or adjust that...' My demands are generally higher than those of the customer."'

Others, such as Carol and Vicky, had a different view: '"it doesn't all have to be perfect, as if it's machine-made. You should be able to see that it's hand-made"' (Carol). Vicky agreed:

> '"The thing is… perfection, what the hell… You know, some of the times, yes, you want to get it absolutely just so. Other times, so it's a bit interesting, run with it. Because, actually, it shows it's handmade. If it came out looking like it came out of a machine, and you can run them off identical, what would be the point?"'

While some of the crafters wanted to do everything perfectly, and others felt their work needed to show imperfections, some of the participants seemed reluctant to consider their work to be perfect in any way. Tina mentioned that

was a hurdle for her to approach people to exhibit her work, and Carol came across quite shy in the interview as she repeatedly said that she was unsure if her answers would be of any use. She seemed to downplay her work by saying that she used a variety of techniques in her jewellery making, but '"only simple stuff"', such as drawing, sawing, forging, soldering, sanding, and polishing.

Identity as a crafter or artist & professionalism

Five of the participants brought up aspects to do with their own identity as a crafter or artist, and how they wanted to portray themselves. For Jim for example, his salon was an instantiation of his identity and his brand. It was important for him to distinguish his salon from the multitude of chain businesses in the area:

> '"With the right qualifications anyone can start up one of those. Just fill out the paper work and they will provide you with some things that make your salon fit the brand image. I don't want that; I do my own thing." *Jim adds that his customers have certain expectations because of the brand image of his salon. That is what they come back for, and that is what Jim wants to provide them with.'*

As such, Jim considered himself an artist, rather than a business man and he saw his salon as a vent for his creativity, and for expressing his personality:

> *'[Jim's] creativity is visible in the interior of the salon, what with trendy design chairs, oil barrels as tables, magazine article floor carpeting, chandeliers, pinball machines converted into lights on the walls, and the Christmas tree hanging upside down from the ceiling.'* (See Figure 4.10 for an impression of the salon)

Fig. 4.10 Impression of Jim's hairdressing salon (photo courtesy of Jim).

Tina described the development of her own personal style, when moving from painting realistic, photographic imagery to abstract painting: '"for example, I do want to paint a dog, but I want to do something weird with it," *as is illustrated by a pop art painting she has made of her dog.'* For Tina it was important to be considered professional as an artist:

> '"I have my own business cards. It feels good to be able to give someone a business card. It's more professional." *I ask her if that is important to her, being professional, and what this means, and she tells me:* "I do exhibitions and workshops, I have my own website, if you Google my name you can find me. […] I am not just a lady who messes about with a brush, I am a real artist."

Similarly, Mary was quite adamant about her status as an artist, and her craft as a professional activity. She classified herself as an artist, and puts herself in the professional category, *'because she could do it as a professional if she chose to do so, she does exhibitions, and sometimes works on commission'*:

> '"It's not a hobby, in the sense that… I don't see it as a hobby, like gardening or something, it's a bit more than that… Because when people say: 'oh you're just

a hobbyist' I get quite offended. 'No, I'm not' […] A hobby is something… I'm being a bit of a snob about it, but it's the shades of excellence that you might have in something." *She sees her qualifications as an illustration of her craft being more than a hobby:* "why would I slog away getting a qualification and go to night school to do a fine arts for two years, when I had a baby, and go on summer schools and things […] For me, that's not a hobby, that's becoming more expert in something."'

Discussion and summary

While some of the crafters appeared to be perfectionists, instead Carol and Vicky's attitudes towards perfection match Ruskin's view that roughly made, imperfect things embody a celebration of human imperfections (1997). While Sennett's (2008), and this thesis' view on craft assert that craft should be done 'well', within one's abilities, *this does not mean that is has to be absolutely perfect*; the findings illustrate that even when craft is done well and carefully, a craft result is still not considered perfect, for example because it can still be improved, and often because the crafter is reluctant to call it perfect – regardless of whether this crafter is a perfectionist or not.

It can be seen from the data that both people that could traditionally be classified as artists (e.g. Tina and Mary) and as crafters (e.g. Jim) talked about *their own identities and styles*. This again illustrated that boundaries between art and craft are fading as crafters also want to express their creativity in their own individualized ways and do not just want to 'execute a design' (e.g. Risatti, 2007, Shiner, 2012). Some participants further mentioned their need to be considered professional, and showcase themselves and their work, although, unsurprisingly, this was more present for the professionals and semi-professionals in the sample. This need seemed to exist both for internal reasons (e.g. self-recognition, becoming an expert) and external reasons (e.g. making money by distinguishing oneself from competitors).

DISCUSSION

Reflecting on the findings uncovered through the interview and portraiture methods, it would be fair to say that while observation of craft practice would have uncovered many valuable examples of tacit knowledge (e.g. around skills and tool use), the employed method of narrative interviewing proved to be successful in uncovering personal choices, backgrounds and motivations behind crafting. Since many interviews, at least in part, took place in the workshops or location where the crafter usually works, observations were included in the data analysis. However, even in situations where this was not possible, comprehensive data around craft practice was obtained. While a more extensive reflection on the use of the narrative interviewing and portraiture methods in this study can be found in Golsteijn and Wright (2013), this section briefly reflects on some of the potential limitations of these methods and how the researcher aimed to safeguard the quality of the research. A first potential limitation of the narrative approach is that not everyone will be able to narrate (Riessman, 2008). In conscientiously engaging with the participant, the interviewer was able to adjust interview tactics towards the needs of each individual interview, e.g. prompting more or reformulating questions if a participant was struggling to answer, so that no major issues were encountered around participants' ability to narrate. Further, narrative research raises concerns around anonymity because of its level of contextual and personal detail (Smythe and Murray, 2000). This research tried to maintain anonymity through the use of pseudonyms, omitting details that would give away the identity of the interviewee (e.g. the town where Jim's salon is), and limiting captured photographs to work, tools, and workplaces. There are further risks around the accurate representation of the participant, which requires the researcher's self-awareness and reflexivity around how their background and interests shape the way in which data is represented (Lawrence-Lightfoot, 2005). As such, the portraits made clear which sections were participants' direct quotes and which were researcher interpretations, and they indicated where the researcher's background may have influenced the data collected, or the way the portrait was written (for example in the case of the shared interest of playing the guitar

between Paul and the interviewer). Finally, it is sometimes argued that it is impossible to assess the 'validity' of a portrait, which is countered by the argument that there is not one truth around a phenomenon, but rather multiple truths that are shaped by the context and the research (Lawrence-Lightfoot and Davis, 1997, Riessman, 2008). In attempting to ensure that portraits represented participants accurately and holistically, an iterative approach was employed of taking notes and transcribing, and creating the portraits, whilst carefully checking against the raw interview data in both phases. Further, there was ample use of verbatim quotes from participants, alongside descriptions of the environment and actions of the participant. Finally, in line of feminist research traditions, participants were given the opportunity to read and comment on their own portrait. Using these mechanisms to safeguard the quality of the narrative interviews and portraits, it was felt that the results of these methods provided meaningful input for the data analysis and ideation phases.

Relatedly, the question arises if the thematic analysis would have shown significantly different results if coding had been done on the interview transcripts instead of on the portraits. Although it cannot be confirmed irrefutably, it is believed that coding the portraits not only resulted in a representative and accurate data analysis – after all, elaborate precautions were taken to assure that portraits were representative of participants holistic stories (as addressed above) – but also that the portraits added useful insights to the analysis that would not have been visible in verbatim interview transcripts, such as the observation around Paul's creation of his tools, Carol's shyness to talk about her craft, and Tina's affection when talking about her paintings. Moreover, portraits provided a useful holistic data representation that could be used in ideation (Chapter 5).

Thematic findings from this interview study allowed for the identifications of characteristics of everyday physical craft that can help to theorise craft, for example around how crafters learn, the tools they use, the materials they use, the social character of craft, and motivations for craft. A complete list of craft characteristics can be found in Chapter 8, where these will be compared to

characteristics of digital craft as found in Chapter 7. When reflecting on the choice of participants, it can be seen that only few differences were found between professionals and amateurs, and between people that may traditionally be classified as artists and those classified as crafters (for example in mentioning 'inspiration'). As mentioned in previous chapters, there are ongoing debates in the literature around the blurred boundaries between art and craft (e.g. Shiner, 2012, Veiteberg, 2010) and this study confirms that, at least for everyday practices, art and craft realms are not clearly demarcated. Everyday creativity in making practices (Gauntlett, 2011) manifests itself in many different forms and everyday crafters do not seem particularly concerned with classifying their practices. Further, although the main motivations and learning processes for craft were self-driven and autonomous, a vision of a creative genius (Gauntlett, 2011) who works in artistic isolation in a process characterised by tacit knowledge and states of flow does not paint an accurate picture. Although such expert states in material and tool use, and such emotions, are reached by everyday crafters – and are experienced as highly enjoyable – there is also explicit planning, discussion, research, and organised learning involved. It seems that everyday craft requires a combination of tacit and explicit knowledge as crafters shift between stages of focused 'doing', engaging with materials and tools, and letting out their creativity; and acknowledging what they do not know, and planning further skills development, professionalism, and tool acquisition or creation. Craft also appears more driven by the craft process than the result, and in this process, crafters do not oppose the use of technology or machines, but instead embrace these as means to help them in their craft endeavours as theorised in the literature (e.g. Gauntlett, 2011, McCullough, 1996). This opens up interesting opportunities for hybrid craft as this can offer a new area for creative expression, in which new possibilities are presented through technological means, e.g. a hybrid craft toolkit. If carefully designed, such technological means could support the oscillation between tacit and explicit knowledge as crafters explore and define their own practices within new everyday craft domains. The next chapter presents the design process in which the interview findings were used to design a hybrid craft toolkit.

5 Design Journey

DEVELOPING DESIGN IDEAS FOR HYBRID CRAFT

Design and prototyping activities are crucial to an interaction design research project[26]. As discussed in Chapter 3, design action in research through design, i.e. the development of design concepts and the creation of interactive prototypes, helps to identify opportunities and design directions; creates concrete artefacts that embody theory and opportunities; allows for design solutions to be evaluated, and leads to discussions and new insights and ideas (e.g. Hoven et al., 2007, Zimmerman et al., 2007). Because much design knowledge lies in concrete concepts, and the road towards these concepts (e.g. design decisions, ideation considerations), it was considered crucial to give enough attention to the design journey from ideation to prototype, rather than merely discussing the final implementation. Ideas were generated using the 'idea generation through portraiture' method (Golsteijn and Wright, 2013), and annotated portfolios (Gaver and Bowers, 2012) were created which served to identify 'families' of ideas, and to derive initial design directions. These annotated portfolios serve as intermediate level knowledge (residing between general theories and specific design instances) for designing for hybrid craft (Löwgren, 2013), and contribute concrete design ideas and initial design directions; both will be further developed in Chapters 8 and 9. It is hereby important to note that design ideas function as 'placeholders' (Gaver and Martin, 2000) for design possibilities in the area of hybrid craft: conceptual designs that encourage discussion about hybrid craft without necessarily being the 'perfect' solution. Importantly, as placeholders, the ideas occupy *points* in the design space – while the annotated

[26] Sections of this chapter have previously been published in Golsteijn and Wright (2013) and Golsteijn et al. (2014).

portfolios occupy *areas* in the design space (Gaver and Bowers, 2012) – and they encourage discussion because they are presented as conceptual ideas (Gaver and Martin, 2000). It is therefore of lesser importance to assess feasibility or applications of ideas. This chapter addresses how the idea generation through portraiture method was used to generate ideas, presents the resulting ideas and design directions in an annotated portfolio, and addresses the development and implementation of the Materialise craft set.

IDEA GENERATION THROUGH PORTRAITURE

Findings from the physical craft interviews informed the design work in this chapter through the use of the crafter portraits in ideation[27]. Insights from the thematic analysis were further used in informing design guidelines through a comparison of physical and digital craft and pulling together findings from all empirical work (Chapter 8). The idea generation through portraiture consisted of individual brainstorm sessions by the author of this thesis; each session focusing on one specific crafter. Brainstorming centred on the question: 'if this crafter would include digital media or digital technologies in their craft, what could be designed for them?' Each separate brainstorm session began by writing down a few key statements for each crafter that arose from the portraits, e.g. for John, the wood and metal hobbyist, this included 'recycling materials'; for Jim, the hairdresser, 'apprenticeship'; for Vicky, the silk painter, 'collaborative crafting'; and for Paul, the guitar builder, 'making your own tools'. Subsequently, ideas were generated by considering these key statements and intensively reading and rereading the portraits, which triggered new ideas in an iterative process. Over ten ideas per crafter were generated. For example, for Lucy, who often felt guilty about having the time to craft and therefore about showing her craft, a locket was designed to keep the results of her craft hidden to treasure individually; and for Mary, who missed the co-presence and solidarity of fellow crafters, a remote awareness system was sketched that would allow her to feel the presence of other crafters and communicate with them. After the initial idea

[27] As mentioned, digital craft interviews were done later in the research process after a need for them had been identified throughout ideation and concept development; digital crafter portraits were therefore not included in the idea generation through portraiture.

generation phase, design ideas were distilled into a set of four or five key statements per crafter that summarised and highlighted interesting insights from the portraits and design ideas, for example for Paul this included 'online workshops and guilds rather than a "take what you need" mentality', for Carol 'the craft is influenced by who you are communicating with during the process', and for Jim 'the "fingerprint" or maker's stamp of the anonymous crafter for digital materials'. Finally, two or three ideas per crafter were selected and developed based on originality, feasibility, and relevance to the aim of designing for hybrid craft. At this point ideas were also compared across different crafters and similar ideas were combined to develop coherent concepts that would suit larger target groups, while each idea still related most strongly to a specific crafter. Sketches were created for further exploration of design concepts. This resulted in 22 design concepts in total, addressed in the next section. The process of idea generation for each individual crafter can be seen in Figure 5.1.

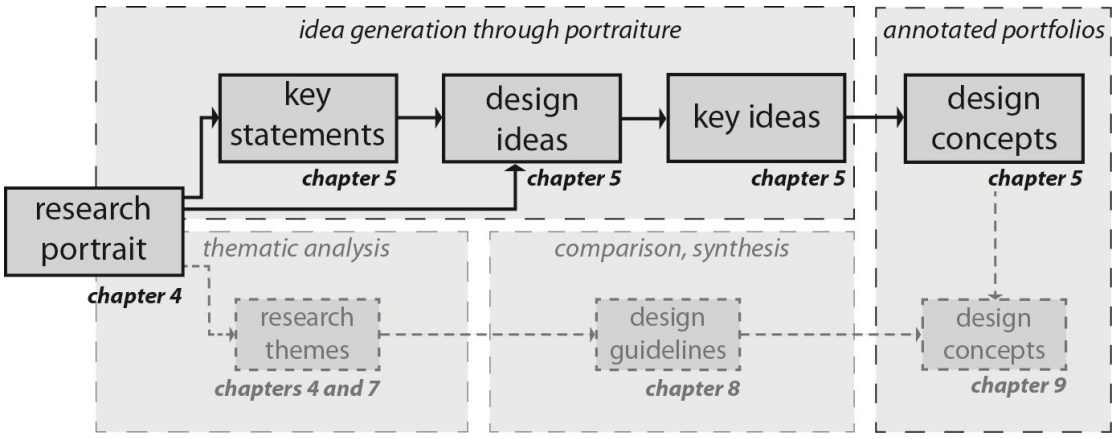


Fig. 5.1 Research portraits around the physical crafters were used in idea generation in a process of writing down key statements per crafter; generating design ideas; distilling and selecting key ideas; and developing design concepts. Note that this figure shows the process for one crafter, which was repeated for all crafters.

ANNOTATED PORTFOLIO

Annotated portfolios can take any form (Gaver and Bowers, 2012), but for this chapter a combination of visuals – the concept sketches of the ideas – and textual annotations is chosen. The 22 design concepts are included in an annotated portfolio figure that links 'families' of ideas that share common characteristics (Figure 5.2). Families were identified by grouping similar ideas and using post-it notes to give short descriptions to groups of ideas (Kawakita, 1982). In Figure 5.2, the coloured frames demarcate families of ideas, which are annotated in bold in the same colour. Ideas within families are further annotated by specifying how each idea relates to the characteristic of that family, which is shown through coloured text in a smaller font.

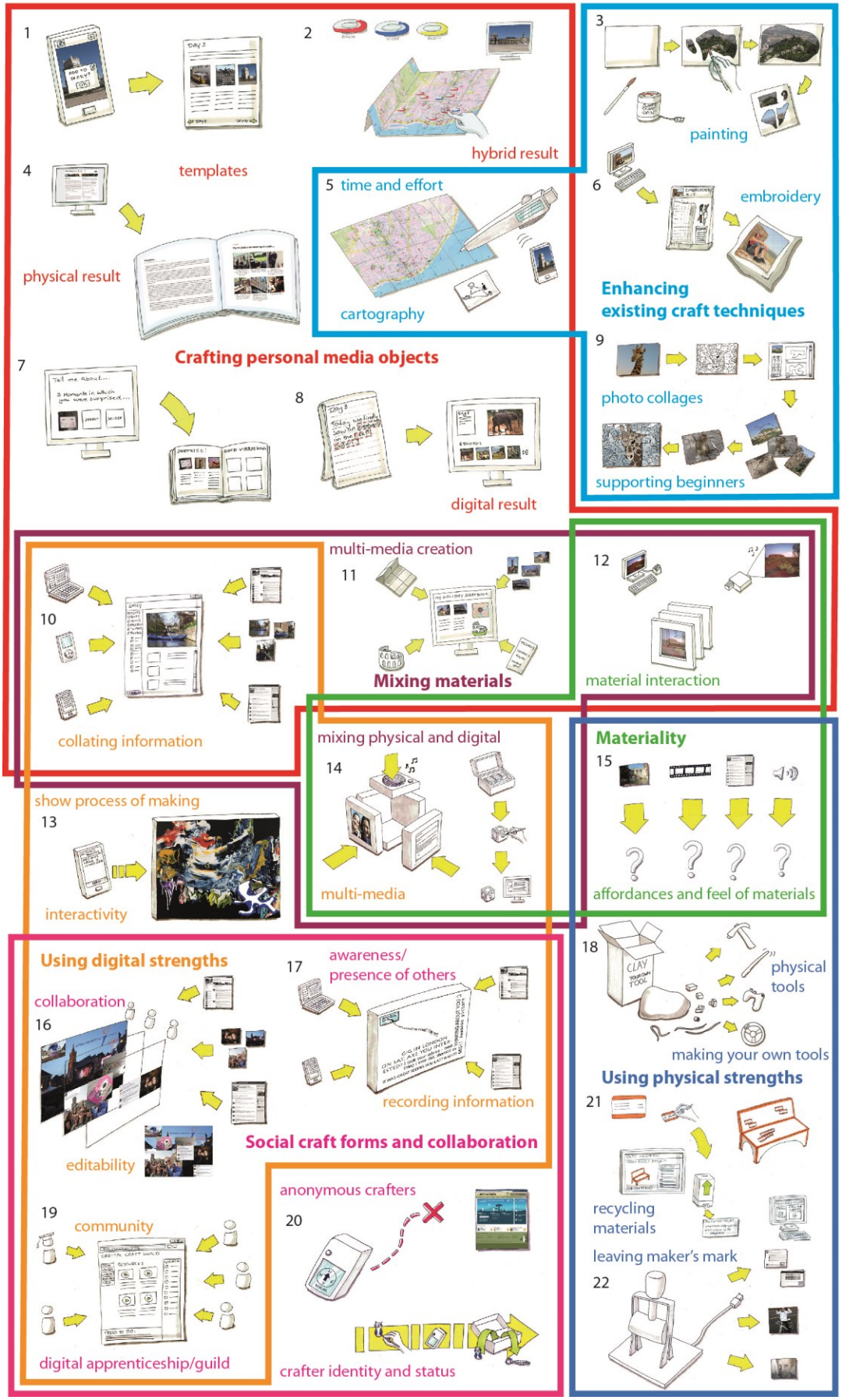


Fig. 5.2 The annotated portfolio represents annotated families of ideas for hybrid craft.

Crafting Personal Media Objects

The first family of ideas that was identified was crafting personal media objects. As an example of an application area for hybrid craft this is believed to be a promising direction for further design ideas. An example of an idea in this family that was based on John's portrait, the wood and metal hobbyist, was the 'information collection tool' (Number 10 in Figure 5.2). This idea was generated based on the observation that John liked efficiency and creating his own tools and systems that made his life more efficient. The information collection tool is an example of a system that could do this for personal digital media: it helps users to collate information from different platforms, social media, local media, and different devices and subsequently craft easily accessible media albums; a similar idea is Number 11, which also includes physical objects in the album, such as tickets and physical souvenirs. Other ideas in this family provided examples of creating physical, digital and hybrid personal media objects, while others considered the extent to which templates can be used to support the creation of personal media objects (e.g. Numbers 1 and 8), i.e. which parts of the craft process can a system support through automation, and which parts can provide an enjoyable craft experience?

Enhancing Existing Craft Techniques

Another family grouped ideas that enhance existing physical craft techniques with digital technology, such as painting, embroidery, making photo collages, and cartography. An example of an idea is 'photos by numbers' (Number 9): any photograph can be converted into a paint-by-numbers type of representation. A software tool helps users to select photos with the right colour features, which can then be printed, cut out, and glued out to form a photo collage of a photo. This idea was inspired by Tina, the paint artist, who talked about the use of colour and about how fellow painters would sometimes paint a copy of an image, which she did not consider art, while she preferred to do 'something special' with an image. This idea calls up questions around what is art or craft. Painting by numbers, from which this idea is derived, is not considered art by most, but it does provide a good platform for beginners to explore painting and colour

composition. This links back to the question posed earlier: how can a system effectively support crafters, without taking away the craft element? A related exploration in this direction is how much the time and effort users may spend crafting physically or digitally (Number 5), and how a system can support this.

MIXING MATERIALS

Several ideas focused on mixing different physical or digital materials, or both, in the creation of multimedia or hybrid objects. The 'multimedia slideshow' (Number 12) uses a software tool and connectable slide-layers to create physical multi-layer slides (e.g. with images, music, and voice), which can then be used in a multimedia slideshow using a projector. This idea was inspired by Lucy, the mixed media artist, who liked to combine different materials. Similarly, in hybrid craft different physical and digital materials can be combined in various ways.

MATERIALITY

This family encouraged thinking about implementing materiality in the interaction with digital media, such as using material interactions or implementing different affordances and feel of digital materials. An example is 'material probes' (Number 15): a number of physical objects that explore how different digital media may feel, e.g. a video may feel smoother than a photo, and a website may have a different shape than an audio file. This idea was inspired by Mary, the glass artist, who mentioned how much she loved the feel of the physical materials she works with; how can such material characteristics be introduced in the digital realm to support hybrid craft?

USING PHYSICAL STRENGTHS

Four ideas were grouped in a family that addressed using the strengths of physical craft in digital or hybrid craft. One example is the 'clay tool' (Number 18), which was inspired by Paul's creativity in making his own tools in guitar building. The clay tool allows crafters to create their own computer input device by using a set of sensors and actuators and a lump of clay, so they can make the

appropriate tool for each task at hand, instead of having to rely on manufactured, generic tools. Another example, inspired by John's love for recycling materials and creating beautiful things from used materials rather than discarding them, was the 'train ticket project' (Number 21). This is essentially an art project in which skilled crafters create a piece from used train tickets while keeping in mind the origins and destinations of these tickets. People can donate their tickets and will receive access to a bespoke website that lets them keep track of the project, get in touch with the makers, contribute to the making, and discuss the project with others. A final example is the 'maker's stamp' (Number 22), which was inspired by the observation that Jim's craft is actually anonymous; people see the hairdos he has created but in most cases they do not know who has made them. Similarly, in digital realms it is often not known who the artist or crafter is, or they are known under a pseudonym. In contract, in most physical craft disciplines, crafters have ways to show the work is theirs, either by using specific techniques, signature creations, or branding a creation (as John did with his craft). The maker's stamp is a physical stamp that can mark digital craft through tangible interaction so that it is always identifiable as being made by that crafter.

USING DIGITAL STRENGTHS

As counterpart of the previous one, this family looked at what digital strengths may enhance a physical craft practice, such as recording and collating information easily or showing the process of making. 'Interactive art' (Number 13) allows for the creation of an interactive art work by triggering paint balloons to pop through text messages. Different messages can have different results so the process of making will be visible in the result. A similar idea that was, same as the previous idea, inspired by Carol was 'communication art' (Number 17): using an interactive canvas, stored communication (e.g. text messages, emails) or communication that was had during crafting, can be selected, included in an artwork, and displayed. Carol enjoyed making creations for specific people and often remembered her making process; using a system such as communication art, her memories and communication with that person can be embedded in a craft piece to potentially make it even more valuable.

SOCIAL CRAFT FORMS AND COLLABORATION

Finally, several ideas include social elements, such as collaborative craft or increasing awareness of the presence of other crafters. An example is 'collaborative crafting' (Number 16), which was inspired by Vicky, the silk painter, who had made a collaborative piece with her silk painters group. Collaborate crafting can be more easily done in the digital realm since it offers possibilities for remote collaboration via the internet. Using digital media, friends each create a layer of a collaborative piece that is subsequently combined. Layers overlap and thus can obscure underlying work, which calls up questions around the editability of digital craft and respect for others' work, e.g. similar to street graffiti codes of conduct, will crafters respect the underlying work of their peers by not obscuring it but instead working around it? Another example is the 'online guild' (Number 19), which is a place where interested crafters can get together to share their love for their craft, and digital apprenticeships can be established. Members have to be committed to the guild and contribute to the community; instead of merely 'taking' the information that is available as is the usual approach to online resources. This idea was inspired by Paul's wish to only teach those students who were committed enough to guitar building.

These families of ideas were considered promising directions for further ideas around hybrid craft. They were used in combination with findings from the prototype evaluation (Chapter 6) and a comparison of interview findings around physical and digital craft to formulate design guidelines for hybrid craft (Chapter 8). These guidelines were used to generate further design ideas (Chapter 9) that aimed to combine physical and digital more strongly based on collated findings around hybrid craft, because in some ideas in Chapter 5, craft was fairly simplistic on the digital side, e.g. it merely consisted of bringing in digital media, but there was no real digital crafting or editing process involved. Ideas nevertheless highlighted interesting themes within design for hybrid craft, and further led to the design of the Materialise craft set, which will be described in the next section.

DEVELOPMENT OF CRAFT SET 'MATERIALISE'

After ideation and the creation of concept sketches, design concepts were considered for further development. Ideas were informally evaluated based on feasibility (could the idea be prototyped in a suitable way?); relevance and depth (was the idea an example of hybrid craft that could serve to increase insight in this area?); and originality (was the idea novel enough to generate ideas for further design and possible applications?) Based on these criteria, the Mixtape 2.0 idea was chosen for further development (Number 14 in Figure 5.2, and Figure 5.3a) because it was believed capable of representing a hybrid craft practice at a fundamental level, which was beneficial for exploration of what this practice may be. This idea was inspired by Lucy's practice of mixing physical and digital craft materials in her artwork and 'exploring media', including the use of personal photographs to explore her own identity. The Mixtape 2.0 idea consisted of a building set that allowed for the creation of a customised media cube by connecting six physical building blocks, which could each hold one specific digital media file, e.g. a photo, an audio file, or a text message, that represented something that was important to the crafter. The physical object could then be decorated and edited, and there could be an associated website with stories behind media, in case a cube was created as a personalised gift. This idea was developed into a much more flexible and open-ended building set for hybrid craft, called 'Materialise'. Instead of building a cube with a fixed number of components, a platform was developed that consists of building components in many different shapes and forms that each can have their own building possibilities and options for including digital media, in order to provide more flexible ways for crafting which appeared so important for the physical crafters. Figures 5.3b-c show sketches that were done to explore which blocks could be included and how they may be connected. To allow for great flexibility, magnets were used to connect building components; the development of the prototype and which blocks were included will be further addressed in the next section.

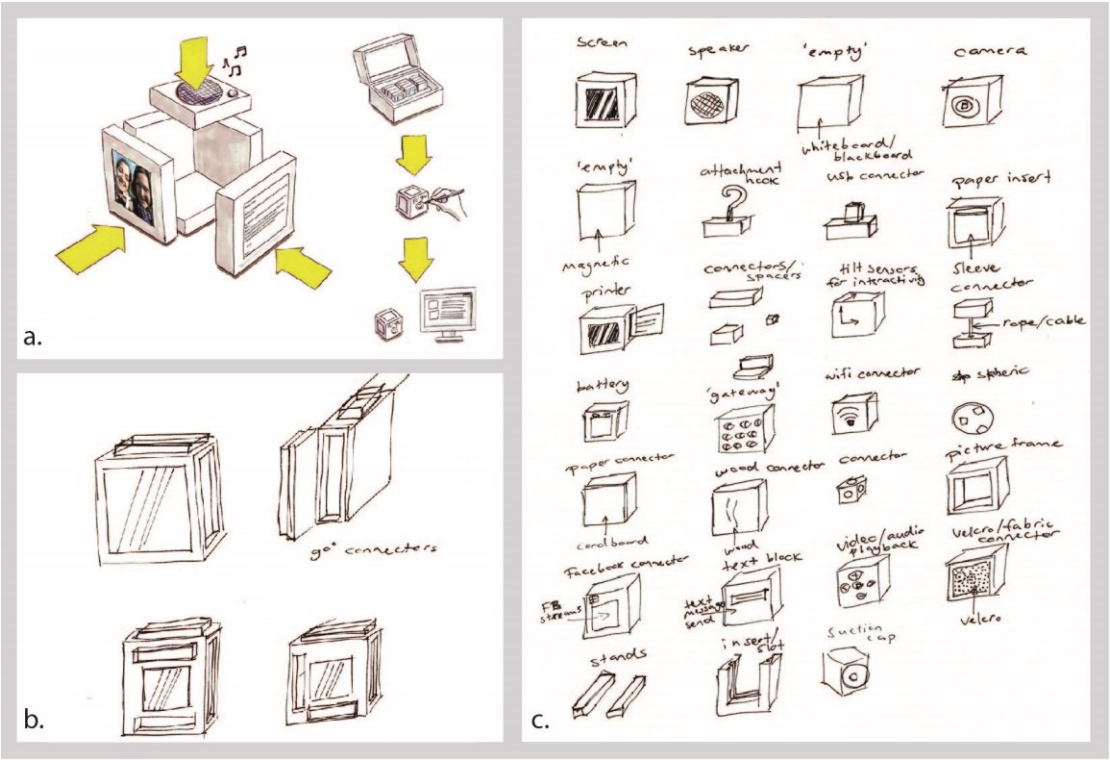


Fig. 5.3a) concept sketch of the Mixtape 2.0 idea; b) exploring connectors; c) sketches that explore which blocks can be included.

The 'Materialise' craft set consists of physical building blocks, some of which can incorporate digital media – in the prototype this is operationalised through the provision of a screen or audio player and speaker. Physical and digital components can be combined in various ways for creative applications, due to the provision of building blocks in different shapes and materials which can be connected in various ways and orientations. As a means to create compositions from physical and digital materials, Materialise not only addresses forms of craft that include existing elements (e.g. media files), but also addresses views in materiality research that consider 'composition' a key factor in successful integration of physical and digital materials in design (e.g. Kwon et al., 2014, Wiberg et al., 2012, Wiberg and Robles, 2010). To support the integration of the digital media files, a software application was implemented that allows users to start composing how the digital media will be integrated in the physical creation, by showing digital representations of the physical building blocks that display the digital media. These blocks can be dragged, rotated and connected in the software in much the same way as the actual physical blocks.

Extending the idea behind the Mixtape 2.0, it was intended that Materialise would primarily be used with *personal digital media*, such as people's photographs and favourite music, because this was assumed to provide a valuable context and goal for hybrid craft that people could relate to, e.g. the creation of personal, interactive, physical-digital media objects. Materialise further embodies the family of ideas around mixing materials, and incorporates some digital strengths (e.g. dynamic display, editability and interactivity) in hybrid craft. Looking back at the thematic results from the physical craft interviews, it is anticipated that the set will be able to provide insight in the autotelic nature of the craft process, surprises and novelty in the process, potential use of craft results, the use of physical techniques and existing physical materials (mostly how they are combined with digital materials), social dynamics around hybrid craft, and enjoyment of craft. In its current design, the set does not allow for extensive exploration of learning craft and developing craft skills, properties of physical materials in relation to digital materials, physical tool use and selection, and crafter identities. However, it would be impossible to explore all these dimensions with a single design, and Materialise aims in the first place to explore hybrid craft: everyday creative practices which use both physical and digital materials, techniques, and tools, to make physical-digital creations. Materialise supports a hybrid craft *process*, by including both physical building with physical components, and digitally composing the media on screen. It further supports a hybrid craft *result,* by resulting in a creation that is interactive (more about this in the next section) and includes both physical and digital materials. Workshops with the prototype (Chapter 6) allowed for an evaluation of the extent to which Materialise is (hybrid) craft. Themes that were not addressed directly in the design, such as the influences of material characteristics and tool use, were later reflected on based on workshop findings, and conceptual ideas were formulated that could serve to further explore these themes in future research (see Chapter 9).

PROTOTYPE IMPLEMENTATION

A prototype of the Materialise craft set was implemented (Figure 5.4) to be used in a set of creative workshops to explore hybrid craft, and designing for hybrid craft. For feasibility reasons, only a selection of building blocks were implemented, which consisted of three 'active blocks' – which contained digital media files – and a large variety of 'passive blocks'– which were not interactive and did not contain digital media but could be used to build physical structures. Further, a software application was implemented that could be used to position and upload media to the active blocks.

Fig. 5.4 The Materialise prototype.

ACTIVE BUILDING BLOCKS

Two different types of active building blocks were implemented. The first type had a touch screen (Figure 5.5a). This type of block could display a series of digital images, and provided interactivity by allowing the user to press the 'next' and 'previous' buttons on the screen to change the image, or it could automatically display a sequence of images by activating a slideshow on the touchscreen. The second type of active block could play digital audio files (Figure 5.5b). It could play a sequence of sounds by pressing 'next' and 'previous' buttons on the block. Due to prototype limitations – the electronic components were too bulky to integrate a speaker in a reasonably sized block – an external speaker was used that was plugged in to the audio block and could be connected to any block with a magnet. Using a long extension cable, there was still plenty of flexibility in where this speaker could be placed. Three active blocks were implemented for the prototype, of which two were of the image type and one of the audio type. The active blocks were implemented using the .NET Gadgeteer prototyping platform[28] and programmed using the C# programming language. Apart from a touchscreen or an audio module all blocks had Wi-Fi capabilities, and a micro-SD card reader. Casings were designed in the CAD software Solidworks, and 3D printed so that each block was as compact as possible for the electronic components that were needed, and magnetic connections could be provided on the outsides of the blocks. Wi-Fi capabilities were used to download media content wirelessly from a webserver, which was the dedicated place for users to store media they wanted to upload to the blocks. Media content was downloaded and saved on the micro-SD card and consequently displayed or played back. Each block further had a 'reload' button which could be used to reload media files from the server if the content on the server had been updated by the user. Wi-Fi capabilities were further used for communication between active blocks. Whenever content was changed on one block, either because a slideshow was activated, or by user input, the filename of the new media file that was displayed or played was passed on to the other blocks wirelessly. The other blocks then checked if their file lists contained media with this file name and, if

[28] http://www.netmf.com/gadgeteer/ (Accessed June 2014).

this was the case, displayed or played that media. This allowed users to associate multiple related media files and display them at the same time, e.g. two photos taken at the same event, and an audio file related to that same event. This function provided interactivity for the hybrid creation; apart from being able to easily change the physical composition, digital media on the blocks could be easily changed and updated by the user to alter the hybrid end result.

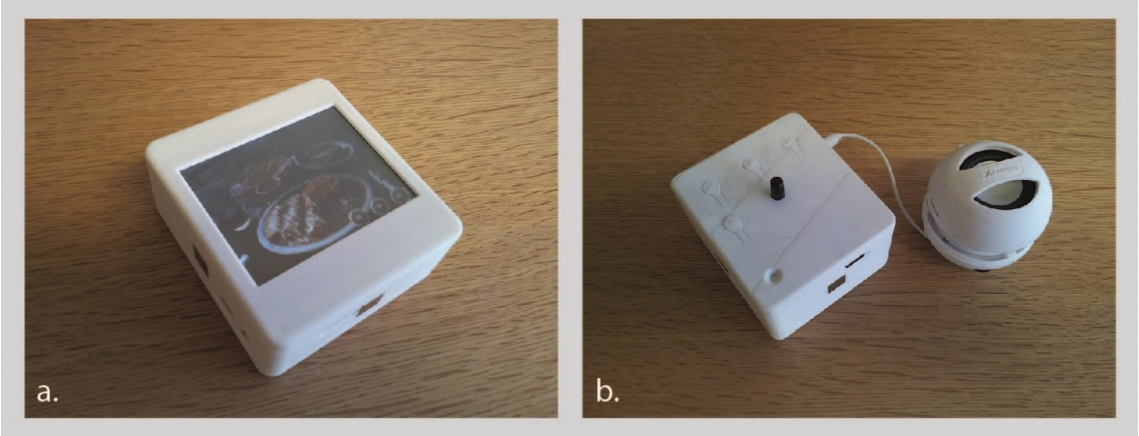


Fig. 5.5 The prototyped active blocks: a) image building block; and b) audio building block with a speaker.

PASSIVE BUILDING BLOCKS

Passive blocks did not have interactive functions but could be used to enhance the physical composition. Most passive blocks were made of wood and included: four white cubes that could serve as whiteboards; four cubes that were painted with blackboard paint; nine bar-shaped blocks; a frame; four rings; two blocks with hooks. Further building blocks were: a pin board; a clip; two magnet boards; and magnetic transparent sleeves. All building blocks, including the active building blocks, were equipped with a number of magnets to allow for them to be connected in different ways. To provide more flexibility in how blocks could be connected metal connector strips were also provided of different lengths and with different angles. See Figure 5.6a for examples of passive blocks and connector strips. Furthermore, whiteboard markers, chalk, paper and pens, scissors, and pins were included to allow users to write, draw, and attach notes to the creation. Finally, a variety of Lego bricks were provided which could be

connected to the other building blocks in a number of ways: some Lego bricks were equipped with a magnet on the underside; other Lego bricks were adapted to have magnets and small metal discs on the top; and a wooden block was provided that had holes in which Lego bricks could be clicked for further building flexibility; see Figure 5.6b for the Lego connector blocks. The passive blocks and connector strips in combination with the Lego bricks were expected to provide the users with great flexibility to execute their ideas about what they wanted to create physically, and in addition provided means to bring in additional materials – for example magnetic objects – beyond the set.

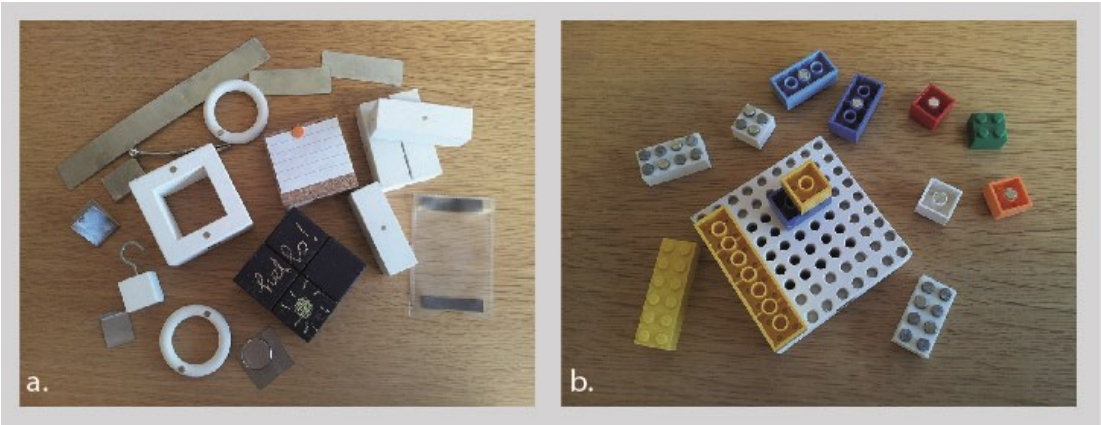


Fig. 5.6a) Examples of passive building blocks and connector strips; and b) Lego connector blocks and adapted Lego bricks.

USER SOFTWARE

With help of a professional software engineer, the researcher implemented a software application in the programming language Delphi. This application allowed users to start exploring the hybrid composition digitally, and helped them with the media uploading process. The software showed digital representations of the active building blocks that could be dragged and rotated to explore the physical composition. By clicking a digital representation of a block (Figure 5.7a), a pop-up window would appear which would allow the user to drag and drop media content from a directory on their computer to the block. Image files could then be seen on the illustration of the block to give the user an idea of what it would look like on the physical blocks and thus how this may be

incorporated in a physical creation (Figure 5.7b). After selecting media and dragging these to the desired blocks the user had the option to change the target file name of each media file to be able to link related media on the active blocks; after all, files with the same file name were displayed at the same time. After renaming, media could be uploaded to the webserver, from where they were downloaded by the active blocks, which each had their own dedicated directory on the webserver. The software provided functions to either add the media to any media that was already on a block, or overwrite existing media and form a new set of content. Restrictions of the implementation of the user software were the absence of built-in image editing possibilities, such as rotating, resizing and cropping images; and audio editing possibilities, such as clipping a section of audio, and changing the bitrate. Because these functions were important for accurate functioning of the active blocks – images needed to be adjusted to fit the screen resolution and the audio bitrate needed to be 128 kbps or lower for smooth audio feedback – some preparation of media files using other software applications was needed during the break in the creative workshops.

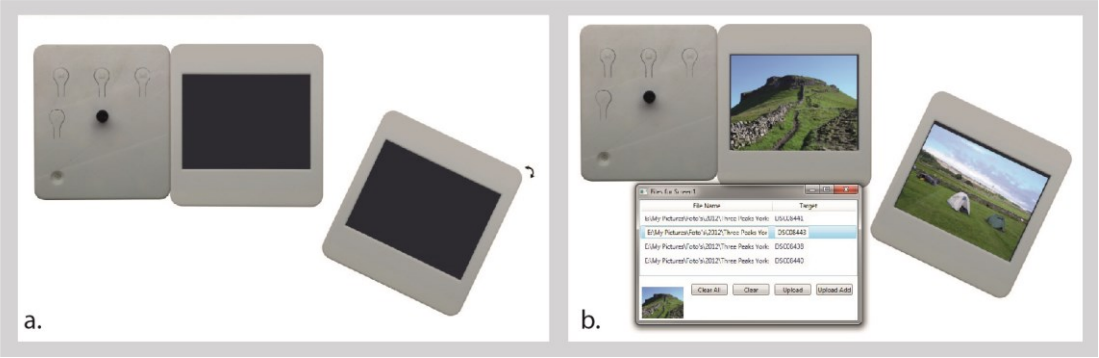


Fig. 5.7 Screenshots of the user software: a) representations of the physical building blocks that can be dragged and rotated; and b) a pop-up window could be used to drag and drop media content to the media blocks and display these.

OTHER ENVISIONED FUNCTIONALITY

Because of technical limitations in the .NET Gadgeteer prototyping platform, and time restrictions, not all envisioned functionality was implemented. As addressed, the blocks could display images and navigate through an image sequence; show a slideshow; play audio files and navigate through the audio

sequence; and communicate wirelessly with each other and a webserver. Other functionality that was not implemented was brought up in the workshops to get participants thinking beyond the current possibilities, and included: downloading content from Facebook, e.g. displaying a Facebook photo on one block and the comments with that photo on another block; live feeds from the internet, e.g. Facebook status updates or Tweets; playing videoclips; easy ways to load web content to the blocks; and text content, e.g. email or forwarding text messages from a mobile phone to a block.

Example of a Dynamic Hybrid Creation with Materialise

In order to illustrate how Materialise could be used to craft hybrid, interactive creations, an example was created that used online available digital media (Figure 5.8). In this example, the image blocks displayed a series of images of cartoon and movie characters headshots (e.g. the Men in Black, the Muppets, Wallace and Gromit, the Blues Brothers); for each movie an iconic duo was included. The physical creation around these blocks represented bodies for the characters so that the physical and digital elements form a meaningful integration of complete characters. The audio block contained the theme songs of all the movies the displayed characters feature in. This creation was realised by first finding the relevant images and audio online, and editing these to create short audio snippets and cropped headshots. The Materialise user software was then used to drag the media to the different blocks and rename the related media so that all files in each set (two images and one audio file) had the same names and were linked. Finally, the physical bodies were created from diverse components available in the set. The hybrid creation was interactive and could change over time: when changing an image or the audio (by pressing a navigation button on a block), the other blocks automatically selected the files that complemented the new image or audio file, so that each block represented media from the same movie. The creation thus reacted to changes made by the crafter. Similarly, the slideshow function could be activated on an image block, upon which the block automatically scrolled through the images, and thus caused

the other blocks to adjust dynamically over time[29]. Although the physical creation did not change with the digital media, a crafter was free to change physical compositions, or find new digital media that could be added to the creation, or used to overwrite the media that was already uploaded to the blocks.

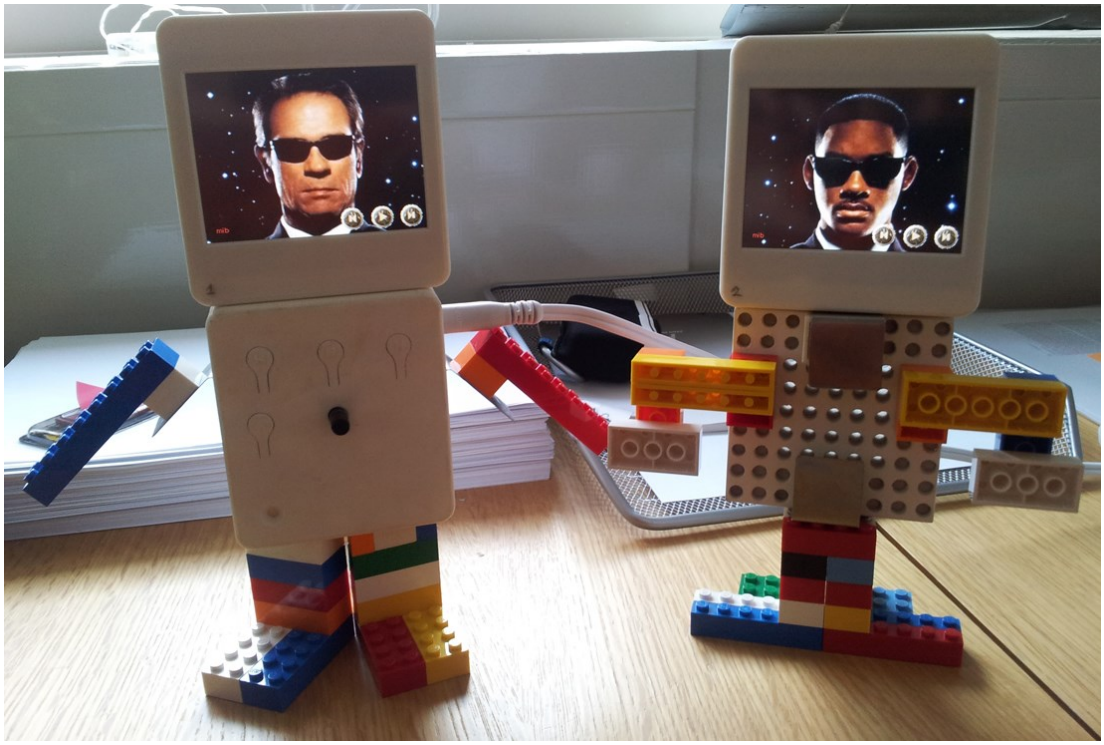


Fig. 5.8 Example of a hybrid creation with Materialise: while the physical body was static, the digital images showed different examples of cartoon or movie duos that were linked and thus displayed at the same time. The examples were further linked to the theme songs of the movies or cartoons, which played at the same time as the images were shown.

To summarise, this chapter has shown the design journey that started in ideation activities and ended with a design prototype of the 'Materialise' craft set that was subsequently used to study hybrid craft (Chapter 6). It has included annotated conceptual design work that in itself forms an intermediate level theoretical contribution to the field of interaction design (Löwgren, 2013), and has highlighted promising directions for further design for hybrid craft. These will be taken forward to Chapters 8 and 9 along with the findings of the interviews and workshops with the Materialise prototype.

[29] See http://www.conniegolsteijn.com/docs/phd/materialise.mp4 for a video of this creation in slideshow mode (Accessed June 2014).

6 Creative Workshops

EXPLORING HYBRID CRAFT THROUGH THE USE OF 'MATERIALISE'

The prototype of the 'Materialise' craft set was used in a series of creative workshops to explore hybrid craft practice[30]. These workshops included hands-on experience with this 'placeholder' design (Gaver and Martin, 2000) that facilitates hybrid craft, as well as group discussions and design activities. As addressed in Chapter 5, Materialise focused on hybrid craft with personal digital media, since this was expected to result in personally meaningful creations and could encourage people to engage more with their digital media. The hands-on experience with the prototype was therefore built around the workshop participants' own media. The workshop aimed to evaluate the design of the Materialise set, as well as derive more general insights around hybrid craft practice by observing how one would go about hybrid crafting with personal digital media; what characteristics of hybrid craft could be witnessed in the use of Materialise; and how the design of the set facilitated hybrid craft practices and how it may be changed to suit the observed practices better. Four two-hour workshops were held, each with three or four participants. The workshops were held with small groups because participants had to collaborate in the workshops using the one-off prototype and a laptop, and it was important that each participant had the chance to be involved in this.

[30] Sections of this chapter have previously been published in Golsteijn et al. (2014).

PARTICIPANTS

The first workshop was held with a group of designers, the second with a group of parents, the third with a group of teenagers, and the fourth with a group of crafters. Each of these groups was considered to be able to provide useful comments either from the perspective of creators and makers – to consider design implications for hybrid craft (the crafters and designers) – or from the perspective of potential target users (the parents and the teenagers). The group of designers consisted of professional designers and postgraduate researchers in interaction design. In line with the definition of craft upheld for this thesis, the definition of who may be considered a crafter was deliberately kept open to include anyone who liked to make things with physical materials or tools; similar criteria were used as in the recruitment of physical crafters for the interviews[31]. All participants were recruited from the personal and professional networks of the researcher through e-mail and verbal explanations of the study. The workshops took place in a meeting room at the University of Surrey, with the exception of the designers' workshop, which took place in a meeting room at the designers' own place of employment. Participants were paid a small incentive (£20.00) for their participation. In each workshop two researchers were present: one facilitator – the author of this thesis – and one other – another PhD researcher – who was in charge of recording audio, video, and photographs.

Thirteen participants took part in the workshops (three men and ten women, ages ranging from 17 to 56; average age: 34), of which three were designers; three parents; four teenagers; and three crafters (Table 6.1). All the designers knew each other through work; two of the parents were also work colleagues, while the third did not know the others; the teenagers were a group of friends; and two of the crafters had met each other once before through a mutual friend. Because all groups were expected to give useful insights, but a comparison of

[31] The workshop participants did not include 'digital crafters' because the realisation that more insight was needed in digital craft – based on reflection on the design ideas – was reached in a parallel process with the organisation of the workshops. Although digital crafters may have given different insights, it is believed that the crafter participants nevertheless gave useful views on Materialise from a crafter perspective, especially because the digital craft side of Materialise was fairly simplistic (as addressed in Chapter 5).

groups was not the aim of the study, the results for the four groups are addressed together in later sections.

Designers		Crafters	
PhD researcher in interaction design	F, 31	Secretary (knitting, embroidery, sewing, spinning)	F, 51
Interaction designer	M, 42	Information security (jewellery making)	M, 53
PhD researcher in interaction design	F, 31	Senior tutor and jeweller (jewellery making)	F, 40
Teenagers		**Parents**	
Recently graduated college student	F, 17	Youth worker; parent of 2 (aged 3 and 7)	F, 25
Recently graduated college student	F, 17	Researcher; parent of 1 (aged 16)	F, 56
Recently graduated college student	F, 18	Researcher; parent of 4 (aged 7, 11, 13, and 16)	M, 46
Recently graduated college student	F, 18		

Table 6.1 Professions (and crafters' crafts), gender, and ages of the workshop participants.

WORKSHOP METHOD

Within the workshops' focus on personal digital media, participants were asked to bring, or email to the researcher beforehand, some of their own digital media to use with the Materialise prototype. The prototype was limited to the use of digital images and audio but this was believed to be a powerful combination (Frohlich, 2004) and capable of evaluating the concept of a multimedia hybrid craft practice. Participants were asked to select from their own media, search online, or create, 5-10 digital images that were interesting, meaningful, or beautiful to them, such as personal photographs, digital artworks, or screenshots from online content. They were further asked to select, search online, or create, 1-5 audio files that were in one way or another related to one or more of their images, for example a song that reminded them of a holiday of which they had included a photograph, or a recorded narrative about an image[32].

The sessions themselves started with welcoming and introducing participants, researchers and the topic of the workshops, followed by three parts: I – a demonstration of the prototype and software; II – hands-on experience with the prototype; and III – a group discussion about participants' experiences, potential

[32] It was expected that it would be more difficult for participants to find personally relevant audio files that were related to their visual materials; therefore the requirement for number of audio files was lower than that for images.

use, improvements and extensions. The following sections will describe each part in detail, while additional material for the workshops (the preparation request, interview schedule, participant information sheet, and consent form) can be found in Appendix D.

PART I: DEMONSTRATION OF THE SET

The demonstration included showing the participants the physical building blocks, the software, and the functionality of the active blocks, as well as verbally introducing other envisioned functionality, in order to get them to think about what they would like to make with their own media. The demonstration was done by step-by-step showing the uploading of media with the software, demonstrating how the media had been uploaded to the blocks and how the blocks interacted with each other, and showing a photo of an example of a physical creation built around these media. The example that was used has been presented earlier in Chapter 5 (Figure 5.8).

PART II: HANDS-ON INTERACTION WITH THE PROTOTYPE

Hands-on experience with the prototype was considered a crucial element of the workshops, because it was expected to be difficult to envision what one may do with such a craft set without trying it, and exploring with one's own media. To this end, participants were asked to do two tasks (see Appendix D for the task sheet) that were designed to familiarise them with the set before asking them to create something with their own media. Both tasks were collaborative because there was only one prototype of the building set available. Participants were left free to devise a task division within the group but the facilitator did keep an eye on the participation, making sure to include all participants in the process.

Task 1: Hybrid craft with example media

To familiarise participants with the set, participants were first asked to build a hybrid creation around a set of example media provided by the researcher. In this task the focus lay on getting to know the prototype and software, while creating something around the media was deliberately kept simple by using sets

of already related media. The media used in this example were a set of images related to Jamaica and reggae; a set of images of London; a set of images of Paris; a set of soundscapes of cities, e.g. traffic and crowds talking; the sound of beach and waves; and a Bob Marley song ('Three little birds'). Using these related media (within the Jamaican theme or a city theme) made creating conceptually easier for participants, although they were free to combine whatever they wanted. This first task was started with composing and uploading a set of images and audio using the user software, for which a software manual was created to support the participants (see Appendix D)[33]. After these images and audio appeared on the physical blocks, participants were asked to build something that was related to these media.

Task 2: Hybrid craft with participants personal media

After a short tea break – in which the facilitator prepared the participants' media, i.e. resized images and changed the bitrate of audio files for reliable functioning of the prototype – participants were set to a second task: building a hybrid creation around their own personal media. This was expected to be conceptually more challenging but participants were already more familiar with the set. In this task, they used a laptop to select media from the collections they brought into the sessions, again in a collaborative activity, and used the software to compose and upload images. There was further opportunity to create new content, e.g. audio narratives, or source new content online. Additional software that was available on the laptop to support these processes was the freeware Audacity[34] and iTunes[35], and Microsoft Office Picture Editor. For these software applications and the actions participants may need to do with them, custom user manuals were created to support participants who were not familiar with these applications (see Appendix D). Apart from this exploration with digital media, participants were asked to upload the digital content to the physical devices, and

[33] The aim of the workshop was not to evaluate how well the prototype could be used without support, or how intuitive it was, but rather get insights from use of the prototype. It was therefore important to support the participants where possible in the use of the prototype, to enable as smooth a process of hybrid craft as possible. Because the user software was prototyped with limited functionality, not all features were optimally implemented, so it was considered beneficial to support the users with a software manual.
[34] http:// www.audacity.sourceforge.net/ (Accessed June 2014)
[35] http://www.apple.com/itunes/ (Accessed June 2014)

create physical constructions using the craft set and other available materials. It was anticipated that participants would switch between working with the digital media and physical building, and that they would try out multiple combinations of physical and digital creations. There was also interest in seeing how participants would negotiate between adapting the physical to the digital content or vice versa, which was why, in this task, the digital and physical creation phases were introduced simultaneously and participants were free to determine which to do first, and to switch between phases.

PART III: GROUP DISCUSSION

In the final part of the workshop, the group discussion, insight was gained in the participants' opinions on Materialise, as well as in potential use, improvements and extensions. These discussions were further used to derive ideas on how these insights may be applied to hybrid craft in general. The group discussion took place in all sessions except the designers' session, due to the participants' time restrictions. The discussion centred on the following questions:

1. What is the participants' general opinion on the craft set?
2. What would they like to use this set for? What physical blocks are suitable or desired for this? What would they do with the result?
3. What digital media would they like to use? In what way? Would they use it for static creations and with existing media, or would they value dynamic, streaming media, such as Facebook feeds?
4. What other building blocks can be thought of? *For this question participants were given a sheet of paper with template sketches of blocks to design their own extensions.*
5. What would they change or add to the software? What would be interesting digital extensions?

The group discussions were semi-structured, and the facilitator adjusted the sequence and formulation of questions to the course of the discussions. All questions were discussed with the parents, teenagers, and crafters.

DATA COLLECTION AND ANALYSIS

Collected data consisted of video and audio recordings, participants media, design sheets with ideas for other blocks (Question 4 in the group discussion), and written notes taken by the facilitator and the other researcher on observations and comments in the group discussion. Data analysis was done thematically and focused on the observations around hybrid craft as facilitated through the Materialise design. Video recordings of the workshops were watched, and interesting observations were thematically categorised by taking notes. Since the observed hybrid craft practice in these workshops was inextricably bound up with the design of Materialise, the next section addresses findings around observed practices alongside reflections on the design, and design improvements, organised into sections about hybrid craft process, hybrid craft result, and potential use of the set (mainly informed by the group discussions). The concluding section reflects on Materialise on a higher level and addresses how observed practices may be applicable to hybrid craft in general.

RESULTS: HYBRID CRAFT WITH MATERIALISE

The thirteen participants together brought in 121 images (ranging from 5 to 25 per person, 9 on average) and 45 audio files (ranging from 1 to 7 per person, 3.5 on average). All participants brought at least one set of related media; either an audio file related to a photo, or two related photos. The majority of the images were unedited photos, either downloaded from the internet, but mostly taken by participants themselves (e.g. of nature scenery, participants and their families and friends, and specific events, such as graduation). Only two images were self-created: an electronic self-portrait, and a photo of a participant and her partner that was edited into a black and white 'pop art' representation. Most participants indicated that they chose images that were somehow representative of different aspects of their lives, such as photos of people, or of things they had made themselves, but there were also instances in which participants carefully constructed combinations of images and music, such as one participant's example of her photo of the Berlin wall in 1989 coupled with the music from the movie 'The lives of others', which is set in Berlin around that time. Audio files

were less personal and were more often downloaded from the internet to fit with images or to provide a diversity of examples, for example ambient sounds of crowds, cities and nature, voices and laughter (19 files), and music (16 files). However, there were also personal examples, such as one participant's radio interview with his grandfather, and a teenager's recording of her talking to her father in a restaurant when she was a small child.

Table 6.2 summarises what the different groups of participants created in Tasks 1 and 2 of the workshops. In the first task, participants worked together on a hybrid creation around a set of example media, which resulted in three explorations of the Jamaican theme and a city-themed creation. The second task appeared to be 'pushing creativity' much more. Participants selected media to use collaboratively by going through their files and telling each other what they had brought, how their files were connected, and the stories behind these files. Because media were so diverse, finding a common theme in their media proved challenging to participants.

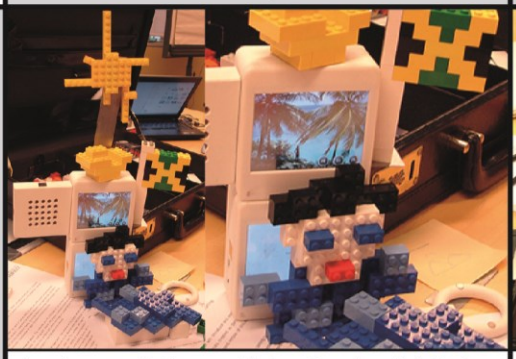
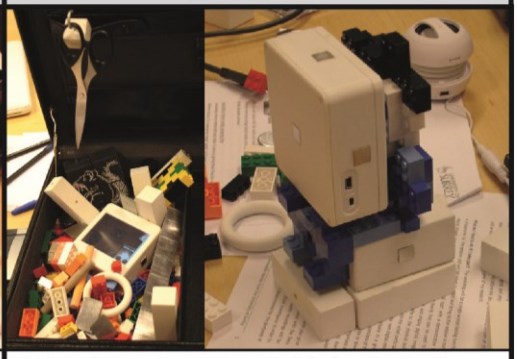
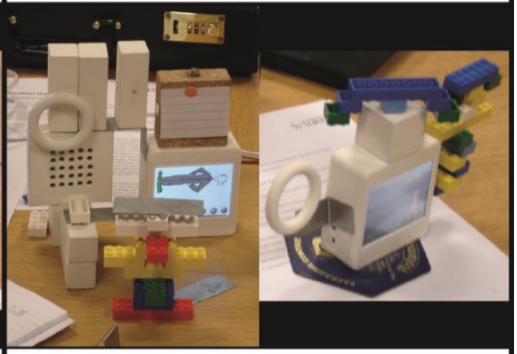
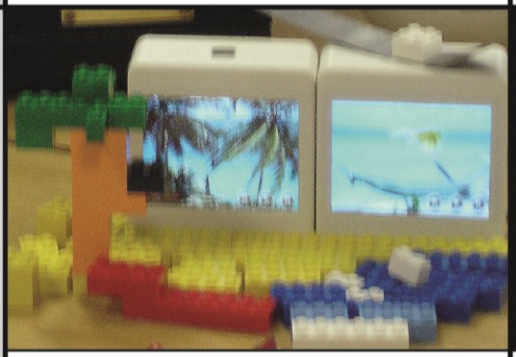
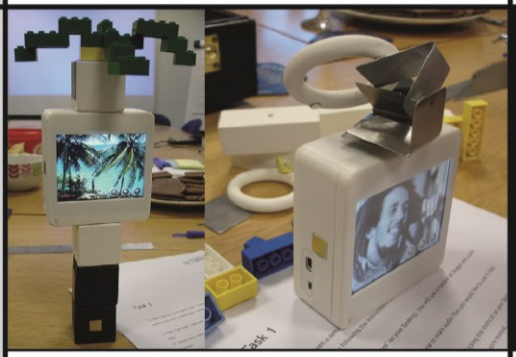
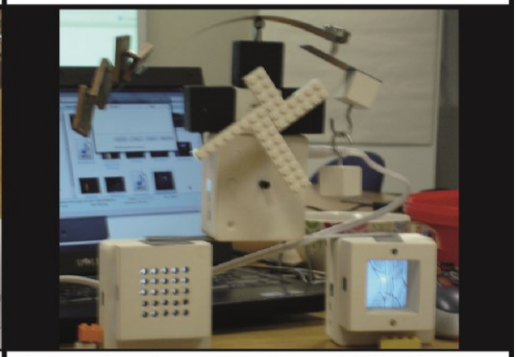
	Task 1 (example media)	Task 2 (participants' media)
Designers		
	Jamaican media theme with Jamaican flag, Bob Marley being washed away by the waves, one of the Three Little Birds and the sun (overview left, detail right).	"Urban diorama" consisting of a "Banksy-inspired" graffiti piece, pillars, piles of rubble, and a car claw (left) and a man on a toilet (right).
Crafters		
	City media theme with (left to right): a bus stop, a London taxi, a cathedral.	Left: unexplained creation around a participant's cartoon image of herself with the sound of laughter and a rabbit (left) and a tea pot (right).
Teenagers		
	Jamaican media theme with the beach, waves, sunset reflecting on the water, and a seagul.	A model of the college with the piazza, the "yellow umbrellas", and the "trees where the freaks hang out", photos of their classmates and a Britney Spears song.
Parents		
	Jamaican media theme with palm tree (left) and Bob Marley with unexplained moveable magnetic exploration (right).	Berlin wall creation: obscured vision (left), looking at a thematic stained glass window through a window (right), "balance thing", and "windmill of change" (top).

Table 6.2 Overview of what the different participant groups built in Tasks 1 and 2.

The designers chose to first go through the media together and tell each other what they had brought and why. They tried to identify a common theme and chose an "animals and people" theme for the first screen, and an urban/war theme for the second screen: "I like the juxtaposition of the war theme with the cats fighting." The audio block contained files that related to both. The physical constructions were a man on the toilet, accompanied by the sound of a flushing toilet, and an image of an art piece of a pair of legs; and an "urban diorama" consisting of a "Banksy-inspired" graffiti piece, pillars, and piles of rubble created in the briefcase, which was meant to be "provocative, not beautiful!" In the parent group, a participant told the story around some of her media files:

> "This is an image of when I was at the Berlin wall when it was coming down in '89. This is the music from 'The Lives of Others', which is a film about people who are living in the east of Berlin, and it was a film made in 2006, and people in Germany said it's very accurate and representative of what was going on behind the wall. And the other one is a stained glass panel I made, actually after I went to Berlin. After I went in '89, I didn't go again for 20 years and I went to a conference and I collected many different quotes and things and made them into a stained glass panel […]."

The participants agreed to make a construction around that theme and they created an abstract piece around this theme that included: looking at a thematic stained glass window through a window; an obscured vision of what is being the wall (by using a block with little holes in front of an image block); "a balance thing" (to indicate the skewed balance of the situation); and "the windmill of change" (change caused by the wall coming down). The teenagers first uploaded some media and talked about what they could use, e.g. kids' photos or holiday pictures, while a particularly large audio file was downloading. The audio file was primarily used for sharing one participant's favourite song with the others and was discarded immediately after listening to the first minute of the song and accidently restarting the song: "oh no, we can't listen to that rap again!" They eventually decided to create a physical model of their college, having all just finished college, around images of friends that reminded them of their college time and the Britney Spears' song 'I'm not a girl, not yet a woman'. After the construction was finished they played the song and the teenagers commented:

– “I miss college!” – “It was like a nice place to hang out, wasn’t it.” One girl teased one of the others: “Are you getting sad now?” In the crafters group more random selecting of media took place and while one participant chose the media and experimented with the software, the others were building seemingly unrelated objects, such as a teapot, and were talking about their media files. The final creation was a collection of these objects which were “built as it went” and consisted of the teapot and a rabbit, with a few associated images around a nature and countryside theme. Because a comparison of groups was not the aim of this study, the results for all groups will be addressed together but where interesting differences were observed, this will be addressed below. The attentive reader may further notice that there is less use of direct quotes in writing up the workshop findings than in the interview study report. This is due to the fact that participants were mostly preoccupied and absorbed in creating with the set, so that comments to each other and the researcher were mostly mundane and focused on the task at hand, such as requests to pass certain components, or asking others to clarify what they were building, e.g. – “What’s this?” – “A sea gull.”

HYBRID CRAFT PROCESS

Looking first at the hybrid craft process observed with Materialise, interesting observations arose around the starting points for building, exploration and iteration; social dynamics; and the integration of physical and digital.

Starting points for building

Materialise provided participants with a predetermined set of blocks they could use, rather than providing the unlimited possibilities of a raw material, such as wood or clay. This was the case for both physical materials, and digital materials (using existing media files). In many cases it could be seen that participants found it easier to start the craft process from digital media and build something around these media (e.g. in the urban diorama that was created around city architecture images), rather than start by building something physical and choosing the digital media to go with this. This appeared to be, at least, in part caused by the fact that digital media already provided starting points around

which to build something, such as an event or object displayed in an image, while the physical building blocks left the possibilities for creation open, and, as such, were more difficult to use as a starting point. On a related note, participants did not create or look for any new media online, which could have helped them if they had chosen something to build physically first and select media after. This may well have been caused by time limitations, limitations in skills with editing software, and the expectation that they were required to use the media they had brought in. Given more time and freedom to explore – which was difficult to achieve to full extent in these workshops – it is estimated participants would iterate more between modes of digital and physical making and explore more in both phases; proceeding to trying out different physical constructions, and starting from these, rather than only talking about them. However, while participants did not search or create digital media to fit their needs, they proved to be very creative in overcoming some of the physical limitations, such as using the bended connection strips to provide connection points where they required them. Extra magnets were further provided, which were used often by participants to fortify connections, make parts move, or connect the metal connection strips to each other. In fact, for some participants these extra magnets, which were small cubes and spheres, were the most interesting parts to play around and experiment with. Finally, some of the provided materials were used in novel, creative ways, such as the use of pins, intended for the pin board, for a representation of barbed wire, the use of chalks in the urban diorama as pieces of rubble, and the use of the scissors to hang over the pieces of rubble as a sort of car claw in the urban diorama. As such, it could be seen that digital media were used less flexibly but did provide more inspiration for creating something, while physical materials, despite consisting of a predetermined set, still provided plenty of room to explore and fit in with a chosen theme chosen based on digital media. Although it can be challenging to find creative new angles to the content of digital media when these are brought in later, overcoming these challenges may increase the 'craftiness' and creativity behind the inclusion of digital materials. Both physical and digital materials can thus provide their own interesting starting points and it would be beneficial for allowing multiple interpretations and open-ended building opportunities if *possibilities for easy*

editing, manipulating, and sourcing new materials were similar for both physical and digital materials. These open-ended possibilities can not only be achieved by providing enough versatile physical parts, such as the extra magnets, but also, for example, by improving Materialise with tangible means for editing digital media – such as cropping media by breaking pieces off a block, or resizing media by folding or unfolding flexible blocks – or facilitating more abstract digital media searches based on theme, colour, or composition. Such tangible interaction mechanisms can further make the connections between blocks stronger – e.g. if one block is needed for another to function, or to edit another – which may prevent active blocks being used individually, as was observed in the sessions (more about this under Social Dynamics).

Exploration and iteration

Participants went through phases of exploration and experimentation with both digital media and physical building blocks – "let's just see what happens" – and in some cases the participants never indicated they were finished, continuing building until time restrictions required them to move on: "the problem is, we could tinker forever." Participants appeared keen to explore the possibilities with the prototype. A parent urged on the others in Task 1: "why are we reading the instructions, let's just do it!" Participants brainstormed potential things to make, such as "Bob Marley's 14 kids", "a real-life model of Bob Marley" or "let's make a cathedral, let's do something epic!" One designer sped off to his office to bring in his Lego model of a VW-van and asked if he could use it as part of the creation: "you don't get more beach than this." Other participants became fascinated with exploring how they could make constructions move by using the metal connector pieces and the attracting and repelling powers of the magnets; see Figure 6.1, while one parent marvelled: "I'm having a three-dimensional crisis right now." Also digital media were changed often, even after having downloaded them to the active blocks, and participants talked about what they could make with certain combinations of media files. However, in most cases the actual physical building only took place after participants had decided on a theme and had decided the media that should feed into that theme. In the final phase before building, participants eventually selected relatively few files to

upload to the blocks, 1-5 images per block, and one or two audio files; and the audio files were generally linked to one or two images, while about half of the images were linked to another image or an audio file. In several groups, the construction was not considered complete without sound: while the designers kept playing the Bob Marley song 'Three Little Birds' while building: – "so what happened to the music?" – "I think it was the general consensus that we'd have a few minutes of silence", after which the music was immediately activated again. One teenager commented, after finishing their beach scene: "We've lost the sound!"; saying after activating the sound of waves with their creation, in unison: "awwww!"

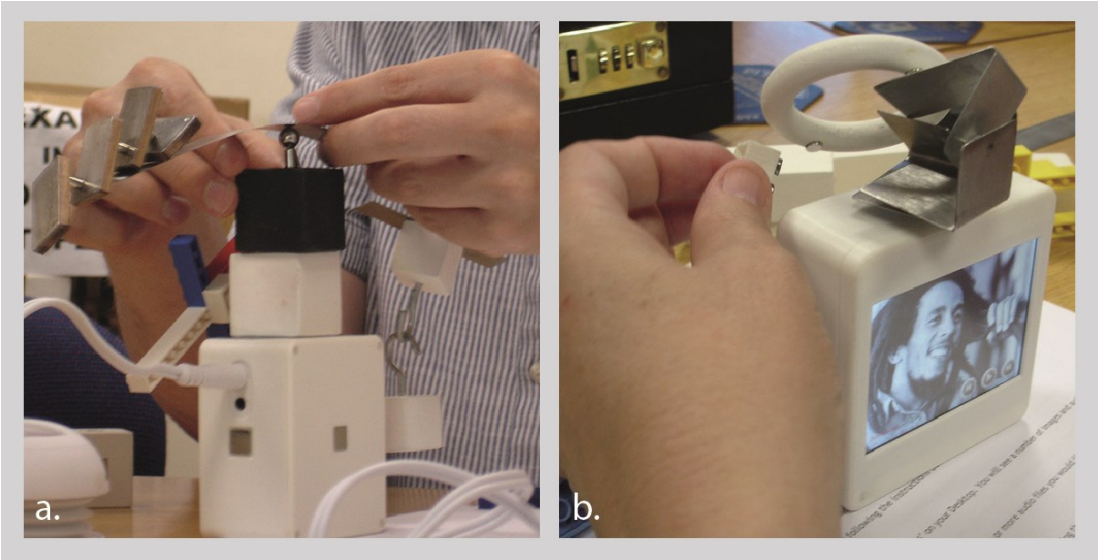


Fig. 6.1 Participants experimented with the attracting and repelling powers of the magnets to create moving parts.

For the hands-on hybrid craft experience it was anticipated participants would switch between phases of physical and digital building, and iterate several times. Although this happened to some extent, iterations in the process of making mostly took place within the digital phase, whereas the physical building came second and was a more linear process. In most cases participants finished the selection and composition of digital media before starting to build something physically. This was in part caused by the instruction for the first task, in which participants were asked to select media first and then build something related; it is likely participants extended the same procedure to the second task, in which

they were free to choose their own procedure. However, it could also be seen that while participants did upload different media to the blocks, in most cases they did not start building until they had a good idea of what they wanted to make. On the other hand, when left without instruction, such as during the initial demonstration and even during the breaks, the participants explored the physical building much more and came up with creative objects, such as the creation of a tea pot. This seems to indicate that participants felt freer to physically explore when they did not have to stick to a theme in their media and build something around this, which was coupled with more thought and planning. After all, when building around digital media the physical construction needed to fit a predetermined theme, while the physical blocks provided more flexibility beyond that. When facilitating hybrid craft, it was thus seen that *exploration, experimentation, and iteration should be encouraged both with physical and digital materials and across these realms* – it should be easier to switch between building with physical and digital materials, and ideally the ways of working with physical and digital materials should be similar.

Social dynamics

Apart from sharing stories behind their media and finding a common theme in a collaborate fashion, other social dynamics could be observed. In each group one participant took responsibility for managing the laptop, often after asking the others if this was okay. This role changed after the first part of the workshop, often encouraged by the person who did it earlier, who wanted to give someone else the opportunity, e.g.: "Does anyone else want to do the mouse? I don't want to be the mouse dictator." Apart from feeling 'in charge' of the laptop, participants often also each felt in charge of an active block because in most groups there were three participants and three active blocks. This can be illustrated by the following exchange between a designer and the person controlling the laptop: – "Don't I get any pictures?" – "Oh, you want a picture? What do you want?" – "A Jamaican one!" In all groups it was common for participants to build elements separately around the active blocks, which were then merely put next to each other (Figure 6.2a) or combined completely into a joined composition (Figure 6.2b).

Fig. 6.2 Examples of creations built separately by participants and then joined: a) the crafters' city creation; b) the parents' Berlin wall creation.

Looking at the different participant groups, it could be seen that the designers, who are professionally trained to work together in teams and come up with new ideas, worked together most effectively, both in media selection and in physical creation. The designers also seemed most comfortable with the set at the start, quickly understanding the linking of files and adjusting images to be displayed correctly. The other groups had slightly more trouble negotiating what media to use and how to divide the building, but all groups succeeded, even if participants did not know each other before the workshops. The parents even saw it as a good way to learn to collaborate, and as a fun activity to see unrelated items come together. Of all the groups, the crafters seemed to be most individual in their creation process and their final physical creation remained a collection of separately built objects (Figure 6.2a). These different practices highlight the importance of leaving the possibilities open for collaborative as well as individual creation, and Materialise can provide people with the means to engage in individual reflective creation as well as collaborative making, in this age in which making becomes more and more social (Gauntlett, 2011).

The use of participant groups may seem at first sight to contradict current craft practice, in which the actual making is often an individual activity. As such, the collaborative character will have influenced what was built with the set in the workshops and how it was used, for example there was less room for individual reflective craft processes and creations around themes of personal significance for one person. One of the designers commented that the collaborative aspect

made it challenging to find a common theme within the media from different people: "because you have to work with what you have, it becomes much more random and neutral and you cannot go in depth around a specific theme." However, most participants saw the collaboration as a positive aspect and they envisioned using the building set as a family activity or with friends, e.g. as a new means for media sharing. In the design of other toolkits, or extensions of Materialise, group dynamics in collaborative crafting could be explored, and the negotiations around media display that take place, for example, in families (e.g. Durrant et al., 2009) could explicitly be addressed.

Integrating physical and digital

All in all, when using Materialise it was observed that rather than having an integrated hybrid craft process, digital and physical phases of the creation process were quite separate. The digital phase happened entirely on the computer through the selection of media, experimenting with the composition, and uploading media, while the physical creation happened entirely away from the computer. This led to the belief that the current building set could benefit from closer integration of physical and digital elements – i.e. materials, tools and techniques – at the time of creation, which may, in fact, be the most important requirement for hybrid craft[36]. One implemented element that aimed for close integration was the digital representations of the physical building blocks in the software tool, which allowed participants to already start exploring their composition on the computer. However, although participants said these representations were useful to imagine what their creation would be like, they did not use the possibilities of rotating and positioning the blocks on the computer to explore the composition. This was partly caused by the active building blocks being the only blocks available as digital representations, which made the focus shift to the uploading of media rather than exploring the composition. By making digital representations of the other physical blocks available as well, exploring the complete composition would be more encouraged. Moreover, however, the physical and digital phases of creation should be closer coupled by *making interaction with digital materials similar to*

[36] This observation strengthened the belief that more insight was needed in digital craft to understand how physical and digital practices may be integrated more closely.

interaction with physical materials and across the same platforms: on the computer (e.g. through the use of digital representations of physical blocks), and away from the computer (e.g. by making digital media files as readily available as the physical building blocks). The interactivity of the physical building blocks could be expanded to support the use of digital media files in the physical exploration phase. This can be done for example by including media control buttons on separate building blocks, but also by providing media editing functions through physical interaction with the blocks; gestural or touch interaction; or changing the blocks or their composition, e.g. cropping media by breaking pieces off a block, resizing media by folding or unfolding flexible blocks, or copying media from one block to another by connecting them. In this way physical craft becomes much closer coupled with digital media, and individual blocks become more interdependent, which will benefit the hybrid exploration of physical and digital materials.

HYBRID CRAFT RESULT

Considering the hybrid craft results, interesting observations could be made around concrete and abstract representations, playfulness versus built to last, and interactive creations.

Concrete and abstract representations

Looking at what was built, it was interesting to see that in both hands-on tasks of the workshop most 'final' physical creations were concrete representations of scenes or objects related to the images and audio, such the palm trees, the bird from the 'Three little birds' song, the model of Bob Marley, waves, and the teenagers' college theme. While the designers' "urban diorama" (see Table 6.2) was less concrete than these examples, the only truly abstract representation was created by the parents, around the Berlin wall theme, and included the "windmill of change" and a "balance thing" to indicate the skewed balance of the situation. This abstract representation was mostly initiated by one participant, while another parent jokingly commented: "that sounds really creative. I wasn't prepared for that kind of…" Despite a few exceptions, it thus appeared that the current set-up of the set mostly triggered thinking about concrete physical

representations. It is likely this was influenced by the limited time the participants had to come up with something to build (participants spent approximately 20 minutes on each task) and the collaborative character of the workshop – it is anticipated that abstract creations may require more reflection and thought, for which there was limited time.

Playfulness versus 'built to last'

When discussing the use of the craft set with the participants, it was discovered that there was a tension between the playfulness and exploration of the craft set, and the desire to craft something lasting around one or more specific media files as expressed by some participants. While certain elements of the set, such as the Lego, allowed for quick assembling and disassembling, possibilities for creating something that can be left on display and has an enduring appearance were limited. When designing for hybrid craft, it was therefore found important to provide means for playfulness and exploration in the building process, but also means for creating lasting constructions, for example by providing different materials to cover up the building blocks, e.g. cloth, wood, or leather, when a final creation is made; or by providing different materials for exploration (e.g. Lego) and for final creations (e.g. wood). Providing more means for such final creations can further strengthen the link between the digital media and physical construction if materials or compositions are chosen that fit closely with the media that is (dis)played more permanently.

Interactive creations

Finally, participants tried to negotiate the dynamic possibilities of the digital (manually navigating through media; using the slideshow; automatic changing of media based on activation of related media on another block) with the static physical constructions. The current prototype did not facilitate changes in digital media through physical manipulation of building blocks. Thus, dynamic changes in digital media and changes in physical construction occurred independently from each other. In the first task, the slideshow function was used often to scroll through different images in one of the example themes within a creation. In the second task, however, in most cases one file was chosen for each block to be displayed statically, or played, and which was used to build something around.

This difference was mainly caused by the lack of more images that clearly fit a certain theme within the participants' own media, because media of different participants were so diverse. On the other hand, the teenagers deliberately chose not to link specific images within their college creation because they had plenty of images in that theme: "Can we just shuffle it? It will match!" Similarly, more use of the linking and slideshow functionality is envisioned if there is enough related media available, as will be the case in people's own home media archives, e.g. images of the same event. Despite challenges around available media, all final creations in the second task consisted of images as well as audio. In some cases the audio was directly linked to the creation (in the case of the parents, teenagers, and designers) and in other cases it was more of a background sound (in the case of the crafters who used the sound of laughter with their nature scene because they just liked that sound).

Because the physical creations are static, the question arises to what extent the physical construction can truly be tailored to complementing changing, dynamic digital media in meaningful ways. Although this provided challenges in the current prototype, and physical and digital were not always effectively combined in the hybrid craft results, it may be exactly this combination of dynamic and static that provides such exciting possibilities for hybrid craft, as long as this combination is carefully designed for. Physical creations can easily be displayed in the home in ways results of digital craft cannot (Kirk and Sellen, 2010), and digital media used in these creations can draw attention to a piece, or make it possible to evolve over time, for example as new media becomes available or as someone's interests change; thus increasing the likelihood a creation will be meaningful over a longer time. To support the integration of physical and digital in meaningful hybrid creations, it is proposed that *the physical must be made less static* than is currently the case for Materialise. Physical building blocks or compositions should be able to change and evolve dynamically; change based on changes in digital content; or change by simple user input – rather than rebuilding the whole composition. A simple example could be to design physical building blocks that can change appearance synchronised with the changing media, such as one participant's idea of an ambient light block; or have blocks

with moving parts, which participants tried to create themselves in the workshops. Another option could be to facilitate and encourage the creation of physical compositions that relate to digital media on more abstract or meta-levels – as was done only to a limited extent in the workshops – in which case physical compositions and digital media may still complement each other if the media content changes. Moreover, *more sophisticated dynamic functions* can be thought of that result in more natural changes in digital media, such as linking hybrid creations to updates on social media, or changing the digital content automatically as a physical creation is adapted.

POTENTIAL USE OF THE SET

When reflecting on hybrid craft with Materialise, it appeared quite challenging for participants to envision such practices in their everyday lives, and to come up with ideas around their own digital media. This may be an unavoidable result of presenting participants with new ways to do things that were not possible before – in this case using their digital media as building blocks in conjunction with physical building blocks. In fact, by asking participants not only to craft – which may be challenging in itself – but also to do this in a limited time, in a group, and with a completely new platform, the workshops were quite challenging for the participants. This highlights not only the importance of using a concrete prototype that people can try out and use to envision other practices, but also the importance of providing people with examples or clear use context, which they can imagine themselves engaging with. Although participants had trouble envisioning how they would fit the prototype in their everyday lives, in the group discussions new ideas arose and were met with enthusiasm for potential use of the set. Participants highlighted two areas of the building set that they considered interesting and novel: the linking of media files, (dis)playing them at the same time, and the separate, wireless uploading of media, on the one hand; and the building of physical constructions around digital media files, on the other hand. Particularly this last point sets Materialise apart from either using only digital or only physical materials or tools. Participants envisioned creating something that could be used as an enhanced music playlist by linking images to

music, which was particularly attractive to the teenagers. They wanted to link their images to their favourite music - both when going through their photos and when playing their music. Further, participants envisioned using it for personal reminiscence and memory support; as a thematic media display and playback device; sharing media with others in more natural photo sharing situations, using physical means; or using it as a remote awareness system, both outside the home and across different rooms in the home. Another suggestion was to have one block per family member. The blocks, and physical constructions around them were considered more interesting than digital photo frames as media sharing and displaying devices, because of their interactive qualities. Looking at the possibilities of linking dynamic, interactive information to the physical blocks, the teenagers liked the idea of Tweets showing up if they were related to images or photos, using hash tag information, and the idea of having a Facebook photo on the one block and the comments about that photo on another block. The parents and the crafters, however, did not care much about social network information, and thought this would be too obtrusive. They preferred static images and ambient noise, as well as links to other online information, such as traffic or weather updates. All in all, while much enthusiasm was shown in building physical constructions around personal media, and participants saw value in linking and displaying digital media files in interactive ways, they also struggled to envision how they would use a set like Materialise in everyday life.

DISCUSSION OF FINDINGS

Materialise offered the embodiment of a vision on hybrid craft without necessarily meeting all criteria to effectively facilitate this envisioned practice. This discussion first reflects on how hybrid craft practice as observed through the use of Materialise, and as envisioned beyond this use, compares to traditional, physical craft, as found in Chapter 4. Surprisingly, the crafters in the workshop seemed more cautious about the possibilities of Materialise and hybrid craft in general than other participant groups. One crafter commented: “maybe craftspeople are not the ones you want to talk to, because we’re not into that [the use of technology]. We like the idea of putting in electronics if someone

else does it for us." Although Materialise did not engage with 'electronics' this crafter associated the set with technology, and therefore could not picture it easily in relation to her own practice. Other groups were more enthusiastic and envisioned many possibilities. This may indicate that hybrid craft appeals to target groups different from 'too traditional' crafters, e.g. 'everyday crafters' such as the parents and the teenagers, and designers. Since everyday crafters were the focus of the set from the start, and more insight will be gained into digital crafters, it is not perceived problematic that the set was perceived to be quite different from traditional physical craft. It is however useful to reflect on why, and on which dimensions, this is the case (using findings around physical craft from Chapter 4) in order to understand how hybrid craft may be made more 'craft-like' through design alterations.

HYBRID CRAFT WITH MATERIALISE VERSUS PHYSICAL CRAFT

Looking first at the use of *materials* with Materialise, it was seen that both physical and digital materials were in some way predetermined. In traditional, physical craft, on the other hand, materials can be more basic and open-ended, for example wood, paper, or clay. While the building components in Materialise dictated how they could be connected (albeit in flexible ways), for physical craft there is much freedom in what can be done with a material. There was little focus on the physical manipulation or changing of existing blocks (e.g. reshaping them or using them in other ways than constructing using the provided magnets) and therefore blocks with different materials (e.g. wood, plastic, metal) did not offer different affordances, as is the case in traditional craft. Materialise thus offers craft as 'composition' of different materials (Kwon et al., 2014, Wiberg et al., 2012, Wiberg and Robles, 2010) rather than reshaping materials and engaging in dialogs with the materials (Chapter 4). Although it is a characteristic of most toolkits to provide predetermined building blocks, it is interesting to consider how such toolkits can limit this in the creation of new components from 'raw' craft materials (as was done in the creation of textile sensors by Perner-Wilson et al. (2011)), e.g. in providing stripped down components for (dis)playing digital media and letting participants craft around these.

This leads to a related reflection around *craft skills and techniques* in Materialise. The current design does not require craft skills in working with physical materials or tools, and its physical techniques are limited to construction. It further used solely digital *tools* to work with digital media, mainly the created upload software, which were not open-ended and flexible, as most physical tools are. While some physical tools were provided to work with the physical materials – e.g. pens, crayons, pins – these were only used to a limited extent. As seen in Chapter 4 the use of tools also made up an important part of physical craft practice and it would thus be worthwhile to explore the inclusion of physical tools in hybrid craft. Crafting one's own components from raw materials and with physical tools could increase the required skill. In its current design, Materialise could be seen as a *starter kit* for hybrid craft, which focuses on introducing this new form of crafting to people through composition; letting them explore what they would like to do with it; and crafting their first hybrid creations. Similar, perhaps, to how in more traditional craft the beginners' medium of clay may introduce the concepts of 3D sculpture to starting crafters, while more advanced crafters may move on to wood or stone sculpture. It is envisioned that other hybrid craft tools or platforms can be designed that support more advanced hybrid crafters, e.g. creating one's own components, allowing for the development of hybrid craft skills, and also providing means to create more elaborate, lasting pieces. The playfulness of the current set can thus be seen as a characteristic of its aim to encourage exploration and discovery of what can be done with hybrid crafting for the beginner while interesting design opportunities are still to be addressed in *how the more experienced hybrid crafter can be supported*, as this new form of craft moves forward.

When looking at the craft process with Materialise, it could be seen that participants kept going when creations already seemed finished, explored and experimented with physical and digital materials, sometimes deliberately planned what they would build, and expressed joy in the creation process. These observations are similar to some findings around physical craft processes and in envisioning the set in a less restrictive context, it is perceivable that the Materialise can offer an enjoyable autotelic craft process, while improvements in

the design as addressed above can ensure the set stays interesting beyond initial explorations (see Chapter 9).

Finally, considering potential application areas for hybrid craft processes and results, it is envisioned that such a practice – be it with a building set such as Materialise or with other systems that can be designed – can, for example, be used in a reflective activity in which, apart from looking through digital media and actively engaging with these media, selecting them, making them, adjusting them, a physical making process takes place, further engaging the user and potentially increasing the engagement to the media and the creation (e.g. Golsteijn et al., 2012, Odom et al., 2011, Petrelli and Whittaker, 2010). One participant, for example, imagined making something themed around his grandfather of whom he had brought some images and an audio recording. Using hybrid craft as a reflective activity is again similar to some uses of physical craft, and it is expected that, as in many physical practices, the mere fact that someone is making something will leave room for flow and enjoyment of craft. Other potential contexts and uses for hybrid craft can for example be enhancing music playlists; embedding interactive content such as Facebook more into the physical environment of the home; personalised gifts; co-present digital media sharing and storytelling; or remote awareness systems. As such, hybrid craft practices can be individual as well as group activities.

It can thus be concluded that although Materialise has potential for facilitating a new craft practice with interesting application areas, the set could be made more 'craft-like' by improving its use of physical materials, tools, and techniques in more sophisticated ways.

COMBINING PHYSICAL AND DIGITAL IN HYBRID CRAFT

After comparing hybrid craft with Materialise to traditional physical craft, it is imperative not to forget the integration of digital elements. One of the main findings from the workshops was that physical and digital realms were not well integrated in hybrid craft with Materialise. Although physical and digital

elements were included in the process, and craft results were hybrid – and Materialise thus meets the criteria for facilitating hybrid craft – improvements can be made to the design that aim to better integrate physical and digital realms in both the craft *process* and *result.*

Looking at the hybrid craft process, there is room for improvement in the combination of physical and digital craft materials, tools, and techniques. It could be seen that physical and digital *materials* used with the set offered different possibilities, e.g. physical materials were more open-ended and flexible, while digital materials offered inspiration and starting points but could not easily be manipulated. Combining these materials in the current set-up sometimes caused problems and resulted in linear, separated physical and digital processes. Moreover, digital and physical materials remained quite separated both in process and result as there were no interactions or changes that happened after combining different materials, or limitations or possibilities based on the affordances of different materials. It is thus important for improvements of the Materialise design to see how physical and digital materials can be better combined, e.g. by carefully considering material interchanges and affordances.

As mentioned, Materialise was further limited in its use of *tools* and only included the use of digital tools, mainly the upload software. Although this software aimed to link to physical creation by showing digital representations of the physical materials, this did not have the full intended effect of bringing physical and digital realms closer together. While, the current physical building blocks did not require any physical tools, future designs that move beyond predetermined components could benefit from a more effective combination of physical and digital tool use, or the use of hybrid tools to work with both physical and digital materials, e.g. providing physical tools for editing digital media. It is expected that if tools are physically present and easier to use, editing of media becomes a more integrated, explorative part of the process. Similarly, linking and uploading media was a process that took place separately from physical building – both spatially and mentally – causing these phases to mostly take place in sequence rather than in an explorative, iterative process. It is expected that if the

tool for uploading media becomes a physical element in the process, in which feedback is immediately visible on the blocks, physical and digital craft processes can be better integrated.

The *techniques* required to craft hybrid creations consisted of separate physical and digital stages, which resulted in the hybrid craft process being an incoherent activity. Physical and digital techniques and making phases should thus be closer combined. Ideally techniques for working with physical and digital materials should take place in the same realm in order to facilitate a coherent, strongly integrated craft process, e.g. providing physical interaction mechanisms for working with digital media by using physical tools or materials. Through its integration with the physical realm, Materialise uses technology in an explorative and less predetermined platform than current computer applications, and can provide an alternative to machine-like devices that is more of an extension of its user, which benefits the craft process (Myerson, 1997).

Looking at the hybrid result it could be seen that there were tensions around the dynamic and interactive digital side, and the static physical side of a creation. The interactivity of hybrid craft results thus requires some further thought, and it can be concluded that the current interactive possibilities are fairly limited. Interactivity with digital media is limited to being able to navigate through media and linking related media to show them at the same time; and of course new media could be uploaded and new creations could be built from scratch. As mentioned earlier, more sophisticated interactive possibilities for digital media can be considered that would keep the set interesting for a longer time as new interactions would be triggered through multiple channels, e.g. changing media through interactions with physical materials. Moreover, to resolve tensions with dynamic digital media, physical elements can be made more dynamic, and possibilities can be implemented for deliberately creating 'final' results instead of pieces that are open for further exploration.

To conclude, the creative workshops with Materialise have shown that physical and digital materials, tools, and techniques can be more effectively combined in order to make hybrid craft practice with Materialise more craft-like and to better integrate physical and digital sides of the process and result. This can be realised through better understanding, and a comparison of physical and digital craft practices. After Chapter 7 addresses the interview study on digital craft, Chapter 8 therefore combines findings of all empirical work, and formulates design guidelines around combining physical and digital materials, tools, and techniques, and interactive craft results. Chapter 9 subsequently presents some design ideas to illustrate these guidelines.

7 Understanding Digital Craft

AN INTERVIEW STUDY INTO EVERYDAY CRAFT WITH DIGITAL MATERIALS, TOOLS, AND TECHNIQUES

This chapter presents the second part of the two-fold interview study into everyday craft by addressing the findings around digital practices. Everyday digital craft practices arise from a personal desire to do so and use only digital materials, digital techniques, and digital tools to create purely digital craft results. Here digital materials are considered to be concrete digital files, such as photos and music, but also text or code; and digital tools are considered to be, for example, software packages required to work with digital materials. Examples of everyday digital craft are thus making digital photo collages, programming, or writing a blog. Again, narrative interview, portraiture, and thematic analysis methods were used to derive insights around the practices of eight digital crafters. Research themes were used to theorise digital craft through the formulation of craft characteristics, and to compare findings around physical and digital craft, which will both be addressed in Chapter 8. This comparison, alongside a synthesis with other research findings, subsequently led to design guidelines (Chapter 8) and design ideas (Chapter 9) for hybrid craft. As addressed earlier, the need for an interview study into digital craft was identified throughout the research process. Because conceptual design work so far has been based on findings around physical craft it appeared that the digital side of hybrid craft designs was quite premature, for example in only considering uploading digital images and not more sophisticated and skilled digital creating or editing. The Materialise evaluations further showed that the physical and digital crafting in the hybrid craft process were not strongly integrated, which was partly caused by differences in the amount of physical and digital craft

incorporated in the design. More insight into digital craft was gained through this interview study in order to explore how physical and digital craft can complement each other and to design more appropriate and conceptually developed digital craft elements in hybrid craft. Ideally, the portraits resulting from the digital craft interviews would have been used in 'idea generation through portraiture' sessions, in the same way as the physical craft portraits were used. However, due to time constraints, and the availability of numerous other design ideas and insights, thematic findings around digital craft were directly used in a synthesis of research findings (Chapter 8) that led to further design work. Increased insight in digital craft helped to make the design ideas presented in Chapter 9 more balanced in their combination of physical and digital craft elements. Since the data gathering and analysis methods have been addressed before, this chapter instead briefly describes how these methods were specifically used in the digital craft interviews – e.g. in describing the context of the interviews, and addressing the development of the coding scheme – before addressing the results of the thematic analysis.

INTERVIEW PARTICIPANTS

Similar to the study of physical craft, it was aimed to gain insights across different digital craft disciplines, and thus participants were recruited from various disciplines. Again participants needed to be considered 'everyday crafters', with the focus of this interpretation lying on a personal desire to craft. Therefore, even the professionals in the sample should be sufficiently passionate about their craft to be willing to do it also outside of work. The definition of who may be considered a 'digital crafter' was left open to include diverse people who worked with different digital materials – e.g. digital images, audio files, video, text, code – and distinctions between craft, art, and design were eliminated to include forms of making that may traditionally be classified in either of these domains (e.g. Shiner, 2012). As such, interview participants included artists, crafters, and designers, which are all referred to as 'crafters'. The practices of all crafters fit the definition of digital craft posed at the beginning of this chapter.

Participants were recruited via personal communication, e-mail and telephone, and were mainly recruited from within the personal and professional networks of the researcher, based on the researcher's awareness of their craft, or recommendations from others. The eight participants again included professionals, semi-professionals, and amateurs (see Chapter 4 for definitions), and included the same numbers of professionals and semi-professionals (who were observed to represent similar views) versus amateurs as in the physical crafter group. The participants were: a digital photographer, a CAD (Computer-Aided Design) modeller and designer, a stop-motion moviemaker, a blogger, an electronic music DJ, a web developer, a photo collage maker, and a software developer. While some craft practices included physical or hybrid elements (and thus could be considered semi-hybrid practices), the interview focused mainly on the digital side of the craft practice. Findings around the inclusion of physical elements will be discussed in this chapter and the next where this is relevant for informing a notion of digital or hybrid craft. Participants included three females and five males (ages ranging between 28 and 54; average age: 41). Participants were Dutch, English, North-American, and Australian, but all interviews took place in the UK. All interviews were done in English, which was the native tongue of most participants. The Dutch participants were all fluent in English, because they spoke English daily for their professions; for ease of translation and transcribing it was therefore decided to do interviews with these participants in English. An overview of the participants can be seen in Table 7.1.

Crafter (pseudonym)	Craft	Pro/semi-pro/amateur	Age	Nationality
Marc	Photographer	Semi-professional	43	English
Tim	CAD modeller & designer	Professional	28	Dutch
Emily	Stop-motion moviemaker	Amateur	47	English
Margaret	Blogger	Amateur	54	North-American
Erik	Electronic music DJ	Semi-professional	34	Australian
Martin	Web developer	Professional	28	English
Ann	Photo collage maker	Amateur	43	Dutch
Nick	Software developer	Professional	54	Dutch

Table 7.1 Overview of pseudonyms, crafts, professional statuses, ages, and nationalities of the interview participants.

INTERVIEWS, PORTRAITS, AND ANALYSIS

This section addresses how the methods described in Chapter 4 were again employed, and in some respects slightly adjusted, in this digital craft study.

INTERVIEW PROCESS: INTERVIEW SCHEDULE, PROCESS, AND SETTING

A narrative interview approach was used in order to gain insight into crafters' personal stories around their craft, such as how they started and their motivations for craft. An interview schedule was used loosely and a new topic was only brought up when a participant appeared to have finished a story. The interview schedule was the same as for the physical craft interviews and centred on the themes: Craft General; Starting and Learning; Materials; Tools; and Motivation. It further included some 'conversation prompts' that were only introduced when brought up by participants, such as perfectionism and social aspects. One question was added to the interview schedule for the digital crafters, in the Motivation category: 'Do you consider what you do a craft, why/why not?' Although this would also have been an interesting question to ask the physical crafters, for digital craft it was considered even more thought-provoking. In discussions of the PhD topic, the author of this thesis noticed that people sometimes have trouble thinking of digital making processes as craft, despite the fact that these practices can easily fit in diverse interpretations of craft (e.g. Gauntlett, 2011, Sennett, 2008). This may have to do with the fact that the digital is a newer domain – i.e. people may associate craft with tradition – or with the immateriality of creating something digital – i.e. people may associate craft with material processes and results. It was therefore considered interesting to gain the digital crafters' perspectives on this in order to uncover assumptions and interpretations of craft. All questions in the interview were again 'narrativised' to elicit stories (Hollway and Jefferson, 2000, p.35). See Appendix A for interview schedule, participant information sheet, and consent form.

In contrast to the physical craft interviews, the majority of the digital craft interviews did not take place at the crafters' homes or craft locations. This was

mainly due to the fact that most crafters indicated that they did not have a specific place where they crafted, e.g. they used a laptop or tablet and worked anywhere, or because 'there [was] not much to see', e.g. they only used a desktop computer and mundane software. While participants may still have been observed working at their devices, it was decided for logistic reasons – half of the participants lived in another country or in a different part of the UK – to do interviews over Skype in these situations, as it was believed this would not negatively influence the interview. In Skype interviews a webcam was used with permission of the participants in order to still witness the non-verbal communication of the participants. Further, Skype interviews were audio recorded using a dedicated software tool on the researcher's computer that captured both sides of the conversation. Interviews with Tim, Margaret, Martin, Ann, and Nick were done over Skype. Interviews with Marc, Emily and Erik were done face-to-face. Marc was interviewed at his home where the interviewer also had a look at his craft location – a shed in the garden where he had his computer, hard-drives with his photos, and a limited amount of equipment[37]. Emily was interviewed at her workplace whereas she crafted at home with her children, and Erik was interviewed in a pub. Further, Erik sent the researcher detailed pictures after the interview of his attic in which he crafted and his equipment; and the researcher was familiar with the craft settings of Tim and Nick, having visited these before, so a connection could be made over the known location and tools, such as Tim's 3D printer.

Interviews had the same structure as the physical craft interviews and were started by the interviewer introducing herself and asking an opening question, such as: 'Can you tell me something about the kind of crafting you do?' Interviews lasted approximately one hour, and collected data included audio recordings; written notes during the interviews on observations, non-verbal communication, and researcher impressions; and in some cases photographs of the craft locations and craft tools. All collected data was used to create written research portraits about the participants. Even though these portraits were not

[37] Marc had just sold some of his lighting equipment to be able to afford an upgrade, which is why he did not have many tools to show at the time of the interview.

used directly in ideation they were nonetheless considered useful to provide a holistic picture of the participants and their stories, and to undertake a similar thematic analysis as was done for the physical interviews for comparison.

PORTRAIT CREATION: INTRODUCING THE PARTICIPANTS

Interview recordings were transcribed verbatim, which was considered to be important for creating realistic portraits because in some cases extensive observations were not included in the collected data as interviews were done over Skype. After creating transcripts, written notes and transcripts were collated and portraits were constructed by combining lengthy participant quotes and researcher descriptions (Harling Stalker, 2009). Portraits again followed the structure of first introducing the participants and their craft, after which other themes in the interview were addressed, such as the use of materials and tools. This section now briefly introduces the interview participants, by using excerpts from the portraits, while full portraits can be found in Appendix E. This section serves to give a background into what participants did; where and when they did it; and when, why and how they started, before going into further data analysis.

Marc – Digital photographer

'Marc has been doing photography since he was very young; his parents bought him his first camera when he was 10. His first "professional set-up" *was started when he was made redundant six or seven years ago, when he also started to build a portfolio website and started getting requests.'*

'Marc has tried landscape and architecture photography but missed "the soul", *so currently he mostly photographs people. […] Photography is not Marc's full-time job. He tried to have a professional career, but his location outside London didn't help and there was a lot of competition. Moreover, he admits:* "I wasn't ready, because I just wasn't good enough." […] *Although he used to charge quite well and did much portfolio building for young models, now he doesn't charge for his time because it is for his own projects:* "I can be a lot more fussy about who I photograph."'

Tim – CAD modeller and designer

Tim is a product designer in a design research lab and CAD modelling – creating 3D models in computer-aided-design software – is a "very important part of his everyday practice."'

'Before he started using CAD tools, he had been making product design models for a long time using wood and other materials. He starting doing CAD models in his last year at university, around 2008, while making a prototype for his graduation project - Tim studied design. He saw other students using the machines and realised he couldn't compete with the quality of the machine. Further, because the turn-around is so quick he realised he could get more work done in the same time: "it's almost like you can work 24 hours a day, because you can go home and send the stuff to the printer and you wake up and the model is there."'

Emily – Stop-motion moviemaker

'Together with her ten year old daughter, Emily, a university lecturer and researcher, makes stop-motion animations in her spare time. […] [She] sees it primarily as something she and her daughter can do together and that "makes [them] laugh a lot."' *'Emily started making stop-motion animations about 18 months ago after she came across a children's book about how one could become an animator […]. The book addressed some free software made by an American university project that can help to make animations, and because her kids like animation she decided to download the software.* "It turned out to be incredibly easy to make a little movie." […] *Since then they have been pursuing their own ideas and have not ran out of inspiration yet.'*

Margaret - Blogger

'As an American living in England, Margaret noticed a great mismatch between American perceptions of the British, and vice versa, and her own experiences, which became the topic of her blog that is aimed at "American Anglophiles"*. […] Margaret started blogging in 2009, on the tenth anniversary of her move to the UK. Earlier she had learned that having a blog is of great importance when you are trying to get a novel published, which got her thinking about setting up her own:* "so, I started this blog […] [and] I eventually settled into a pattern of writing

more lengthy, fleshed-out articles, and they only go up every week or two. That has hurt my reader count […] but that's what I can fit into my schedule and I feel that I'm doing a topic justice if I give it some more research time."'

Erik – Electronic music DJ

'*Erik is in an electronic music* "outfit" *together with his studio partner. They have been doing this together since 2007 or 2008, before which he had been a solo act, from about 2005. Although their music includes vocalists and sometimes guitars in the mix, Erik categorises it as* "electronic-based dance music", *and tells me they engage in various styles that are referred to as bass music:* "as long as it's got energy and groove and bass in it, preferable attitude, we're generally all up for that." *Erik has a 32-hour job and he tries to put time into his music next to that. On weeknights, when he can often be tired from work, he does administrative work, such as answering emails, or updating their Facebook page, while on days off he collaborates with his partner in studio sessions for usually four to six hours a day.'*

Martin – Web developer

'Martin is a software developer who specialises in websites and web applications, and mobile applications. One of his recent projects was an online enrolment system for a local student union, which enabled students to register for clubs and societies.'

'Martin explains to me why he decided to go into the web development line of business: "I just like solving problems, I guess. When I was a network manager, you see certain problems that keep reappearing and sometimes you think: 'wouldn't it be better if we could just program something that prevented that from happening?' So I started doing just basic programming, kind of like windows active directory which would enable to reset passwords etc. And then it builds up all the time." *He adds:* "Fortunately I've managed to do part-time studying. […] I really did learn and understand how to do the programming."'

Ann – Photo collage maker

'Ann's craft is the creation of photo collages based on patchwork and quilting patterns, often using photos of flowers and nature. She does this in her spare time, being a university lecturer and researcher by profession. She tells me she likes

taking pictures and likes to "create stuff"*. She started in early 2012 when she ran into a book on patchwork. Because she did not like sewing, she came up with the idea of using the principles of patchwork and quilting to create collages out of her digital visuals. For Ann it is important that the pictures she uses for her collages are taken by her. After taking the pictures, making the collage may take about two or three hours for a relatively simple one. She works on it mostly during holidays […].'*

Nick – Software developer

*'As a software developer, Nick says he does not "*have any specific area in which [he has] specialised"*, which he calls* "one of [his] strong points but also one of [his] weak points, because usually people ask for a specialisation." *Software engineering is his day job […][and] he tells me later, in his head he is always working. He has recently bought a Dictaphone to document ideas, which is especially useful when he is cycling; this is when he often gets good ideas. Examples of projects he has worked on the past are a webserver and statistical software, while his current project is an application that registers information, such as temperature, for hospitals and laboratories. He tells me that he usually gets bored quickly, but […]* "the requirements change continuously." […] "And that's not boring at all, that's what [keeps] it interesting."'

THEMATIC ANALYSIS: COMPLEMENTING THE DEVELOPED CODING SCHEME

The research portraits were used in a thematic analysis, in which interesting themes in the data were identified that covered insights around digital craft. As in Chapter 4, an 'open coding' approach was used in which research themes were derived from the data, rather than coding the data within a predetermined coding scheme (Liamputtong and Ezzy, 2005). However, since one of the goals was to be able to compare physical and digital craft, and the two studies were counterparts in a two-fold craft study, it was considered beneficial to employ the coding scheme developed in the physical craft study, and complement it where new codes arose from the digital craft data. As such, the data was partly coded using an existing coding scheme, and partly coded 'openly' into new codes. The existing coding scheme was used critically, and data was only added to an existing code if it fit easily. Wherever there was doubt, or data did not fit easily, a

new code was created. This was an iterative process of coding all portraits first and then going through the data and codes again to see if any codes needed to be combined or revised. As such, 43 codes and sub-codes were added to the coding scheme, while 53 codes in the existing coding scheme did not contain any data for digital craft (leaving 73 codes of the existing scheme). In this way, a comprehensive set of 116 codes and sub-codes around digital craft arose that was not compromised by using the existing coding scheme; after all, the existing coding scheme had been developed in the analysis of a similar data set that was generated using the same interview schedule. For data and analysis organisation, codes and sub-codes were again categorised under the overarching categories of 'Background and Introduction'; 'Learning and Skills'; 'Craft Process'; 'Craft Result'; 'Materials'; 'Tools'; 'Social Aspects'; 'Motivation and Interest'; and 'Other Characteristics of Craft and Crafters'. Table 7.2 shows examples of codes and sub-codes that were added to the existing coding scheme, and of existing codes that did not contain any data for the digital craft interviews. The complete coding scheme for both physical and digital craft interviews thus consists of 169 codes and sub-codes, and can be found in Appendix C – including an overview of how many participants addressed each code, and number of references in each code.

Category	Examples of codes and sub-codes added	Examples of codes and sub-codes removed
Background & Introduction	*none*	*none*
Learning & Skills	maintenance of tools; don't have the time to learn; limited knowledge; time pressure; craft-specific skills; know-how of materials and tools; being organised; seeing new angles, new ideas; problem-solving	specific people; being relaxed about mistakes; creating or using certain tools to limit risks; learning from mistakes; injuries; feeling guilty; developing one's own style; making the next thing better; fine motor skills; precision
Craft Process	*none*	repairs; precise vs. rough; staying true to traditional craft
Craft Result	result on social media; 'identity' or personality of crafter in the result	selling the result; exhibitions; functional result; price-quality value of making it yourself; result is a combination of physical and digital; results in a physical portfolio; result as a record of life
Materials	*none*	materiality of the process; mixing materials; know-how of how material behaves and how to work with it; tried out different things; recycling materials; exploring materials
Tools	which tool determines the result; different tools have their own strengths; already familiar with tools; doing research about tools; expensive or new tools do not make a good crafter; switching tools takes time	universal tools; dedicated tools for materials or crafts; using anything at hand; certain tools limit risks; making your own tools; tools get worn in
Social Aspects	testing or evaluating with others; creating something for a larger, unknown audience; competition	giving result to someone after it's finished; being together with peers while crafting; taking, or not taking, advice; learning from influential people; teaching others
Motivation & Interest	expressing oneself; like being creative; doing it with others	seeing something come into existance; feeling with the materials; forgetting worries; drive to make; pride, showing what you can do; therapy, physical activity; making something functional; freedom and having time to do it
Other Characteristics of Craft & Crafters	is it craft - struggling to answer, not sure; 'I'm not good enough'; comparisons to art; physicality, with your hands; it's about 'creating something'; it's a science; definately a craft; uniqueness	it doesn't have to be perfect

Table 7.2 Examples of codes and sub-codes added and removed from the existing physical craft coding scheme in the digital craft interview analysis.

RESULTS

This section focuses on a qualitative treatment of the results for the remaining eight categories of findings (after Background and Introduction). Because of the individual and distinctive nature of each interview, and because of data possibly being coded at multiple codes, it is problematic to attempt to draw quantitative conclusions from the number of references or participants within a specific code. However, the number of references, and number of participants talking about a specific theme were used for researcher reflection on codes, and to assure data analysis was done reliably. For example the observation that four of the 'digital

crafters' addressed themes coded under 'Materials' while the other four did not, caused a critical reconsideration of what constitutes 'materials' in digital craft practice, and a consequent adjustment to the coding in this category: for consistency coding was adjusted to include, next to images, videos, and sounds, also text, code, and music pre-sets, which are created out of nothing by crafters.

LEARNING AND SKILLS

The first organising category of findings addresses how participants learned their craft, how they continue their development, what skills they need, and what can go wrong within their craft.

How did participants initially learn their craft?

The majority of the participants said they had learned by 'just doing it', for example Marc, the photographer who said: '"I didn't wait until I thought I was good enough to go out and do it. I started doing it when I was crap."' Similarly, Ann, the photo collage maker, explained her process of learning as follows:

> '"I first did a lot of things wrong. […] I'm not one for going through a whole tutorial […] I thought I found a useful tool, someone had suggested it to me when I was saying what I was doing and I tried it out and I thought it worked, but only after I had been doing it […] I saw that it did something else than I thought it did.'"

Half the participants further described learning from the internet, for example by watching YouTube videos (Marc) or looking at forums (Martin). Erik, the electronic music DJ, told the interviewer how when he started there were hardly any online resources available, but nowadays '"you can literally teach yourself"':

> '"I have a website […] that has tutorials and you can watch a tutorial that might go on an hour or two and it's very in depth and you can learn about all of that and you pick up mixing tricks and things like that along the way."'

This information on the internet sometimes caused difficulties though; Erik added: '"People in electronic music today [are] almost at the point where they have too much information and too much choice."' Martin, the web developer, highlighted a different concern:

'"It's not always the case that you get the best person to give you an answer […], but these days with some of the websites the answers get voted so you know which answers to trust […]."'

Following learning by doing and learning through the internet were books, education, specific courses, and looking at other people's work. Marc, for example, said:

'"I started looking more critically at other people's work and how they were doing it and I spotted things I never spotted before […] and digging from that what fascinates me […] I have no interest in copying anybody but I like using somebody as an inspiration […]."'

How do participants continue their development?

Participants talked a limited amount about continuing their development but did mention building on previous or existing solutions (Tim), and setting personal learning curves or aiming for next levels (Erik, Emily):

'[The] science of the music was a large focus of Erik in his development: "I was trying to get better all the time at mixing and making sure my frequencies had the most impact because that plays a massive part in writing electronic music."'

Emily said how she envisioned doing different things with stop-motion than the movies of '"little people doing things"' she and her daughter were doing now:

'"I've been trying to explain to my daughter about how the whole idea of stop-motion is you're supposed to be able to make things… do things they can't in real life. […] You see those really clever ones where a drawing just kind of emerges, without a hand on it, because it's drawn in stages. I'd be fun to try and do something like that […]."'

She added: '"Maybe this is me being the kind of... educative mother, I can't just let it run."'

What skills are needed to be a good crafter?

When asking about the skills that crafters thought were needed for their craft, half of the participants mentioned some craft-specific skills, such as having a good eye (for photography, Marc), *'a sense of how different sounds go together and* "[understanding] the key, and the rhythm"' (for electronic music, Erik), being

amusing, personable, and not boring (for blogging, Margaret). Further skills mentioned were creativity: *'a sense of colour, and graphic skills:* "to make sort of the overall lay-out, and that includes things like composition"' (Ann) and '"you just have to be able to come up with creative ideas to do what you want to do"' (Nick); problem-solving (Nick and Martin); and know-how of materials and tools, e.g. Tim:

> *'[Which skills you need] is very dependent on what you make:* "even if you specifically look at 3D printing, the amount of different printers you have, different materials that you can use, they all require skill, they all require know-how." *You need to know what material the printer prints and what the qualities and characteristics of these materials are.'*

Finally, participants mentioned patience, being organised, seeing new angles or new ideas, and procedural thinking.

What can go wrong, or cause limitations to the craft?

Most mistakes and risks lay in limited knowledge and limitations in materials or tools. In the first category, Margaret, for example, said it is frustrating that she does not know the Wordpress software she used for blogging well enough: '"I have subscribers and if, for a while, the subscribers are not getting the column, I don't know why that's happened."' Further, Emily called stop-motion moviemaking '"less stressful"' now she knows how to use the software. Similarly, materials or tools may be limited: Margaret had trouble getting Microsoft Word and Wordpress to work together, and Emily had trouble getting the software to recognise her external webcam. Crafters further indicated they did not have a lot of time to learn to use the tools (Margaret), sometimes had to deal with time pressure (Nick), or did not pay enough attention on occasions (Emily). Martin further added that he needed to be in the right emotional state of mind:

> '"You know, if you're worked up about something else, it's really difficult to do the programming. […] I've had it a few times basically where what's happened is that let's say something got me about something else, […] that kind of… makes me be a bit more aggressive. So I start programming and I become more prone to mistakes. And once you start testing you realise: that's not working, that's not working, you've actually gone backwards rather than

forwards because you broke out the thing that was already working. And it could be a rather vicious cycle if you're in that situation."'

Discussion and summary

The main way to learn digital craft appeared to be *learning by doing*, or 'enlightenment through practice' (Sennett, 2008, p.96). Further, the *internet* was widely used to seek information, e.g. tutorial videos or existing solutions for problems on forums. Participants indicated there were plenty of online resources, but the magnitude of online information appeared to be overwhelming at times (Torrey et al., 2009). It was furthermore difficult to assess the reliability of the answers of unknown peers on forums. These findings may imply that digital crafters would be better served with a more personal approach to online learning and information sources (Rosner, 2012).

Furthermore, with learning by doing and internet learning as the largest drivers and sources, digital craft development appeared to be *personally driven and executed*, without participants relying on courses or assignments to teach them. However, it also appeared that *lack of knowledge* was one of the main aspects that limited or risked the ability to craft. It appears that although crafters wanted to explore and learn autonomously, they do not always seemed to be able to gather all the necessary skills and information, be it for a lack of time to learn, limited reliable information available, or limitations in what could be done with their digital tools. Thus current digital tools and information provision do not seem to support the ways in which people want to learn their craft all too well, which can provide interesting design opportunities.

Digital crafters did not talk much about continuing their development. Although some participants, such as Emily and Erik, seemed to be personally driven to keep exploring new things and keep developing themselves, other participants did not mention such drives at all and seemed happy to keep going the way they were, perhaps finding out new things as they got on. It appeared most digital crafters had a fairly 'ad hoc' approach to their craft; not envisioning a clear trajectory of development, but rather picking up skills and knowledge as and

where they were needed. It is also possible that because participants had not fully mastered their skills in many cases, they felt like they were not ready to move on and instead focused on mastering their skills.

Finally, digital crafters were able to pinpoint some skills that were needed for their specific crafts, but these skills were highly craft-specific. As discussed in Chapter 4, the usefulness of the word 'skill' has been contested by David Pye (1968) who said that skills are different for each form of craft; similarly, digital craft skills appear to be either implicit or craft-specific know-how.

CRAFT PROCESS

Unsurprisingly, participants gave many descriptions of their processes, such as Tim, who called it: '"a little journey from an idea that pops into your mind"'. The process further greatly depended on the materials or tools one was working with, and the goal they were trying to reach. Tim further explained that his process in 3D modelling may be very different from someone else's:

> '"I think I tend to use [CAD modelling] relatively early on in the process compared to other people […] Because I have been working with it for so long for me it's a really lightweight tool […] And that doesn't necessarily mean that any of the stuff I printed for that project the first round has anything to do with the final outcome, really. So it's very, kind of, hands-on and explorative in that sense."'

For Nick and Martin the process was strongly determined by what the client wanted, and they aimed to show small demos to the client early in the process. For Erik, a process could start from many different things:

> '"Sometimes it can start with a lyrical idea and then we try to craft an attitude around that. Or I'll start with a programmed beat or a bass-line or something that catches our ear or sound and then we'll expand upon that. Once we have a good sound to work with that inspires us we expand that to a four bar loop, then an eight bar loop, then a sixteen, then a thirty-two […] As long as we start with something that inspires us and that keeps on moving, the track will eventually finish itself."'

Surprise and unexpected outcomes

Many of the participants mentioned surprises that arose in the process and never knowing at the start what exactly was going to come out. This was crucial in the further development of ideas as the process progressed, for example in the quotes above from Tim, who used modelling to explore, and Erik, who did not have a finished piece in mind when he started creating:

> '"Sometimes it's a sound that you have in your mind, other times it's a lucky accident that you didn't intend and then you get a really good sound, and it's really surprising. And that might take you in a new direction. We try to keep it within a scale so that we can move forward but also keep an open mind to new ideas and not be afraid to change the track if we find something that we consider to be better."'

Emily similarly said that she and her daughter '"just [made] it up as [they] went along"' and Ann explained how she selected materials for a Christmas collage:

> '"I wanted sort of the basic colours: yellow, red, blue, […] and then I think I also looked at how many I needed for the sides and I think I added an extra one, but I'm not sure. So sometimes depending on sort of the mathematics, I'm never sure… I can never figure it out beforehand but as I go I realise, for example, that having six colours is not clever so I need to add an extra one or something. […] I cannot always predict yet what will happen."'

Inspiration

Another frequently occurring theme was inspiration; participants talked about looking at other people's work to get inspired, or working with specific tools or materials to get inspired, such as Erik, who often used physical tools: '"sometimes the knobs in the interface, having a physical interface, can help you get inspired."' Margaret says she mainly has to '"just [keep] [her] eyes open"' and '"always [be] on the look-out"':

> '"If I'm low on ideas I'll look around and see is there a museum, a stately home, an art exhibition, is there something going on and I'll let it be an excuse for me to have a day off and go see it, and then I get a column out of it. But a lot of it is just, you know, there's so much… […] [England and the US have] such different

cultures and I'm smacked in the face every day by something that points out the difference. All I have to do is write it down so that I don't forget it."'

Enjoying the process

Many of the participants indicated that they enjoyed the craft process and this appeared to be more important than the result in many cases. Unsurprisingly, this was mostly the case for amateur crafters, while professional crafters also relied on the result for their pay check. However, these crafters also considered the process valuable, for example Nick, who liked the challenge of making his software clear to the users. Ann highlighted the following:

'"with those [digital] tools, the process becomes more important, because when I made a card with markers, I can't change it anymore, right, but with these collages I can. Because if I have these layers still, I can still move them around. So I can also make variations of one. […] You can come up with new ideas when you're already done basically and still do something with it."'

Marc vocalised clearly how the process was the most important element of photography for him:

'"If I photograph somebody and I spend three or four hours with them and I don't get a single image that I like, I'm disappointed but actually the most fun part, I actually had." *He talks about an intimate 'conversation' that happens between the camera and the person, especially in a one-on-one situation between photographer and 'model'* […] "And then it's up to me to portray what I see somehow with a camera, and that whole process of doing that really fascinates me." *He adds:* "there's something about that for me that's more than the result. Maybe having a really good result is like the icing on the cake, but yeah, the actual thing was the process and the creating."'

Some participants further said they liked "the step before" the process, which for Tim was coming up with ideas; for Margaret was doing the research for her columns; and for Emily was talking about what movies to make, "casting the characters", making little costumes, and creating a set. Finally, Erik emphasised the importance of '"taking a personal journey"':

'"If you're not taking a personal journey, and you definitely wouldn't be if you were just picking up loops here and there and not changing them from sample

libraries […], usually the audience can detect that and so can the listener; […] it's just not as cohesive as something where all the sounds have been designed from the ground up. It just seems to have less impact." *Such tracks are usually less successful, and if they do become popular they are often criticized for their lack of* "artistic integrity": "people are still really interested in seeing what you have to say as a musician, as opposed to what other people write for you."'

Discussion and summary

For many participants the *process of digital craft was important, enjoyable, and personal*. Much in line with the crafters' autonomous and ad hoc approaches to craft, surprises in the process appeared to be crucial. *Surprises were strongly connected to developing ideas*, and were both cause and result of developing ideas throughout the process. Participants often did not have a clear idea beforehand of what a finished craft result was going to be like. As mentioned in Chapter 4, novelty and discovery are crucial for experiencing 'flow', 'an almost automatic, effortless, yet highly focused state of consciousness' (Csikszentmihalyi, 2010, p.110) that is often reached in craft and may well be the main reason craft is enjoyable.

Many participants talked about *inspiration*, which included both participants who aimed to create things for creative expression (e.g. Marc, Ann, Margaret), and participants who needed to come up with concrete ideas to fulfil a job description (e.g. Tim, Nick, Martin). Interestingly, Ann pointed out that the fact that she was crafting digitally made the process more important, because she could still edit a craft result after she had finished it; thus prolonging the process. She indicated she could easily reuse and replicate elements of her craft results, which makes digital craft inherently different from physical craft. Such themes and comparisons will be addressed in the next chapter.

CRAFT RESULT

Examples of craft results included Marc's edited and watermarked digital photographs, Tim's 3D printed models, Eric's music performances, Margaret's

blog columns, and Nick's statistical software. Obviously, craft results were strongly discipline-specific, although overarching themes could be identified.

Sharing and publicising craft results

A number of codes in this category addressed how digital crafters shared and publicised their craft results. Marc and Tim gave away some of their craft results to specific people; Marc gave copies of his digital photographs to his models, and Tim gave 3D printed objects to friends and family as presents. Emily showed her stop-motion movies to a select few, by emailing the link to a privately posted YouTube video. She added that sharing was important to her, and she probably would not do her craft completely privately without sharing the results. Similarly, Ann sent out copies of her photo collages as digital cards to a select group of people. She said she would like to print her collages because '"it's much nicer if you give them a tangible [card]."' Participants also used social media and personal websites to share their craft results and publicise themselves, such as Erik, who used Facebook, Soundcloud, Twitter, and a personal website to promote his music act; Margaret who posted on her own Wordpress website and used Facebook and Twitter to publicised when she had posted a new blog post; and Emily and Ann who both occasionally put their creations on Facebook. Emily indicated she did not use Facebook actively but felt like she could upload her movies because they were concrete things to show. Similarly, for Ann's collages, *'sometimes people 'like' her collages, but she says these 'likes' sometimes just mean* "I've seen it"*, but, she concludes* "At least somebody's seen it."' Marc publicised his work on his portfolio website but indicated: '"I'm very self-critical and actually I like very little of what I do, so if it goes on the website that means I really like it."'

Printing and 'materialising' digital craft results

Some participants talked about printing, or in other ways 'materialising' their digital craft results. Marc kept all his photos stored on hard-drives and *'[liked] the process of going through old photo shoots and finding new things that fascinate him.'* However, he regretted not printing more of his work:

> '"Very little stuff I print as well, which I think is a big mistake. I've printed some of my stuff and had it done properly, not by me with a printer […] and that is a lot more rewarding than seeing it on a screen, I'm not sure why.

Seeing your work in your hand on a really good quality paper, there's something… I was going to say tangible. That sounds stupid, of course it is… I don't know what it is, it just seems very different from seeing it on a computer screen."'

Similarly, Margaret *'has thought about collecting all posts into one volume and printing it as a book'* but there would still be some hurdles for her, such as self-publishing and obtaining the copyright for the images she used. Ann also experienced problems when trying to print her work:

'She has thought about printing her collages and has tried this using a photo printing service, but the quality was not good enough. Her version of Photoshop also only let her export low resolution images because of license constraints, which were not good enough to print. "But I would like to also print them out so that I can give them as a card to somebody." […] "And the other thing is then: if you've made this design: is it nicer if it has a wide edge around it, or a black edge? So that graphical stuff, I haven't sorted out yet."'

Personality influences craft result

In some cases, the crafter's personality influenced how the result turned out, for example in Marc's approach to editing his photographs:

'After photographs are taken, he uses software – Photoshop CS5 and a few plugins – to edit the digital images, although he edits very selectively, for example some skin smoothening, because his photos are all about "being raw and what you see is what you get". "I see a lot of photographers; when you see the raw image from the camera, what comes out of Photoshop is so different… and that turned me off as well. I didn't really want to do that, I really wanted to get it right in camera. I don't think it's cheating to do it in Photoshop because there is still an artistic eye you need to, to come up with a finished product but it didn't fascinate me as much as being able to do it in the camera. What happens if I lose Photoshop or my computer? I still want to be able to take good pictures, and I don't want to have to rely on Photoshop to do these things for me."

Further, Erik explained that artists have to '"bring a lot more than just music"':

> '"You have an image and you have a philosophy, and people are into you as a person as well as being into your music. It's very hard to do it all but you almost have to create a very strong identity and concept behind your music alongside the music itself to lead into other ways of expressing yourself; whether that be through film or soundtrack or just a cool image to have in a live show."'

Erik added that there are some electronic music acts that have only pre-recorded material and pretend to change their tracks live, which he called '"big fakers"': '"I try to change it a bit more than [those fakers], but I think that the more we play live, the more we'll […] learn how to do it freely."'

Earning money with the craft result

Some participants relied on their craft results to make money, which sometimes influenced what projects they would take on. Martin told the interviewer how his view on his process and results had changed:

> '"To begin with I think it was more about having fun but as time goes on and you realise that you need to make money…. That has definitely become more important, definitely. So I tend to take on projects that I like doing but recently I did have to take one… which maybe last year I wouldn't have done because we needed the money this time."'

However, sometimes the enjoyment in the craft took priority over the financial aspects. Marc took up a job next to his photography when he realised that *'the only way to make enough money was to photograph weddings which* '"bores [him] senseless"'.

Enjoying the result

Half of the participants explicitly expressed enjoyment in the craft result, e.g.:

> *'Tim's enthusiasm is captured in his description of why he likes the result of the 3D modelling and printing process:* "when you get this little box [with the printed product] at home and you unwrap the box, it's almost like a little boy getting a present. […] It's just really cool, making your own products."'

For Erik, the main goal and enjoyment of making his music lies in performing live, which he brings up as 'the result of his craft':

'"A lot of artists have said it is 1% inspiration and 99% perspiration' in a process of 'break[ing] your own barriers […], a lot of self-development […], analys[ing] and re-invent[ing]." *He considers the result – playing his music live – the delivering of all that hard work, which he calls* "ultimately much more satisfying."'

The following excerpt describes his craft result in the form of a live performance:

'*When they perform live, Erik will be on the keyboard while his partner is singing. He has a DJ style controller with which he can apply effects and* "juggle and rearrange the beats on the fly" *and a* "chaos pad"*, a touch sensitive pad that generates sounds, which he uses to* "build up sweeps" *while simultaneously* "juggling the beats with the effects controller." *The shows are a combination of pre-prepared material and live improvisation and vocals.*'

Discussion and summary

Although digital craft is in a way 'autotelic' – the process is enjoyable and is 'an end in itself' (Csikszentmihalyi, 2010, p.113) – it appeared that the *craft result was also important* to participants, be it to be able to share, give away, earn money, or simply keep. In many accounts of sharing it was implied that participants would not do their craft if it was not for someone else to see or hear (e.g. for Emily, Erik, and Ann). The result of craft was enjoyable, and this enjoyment was caused by internal factors (e.g. Tim feeling like getting a present, or Erik delivering his hard work) and external factors (e.g. getting recognition from others on online social networks). Some participants further highlighted the importance of their personality or identity as a crafter in the final result, and this influenced how they crafted (their personal journey) and how a craft result manifested itself; the craft result thus embodied crafters' personal or professional ideals.

Participants thus did seem *attached to their digital creations.* Several crafters had thought about strategies to print or 'materialise' their digital craft results, although none of them actually had found a regular practice of doing this. They mostly wanted to materialise their results because they felt that having their craft results in material form would make them more emotionally valuable or

aesthetically pleasing, for example in being able to give away tangible cards (Ann). Interestingly, materialising their craft results was not possible for all crafters, e.g. a stop-motion movie, software, or an electronic music composition are ephemeral in nature, and there is no physical counterpart that could be perceived without a physical medium. In this way, use of digital craft results was dictated by the nature of these creations, and it is possible that participants reverted to online sharing in order to 'do something more' with their creations. These practices could be driven by a desire to *transport digital craft results out of the invisibility of computers and hard-drives*, and make it possible for others, and crafters themselves, to see them.

An interesting question arose in the previous section and this one around the finality of the process and result of digital craft. As Ann's quote in the previous section showed, for her the process became more important because she could always edit the result, thus prolonging the process. The description of Erik's interpretation of his craft result, a live performance, shows that final results are not final at all; he is editing them live on the stage. He may have described this as part of the craft process, and instead call a recorded track on CD or MP3 a craft result. However, as the ultimate goal for his craft and the means to deliver his hard work, performing live was truly the result of craft for Erik. Similarly, Nick and Martin had both worked on new versions of software that they had written before, and which had already been used as final products, and yet were being altered now. It seems thus that in some forms of digital craft practice, *process and result are not clearly demarcated*; some craft results are not final and static, but instead editable and dynamic, and variations can be made with little effort. As such, digital creations have the potential to be used in what Cardoso calls the 'individuation of experience' (2010, p.330), in which craft extends beyond the initial creation into a personal process of using, remaking, and augmenting.

MATERIALS

Perhaps unsurprisingly, materials did not make up a large theme in discussions with the digital crafters, and it was the category which provoked most thought in the coding process. Initial coding resulted in only four of the eight digital crafters even mentioning materials, which caused the researcher to rethink the interpretation of what constitutes a digital craft material. It is tempting to think like John (from Chapter 4), who is a physical crafter and software engineer: '"[Software engineering] is also building, with little materials; with software you actually have no materials, you only have tools."' However, digital material in this chapter are considered to be concrete digital files, such as photos and music, but also text or code, which included the truly ephemeral materials Nick, Martin, and Margaret work with, as well the music Erik creates by playing from scratch and including digital pre-sets. These were examples of digital materials that are created by the crafters themselves.

Materials are created by the crafter

Although some crafters clearly used existing digital media, such as photographs (Ann and Margaret), music pre-sets (Erik), or software libraries (Martin and Nick), in many cases there was no concrete 'material to start with', e.g. Tim had to create 3D models from mouse actions, Nick and Martin had to create their software by writing code, and Margaret had to write her columns from scratch. Sometimes, these materials were created by the crafter and could then be reused, as was the case in Nick's object-oriented programming:

> '"For instance both Java and C++ are object-oriented so there are many objects in the software I write, and at a certain point I need one of those classes […]."'

The same was true for Erik's music loops, which he '"literally sometimes [crafted] from basic sine waves"', sampling analogue sounds, which he could then reuse in later loops. Erik sometimes started with a pre-programmed beat or bass line, but he preferred it if '"sounds [had] been designed from the ground up"', using both analogue and digital input. He added that it is difficult to create an individual music style when using digital plug-ins, because anyone can use these; which is why he preferred creating his own sounds. Similarly, *'for Ann it is important that the pictures she uses for her collages are taken by her.'*

Materials are physical

Furthermore, some of the digital craft practices appeared to be still closely coupled to physical materials and practices, and the materials that formed the input for digital craft was actually physical, for example for Marc:

> *'Apart from the people he shoots, it could be said Marc's craft materials also include the physical location in which photography takes place. He avoids shooting in a studio:* "how can a studio ever be as inviting as the outside world? I've got a myriad of backdrop available to me anywhere in the world; why would I want to use a studio?"'

Similarly, Emily used physical materials to create something interesting to capture, which was then used in the digital craft process:

> *'The materials used for their stop-motion range from existing plastic toy figures to elaborate self-made costumes and backgrounds. For example, a winter wonderland was created by* "junk, rubbish modelling": "The backdrop was a white sort of towelling sheet because it was ice and snow […]. I think, cardboard boxes with little dolls cut in them and plastic tubs with little dolls cut in them."'

Also for Tim, who did not always, but often, printed his 3D models, physical materials were important and he had had experiences printing in different materials, such as stainless steel, brass, and ceramics.

> *'While many interesting materials are available, such as nylon, ABS, transparent materials, silver, platinum, gold, gold-plated, and bronze, [Tim] expects more interesting possibilities when materials can be mixed for 3D printing, e.g. rigid and flexible materials printed in one go and combining them (which is now possible):* "it expands the possibilities for playing around with it and turning it into a craft."'

Influences of materials on process and result

In some cases which materials were used influenced how to work with them and what the result was, e.g. for Tim's 3D modelling:

> *'Some materials afford higher quality prints, which influences the design, e.g. how thin the walls can be, and how much detail there can be.:* "you need to try

these things and you need to gain experience in […] how you can push the boundaries."'

Also for Emily, the stop-motion movies she could make depended on the physical props, for example new possibilities arose when she used dolls with articulated legs. Sometimes the desired end result also influenced which materials a crafter chose to use, as in the case of Ann looking for photos within a specific theme to use in her collages, such as seasonal flowers, or Christmas-themed things.

Discussion and summary

As the questions that came up in the iterative coding process show, the concept of a digital craft material is not easy to grasp. Crafters used a variety of existing materials, and materials they created from scratch; and they used combinations of physical and digital materials, all of which supported them in their digital craft processes. It was not always clear to grasp what starting material there was, and if there was none, creating materials became a necessary part of the craft process and not something participants consciously did.

Craft materials were not strongly craft-specific, e.g. both Marc and Ann worked with digital photographs but engaged in different practices; Nick, Martin, and Margaret all wrote text but the results of their crafts were very distinct. It seems thus that *digital craft materials are generic*; they provide possibilities for doing many different things. Similarly, while the materials sometimes influenced the process and result, and vice versa, this seems to be mostly true for physical materials: for Tim it was limitations in physical materials that dictated how he designed a CAD model, and for Emily it was a characteristic of her physical props that opened up new possibilities. The only true digital materials mentioned in this code (Ann's photographs) did not dictate process or result, but the choice of materials was influenced by the desired result. It seems then that while Chapter 4 has shown that physical materials are autonomous and distinctive – which again could be seen in Tim and Emily's practices – *digital craft materials seem much more subservient.*

Interestingly, many digital craft materials were created from scratch by the crafter. As such, many digital craft processes were started with no existing materials. One could argue that there is always a starting material, which in this case may consist of bits and bytes, but obviously this is as hard to fathom as talking about the molecules in a physical craft material. It is, however, clear to see that digital practices that require creating their own materials, as discussed in the example above, are quite distinct from other digital practices that use existing digital media, and from physical practices that use wood, steel, or clay. Thus, without going into detailed discussions around craft materials at the molecular or bit level, it can be said that for many digital craft practices *craft materials are creatable*, which can explain why it is difficult to grasp what a digital material is; after all it is possible that this is non-existent at the beginning of a craft process. This gives these materials an interesting characteristic, namely that *they are reusable*, and in addition they are *infinite*; Nick's software objects, and Erik's music loops could both easily be reused, if necessary with slight adjustments, without having to destroy a finished craft result, and without this material ever 'running out'. Taking this example further, it is easy to see that this was true for most of the other digital craft materials, such as Tim's CAD models, Margaret's text, and Ann's photos. This links back to the discussion in the previous section; the reusability of materials – even if they are already incorporated in a finished craft result – can explain why process and result of digital craft are not strongly demarcated.

Finally, it could be seen that some of the interviewed digital crafters used physical materials, e.g. Marc, Emily, Tim. These practices are thus semi-hybrid in that their processes are both physical and digital, but the results are digital[38]. Interviewing these participants still gave many good insights in the digital side of their craft practices as interviews focused on this side, but also highlighted an interesting observation around the use of physical materials in digital craft practices. Including physical materials was done easily and without further

[38] In Tim's case the result could also be physical if he had printed a model, but in that case craft process and result were still not considered fully hybrid, because it did not result in an interactive physical-digital creation. The interview focussed mainly on the digital side of his practice, the CAD modelling.

thought, and the physical materials fluently fit within the process. Even participants who did not explicitly use physical materials would still revert to them in some case, e.g. Martin who jotted down his ideas on pieces of paper. This seemed much less true for the physical crafters in Chapter 4; only Vicky and Lucy mentioned using simple digital actions in their processes, but this included materialising digital materials early in the process. It thus appears that working with both physical and digital materials is easier and more natural when one starts from digital practice, whereas thinking of hybrid craft practice when starting from the physical is more challenging[39]. This may be caused by the fact that physical actions are much older and more familiar than digital ones, but it also indicates that *digital craft materials can be suitably complemented by physical materials*; more so than vice versa.

TOOLS

Tools made up one of the largest categories in the data, and just like materials, digital crafters also use both physical and digital tools. Physical tools included Marc's camera and lighting equipment, Tim's 3D printers, and Erik's analogue synthesisers and mixing pads. Digital tools include software such as Photoshop (Marc and Ann), Lightroom (Marc), Solidworks (Tim), Ableton Live (Erik), Wordpress and Microsoft Word (Margaret), a stop-motion package (Emily), and Netbeans (Nick); and frameworks such as Martin's Zend Framework, and his jQuery library. This section addresses how participants acquired these tools, how they handled them, and how tools influenced process and result.

[39] This further strengthens the belief that ideation around the inclusion of digital materials in physical craft practice (Chapter 5) will have addressed the most challenging design ideas. Although doing the same while starting from digital craft practice may provide interesting counter ideas, it is believed that because hybridity in digital practice is already common, this would not lead to strongly innovative ideas. Moreover, because it feels quite natural to include physical materials in digital practice, it would be more beneficial to focus on increasing the craft elements on the digital side of a hybrid practice, which will be easier to do with the increased insight from this chapter.

Acquisition of tools

Participants talked about getting tools that were affordable to them, both physical and digital, e.g. Marc '"just went for the best camera [he] could afford out of [Nikon's] range"', and Martin chose to use a Linux set-up because it was cheaper than Microsoft. The choice of tools was often preceded by research, e.g. Ann was still searching for a good tool for her photo collages:

> '"You also have to find the digital tool to do it with, so I looked for some tools and I couldn't really find a good one. In the end I did it with Photoshop, which is rather heavy for what I want to do, but because I want to make all these cuts, and you have to put them in layers so you can still move them about […] With a lot of tools you can't keep those layers, so then it's hard to change it as you're making it."'

Choices of which tools to use were often also based on familiarity with the tools, and their availability. Martin, for example, explained why he used PHP:

> '"I prefer the kind of syntax of the PHP call to, it would be ASP on the Windows side, because I'm just more familiar with it I guess. It's the way I've come through learning in university and other things out there. And the Javascript is just a spin-off from that as well because it's again a similar syntax to the PHP, works a similar way. I think Javascript is probably the future for most things actually, there's so many people who know it and have been working with it for so long. It's very powerful now, the services, and frameworks to push people in the right direction."'

Tim also mentioned that he had access to a certain type of 3D printer through his job, which is why he used that often, but he also used commercially available printing services, which are becoming affordable and quick. Some participants further indicated that switching tools takes time:

> *'[Nick] tells me he has played a bit with other IDEs [Integrated Development Environment] but one of the reason he uses Netbeans is that he started off using it:* "As you can imagine these IDEs are... although they are in principle very simple to use, because of the incredible amount of features they have.. […] it takes quite a while before you're really comfortable using a thing like that. And I have to have a very clear reason to switch, and I haven't had it yet."'

Moreover, some participants were adamant that tools did not change their abilities or skill level. Marc said it is easy to be '"caught up in buying new gear"', while *'he knows some photographers who have really expensive cameras but whose work he still does not like, and some pictures are taken with* "crappy cameras" *but they are still stunning images.'* Erik emphasised the importance of finding the right tool and sticking with it:

> '"Otherwise you get addicted to just buying new things in the hope that they are going to make your music better, but in fact you're learning a new interface. When you're learning a new interface, imagine in the traditional sense, if you started learning bass for three months and then thought: 'Oh that isn't going to give me the sound I want, I'm going to learn guitar for three months', you're going to be okay at all of them, but you're never going to be a master of each of those instruments if you keep on switching. So, with electronic music you do have to sort of narrow it down to your favourite tools […] and eventually your personality will come out of them."'

Handling tools

Although participants addressed extensively how they chose their tools and how tools supported them in the process, they did not mention much about how they actually handled their tools. In the few occasions where this was mentioned, participants referred to physical tools, or physical interaction with tools. Marc liked the sound and feel of the physical shutter of his camera, and Erik liked working with his analogue gear (see Figure 7.1):

> '"Sometimes the knobs in the interface, having a physical interface, can help you get inspired. I remember when I first got my first analogue synth, I was just tweaking it forever and I didn't know what I was doing but I'd just move all the sliders around and be fascinated by the way the sound twisted and changed. And it's much more predictable with a digital instrument: you almost know what is going to happen and you don't get this random chaos that comes from sort of hearing circuitry."'

Martin's company had invested in an iPad and an Android tablet to test their applications, in addition virtual emulators, because they had found that

> '"once you put the device into somebody's hands, it's different. The way you interact with it is, well, unique. Because it's a touch screen and there's different thing you do, rather than just pressing a button, so holding the mouse and clicking and dragging."'

The physicality of handling tools seems thus important also for digital crafters. Similar comments were made by Lucy, a physical crafter from Chapter 4, who made movies together with participants as part of her research. She said about her digital activities with digital tools:

> '"It doesn't excite me as much. I find it too controlled. I find it unforgiving. I find it too linear. I find it… I don't know, I don't think many digital tools lend themselves to, for my way of thinking and for me being more of a haptic person, a touch person, the physical and the embodied, that's what I like about producing. It just doesn't do it for me, at all. […] It just feels like too much of an illusion. It bores me. I also don't like being dictated by tools."'

On the other hand, Martin had found that the computer was more natural for him to use in his digital process than physical tools:

> '"I've gotten into the habit of using the pen to draw out [my] things… I just do it so quick that it's relatively worthless because I can't kind of decode that. […] And I find that very difficult. Because when I'm programming I can just kind of react very quickly: right, this is what I've got, and tags and things, really quick on a keyboard, it starts to come alive. But when I put things on paper, I think I'm scared of losing the idea before it gets to the paper and then on to the computer."'

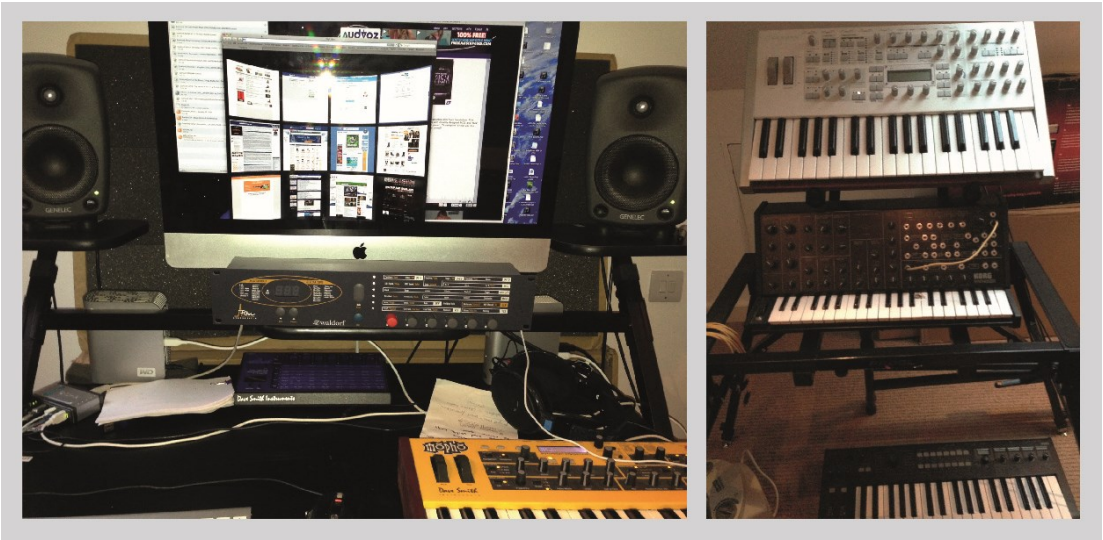


Fig. 7.1 Examples of Erik's analogue tools.

Influences of tools on process and result

Tools did not only influence the process and result of craft, but also depended on the process and desired result for which tools were used. For example, Tim sometimes used Adobe Illustrator to make models which could be laser-cut, instead of 3D modelling and printing, when his ideas were not that far developed yet; and Erik used analogue gear to *'give a sense of individuality'* to his music. Often tools influenced process and result though, for example Ann found that when she bought an iPad and the Photoshop Touch application, she started to make circular photo collages:

> '"Because it's so easy to make the round things, that influences the ideas you come up with for your designs, so to say. […] And this app is really simple. I mean, very easy to use, so yes, then it becomes easier to do certain things."'

Tools further made certain tasks easier or faster, for example, Marc used plug-ins for things he could not do himself, *'such as complicated black and white conversions,* "or if I have made a mistake with the lighting and I'm not happy with it."' Emily's software helped her to determine how to position the shots for her stop-motion movies:

> '"Where you've got what the webcam is looking at, at the moment, [the software] does what's called onion skinning, […] where it shadows the thing you last did and the thing you're looking at, at the moment. So you can see if

you want to just move a character just a tiny little bit you can actually see sort of simultaneously the before and after […].'"

Similarly, Nick described how his developer's environment helped him:

'"It has internal knowledge of the software I write. […] [It] indicates in the code I'm writing with a red wriggle beneath a line where there are problems, for instance syntax errors and things like that. It makes it a lot easier to read and to find problems. […] And there are always a number of basic steps you always have to do when you start a new class, for instance. I just tell it I want to create a new class and it gives me a framework. So it saves me a lot of time. It can do all kinds of things that before I all had to do by hand […]."'

Tim and Erik both reflected that their tools took away some of the craft elements of their work, e.g. Tim:

'"What I think kept me from doing [3D modelling and printing], is that I really think [traditional model making] is a craft that you can do with your hands, but at some point you will have to start exploring the craft in laser-cutting and 3D printing because you will never be able to do these things, even with enormous skill. […] It feels to me like I'm going to bin my crafting skills and have a machine do it for me but there's no way you can do it without the machine."'

Tim added that he did like the new possibilities his tools gave him to do things he could never do without them.

Discussion and summary

Most tools appeared to be *highly craft-specific*; although some tools could be used for multiple different practices (e.g. Photoshop), on many occasions, tools, or the parts of tools crafters used, were quite specific to their craft-specific needs (Lingel and Regan, 2014). Crafters used *one or a limited number of different tools* in one craft activity, and not much mixing of tools occurred. Selection of tools was often preceded by research and was based on costs, familiarity, or availability; and once a crafter had decided on a certain tool, they *did not switch easily* unless there was a good reason for it. This was partly because switching tools takes time, and because participants believed that having different or better tools does not make someone a better crafter. Moreover, if one keeps

switching tools one can never become an expert. Although it did happen that participants were already familiar with some tools and then explored others – e.g. Tim had worked with modelling software Rhinoceros and 3D Studio Max, which helped him to learn Solidworks – in most cases switching to another digital tool was considered to require starting at the bottom of the learning curve, which was often not worth the trouble. *Each digital tool thus appeared to require a distinct set of skills and knowledge.*

In addition, participants *did not have full knowledge of their tools* – be it for a lack of time to learn or limited information available – and they often only used a limited number of functions within their tools (e.g. Marc in Photoshop), or used tools that were a poor fit with their practice (e.g. Photoshop was too 'heavy' for Ann's use; and Margaret's Word processor did not work well with her Wordpress software). Further, although participants in some cases selected tools based on specific needs and requirements of process and result, it appeared to be more common that what they did in their process, and what the result was, was influenced by their tools. All in all, it seems that digital craft practice is not well supported by available digital craft tools; crafters select and use a limited number of tools, of which they have limited knowledge, which subsequently *dictate their craft processes and results*, instead of being able to flexibly select tools 'ad hoc' to suit different needs in different phases of the process.

While crafters sometimes sentimentally reflected on how tools took away some craft elements that otherwise would have to be done by hand, technology and tools also provided *exciting new possibilities*, which would not have been possible otherwise*. They further supported the crafters in doing mundane, repetitive tasks* that they were not very interested in. It thus seemed that crafters were happy for their tools to take over basic tasks that did not require much skill, and overly complex tasks that crafters felt could not be achieved without tools. Crafters wanted to be proficient in their craft between these extremes because they still wanted to be able to make things if they were to lose their tools (Marc). This implies that crafters aimed for a level of challenge in their craft that matched their capabilities, which is important for reaching flow (Csikszentmihalyi, 2010).

Finally, handling tools and the way to interact with them did not seem very important to participants; *tools were primarily discussed around functional themes*. Participants did value physicality of certain tools and actions, but this did not always integrate easily with their digital practices and tools, for example Martin's struggled in integrating his physical note-taking in his digital practice.

SOCIAL ASPECTS

Stories around social aspects turned out to be prevalent in the data; despite social aspects being merely a 'conversation prompt' – only expanded upon when participants brought it up – all participants mentioned themes in this category, such as learning from others, collaboration with others, competing with others, and others are involved with the result.

Learning from others

Mostly, participants learned from unknown peers on the internet, for example by watching YouTube videos, or browsing forums; half of the participants had learned from others in this way. Two participants further had learned from looking at specific examples of other people's work, although this was often also done using the internet, on which others had uploaded some of their craft results. Only Nick mentioned he learned from someone in an educational setting:

> *'In high school [Nick] did evening classes in programming taught by a teacher who was a programming enthusiast.* "It was a language that had been developed especially for schools, it was called Ecol."'

Collaborating with others

Collaboration with others took various forms; participants discussed their work with others, e.g. Marc, Martin, and Nick. Nick missed having contact with other programmers, because he worked from home as a freelancer:

> '"The software world […] is really exploding. It's hard, no it's impossible, to keep up with the developments. […] I have to come up with my own solutions for everything I do. […] I can never ask somebody else: 'can you have a look at my code and what do you think of it?' I could well imagine that some of the things I do are maybe not the most efficient way to do it, or the best way to do

it, or maybe there are, for some things I do maybe there are tools that can help me even better than my IDE […].”’

In other cases, others were involved ‘loosely’ in the process, for example Marc’s photo models, and people who helped Margaret with her fact-checking; or functioned as clients, e.g. for Martin and Nick. Martin explained that he had developed a reputation so clients would find him, but he would also approach people and point out what he could do for them. Other participants had experience in collaborating on craft pieces: e.g. Martin sometimes had help for specific tasks from students, Erik worked with his studio partner, and for Emily the collaboration with her daughter was the main drive for doing her craft:

> *‘[Emily] sees [stop-motion animation] primarily as something she and her daughter can do together and that* “makes [them] laugh a lot”. *Although Emily had initially introduced her daughter to stop-motion animation, now it is done mainly on her daughter’s initiative, and it is a joint process:* “So we're at the stage now where we're both involved in setting it up but then I can just leave her shooting a movie […] and then I take over and I do the bit of exporting it to the right format and uploading it.”’

Competing with others

A few participants mentioned aspects that had to do with competing with others. Unsurprisingly, this was most important to crafters who made money in one form or another from their craft. Crafters used personal websites and social media to publicise themselves and their craft, but only in limited cases they ventured beyond the online domain to make themselves known to the world, e.g. Erik and his studio partner were doing unpaid performances ‘“to get [their] skills up”’ and to publicise themselves. However, Erik indicated, it was difficult:

> ‘“There is a lot of competition: everyone’s got home studios, everyone’s a DJ, everyone’s a producer […] With so many people doing it as a hobby it can sometimes drown the market to the point where it can be very hard for the average consumer to really sit up and take notice of a particular thing unless people are blogging madly about it.”’

Marc further told the interviewer that he tried to be a professional photographer but had to give up because he was not in the right location, and because of the amount of competition.

Involvement of others with the result

The largest theme in the Social Aspects category grouped occasions in which others were involved with the results of digital craft. Half of the participants talked about sharing the results of their craft with others, mostly through social networks and personal websites. They liked getting reactions from others; Emily explained her thoughts on why people appreciated her stop-motion animations:

> '"People seem to be quite impressed in that is not something that… everybody has taken a photo, everybody has taken a video. Those are very sort of ubiquitous, mundane things, but this one is a bit quirky, and people don't know how to do it themselves. […] It's just that people don't have the resource to do it and they look at it and they think: 'wow that must be really clever.' And it's not."'

Further, participants created things for specific people, or groups of people, at their own initiative, e.g.:

> *'[Tim] tells me 3D prints things as presents for friends and family, or he models his own ideas. He uses his skills to solve problems in everyday life, for example when he created a little hook for his granddad's garden tool.'*

Ann created photo collages to send as digital cards, and had considered making a personalised birthday card for her sister, although she would first need to take pictures of her sister's family. Emily and her daughter created a stop-motion movie for her daughter's drama group:

> '"We knew with that one that we were going to show it to someone who wasn't just us, friends and family. […] it was going to the rest of the drama group […] so we were a bit more organised about that one."'

Participants further sometimes got specific assignments, as was the case with Nick and Martin's clients, who were involved with the process and the result:

> '"I like to be very pro-active though and give them something visual very quickly. I won't get bogged down in specifications, I will just kind of go away and give them the screenshots, or a working prototype, so that they can see

> the things that are in place, that everything they need is there, before I move on to the next phase. […] I tried to get feedback where possible."' (Martin)

Erik and Margaret further created their pieces for a larger, unknown audience. Margaret usually had around one hundred readers who mostly found her blog through Google, although some of her pieces were more popular than that. For Erik, reactions from the audience were the main drive for his craft:

> '"Seeing people react to it is probably the most amazing thing. […] To get that reaction, that rush, that connection with the audience. It's a physical thing and it's a wonderful thing to do. […] We feed off that and it's like this whole recursive energy that flows between us that goes back to the times of early man, I think. Dance music, it's a very primal thing, and once you get into it it's an amazing spiritual connection as well as emotional and physical. It works on so many levels and I think it's very satisfying."'

Finally, others were involved in testing craft results, such as Martin's applications.

Discussion and summary

Digital craft appeared to be social, both in process and result, which is in line with Gauntlett's vision on making and connecting with others (2011). Involvement of others was most important with the craft result – for example in sharing craft results online, and in creating something for specific people or a larger audience. For some crafters, social possibilities were what made craft worthwhile (e.g. Erik and Emily). Others were also involved in the process; crafters learned from others, discussed their work with others, collaborated with others, publicised their work, and competed with others. Often these practices were done online with unknown peers, while little co-present collaboration, discussion, or crafting took place. It appeared that *social connections were made in an 'ad hoc' approach in the process* – e.g. looking for information from others when it was needed and discussing craft when the opportunity arose – while *craft results were strongly driven by social sharing and recognition, and connecting with others*. As addressed, social sharing was an important reason for enjoyment of digital craft results.

MOTIVATION & INTEREST

Participants clearly thoroughly enjoyed their crafts, and 'Motivation and Interest' was one of the largest categories. In this category both explicit verbal expressions of enjoyment were coded, e.g. Tim: '"I really love my job, so I'm very lucky to say that I could also be doing the same as a hobby"', as well as observations and less explicit expressions, such as the fact that Marc showed the interviewer folder after folder of his photographs after the interview while giving anecdotes about the shoots, clearly being enthusiastic about his craft.

Some participants indicated they had always been interested in aspects related to their craft, such as Emily, who calls herself '"a bit of a bricoleur […], a 'making things out of nothing' kind of person."' Further, Ann had always liked being creative and used to make marker drawings, and aquarelle and oil paintings. Nick's fascination with computers dated back a long time ago:

> '"As soon as, as a small boy, I heard of computers and knew what it was, I was fascinated by the concept. But that's a long time ago, and in those days computers were not like they are now, they were big machines and in particular they were really expensive, so I couldn't afford a computer, but I started to learn programming […] just because I thought it was fascinating that a machine could do these things."'

Participants also reflected which parts of their craft they liked and did not like, and Martin said: '"normally, when things are going well, I'm delighted. Sometimes it goes too far the wrong way, but ultimately the responsibility is with me […]."' Margaret indicated that she mostly liked the fact that doing research for her blogs got her to places she would not normally have access to: '"there's nothing as interesting as backstage, anywhere."' Marc explained that he did not like landscape or architecture photography because he missed '"the soul"', which is why he liked to photograph people and do naked photography:

> '"I like stuff that has got some real attitude […] and something about 'nice' just doesn't seem to be authentic enough for me. I like the combination of a beautiful person with a bad attitude, if that makes sense." *He later adds:* "what

fascinates me about people is their vulnerability. […] seeing someone completely stripped away from any pretence, or in fact, from anything that the majority of the world sees.”’

Marc was further fascinated by the sound and feel of the shutter clicking:

‘“You know that 250th of a second is never going to happen again in the rest of eternity, and that person is never going to quite pull that same face again, and we just happened to be saying that thing at that time and I got it, that’s never going to happen again in the rest of the history of the universe.”’

Overarching themes that were present in different digital crafts were social factors and personal rewards and emotions associated with craft.

Social factors

One of the largest themes in the Motivation and Interest category was ‘appreciation from others’, which was brought up by half of the participants. As addressed in the previous section craft results were often shared, which was a main driver, and also source of great enjoyment for the participants – this comes forward strongly in Erik’s description of his live performance. Emily said:

‘“I don’t think it would work as a totally private... Maybe it would, but you definitely get something much more out of it by the fact that it’s sort of, collaborative in the making, but then also something you share when you’ve done it.”’

This quote from Emily shows not only the enjoyment in sharing with others, and getting appreciation from others, but also crafting with others. Finally, Ann liked crafting for others:

‘“It's because I like making it, but it's also sometimes that you have a personalised gift, to give to somebody.”’

Personal rewards and emotions associated with craft

Participants further described personal rewards and emotions associated with craft, for example that they were good at their craft, which pleased them, e.g. Tim: ‘‘it’s almost unlimited what you can do with 3D printing. I’m quite compelled to say… certainly about the skills I have, basically at this point I can make anything.”’ Crafters further liked ‘being creative’, e.g. Nick:

> '"It's just great if you can do something, if you can have a creative job – a job for which you have to be creative. […] I have to come up with solutions for everything I want to achieve. […] And there's millions and millions of possible solutions and you want to choose one that is efficient and that works, and that always works, and that other people can understand as well, which is a pretty difficult set of restrictions, I think. But I always say 'my brain is bubbling' [translated from Dutch], it's just… it's like I have ever fresh water in my head and that's a great feeling, and if it works, it's a very rewarding job for me."'

Challenges were also considered positive, for example for Nick, who got bored easily and liked the challenges of having to integrate ever changing requirements into his software, and these challenges, as well as reactions from others (Eric) made digital craft rewarding and satisfying. Marc further liked the fact that his photography gave him '"a creative outlet"' for expressing himself and getting to know himself:

> '"[Photography] gave me an insight into a world that otherwise I wouldn't get access into, if that makes sense" [while struggling with his sexuality]. "I expressed through my pictures stuff that I failed to express through my music when I was younger, which I couldn't do just because of being afraid and not being bold enough to take risks, but for some reason I found that I could be a lot bolder with a camera than with a guitar."'

Finally, Margaret indicated she liked losing track of time when writing her blog posts:

> '"Editing, making music, and programming computers are the three things that I can totally lose track of time doing, just getting engrossed in the task and oblivious of what's going on around where I am."'

Discussion and summary

All participants visibly enjoyed their craft, and some explicitly mentioned they had always been interested in aspects of their craft. These participants experienced a *'drive to make'* (Gauntlett, 2011, p. 222), which often first expressed itself in physical making, and later in digital making (e.g. for Emily and Ann). The craft process brought participants many personal rewards and positive emotions, such as being creative, being good at something, satisfaction,

it challenged them, and allowed them to explore and get to know themselves. Craft was thus enjoyable as a process in itself, and was intrinsically motivated. Intrinsic motivation could often be traced back to experiencing 'flow', e.g. Margaret's expressions of losing track of time and place, and the joy of working on challenges that are in balance with one's skills (Csikszentmihalyi, 2010).

Apart from the enjoyment of the craft process, it appeared that sharing with others, and appreciation from others, were strong motivators for craft, and important sources of enjoyment. This indicates that digital craft is not a solely autotelic activity; while it does give enjoyment merely from doing it, it is also important for digital crafters to be able to share the results of their craft. Thus, *digital craft appeared to be intrinsically as well as socially motivated.*

OTHER CHARACTERISTICS OF CRAFT AND CRAFTERS

In the final category, the themes 'perfectionism' and 'identity as a crafter or artist' remain to be addressed, which did not fit easily in any of the other categories. Further, participants' comments around if what they do is a craft were placed in this category.

Perfectionism

Two of the participants brought up perfectionism: Marc, who called himself '"very self-critical"' and Emily, who sometimes had to suppress her perfectionism in working with her daughter:

> '"Sometimes we mess up, something does move, and you think: 'oh, do we trash the whole thing or do we just make it as good as we can do?' So I think that's the borderline between keeping it fun for the children. I can be too much of a 'prima donna' here, and it would just be… too stressful. […]"'

For Emily, her answer to the question if stop-motion animation is a craft also has to do with it not being perfect:

> '"It isn't intimidating in the way that art would be, this is craft, this is something that is made with love by hand, with all its faults and imperfections. And I kind of… I kind of like the idea that in a way you can look at these things and you know the dolls' house family can't really move, you

look at them and there's no hiding of the artifice… It is what it is. And I think it's funny because they're endearing, because they are, you know, you're not supposed to believe in it. […] We're not trying to create a world you can believe in. We're just… you know… putting something together to get a smile. Yeah, craft! It is a good word."'

Identity as a crafter or artist & professionalism

Identity as a crafter was important to Erik and influenced his process and result; he further tried to bring a coherent picture, in which his physical appearance and his music were both part of his journey in finding his identity as a person and as a musician:

'I ask him if his appearance [multiple facial piercings; long braids at the back of his short-shaved head; and graphic shirts] has to do with putting an image out there for the music and he answers that he does not change what he wears for the music […]. [However] he believes that [his hairdo and his piercings], alongside his music, were also part of his journey of finding his identity and communicating this.'

Margaret further indicated she sometimes needed to emphasise her professionalism:

'"I find that when I say to people: I'm a writer or an editor they look at me like: 'oh yeah, yeah, sure.' But when I say 'I'm staff at the Virginia Wolf Bulletin,' you can just see them change their assessment and decide that I'm real."'

Is digital making a craft?

Over half of the participants drew connections to physicality and doing things with your hands, when asked if what they were doing was a craft, e.g. Marc:

'"Craft feels to me more like something you do with your hands. Whether you craft a sculpture or maybe you carve wood or something, that sounds like you craft something."'

Ann also made this link but still considered making photo collages doing something with her hands. Nick had a pragmatic view on physicality, which led him to conclude programming is craft:

'"[Craft is] something really manual, and certainly part of my job is manual, that's the programmers' side I think. […] I have to put the letters into my

> computer using a keyboard, that's craft. I have to build things, I have to… the ideas I have in my head, I have to put them on a… it's called software, but it's still a hard disc. […] In the end it's a hard byte on my disc somewhere and I have to put it there, and that's the craft."'

It used to be Martin's view that craft needs to be physical, but he had changed his view; he now believed craft had to do with having skills and tacit knowledge, and creating things. Tim and Margaret shared this opinion and talked about skills and tacit knowledge, e.g. according to Margaret, writing is a craft because of

> '"the fact that a lot of the writing is in things that don't so much have to do with rules, but have to do with rhythm and being aware. […] People can write perfectly grammatically and still either write things that are boring, or write things that are awkward and unreadable and they don't know why."'

Half of the participants indicated that creating things was crucial for craft, which led them to conclude they were crafters, for example in Emily's quote at the beginning of this section. Another theme was creativity and coming up with new ideas to do things differently, or use tools differently, e.g. Tim:

> '"What if you make something that is just not easy to [mass produce in China], where you really need [3D printing] to manufacture the product. […] I think the craft is […] in making something that uses the technology, pushes the limits, and turns the usage of these technologies into something really creative and novel."'

Some participants drew comparisons to art; Marc, for example, was reluctant to call his photography art or craft because he felt that was pretentious, although he also felt that what an artist or crafter did, in essence, was create things, so he did see similarities. Erik, on the other hand, felt like electronic music making was more like '"a science"':

> '"We literally sometimes craft sounds from basic sine waves and then work up from there. […] When you get advanced as a producer you start looking at things like harmonics and their relationship in a mix and how it affects the human being. So you really do get very deep into sound design and you need an understanding of harmonics and frequencies to give the best sound. Without that science you need someone else to do it for you."'

Ann further wondered if craft needs to result in unique objects, but concluded that if she printed her photo collages, they could be unique. All in all, some participants struggled to answer and were not sure if what they were doing was a craft; this mostly had to do with their initial associations with the word craft, but when reflecting on characteristics of what they considered craft, they often concluded their practice was craft too. Other participants were more decisive and considered their practices '"definitely"' a craft (e.g. Erik and Margaret).

Discussion and summary

Perfectionism, crafter identity, and professionalism were not large themes to be discussed on their own. However, the personality and identity of the crafter were often embodied in the craft result and influenced how they worked; a crafter's personal journey influenced what a craft result was like. *Crafter identity thus appears to be implicitly important to digital crafter*s; their ideals are implicitly manifested in the process and results of their craft.

Digital crafters brought up many aspects of what they considered craft, e.g. *creativity, coming up with new ideas, creating things, having skills and tacit knowledge*. Despite some initial doubts around implications of the word craft, such as the inclusion of physical aspects, uniqueness, and the quality expectations around the words 'art' and 'craft', all participants eventually concluded they were crafters, as their practices shared many characteristics with those they would classify as craft.

To summarise, this chapter has uncovered a broad understanding of digital craft practice that includes how crafters learn, the tools and materials they use, and what motivates them. A complete list of characteristics of digital craft can be found in the next chapter. It appeared that digital crafters encountered many difficulties in their use of tools and materials, and in learning their crafts. While technology and tools provide new possibilities and empower digital crafters to do things that were not possible before, these tools also complicate craft processes as crafters struggle to master their tools and appropriate them in their practices. This may be because digital craft is a relatively new area and crafters

are still finding their way in this 'pre-paradigmatic' field where no dominant underlying theory or way of working has been established (Gaver, 2012). However, it highlights the importance of careful consideration of how tools and technologies for craft should be designed. Findings further show that certain elements of craft practice that are easy and natural to address for physical craft practices are more difficult to address for digital practices, such as materials, tools, and whether a practice is a craft. This suggests that notions we are familiar with from physical craft do not always carry over easily to the digital realm. Through a careful reflection and comparison of physical and digital craft practices, and a synthesis of findings from empirical work in this research, the next chapter provides insights in differences and similarities of physical and digital craft, how these may be combined in hybrid practices, and what design guidelines can be formulated for systems that can facilitate hybrid craft.

8 Comparison & Synthesis

DERIVING DESIGN GUIDELINES FOR HYBRID CRAFT

This chapter functions as a synthesis of research findings from the studies presented in earlier chapters. By reflecting on the design work and Materialise evaluation, and comparing findings around physical and digital craft, guidelines are derived for the design of systems that aim to facilitate hybrid craft. The Materialise evaluation has shown that the current system would benefit from closer integration of physical and digital craft in both process – e.g. by more effectively combining physical and digital materials, tools, and techniques – and result – e.g. by designing better interactive possibilities of hybrid craft results. It further showed that Materialise could pay more attention to features that are important to craft practices, such as skill development and craft techniques, surprise and discovery, and exploration of materials and tools. Also beyond Materialise, effective combination of physical and digital realms and attention to craft elements form the basis for successful design for hybrid craft. Thorough knowledge of physical and digital craft, and a comparison to see where these can complement each other, can help to determine how a 'crafty' and thorough combination of physical and digital can be reached. This chapter therefore centres on this comparison – structured into sections around craft process and craft result – while it reflects on how insights are embodied in Materialise – in order to derive a set of design guidelines for systems or tools that can facilitate hybrid craft, which designers and design researchers can act upon.

COMPARING PHYSICAL AND DIGITAL CRAFT

Before reflectively comparing physical and digital craft centred on themes that can inform design for hybrid craft practice, this section first turns to a brief methodological discussion around differences in the physical and digital interviews to make transparent any differences due to methodological variations. Subsequently, it reflects on the coding scheme that emerged from the data in both studies to identify differences and similarities, and it summarises findings of Chapters 4 and 7 in characteristics of physical and digital craft.

METHODOLOGICAL DISCUSSION

When looking carefully at the methodological execution of both interview studies, some differences have been introduced in the process that may have influenced the results, and thus are important to reflect on before comparing the findings of the two studies. First, considering the *interview participants*, it can be seen that the physical crafters are older on average than the digital crafters (average ages were 53 and 41, respectively). This may have influenced some of the results; older crafters may have had more time to learn their craft and thus focus on different stories in the interviews, e.g. older crafters may be more focused on developing their own crafter identities than on learning basic skills. Despite age differences, however, in both groups participants had various levels of experience, varying from a few months to up to 30 years. It is therefore believed that both groups had a balanced mix of novices and experts, and that by carefully considering individual differences as well as group differences, bias is limited. Furthermore, the group of digital crafters contained more professionals (three, compared to one in the physical crafter group), which resulted in more discussions around making money from craft and working for clients in the digital craft interviews. However, this difference was balanced by two factors, which helped keep differences caused by professional status to a minimum. First, all crafters were selected based on the fact that they would also do their craft outside of their profession; as such, they were considered to meet the criteria of everyday crafters, no matter if they were professionals or amateurs. Second,

both groups contained equal numbers of professionals and semi-professionals combined (with two semi-professionals in the digital group and four in the physical group). Since semi-professionals' stories about certain topics (e.g. making money) were similar to those of the professionals, this evened out the balance between the groups.

Second, addressing the *interview schedule*, the obvious difference was addressed in Chapter 7: the digital crafters were asked if they considered their practice a craft, which the physical crafters were not asked. As mentioned, this was considered also interesting for physical craft, but for digital craft it was considered even more thought-provoking and insightful as the researcher had noticed that people sometimes have trouble thinking of digital practices as craft. As expected, answers to this question did provide interesting insights, and this question was always asked last in the interviews, so that it did not influence participants' earlier stories and answers. Adding this question therefore has not caused differences between physical and digital crafters.

Third, differences arose in *interview settings and conducting the interviews*. In the digital craft study, most interviews took place over Skype; while in the physical craft study they took place face-to-face, often in the crafter's workplace. This limited the digital craft study in that the workplace of the crafter could not be observed, and limited examples could be shown (although some participants did this by sending files through email or Skype). In many cases though, there was no specific digital craft workshop, and observations would not have been possible in any case. In addition, the researcher had seen some of the digital craft set-ups before; some participants sent photos of their tools; and in using the webcam on Skype as much as possible, non-verbal communication could be observed. These mechanisms aimed to reduce any limitations caused by not conducting the digital craft interviews face-to-face in a workshop, and it is therefore believed that few differences in findings will have been introduced by the differences in interview set-up. Further, both groups contained some participants for whom

English is not their first language[40]. While in the physical craft study interviews with these Dutch participants were done in Dutch; in the digital craft studies these were done in English[41]. This may have caused some translation bias, both from the researcher translating the participants' meaning (for physical crafters) and from participants having more limited means to express themselves in a foreign language (for digital crafters). However, these effects were believed to be minimum to non-existing as the researcher and the digital craft participants were highly proficient in the English language (they all spoke English on a daily basis on a professional level) and portraits were in most cases checked by participants to confirm if the right meaning was conveyed.

Fourth, when considering the *portraits*, it can be seen that later (digital) portraits were slightly different in style, and contained longer verbatim quotes. Digital craft interviews, as well as later physical craft interviews, were transcribed verbatim in full, while for early physical craft interviews sections that provided great detail or insightful quotes were transcribed, which has caused these differences in part. Further, lengthy quotes were considered more important in the digital craft interviews, as interviews were more verbal in character (after all, there was limited opportunity for observation). In physical craft portraits observations and verbatim quotes took up roughly equal parts in the portraits. Further, because each interview was so distinct in nature – due to the nature of narrative interviewing – some portraits contained different distinct stories than others, e.g. more information about the participant's background. Differences here arose because the researcher already knew some of the participants, and some craft areas, better than others, which influenced how much background information participants gave. The researcher was careful to keep an open mind and ask participants for more clarification when they clearly left out information believing that the researcher knew this already. All in all, since the main focus of these studies lies on uncovering interesting personal stories around craft

[40] This was not a deliberate decision, e.g. because a cultural comparison was aimed for, but was a result of recruitment from the personal and professional network of the researcher.
[41] Doing interviews in English with all participants would have been the preferred approach for ease of transcribing and analysing, but the proficiency in English of some of the physical crafters was not sufficient, and the researcher aimed to prevent participants from feeling self-conscious because of this.

practices, it is believed that ultimately the format of the portrait is of little significance, as long as it communicates the nature and content of the interview. In following the same reflexive process in writing portraits for both sets of interviews, and letting participants check them, it is believed that minimal differences in findings have been introduced by differences in portraits.

Finally, for digital craft interviews the *thematic analysis* was started from the existing coding scheme that was derived by open coding of the physical craft interviews, for ease of comparison of similar codes. Since a critical, iterative process of coding was employed for digital craft interviews, and content was only coded under existing codes if there was no doubt or ambiguity, this is believed to have had a minimal effect on data analysis, as many new codes arose from coding digital craft interviews. The next section briefly reflects on those codes that were omitted and added after coding the digital craft interviews, to highlight differences between craft realms.

Comparing Derived Coding Schemes

When comparing interview findings around physical and digital craft, one cannot look at only quantitative aspects such as number of participants mentioning a certain theme, or number of quotes in a code; instead, a qualitative comparison is needed. After all, the distinct character of each individual narrative interview makes it impossible to draw conclusions based on number of occurrences. However, looking at differences in the coding schemes that were derived from both interview studies (Table 7.2 in the previous chapter) can give an indication of where to look for interesting similarities and differences. When considering crafters' motivations and interest, digital craft resulted in fewer different codes which may indicate that there were fewer nuances in why digital craft was appreciated. Although digital craft was considered enjoyable, this may have been only for a limited number of reasons – e.g. creativity, expressing oneself – or digital crafters may have been more implicit in expressing why they liked craft. It can further be seen from this table that there are few differences for the craft process category, which indicates that craft processes may be quite similar in

physical and digital realms. For craft results, however, there were more different codes for functions of physical craft results (e.g. selling, exhibitions, function), which can indicate that digital craft results were used to fewer different ends, e.g. some results were shared on social media but did not serve a functional goal. Similarly, there appears to be new emphasis on the craft result in social aspects of digital craft (testing with users, audience), while for physical craft the emphasis lies on the process, e.g. learning from other, teaching others, being with peers while crafting. This illustrates an ad hoc social approach within digital craft processes while the craft result was strongly socially driven, e.g. through online sharing. In the Learning and Skill category, a first look shows added codes with slightly negative connotations for digital craft, e.g. limited knowledge, time pressure, do not have time to learn, while physical craft shows more codes with positive connotations, e.g. using tools to limit risks, developing one's own style, fine motor skills. These codes suggest that physical crafters mastered their crafts better and appeared more 'in control', and a qualitative comparison indeed shows that digital crafters experienced more difficulties in their learning process. In the craft materials category, there were fewer codes for digital materials, e.g. know-how, trying out different things, and exploring materials were removed. It appeared to be more challenging for digital crafters to discuss their materials because it was not always clear-cut what these materials were. Digital crafters did talk extensively about their craft tools, and the codes that were added to the coding scheme highlighted thought and consideration around selection of tools, and tool use, e.g. research, different strengths, and already being familiar with tools. The next section summarises the findings and reflects on these findings on a high level, after which the following section compares some of the findings in more detail.

CHARACTERISING PHYSICAL AND DIGITAL CRAFT

To support discussions around a qualitative comparison, the findings from Chapters 4 and 7 are summarised in Table 8.1 as similarities and differences of everyday physical and digital craft, organised in the categories from the coding schemes from these chapters. Having discussed their practices with people who make things physically and digitally, it can be seen that it is not always straightforward to talk about digital practices as craft. People have strong associations with physical craft and can easily imagine what physical craft materials, tools, and techniques may be, but for the digital realm this appears more problematic. When looking at Table 8.1, it is apparent that physical and digital making practices, although different in some categories, at their core are not that different: both physical and digital crafters require tools to make something that may change slightly throughout the craft process and is put to different uses, e.g. social, functional, communicative, or emotional uses. Craft often requires implicit craft skills, and surprises are encountered along the way. Both physical and digital crafters enjoy their craft and oscillate between explicit knowledge (thought, research, planning development) and tacit knowledge (creativity, surprises, flow, engaging with tools and materials).

	Similarities	Differences	
		Physical craft	Digital craft
Learning & skills	- The learning process is autonomous. - Learning is mostly done by experimenting and doing. - Craft skills are implicit and strongly discipline-specific. It is easier to pinpoint crafter character traits, e.g. patience. An overarching craft skill may be to work carefully.	- Learning is also done by observing others around them and their work. - Continued self-development is important. This is intrinsically driven and pursued autonomously.	- Learning is also done by looking for information online. - Skills and knowledge are picked up ad hoc; clear trajectories for continued self-development are not common.
Process	- The process is autotelic; it is an end in itself and gives enjoyment. - Surprise, novelty, and discovery are crucial and desirable in the craft process.	- Surprises in the process are caused by internal (e.g. the crafter's ideas change) or external factors (e.g. the material reacts unexpectedly).	- Surprises in the process are mostly caused by internal factors (e.g. ideas changed constantly). - The craft result is important next to the autotelic process.
Craft result	- Craft results are put to a wide range of different uses, e.g. using, selling, storing, gifting, displaying.	- Craft results are implicitly important: they are not always explicitly identified as having emotional value but crafters struggle to discard craft results. This may well be because of the experience and process of crafting behind them.	- Craft results are explicitly important for both internal (e.g. embodying personal and professional ideals) and external (e.g. sharing) factors. Strategies for 'moving them out of invisibility' are considered. - Process and result are not clearly demarcated; the process becomes more important as it is prolonged into the craft result phase.
Materials		- Physical craft materials are malleable, fathomable, distinctive, and autonomous.	- Digital craft materials are generic, subservient, creatable, reusable, and infinite. - Digital craft materials can be suitably complemented with physical craft materials.
Tools	- The selection of tools requires craft knowledge, and is driven by craft-specific requirements and personal preferences.	- Mastery of tools is implicit; craft tool use appears to be repetitive and simple, but tacit skills are required for tool use. - Craft tools occupy a space on a scale of universality, being strongly universal, strongly dedicated, or something in between.	- Digital craft tools are distinctive and highly craft-specific, and each tool requires a different set of skills and knowledge. - Crafters use a very limited range of tools that are selected based on familiarity, cost, or availability. - Tools cause difficulties and dictate craft processes and results. - Tools support parts of the process, e.g. taking over repetitive tasks; they are valued for functional reasons.
Social aspects	- Craft is social: the craft activity itself is mostly individual but crafters learn from others; teach others,craft together with others, exchange ideas with others, work for others, or give their craft results to others.	- Social interaction takes place with peers in physical surroundings. - Social interaction in the craft process is often a deliberate choice, while interaction around results is often more ad hoc.	- Social interaction mostly takes place online, often with unknown peers. - Social interaction in the craft process is ad hoc, while crafts results are strongly driven by sharing and connecting with others.
Motivation	- Craft is intrinsically motivated: crafters often have, and always have had, a 'drive to make'; and craft is associated with positive emotions and personal rewards. Enjoyment in craft is primarily caused by 'flow'.		- Digital craft is also socially motivated, e.g. through sharing and appreciation from others.
Other findings	- Craft is not perfect; craft results may always be improved, and crafters may be reluctant to call their work perfect. - Characteristics of craft include creativity, new ideas, creating things, skills, and tacit knowledge - both physical and digital making are therefore considered craft.	- Personal crafter identities, styles of working, and individualised techniques are important for crafters to distinguish themselves, both for external (e.g. beating competition) and for internal reasons (e.g. becoming an expert).	- Personal crafter identities are implicitly important and are embodied in craft process (personal journey, way of working) and result (e.g. finality or rawness of the result).

Table 8.1 Similarities and differences of everyday physical and digital craft as they were seen in the interview study.

However, definitions and notions known from physical craft do not easily carry over to the digital realm. For example, what is a craft material? In the physical realm, craft materials are 'raw' substances that are transformed (through manual manipulation) into craft results. In the digital realm, materials are often more predefined as they are designed and implemented by someone else, e.g. digital images; digital materials thus do not have natural characteristics in the same way as physical materials do. In other occasions digital materials can be created by the crafter themselves, e.g. text or code. Digital materials are further used in different ways: they are not transformed into a craft result, after which they do not exist anymore in their original state; instead, copies are created which are evolved into a craft result, while the original material is still available. This makes digital craft easy to edit and reproduce without going through the same effort as would be required in the physical realm to create a second object. Moreover, a crafted object is not truly unique in the same way a physical object is. Is it then still craft to almost effortlessly create new digital craft results or duplicates? It may be that these affordances create new possibilities, e.g. in the case of Ann's collages which could easily be changed and reused in new creations. Similarly, digital tools can help crafters by automating parts of the process, e.g. repetitive tasks or tasks that are too difficult to realise. While physical crafters can also use tools to assist certain tasks, digital tools have more complex possibilities, especially when looking only at tools that are available for everyday crafters. Digital crafters justly asked themselves: is it still craft if my tools do the work? However, they also concluded that there is also craft in the use of tools and technology, a similar opinion as the physical crafters had. Moreover, while physical craft call up visions of skilled manual labour with tools and materials, digital crafters' physical techniques are often limited to keyboard and mouse interactions, and digital techniques are much harder to grasp: probably a digital craft technique is not so much the ability to drag the cursor and click, but it is extended into the crafter's knowledge of knowing where to click and in which sequence. This makes craft techniques also inherently different in both realms and if manual actions are limited, what exactly constitutes a digital craft technique? This thesis does not claim to hold definitive

answers to these questions, but it does initiate a discussion around these issues and offers some possible answers through the interview findings. At the same time it highlights that both physical and digital practices can be considered craft in contemporary definitions of the word (e.g. Gauntlett, 2011, Sennett, 2008). It is likely that digital craft is still a 'pre-paradigmatic' practice where no dominant underlying theory or way of working has been established (Gaver, 2012). This makes it difficult to fully grasp, and further explains why digital crafters often encountered difficulties around learning their practices and using their tools. As digital practices mature, prevalent craft materials, tools, and techniques may arise that make discussions around digital craft more clear-cut. Moreover, combinations with physical craft can illustrate how similar digital and physical practices can be, and how their differences can be used to new exciting hybrid ends. In order to design appropriate systems that can support such hybrid practices, the next section compares the findings around physical and digital craft practices, centred on how physical and digital materials, tools and techniques may be combined in a 'crafty' hybrid process, and how suitable interactive hybrid craft results may be realised that effectively combine physical and digital realms.

RESEARCH SYNTHESIS: DERIVING DESIGN GUIDELINES

This section employs a qualitative comparison of physical and digital craft practices to derive design guidelines for systems that facilitate hybrid craft that effectively combine physical and digital craft in both craft process and craft result, while keeping an attentive eye on 'craftiness'. Insights from design work and the Materialise evaluation will be brought in to reflect on how the designed tookit currently embodied these features, and how it may be improved.

CRAFT PROCESS

For both physical and digital crafters the craft process was enjoyable and an end in itself. It is therefore important that a hybrid craft process also includes those

elements that make the craft process a rewarding activity. Physical and digital craft appear to be appealing for very similar reasons. Crafters often have a 'drive to make' (Gauntlett, 2011, p. 222), both physical and digital craft practices are at least partially intrinsically motivated, and it was found that flow (Csikszentmihalyi, 2010) is an overarching factor that makes craft enjoyable. It is thus important that hybrid craft enables 'getting in the flow'. Flow can be enabled, for example, by encouraging surprise and discovery, providing immediate feedback to actions, offering challenges that match a crafter's level of skill, and designing repetitive, engaging, pleasant and precise craft actions. Through a careful combination of physical and digital *materials, tools, and techniques*, designed systems can enable flow and make hybrid craft enjoyable and crafty; this section therefore first considers craft materials, tools, and techniques.

Materials

Physical and digital craft materials have quite distinct characteristics, which can provide interesting opportunities for hybrid craft when combined, or when characteristics of one realm are transposed to the other. Physical craft materials are malleable: the materiality of craft and feeling of materials are important. In transposing this to digital materials and hybrid craft, this means that more materiality should be included in working with digital materials. Design work in Chapter 5 proposed that different media types could be materialised to have different tangible properties, e.g. a video may feel different from a video. Hybrid craft can further include physical interaction mechanisms for working with digital materials (see Techniques), and can include the use of several different physical materials (as building blocks or as raw materials) to maintain malleability. As opposed to physical materials, digital craft materials are creatable, reusable and infinite. This opens up possibilities for the inclusion of an array of different physical and digital materials that can quickly be created, edited, and reused within the specific needs of hybrid creations, e.g. a photo collage that groups images with the same colour features to complement a physical creation, or a sound track that provides an appropriate background noise. To support this, a hybrid craft system could: offer more abstract media

searches, for example based on colour or composition; serendipitously suggest digital media to use in a hybrid creation, based on what is already present, who the crafter is, or which peers are present near the hybrid creation; and provide easy means to edit media, for example through tangible interaction mechanisms (see Techniques). This would make digital media more open-ended and easier to bring in at a later stage of the craft process – since they can easily be adjusted – so it could encourage crafters to start crafting from both physical and digital components and move flexibly between these realms. The Materialise evaluation further showed that physical and digital materials resided in different locations (physical materials were physically present and digital materials were hidden on the computer), which made finding, creating and editing materials in both realms unconnected. To integrate physical and digital crafting and make both types of materials available for exploration and easy editing, digital materials should be made more readily available to work with alongside physical materials, for example by creating simple tangible representations that can easily be edited through tangible means (see Techniques).

Design guideline 1:
Make both physical and digital materials available as substance in the craft process for exploration and experimentation, and allow for easy creation and editing of these materials across materiality realms, e.g. in hybrid manners.

Physical craft materials are further fathomable, distinctive and autonomous: crafters need to understand their materials and each material has its own distinct behaviour. Digital materials on the other hand are generic – they can be used to many different ends and do not exhibit autonomous behaviour – but at the same time they restrict a crafter's imagination because they often provide a 'fixed' representation, e.g. a photo. While this provided focus to hybrid crafting with Materialise, digital materials were also considered conceptually less open-ended and did not allow for experimentation and exploration in the same way as physical craft materials did, i.e. starting a process and letting material behaviour determine what would happen. This may be due to the fact that physical materials have natural characteristics that determine their affordances, while

characteristics of digital materials are designed and implemented to support certain goals, e.g. digital images are resizable and rotatable for easy of viewing. It could provide interesting challenges for crafters if more knowledge of digital materials was required to work with them in hybrid craft, e.g. a crafter would need to adjust a creation to be able to include a photo with a certain colour saturation, or would have to edit media at bit-level. Physical crafters also enjoyed the autonomy of their physical materials, and digital materials in hybrid craft could thus be designed to include more regard of their origin and history, e.g. expressing how old a photograph is by showing irreversible worn and aged features (Gulotta et al., 2013) or showing edits and creation history in the hybrid craft result. Further, more open-ended, autonomous and ambiguous digital material behaviour could be implemented. Photographs may for example respond to other photographs, e.g. automatically moving closer to, or away from, other photos, or including a particular photograph may unlock different colour filters. Certain media types may not go together well, and certain media may be combined with physical materials in different ways, e.g. the sound of a crackling camp fire may be uploaded to a wooden building block, but not a metal one. Implementing such digital behaviour can cause surprise and discovery within the craft process, which is an important condition for flow (Csikszentmihalyi, 2010). While such ideas impose more designed – as opposed to natural – behaviour for digital materials, if new digital material behaviour is explicitly designed to be more open-ended for appropriation in different ways, it could result in an enjoyable and autotelic hybrid craft process that stays true to craft elements.

Design guideline 2:
Design digital materials to be autonomous and have different characteristics and behaviours in the same way as physical materials do; and implement surprising and challenging material interchanges within physical-digital combinations.

Of course, not all material properties can easily be transposed from one materiality realm to another, e.g. physical materials cannot be changed much in their raw nature, while digital materials can be changed by imposing rules

through software or meta-data. Further, it would not be desirable to transpose or combine all characteristics to the same extent, e.g. making digital media too limited to only be used in certain contexts – in making them more distinctive and autonomous – could cause hybrid craft to become limited in its possibilities. It is therefore of equal importance to maintain valuable characteristics of physical and digital materials for these realms, and effectively combine these for hybrid craft, for example the fathomability and malleability of physical materials, and the infinity, creatability, and generic nature of digital materials. The design guidelines and the ideas in the next chapter aim to provide inspiration for interaction designers for combining existing properties of physical and digital craft materials alongside a set of new characteristics.

Tools

Digital crafters experience a lack of knowledge and skills in their tool use, which was not seen to the same extent in physical crafters. Digital tools are often strongly specific to certain crafts or tasks, and contain many different functions that digital crafters have not all mastered. Digital crafters often do not have the time to master different specific tools, each requiring their own skill set. In addition, digital tools do not clearly show what can be done with them, and often it requires a great deal of research to find out which tool to use, what functions a tool provides, and where a function can be found in the interface. As a result, functions remain hidden and crafters use tools to a limited capacity or use tools that are not suitable to their practice. Physical tools, on the other hand, appear to be much simpler and allow for a simple set of functions that are visible from the appearance of the tools. Although physical tools are often strongly task-specific, e.g. a hammer is designed for the specific action of hammering, they are often quite universal for different craft disciplines, and once a crafter has mastered one relatively simple task, s/he can use it in other practices. Moreover, as the interviews have shown, the same actions can be done with different physical tools based on personal preference and skill level. Similarly, physical tools can be appropriated in different ways and can encourage unconventional use, e.g. using a screwdriver to open a can of paint, or a using a hammer head as an anvil in precision actions. Digital tools, including the tools used with Materialise, are not

as open-ended; they are, just like digital *materials*, designed to efficiently fulfil a specific goal and allow for little variation outside that goal, e.g. you cannot edit audio in Photoshop. For digital tools, there further appears to be less overlap beyond the basics of using a mouse and a keyboard. Even if functions work in a similar way, the layouts of tool interfaces are different and functions can be difficult to find. Contrarily, physical tools can be arranged visibly so that the use of one tool can lead to use of the next.

As design work in Chapter 5 has suggested, opportunities for effective hybrid craft tools arise by employing the strengths of physical tools for the digital realm and vice versa. Hybrid craft tools can be thought of that transpose strengths of digital tools to physical or hybrid tools, for example they could automate repetitive, mundane tasks using digital technology, or support complex tasks that lie beyond the capabilities of the crafter, for example in creating complicated 3D prints of objects that would have been impossible to realise using physical craft techniques. Furthermore, hybrid craft tools could help to learn, or assist in, physical craft actions, in a similar way that a programmer's developer environment helps him or her, e.g. using digital projections to visualise and evaluate the movement and the hit surface of a hammer to support skill development in hammering. On the other hand, hybrid tools could be made more effective in working with digital media by employing strengths of physical tools. They could for example be made strongly task-specific and limited in number of functions; show their affordances in their appearance; and be visibly arranged so that a crafter knows which tool to use next. One way of achieving this is by designing physical tools for crafting with digital materials. It is expected to be a promising direction for the design of effective hybrid craft tools to transpose strengths of physical tools to digital or hybrid tools, rather than vice versa, because more difficulties are experienced with digital tools. By making these hybrid craft tools *physical in materiality* it would open up possibilities for using the same, or similar, tools for working with physical and digital materials, which can help to integrate physical and digital crafting more strongly in a design such as Materialise, as crafters can easily shift between materiality realms. It can further form the basis for intuitive hybrid craft tool use because crafters may

already be more familiar with physical tools and have a frame of reference for learning to work with these tools. Such physical tools provide physicality in the process, which crafters enjoyed. They could finally make craft actions with digital media more repetitive, engaging, pleasant and precise – enabling the merging of action and awareness and thus facilitating flow and enjoyment (Csikszentmihalyi, 2010) – instead of focusing on automation and applying an effect with a single press of a button.

Design guideline 3:

Provide a wide range of new, but familiar, task-specific physical tools that can be used to interact with, and edit, physical and digital materials in a similar, tangible manner, to allow for experimentation and iteration in the hybrid craft process.

Finally, interview findings showed that several physical crafters created or modified their own tools, which made their tools more tailored and effective and gave them joy and satisfaction. Although digital crafters tried to create and reuse materials, and one crafter (John) created his own digital tools, it appeared to be much more challenging to create tools for working with digital materials. Creating one's own digital tools requires different skills than working with these tools, e.g. programming skills versus photo editing skills, while making physical tools can often be achieved using the same skills as one needs for operating these tools, e.g. sawing and filing. Current digital tools also do not allow for much personalisation; possibilities are limited to activating and deactivating various toolbars while functions remain grouped within specific toolbars, and toolbars can only be placed in specific areas. While creating and personalising tools may be more enticing to more experienced crafters, it seems worth considering how hybrid crafters could be supported in creating their own tools for working with physical and digital materials alike.

Design guideline 4:

Think of ways in which experienced hybrid crafters can create their own hybrid tools, and provide them with the materials and templates to do so.

Techniques

In both physical and digital practices, craft techniques appeared to be part of crafters' tacit knowledge; they did not explicitly express what actions their craft required and how they went about these. Nevertheless, findings around digital and physical craft processes, and the observations around the separation of physical and digital craft phases with Materials allows for a reflection on findings towards design guidelines. The Materialise evaluation suggests that interactions with physical and digital materials should ideally be done within the same realm – either physically or digitally – so that both realms can be closer integrated in hybrid craft. Of course, it would be challenging to only include either physical or digital techniques in hybrid craft since materials from both realms are included – e.g. advanced tasks may go beyond the capabilities of a tangible interface, and digitally created and printed physical designs may still need to be assembled. However, it is worth considering how hybrid craft results may be using *predominantly* digital techniques to work with physical and digital materials, or using predominantly physical techniques to work with both. Digital fabrication and Computer-Aided Design (CAD), for example, use digital techniques to work with physical materials. As an example of hybrid craft, a personal digital photo frame could be created using CAD modelling and 3D printing, and this would result in an interactive physical-digital creation after digital photographs are uploaded. Although tools are available to support such practices[42], e.g. CAD software and 3D printers, these tools are expensive and require specialised skills that are not always available to everyday crafters. Alternatively, previous sections have suggested tangible interaction mechanisms – using physical techniques – for exploring, editing, and composing digital media, to allow for iteration and experimentation across physical and digital craft realms. This extends the current Materialise design and fits an idealistic vision on hybrid craft as an enjoyable, autotelic activity that enables flow. Materiality was a great source of enjoyment, and even digital crafters included physical processes in their practices. Physical techniques could help to provide immediate feedback to actions – an important criterion for flow (Csikszentmihalyi, 2010) – by closely

[42] Meaning commercially available products and systems, as opposed to design probes in research.

coupling physical actions with changes in digital media, e.g. editing a video by rearranging physical objects that represent different scenes. Tangible representations of digital media could further be edited by breaking, folding, or rotating them, and media filters could be applied to digital media files by attaching physical filter objects to a tangible representation of digital media, e.g. a colour filter by using coloured objects; a media characteristic (e.g. black and white image) by using another media representation object; or a material characteristic by using an object made of a certain material. Design work in Chapter 5 has further suggested considering how existing craft techniques can lead to new interactions with digital materials, e.g. sanding a physical representation of a digital image could decrease a grain in the image, or hammering a physical representation could give a digital file a damaged or rough appearance. Considering the appreciation, and existing skills and knowledge around materiality in craft, it seems counterintuitive to remove more materiality from the process in favour of designing for predominantly digital techniques. Moreover, truly *hybrid techniques* may be those that allow for the manipulation of both physical and digital elements in the same action, as is the case in the example of tangible mechanisms above. Digital techniques, on the other hand, result in creating physical elements after they have been digitally prepared, which again separates physical and digital making. Therefore, designers are encouraged to explore tangible techniques for hybrid craft.

Design guideline 5:
Design for a wide variety of tangible techniques and platforms for exploring and editing physical and digital materials, within which crafters can develop their personalised techniques and ways of working.

This section further leaves room to discuss findings around learning and development as crafters built up skills and knowledge of craft techniques. Interview showed that in both physical and digital craft practice, learning is a self-driven and autonomous process; crafters look for information and inspiration in sources available to them and set their own learning objectives. Physical and digital crafters learn by 'doing' and by exchanging ideas with others;

through getting together with peers, or looking for online information and examples and learning from unknown peers, respectively. This causes some problems for digital crafters, as they do not always know where to look for suitable information, and do not know what information is reliable. For hybrid craft there is thus an opportunity to combine learning through a network of known peers – as known from physical craft – with the availability and instantaneity of online information, for example as proposed in the Online Guild idea presented in Chapter 5: an online place where interested crafters can get together to share their love for their craft and learn in a personal manner from known peers. Such a community could further support an ad hoc learning process as well as continued development, which are common for digital and physical crafters, respectively. This difference may be caused by a combination of factors, e.g. digital crafters often had not fully mastered their tools, so they may focus on this before making plans for further development. Further, it may be the case that physical crafters were triggered to develop themselves more because they were more in contact with known others and saw their work, i.e. they wanted to develop themselves in relation to what they saw their peers doing. Further, physical craft practices have existed for longer so crafters can more easily imagine what they may do next; for digital crafters this may be difficult because there are not that many existing examples. These differences may thus partly be caused by the nature of physical and digital craft (e.g. how one learns from others) and partly by the current maturity of the practices (e.g. how skilled the average digital and physical crafter is, and how much variation and progress can be witnessed in the practice). It is then likely that combining the physical and digital realms in hybrid craft will follow a similar trajectory: because hybrid craft is a new practice, development and learning will be ad hoc at first because limited examples and knowledge are available, and the focus will be on exploration (digital craft is probably predominantly still in this phase). As the practice matures, hybrid crafters will be able to envision their own development and plan this accordingly. This wish for development will be supported by having physical elements in the craft, which enable crafters to potentially come together and work with peers as the physical crafters often did.

The Materialise evaluation suggested that the current toolkit can serve as a beginners' system that focuses on exploration, while different design variations may be realised for experienced crafters. Hybrid craft toolkits may adapt to the needs and goals of the advancing hybrid crafter, e.g. beginners may use predetermined building blocks, while experienced crafters move to 'raw materials'; experienced crafters may create their own tools, develop their own personal craft techniques and specialties, or develop expertise around physical and digital materials and how these interact with each other. Finally, as suggested in Chapter 6, experienced crafters may be more interested in creating elaborate finalised pieces, instead of exploring possibilities with a hybrid craft toolkit. Skill development and learning are important features of any craft, and it is an important criterion for enabling flow that the level of challenge a task provides matches the crafter's abilities (Csikszentmihalyi, 2010); it is therefore important to consider the proficiency of hybrid crafters and design adaptive craft systems accordingly.

Design guideline 6:
Design hybrid craft materials, tools, and techniques that support ad hoc and continued learning and development, and maturation of personalised techniques and skills, for example by implementing design variations for novices and experts.

CRAFT RESULT

Suggestions for more effective combination of physical and digital craft materials, tools, and techniques in the craft process of course also affect the craft result, e.g. new digital material behaviour may influence what can and will be crafted. However, the Materialise evaluation also showed important areas of improvements explicitly for hybrid craft results. Tensions in the dynamic digital and static physical elements made physical and digital realms unconnected. Further, digital elements – and in the current design also the physical elements – could easily be changed again when a creation was finished, which limited possibilities for making 'final' creations. As important features of interactive

hybrid craft, this section addresses these concerns and resulting design guidelines. Finally, remaining considerations within hybrid craft practice are the craft context – and the purpose of hybrid craft – and social aspects. Although these elements do not serve directly to strengthen the combination of physical and digital craft, or increase craftiness of hybrid craft, they do address important influences on the craft process and result that can inform design decisions.

Interactive craft results

The interviews showed that while physical and digital craft results are both important to crafters for internal (e.g. embodying the crafter's ideals) or external reasons (e.g. being shared with others), physical craft results are mostly static and final, while digital craft results have the potential to be dynamic and editable. A digital craft process and result were thus less clearly demarcated. Combining digital and physical elements in hybrid craft opens up a new design space of highly interactive craft, which comes with its own set of design challenges and opportunities, e.g. how to successfully combine physical and digital elements in interactive hybrid craft; how to interact with interactive hybrid craft results; and how hybrid craft results may change following interaction. Having an editable craft result can both have positive and negative effects. Negative effects include not knowing when to call something finished, and having a lack of finality and permanency (if a craft result can easily be edited, it can also easily be deconstructed). Further, when sharing a craft result that can easily be edited online (as was often done by the digital crafters), it is also more susceptible to editing and manipulation by others (Dijck, 2007). However, while in most cases it is considered disrespectful to change or complement someone else's finished physical craft or art, in the digital domain this is far more common: websites get updated regularly, software gets adapted and 'fixed' by others, content on social networks is commented on and tagged. In some cases, it may even be this engagement from others that makes the work more acknowledged and valuable. Editability and dynamic qualities can thus also have positive effects, such as the possibility of creations that grow or change over time; creations that have specific behaviours or agencies and that can behave in unexpected ways and thus encourage their creators or others to further engage

with them; creations that are different in different situations, e.g. when different people are present in a room; or creations that can be edited as new material becomes available or as someone's interests or preferences change. Hybrid craft results further provide unique opportunities for materialising digital craft elements in meaningful ways (as was often desired by digital crafters), after which they can be displayed effectively (Kirk and Sellen, 2010) in the autotopographies of everyday life (González, 1995). Hybrid craft thus has the potential to combine the best of both worlds in allowing for craft results that are both static (in maintaining certain physical characteristics) and dynamic (in containing editable digital content), in an 'individuation of experience' that extends the craft process into the craft result (Cardoso, 2010, p.330).

However, this combination of dynamic and static caused tensions in the Materialise evaluations as participants struggled to make relevant connections between their changing media and the static physical elements. Chapter 6 has therefore suggested that the physical elements could be made more dynamic – they could evolve dynamically based on changes in digital content or through simple user input, e.g. change colour or shape – or be made to relate to media on more abstract levels. Further, more sophisticated dynamic functions (than currently implemented in Materialise) were suggested, e.g. linking hybrid creations to updates on social media, or changing the digital content automatically when a physical creation is adapted. Changes to a hybrid craft result can be initiated by a desire to change the physical construction, or a change in digital content (manually or automatically), or both. What forms interacting with, and changing, hybrid craft results take depends on the application and use context of the hybrid craft result (see next section); crafters may pick a set of core digital media they would like to display for a longer time with a fixed physical construction, e.g. for reminiscing or gifting purposes, or they may want to change media frequently, e.g. in creating a dynamic media display. New designs could thus explore how people want to change their media in different contexts, e.g. automatically over time, manually by themselves, or in collaboration with others. Further, while research is exploring moveable physical elements in tangible interaction (e.g. Alexander et al., 2012, Iwata et al., 2001), in

practice possibilities for dynamic interactive digital content extend possibilities of physically changing components. New designs could therefore also explore both conceptual possibilities of dynamic physical components, and physical changes through manual actions – i.e. building something new or implementing changes or additions based on new digital content – which both could result in closer links to dynamic digital media.

Design guideline 7:
Design for quick and easy changes of physical and digital materials within hybrid creations, both automatically and manually, in order to allow for tailoring and personalising over space and time.

While advantages of editable and dynamic hybrid craft results have been addressed above, participants in the Materialise evaluations indicated that in some situations, e.g. when finishing a creation for reminiscence that is to be displayed in the home, it can be beneficial if hybrid creations can be made 'final' so that no further editing is possible. Of course this is not necessary as one can always choose to not change a craft result anymore, but it may form a nice deliberate gesture for the crafter to be able to physically and digitally, as well as mentally, close off the craft process, as is often the case in physical craft practice.

Design guideline 8:
Include mechanisms and deliberate actions to finalise hybrid craft creations for which further interactivity is not desired.

Craft context

The Materialise evaluation suggested that a clear context for hybrid craft should be envisioned and presented to the crafters, in order for them to position hybrid craft practice in their everyday lives; understandably, users had some difficulties in this respect because hybrid craft is unlike any of their existing practices. Design work (Chapter 5) has proposed ideas for craft contexts and purposes, e.g. creating personalised media objects or mementos (hybrid crafting can be a form of individual reflection and reminiscence); personalised gifts; media sharing; and

materialising digital materials for accessibility, organisation, preservation, or visibility. Each of these proposed uses comes with its own design requirements, for example the creation of mementos would require hybrid craft to include different meaningful physical and digital objects, would encourage exploring a variety of digital media that may lead to reminiscence, and may include extensive annotation; personalised gifts may instead focus on uniqueness and may include mechanisms to make digital media unique through combinations with unique physical materials; media sharing, as well as gifts, may further benefit from means to express personal identity or personality in hybrid craft; and materialising media may focus on easy ways to make digital materials physical while staying true to the digital format, without specific concern for a successful combination. Because the design guidelines formulated in this chapter do not restrict themselves to specific contexts, these issues will be summarised in the following guideline that calls for a careful consideration of context of use for hybrid craft.

Design guideline 9:

Envision a desired context of use or application area and design tailored, open-ended materials, tools, and techniques to facilitate hybrid craft in this context.

Social aspects

A reoccurring theme in the empirical work was social aspects of craft. Both physical and digital craft appeared to be strongly social in both craft process and result, which makes it likely that hybrid craft would also be a strongly social practice. According to Gauntlett, new forms of making in this digital age are important to connect with others and form meaningful social relations (2011). Vice versa, social connections also appeared an important driver for craft, mostly for the digital crafters; some digital crafters implied they would not do their craft as a completely isolated activity. It is highly dependent on the application area of hybrid craft which forms of social interactions will take place in process and result, e.g. co-present crafting, collaborative crafting, or individual crafting, sharing online or physically. For example, it is likely that a hybrid craft process

aimed at reminiscence will be individual (although the result may still be shared with others), while creating something for the family home may be a collaborative activity. In any case, it is clear that the combination of physical and digital practices opens up possibilities, e.g. including physical elements makes it easier and more meaningful to collaborate and craft while being in the same physical location, and to show craft results to others who are physically present; while the inclusion of digital elements opens up possibilities for online sharing of craft results. While online sharing was an important driver for digital craft, extra attention could be given to suitable sharing of the physical elements in a hybrid craft result. A simple solution would be to create a digital representation of a hybrid creation, such as a photo, but another option would be a virtual representation of the physical and digital elements in the creation that gets built alongside the physical creation and can easily be shared online. However, sharing should fit the needs of the crafters, and it is likely this does not require a multi-faceted representation of the creation, but a simple photograph or video may suffice. Instead, design efforts can focus on providing an appropriate venue for sharing hybrid craft results, such as a dedicated online community which can be used to share with peers, or provide a context for others to understand the work for sharing on social media networks. Within this online community, more fluent forms of presenting craft results can be thought of, that are similar to the 'open studios' common in physical arts and craft practice. Users would open up those parts of their collections, or those creations they would like others to see. Consequently, other people would be invited to see these creations by an online system, or they could come and have a look at their own initiative. Such a digital open studio platform could further provide more explicit mechanisms for letting users work together on creations – remotely or co-located –, connecting with others, and creating craft results for specific people in a social network. To further increase the meaningfulness of these crafted gifts, the system could visualise the time spent on an object, or allow the receiver to comment, add, or modify the gift, and in this way contribute to the life of the crafted object.

Such a system could further aid the communication of personal crafter identities and expertise. For both physical and digital crafters a crafter's identity was important, although for digital crafters this appeared more implicit, and craft identities were embodied in the craft process (in going on a personal journey with a personal way of working) and the craft result, which showed personal and professional ideals (for example how 'perfect' or 'raw' a craft result was). It may be difficult to maintain and communicate a crafter identity in the digital realm, because of the lack of a personal relationship between crafter and the person who sees the craft. Others may struggle to interpret embodied crafter ideals if they do not know the crafter. Parallels may be drawn between the lost traditions of workshops that were part of a guild, in which the identity of individual craftsmen was secondary to the identity and reputation of the workshop (Sennett, 2008); and online spaces, in which the group of crafters, e.g. bloggers, software programmers, hackers, may be more important than the identity of individual digital crafters. A digital crafter may easily be more of an 'anonymous crafter', while it is likely that s/he still wants to leave a 'fingerprint' on a creation and express a crafter identity (Tinari, 2010). Having an online community of hybrid crafters can help this endeavour. Whichever form social aspects may take in hybrid craft, design decisions should be made to support the various ways in which hybrid craft is likely to be social.

Design guideline 10:
With the envisioned context of use in mind, decide on the desired social set-up of the craft process, and possibilities for physically and digitally sharing the hybrid craft result, and design an appropriate platform to support this set-up.

In sum, this chapter has used a synthesis of research findings – centred on a comparison of physical and digital craft alongside reflections on the Materialise design and evaluation – to derive design guidelines for hybrid craft that aim to realise an effective and 'crafty' combination of physical and digital realms in hybrid craft processes and results. The next chapter illustrates some of these guidelines with design ideas around materials, tools, and techniques, and interactive craft results.

9 Conceptual Ideas

IMPLEMENTING DESIGN GUIDELINES

After having identified design guidelines for hybrid craft by synthesising findings from the empirical studies, this chapter presents some conceptual design ideas that embody and illustrate those guidelines, explore some of the unresolved questions around the successful facilitation of hybrid craft, and evolve the Materialise design. This serves to illustrate how design guidelines may be acted on in the generation of new design instances (Gaver, 2012) and to progress insight into hybrid craft. All ideas were generated in individual brainstorm sessions by the author of this thesis by brainstorming around the design guidelines and reflecting on observations and findings from the empirical work. Ideas are again presented in an annotated portfolio, although this takes a different form than the one used in Chapter 5; after all, according to Gaver and Bowers (2012), annotated portfolios can take different forms for different purposes. Since ideas in this chapter were generated to embody design guidelines, sketches are integrated in textual explanations within sections around the combination of physical and digital materials; tools; and techniques; and interactive hybrid craft results. These sections present ideas in most of the design guidelines addressed in the previous chapter, namely those that were explicitly focused on in the research questions for this thesis. While ideas and explanations are included in the previous chapter around craft context and social aspects, no further ideas were generated for inclusion in this chapter. Note that this chapter uses Materialise as the starting point for further design, and most ideas thus focus on evolving the current system. This does not mean to imply that this is the only, or best, design for hybrid craft – instead, it is a 'placeholder' idea (Gaver and Martin, 2000) that occupies a point in the design space without

necessarily being the best solution. The conceptual ideas in this chapter are similar placeholders, and thus it is of lesser importance to the aim of this chapter to assess feasibility or technical details. It is believed that continuing the reflection and development of a specific design provides more thorough and detailed insight than switching between multiple unconnected ideas (Frohlich et al., 2014). The purpose of this chapter is thus not to optimise the design of Materialise, but provide further exploration of designing for hybrid craft and illustrate the design guidelines, which are applicable beyond the Materialise set. Many of the presented ideas further focus on visual digital material, images, because these can effectively be communicated in sketches. Most ideas are, however, easily applicable to other digital media types, such as audio or text.

COMBINING PHYSICAL AND DIGITAL MATERIALS

Chapter 8 has suggested that existing and new material characteristics of physical and digital craft materials could be combined to make the craft process more closely integrated and 'craftier'. The first idea in this section (Figure 9.1) addresses the call for digital materials to be available as building blocks, so that these can as easily be used for exploration and experimentation in the craft process as physical materials. In this idea, one stripped down component, such as a speaker or a screen, represents one concrete digital media file, which can then be connected to a base block to make it interact with the rest of the creation, e.g. a Facebook connector allows for updates from the social network; a multiplier allows more than one image or audio file to be uploaded to a screen or speaker; and playback controls can be connected to interact with the media (Figure 9.1a). In addition, Figure 9.1a (bottom left) shows the different modes of connecting blocks; by using separator blocks in between, photos will be limited to their own block, but if these separators are not used, panoramas are formed. While this idea still implements fairly fixed components, the Materialise evaluation showed that participants were flexible in using the provided components in different ways, and this variation opens up possibilities beyond the current prototype. To support more flexibility, Figure 9.1b shows a variation

on this idea – which may be more suitable for experienced hybrid crafters – where the base block is a smaller component that can be connected using cables; and components are more malleable. Screens, speakers, base blocks, and other components can then be integrated in whichever material the crafter wants to use, such as fabric or clay. Further, technical components such as screens, chargers, buttons, can be provided in different shapes and sizes to suit different creations. In both ideas, digital media files become concrete building blocks in the creation, with which additional actions can be taken. Further, building elements can be made to look more editable, e.g. by using low-tech materials such as paper or clay to encourage making, editing, exploring, and actions that were not done with the Materialise prototype due to concerns over ownership of the building blocks, e.g. painting on them, or damaging them.

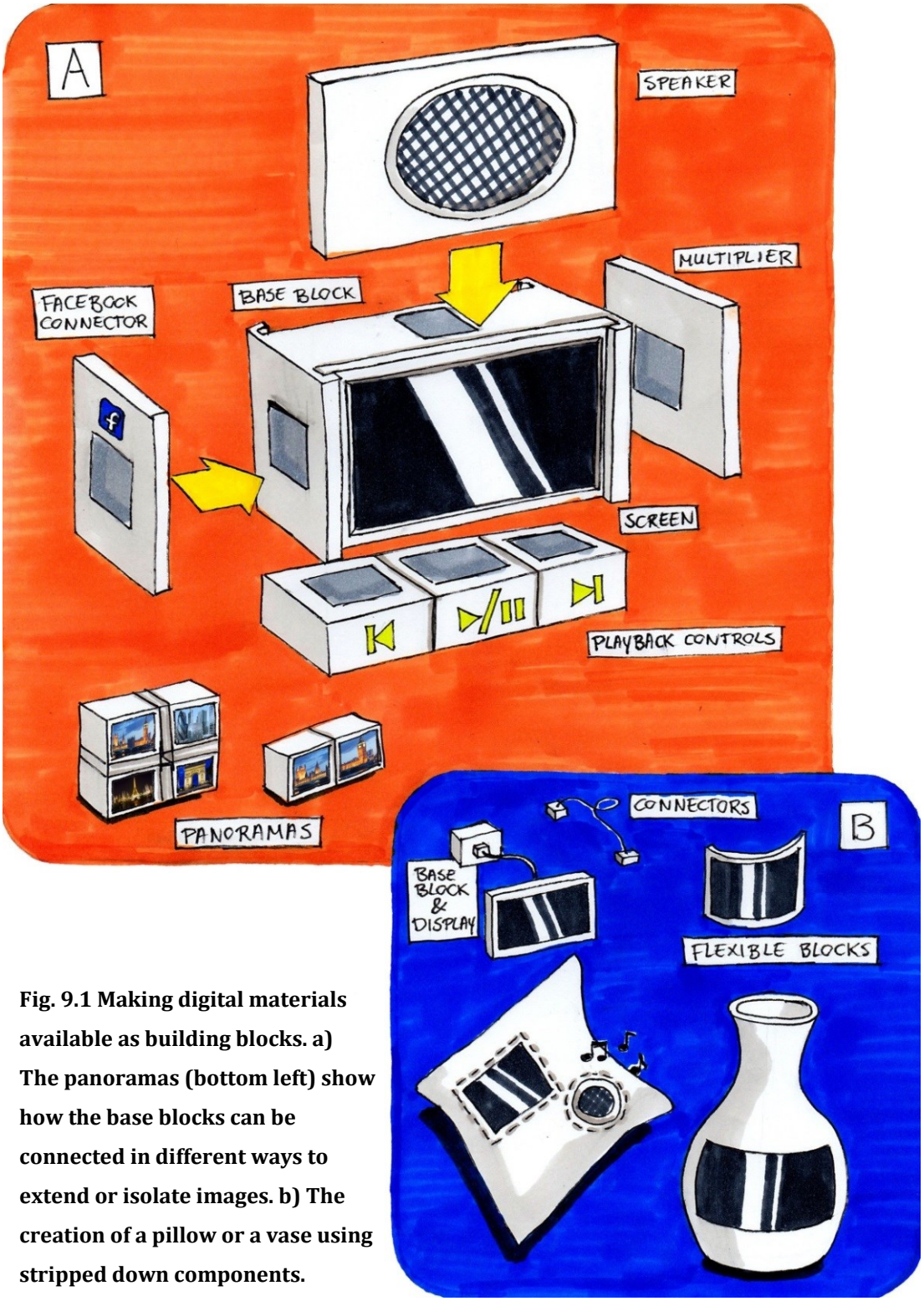


Fig. 9.1 Making digital materials available as building blocks. a) The panoramas (bottom left) show how the base blocks can be connected in different ways to extend or isolate images. b) The creation of a pillow or a vase using stripped down components.

The second idea (Figure 9.2) zooms in on easy editing of digital media, preferably using physical means, as suggested in the sections on Materials and Techniques in Chapter 8. One idea is presented to easily apply filters to media: by attaching coloured blocks to a media block, a colour filter is applied to a photo; by

attaching a block which has a filter applied to its media (for example a black and white filter) to another media block, this filter will also be applied to the other media; and by connecting physical blocks with certain material features to a media block, a similar filter will be applied to that media, e.g. a rough stone block may make an image grainy, and an audio track scratchy. In this way, physical and digital materials can easily be played around with, and edited, and this idea embodies the design guideline around implementing interchanges within physical-digital combinations. More means for easy editing will be addressed in the next sections (Tools and Techniques).

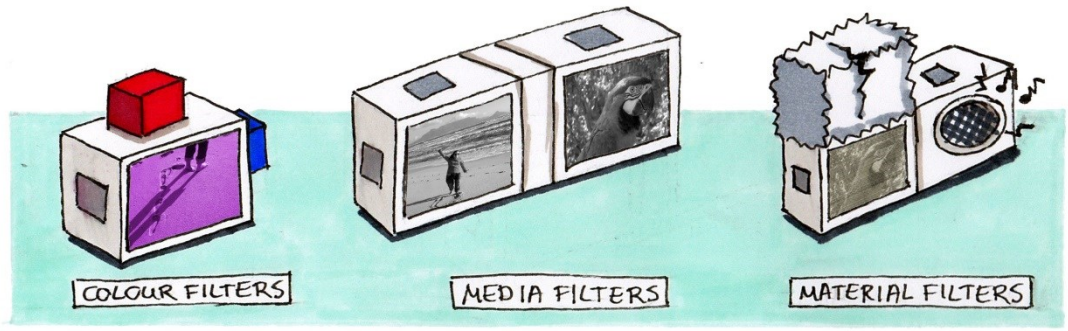


Fig. 9.2 Easy editing of digital media using colour filter blocks, media filters, and material filter blocks.

The third idea (Figure 9.3) focuses on more distinctive and autonomous digital materials. In this idea digital media files have characteristics that determine whether they can be combined with other digital media files, e.g. the place they were taken, or who is depicted in a photo. In the example two photos taken in London can be combined, while a photo taken in London cannot be combined with one taken in Paris. The polarity of the connecting magnets can be reversed to provide tangible feedback of attraction and repulsion between media. Hybrid crafters will need to learn to work with these characteristics of the automous digital materials and find ways to achieve their goals, thus making the craft process more challenging and surprising.

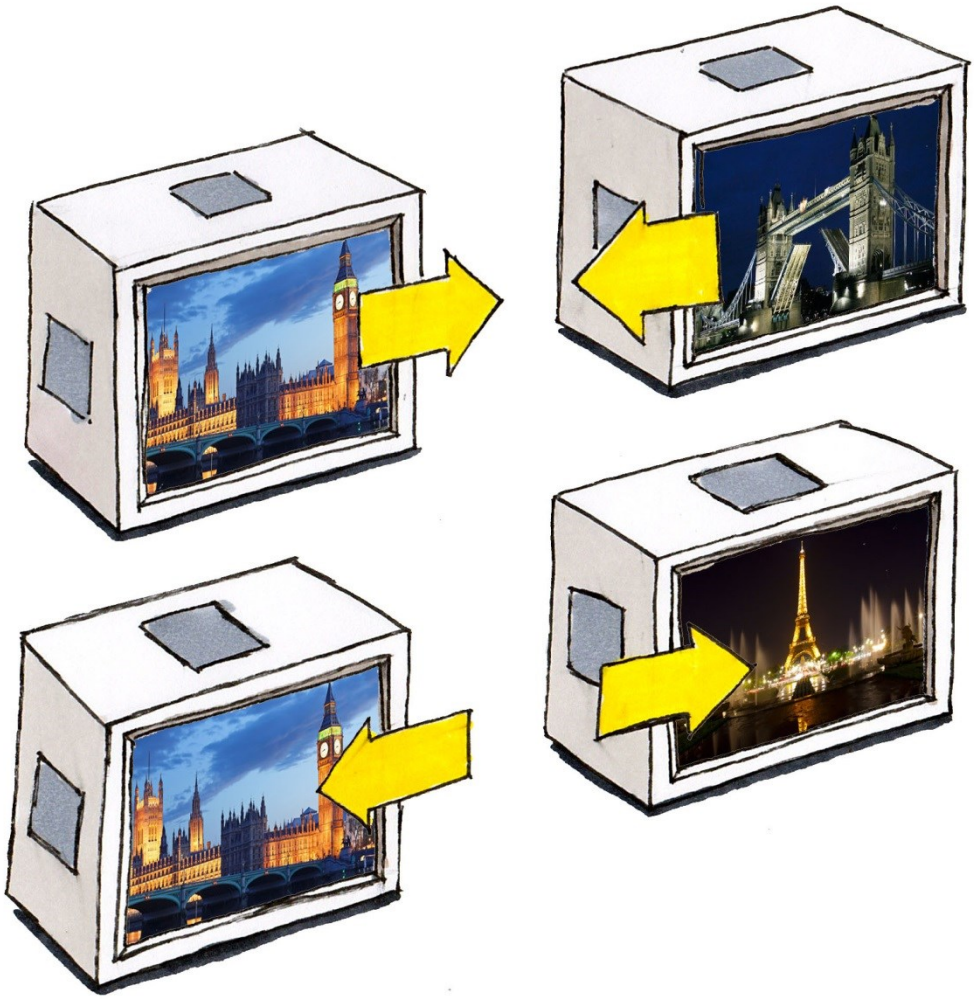


Fig. 9.3 Implementing autonomous digital materials: media taken in the same location can be connected.

The fourth idea (Figure 9.4) follows this trajectory and provides an idea for digital materials to have different behaviour depending on which physical materials they are combined with, thus also embodying the second design guideline. It is hereby envisioned that physical building blocks can be made of different materials, such as stone, wood, clay, while each can contain digital media. Different media files may then react differently to different physical materials. In Figure 9.4 a photograph of a camp fire can be uploaded to a wooden block, but not a metal one, while a picture of a Transformer robot[43] can be uploaded to a metal block but not a wooden one. Again, this can provide pleasant surprises and challenges in the craft process that can lead to flow.

[43] 'Transformers' is a series of toys, comic books, and movies starring (metal) alien robots.

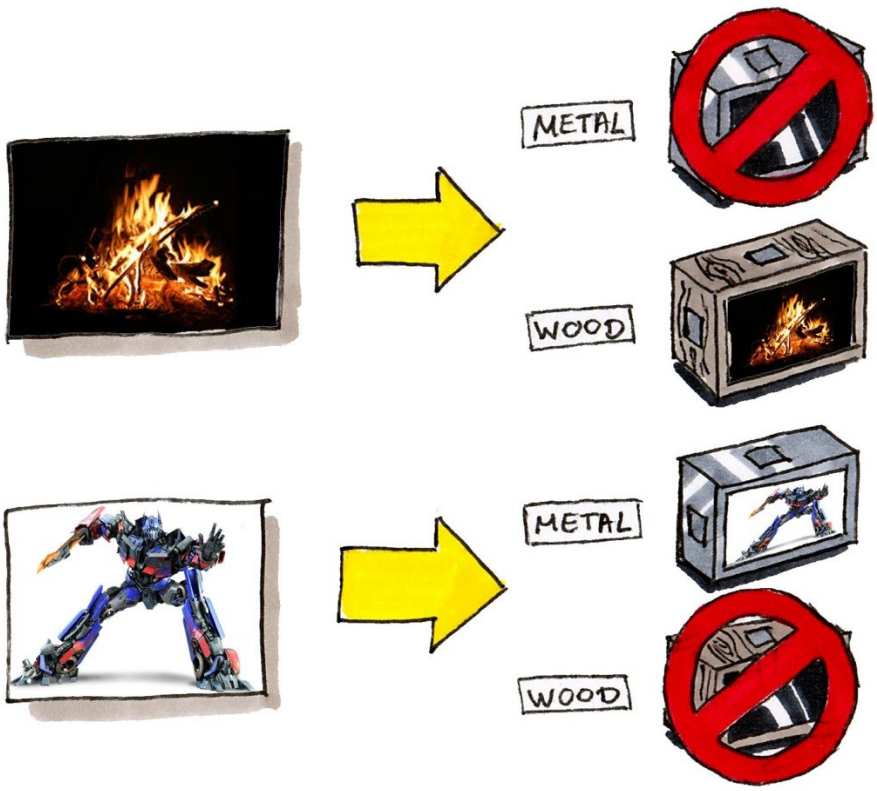


Fig. 9.4 Implementing digital material behaviour in interchanges with physical materials.

Finally, the possibility to easily create physical and digital materials was considered, for which ideas included: a recorder block with a camera and sound recorder to easily create new digital media; links to a mobile phone app which allows easy creation and uploading to the hybrid creation; the use of flexible physical materials, such as clay; and the possibility to scan or imprint physical materials as digital files by pressing them on a screen, after which they can be digitally edited using filters or some of the tools addressed in the next section.

COMBINING PHYSICAL AND DIGITAL TOOLS

When combining physical and digital tools, it was suggested that strengths of tools in both realms could be transposed but it was considered a promising direction to explore the use of new, but familiar, task-specific physical tools that can be used to work with physical and digital materials in a similar, tangible manner. It was further suggested that more experienced crafters may be interested in creating their own tools. The first idea in this section (Figure 9.5)

presents a hybrid craft toolbox that contains a number of physical tools for tangible interaction with digital materials as suggested by the third design guideline. These tools are inspired by familiar tools in physical and digital realms, and implement some of the advantages of physical tools: they are task-specific and limited in number of functions; they show their functions in their appearances; and they can be laid out visibly to aid the crafter. These tools focus on working with digital materials in the hybrid craft process, because physical tools did not seem to cause many issues. Many of these tools can be used with physical materials as well, or there is a similar tool available specifically for physical materials, thus making the interaction with physical and digital materials similar. Ideas for tools in the toolkit include the following:[44]

1. Tweezers: can be used to pick up media from a block or a computer and transfer them to other blocks.
2. Polishing cloth: can be used to polish media, e.g. red-eye correction, or sharpening images.
3. Sanding paper: can similarly be used to polish, or to make media rougher, depending on the grain that is used.
4. Eraser: can be used to delete media from a block by touching it.
5. Hammer: can be used to make media purposely look damaged where desired.
6. Pen and brush: can be used to write, draw, and annotate media.
7. Cropping tape: can be used to crop media by applying the tape and removing it again.
8. Scissors: can be used to crop or resize media.
9. Knife: provides the same functionality as the scissors.
10. Binoculars: can be used to zoom in or out by holding different sides of the binoculars to the media.
11. Sponge: can be used to wipe tools clean and allow them to pick up new media, e.g. the tweezers, suction cap, or eye dropper.
12. Suction cap: provides the same functionality as the tweezers.

[44] Note that these ideas are, again, conceptual and technical challenges in implementation have not been considered.

13. Eye dropper: can be used to scan and pick up media characteristics, such as colours and fonts, and apply these to other media (known from the Photoshop software).

Some tools in the toolbox provide the same functionality, such as the tweezers and the suction cap; and the scissors and the knife. It is considered important to provide different means to do the same digital actions based on personal preference and skill level, just like different tools can be used to do physical actions. Moreover, it should be possible to appropriate these tools in different ways and in unconventional practices. These tools all support the hybrid craft process in making editing of both physical and digital materials easier and similar, and can thus improve iteration and experimentation in the process.

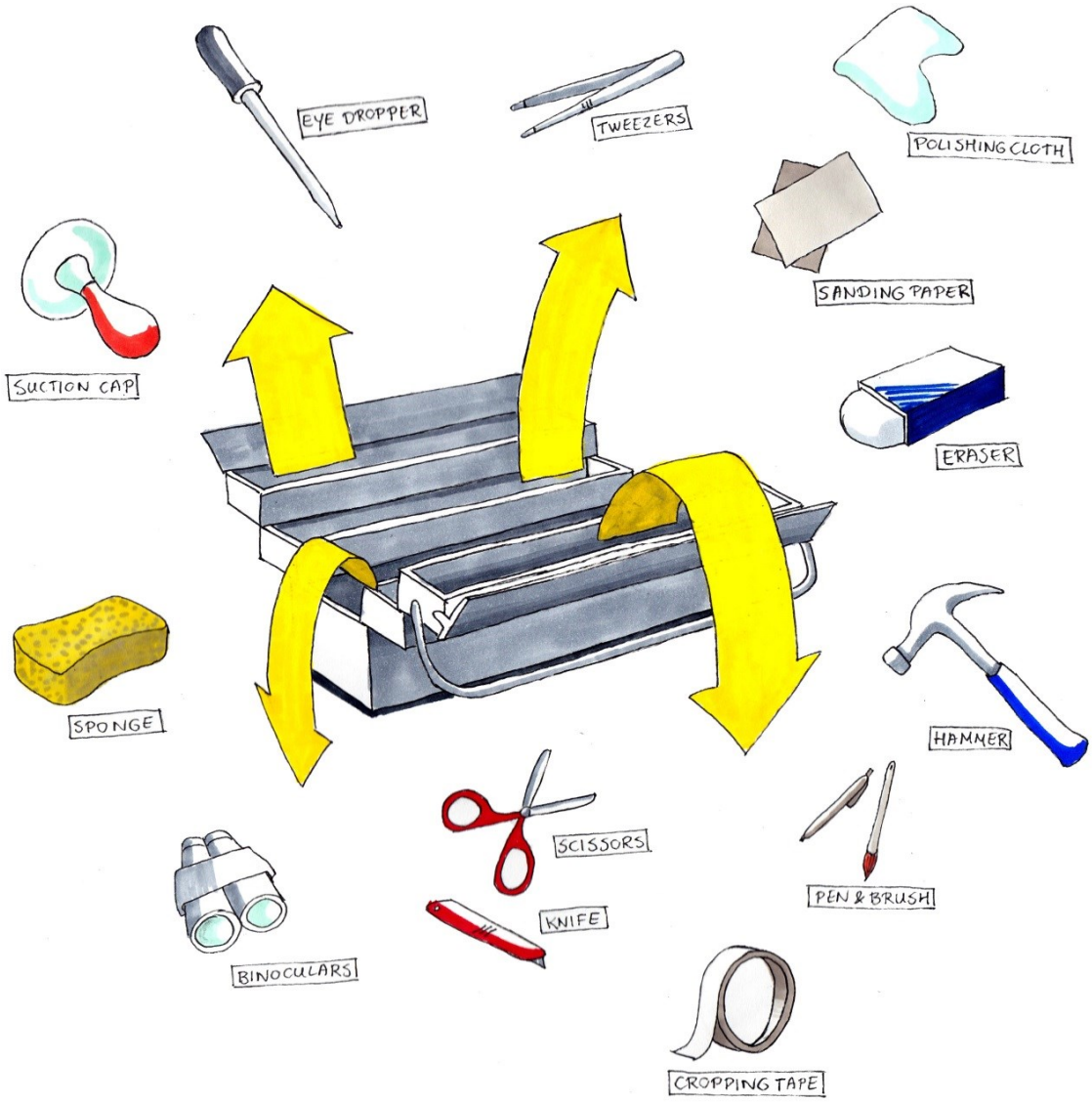


Fig. 9.5 Proposed tools in a hybrid craft toolbox.

Second, possibilities for making one's own hybrid craft tools were generated, similar to the Clay Tool presented in Chapter 5. It is likely this possibility would be more attractive to experts than novices, and although detailed scenarios were not worked out, it is envisioned that personal craft tools could be built using a platform such as MaKey MaKey[45], which lets people easily connect conductive physical materials to digital keyboard input for tangible interaction. This idea could be extended with a software tool that holds the necessary background code for each digital editing action, e.g. cropping, resizing. Crafters can then use conductive surfaces and physical materials of choice to create physical tools, and associate these with the digital editing actions using the software tool. They can thus make their own physical tools based on the crafts they are familiar with, e.g. a knitter may prefer needles, while a woodworker may prefer a hammer.

COMBINING PHYSICAL AND DIGITAL TECHNIQUES

When looking at the combination of physical and digital techniques, it is important to note that this includes parts of the process and how a crafter works, as well as how a crafter handles tools and materials, and specific ways of working or techniques a crafter may develop. Chapter 8 has suggested that a hybrid craft process may consist of predominantly digital or predominantly physical techniques – of which the latter was considered more interesting – and that, ideally, techniques for working with physical and digital elements should take place in the same materiality realm. To this end, a tangible media system was proposed (Figure 9.6) that can be used to explore media to use in hybrid creations and thus embodies the fifth design guideline. An interactive surface is connected to the home media archive and provides an alternative to manually browsing media on a computer, tablet, or phone. By placing a media block that contains a media file on the surface and selecting one or more of the search options (e.g. place, time, person, colour, grain, or any crafter-determined option) more media can be explored that are similar to the current media files, e.g. photos of the same person. Media can then be added to the block by swiping the

[45] http://www.makeymakey.com (Accessed June 2014).

block across the surface over the images that need to be uploaded. Similarly, coloured blocks, blocks of specific materials, or blocks with specific material properties (e.g. roughness) can be placed on the surface to search for media that may fit with these materials, e.g. a photo with red features, or a scratchy sound file. In this way, media can be found and linked that can provide coherent input for any hybrid craft piece. Exploration of media can take place in a fun way, and the use of such a platform may provide a sense of flow in getting lost in one's media by trying different media and different search options.

Fig. 9.6 Tangible system for media exploration.

Second, in line with the Tools section, more tangible techniques for editing, exploring, and manipulating digital media within hybrid craft were explored. Figure 9.7 shows some examples of how copying media; moving media from one block to another; resizing, cropping, rotating, and deleting media; uploading media from a computer to a block; linking related media files; and applying filters to media can be done using tangible interaction. Some of these proposed interactions make use of ideas presented earlier, such as the use of coloured blocks to apply filters, and the use of proposed tools, such as the suction cap and

the eye dropper. Without going into detail for all of these ideas, it can be seen that a rich variety of tangible interaction mechanisms can be thought of that can provide similar ways of working with digital and physical materials, and can help to integrate physical and digital craft processes. Same as for the hybrid craft tools; it is believed that having a wide variety of actions to achieve one task is beneficial for letting crafters develop their own personal styles.

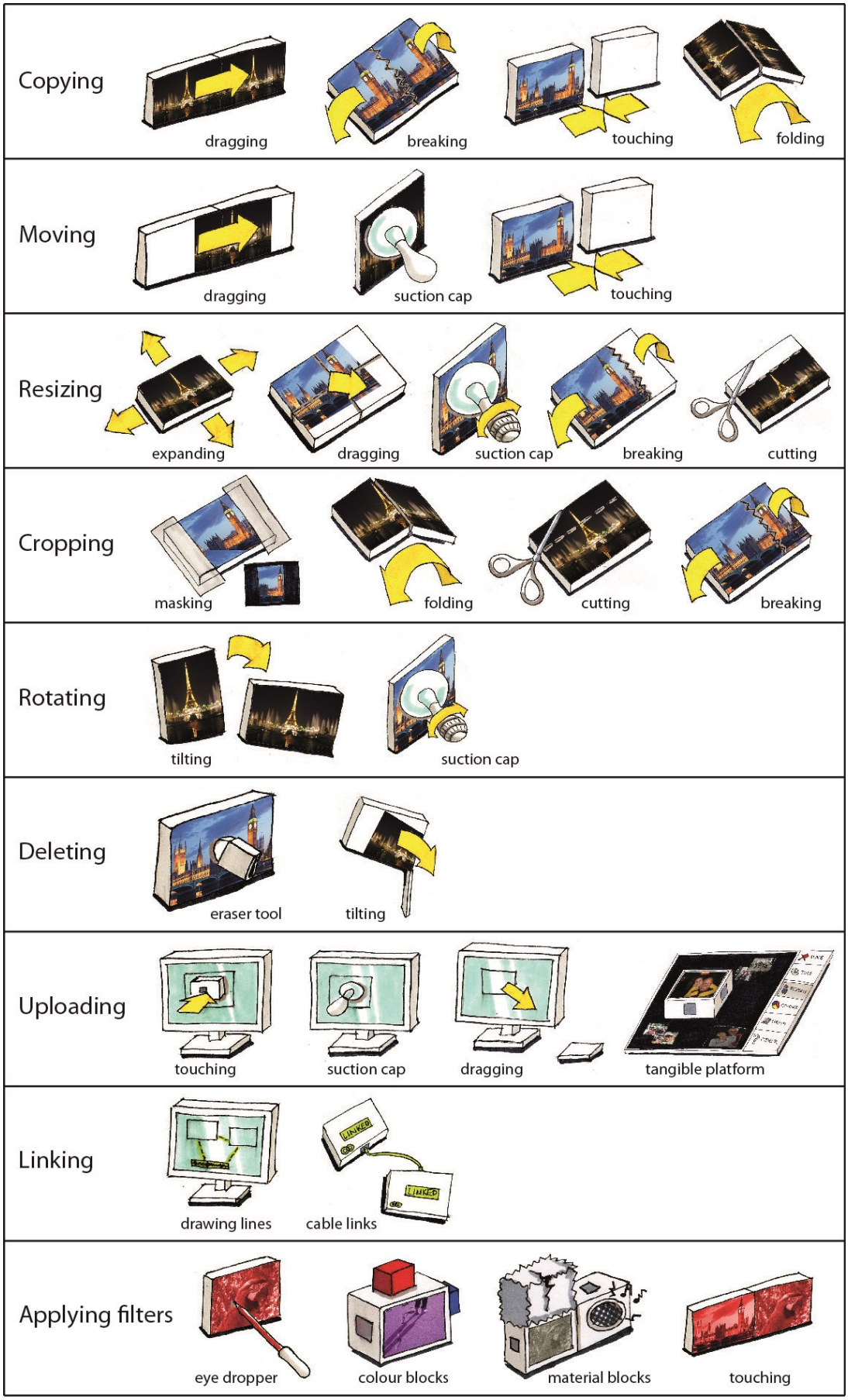


Fig. 9.7 Tangible techniques for working with digital media.

Third, in line with the sixth design guideline, it was considered how skill development and maturation of personalised techniques can be supported for progressing crafters. While the use of the tools in the previous section and the techniques above can be learned and perfected, it would be interesting to provide a tool that allows an experienced crafter to achieve something quickly, while it may trigger a sense of wonder and achievement from novices. The device sketched in Figure 9.8 gives an example of how a seemingly simple object may have several hidden options that would allow an expert to quickly crop, resize, rotate and upload an image, for example. In this way, crafters can keep developing their techniques and learn personal short-cuts, in a similar way one may think of, for example, solving a Rubik's Cube.

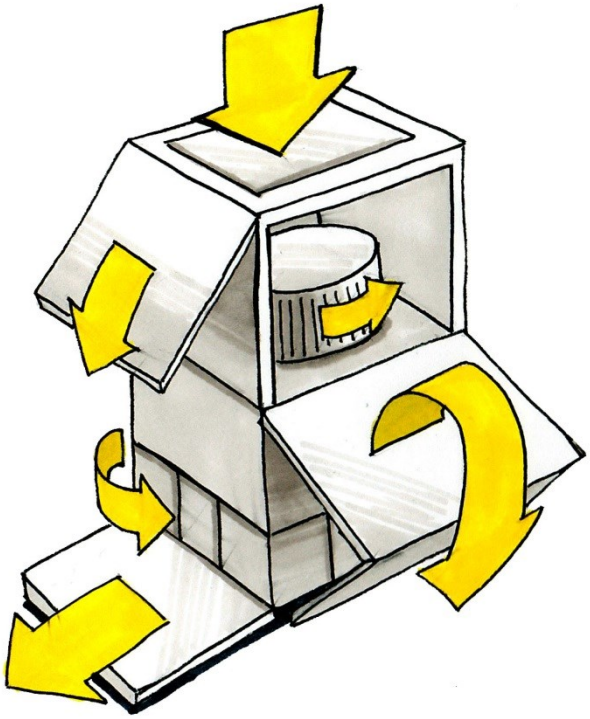


Fig. 9.8 Tools can be thought of that let experienced crafters learn to locate and use hidden controls and short-cuts for functions; crafters can then personalise their techniques and developed skills and expertise.

Further, the process of making a hybrid craft creation could be recorded and shown in a separate visualisation or on a dedicated building block, in the same way the history of actions is shown in Photoshop. In this way it could be possible to go back to a certain step and reverse any subsequent actions, and at the same time it increases the importance and awareness of the craft process by making it

explicit and visual. Finally, ideas have been addressed in the Materials section that can cause surprises and challenges in the process of making, which is also of great importance to the combination of physical and digital techniques.

INTERACTIVE HYBRID CRAFT RESULTS

To resolve tensions between static physical and dynamic digital elements in interactive hybrid creations, Chapter 8 has suggested that physical elements could be made more dynamic, and digital changes and interactions be made more sophisticated, to allow for tailoring and personalising hybrid creations over space and time. The first set of ideas in this section addresses the call for making physical elements more dynamic (Figure 9.9). Examples in this set are: the design of physical blocks that can emit light, e.g. as an ambient light that matches an image (a); projecting moving content onto physical blocks, such as a virtual aquarium (b); making blocks that can be moved and rearranged, e.g. to display different media (c); showing interactive light feedback on a physical block, e.g. a led matrix, or a sound equalizer (d); and making physical blocks more malleable so that they can be reshaped (e).

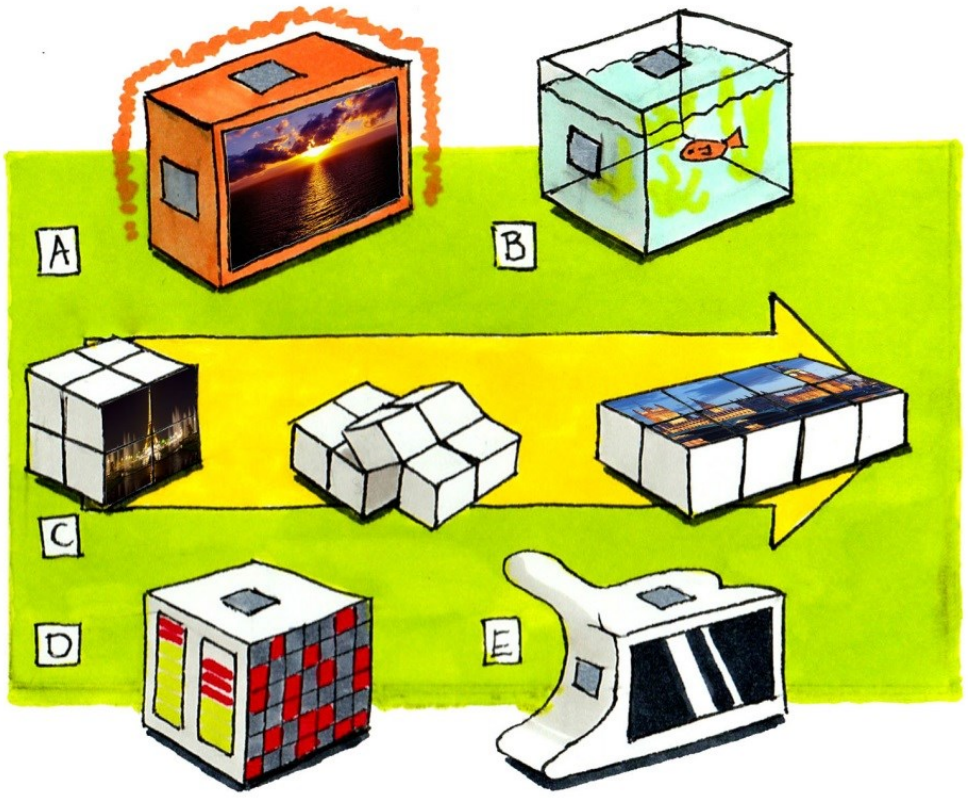


Fig. 9.9 Making physical elements more dynamic.

The second set of ideas proposes some thoughts on changing digital content easily and dynamically (Figure 9.10). This can be done automatically or manually. Examples of automatic changes are: physical presence – content changes when people are near the creation, e.g. displaying and playing media relevant or interesting to the person present; and media changes – content changes when new media becomes available in the home archive or on social media, when a crafter's interests change (e.g. by looking at Facebook 'likes'), or serendipitously over time. Examples of manual changes are: social input – remote others can change a creation by uploading new media from their computers or a mobile phone app (which can trigger surprise and the wish to change the physical creation); and personal input – quick search options and filters can be attached that update the creation with new media that fits the search option, e.g. photos taken at the same event. Of course, changes need not be made using tangible interaction, but can also be triggered through voice or gestural controls. In these ways, hybrid craft creations can be tailored and personalised over space and time, e.g. to make them meaningful over longer periods of time, or to provoke continued desire to keep crafting new creations.

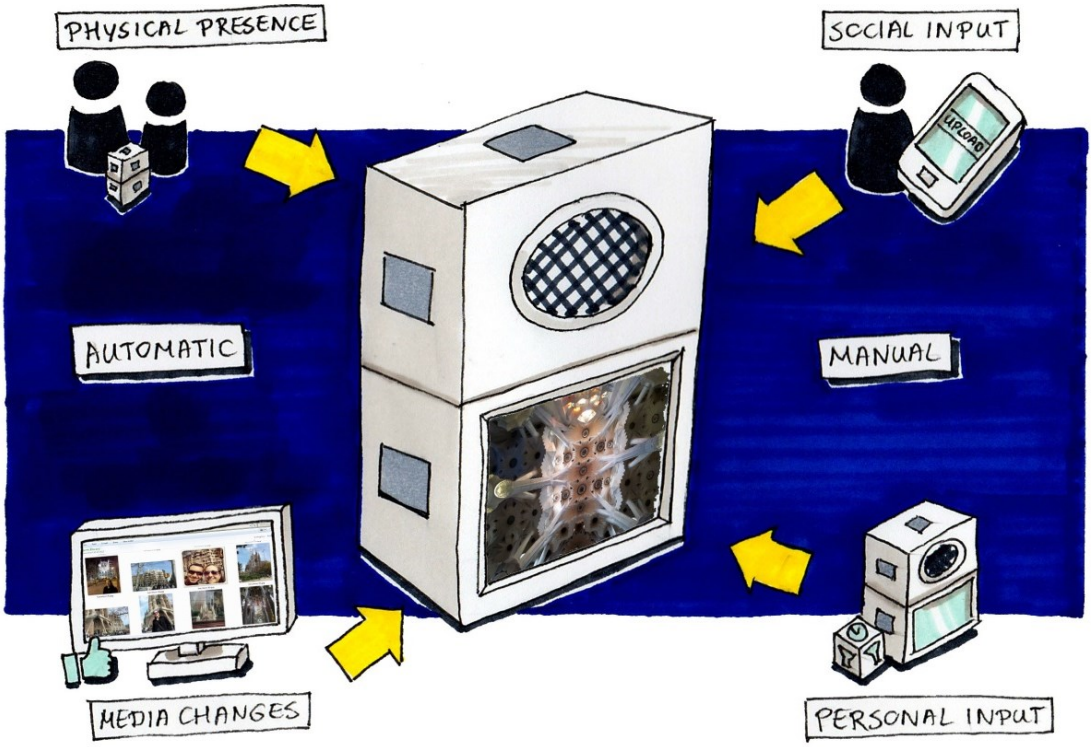


Fig. 9.10 Changing digital content easily and dynamically.

Ideas were further generated to address the tension between playfulness and exploration, and building finalised creation (Figure 9.11) to embody the eighth design guideline. To limit this tension, specific actions could be taken to indicate a creation is finished and cannot be changed or interacted with, e.g. applying a special varnish to finalise (a); immobilising physical building blocks could be operationalised by 'locking' the magnetic connections. Further, the appearance of final creations can be changed with covers in different materials, such as cloth, paper, wood, metal, or clay. Hybrid creations can then be given a coherent finalised appearance if desired (b).

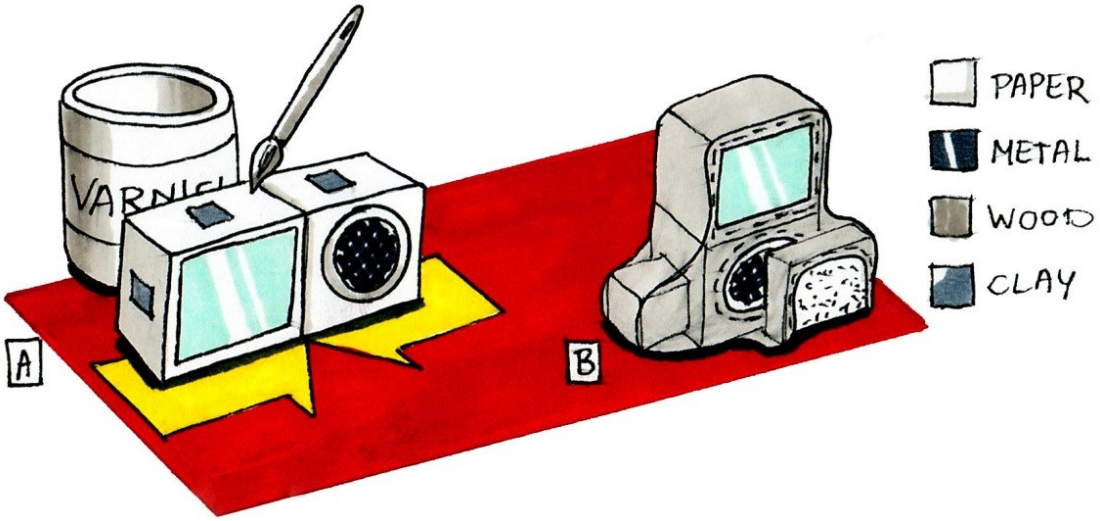


Fig. 9.11 Building finalised creations through a) applying varnish; or b) material covers.

Finally, to increase interactivity it was thought to have more interactive digital representations of the hybrid creation that change real-time with physical changes, and can be shared with other on social networks. All these examples have explored the questions of how to successfully combine physical and digital elements in interactive hybrid craft (e.g. negotiating the static physical with the dynamic digital); how to interact with interactive hybrid craft results (e.g. automatic or manual interactions, applying finalising touching when interactivity is not desired); and how hybrid craft results may change following interaction (e.g. changes in the physical and/or in the digital, or finalising results).

To sum up, this chapter has presented some conceptual design ideas that embody and illustrate the design guidelines addressed in the previous chapter by thinking about how the design of Materialise may be evolved to explore more unresolved issues around the facilitation of hybrid craft. Although further exploration through new prototypes and studies are outside the scope of this research, design ideas and guidelines can serve to inspire other designers and researchers to create new systems in this area and increase insight into design for hybrid craft. Thus, while Chapters 8 and 9 have provided practical knowledge and information for designers, the final chapter of this thesis discusses hybrid craft on a more abstract level, reflects on the design research methodology, and draws conclusions on the nature of everyday hybrid craft.

10 Discussion & Conclusions

This final chapter reflects on the findings and methodology of this thesis. Since discussion sections on sections of the findings have been included in previous chapters, this chapter reflects on all findings on a higher level of abstraction, and in a more visionary fashion. After all, interaction design often proposes changes to our current society, and introducing the currently unknown practice of hybrid craft potentially is one of such changes. First, the methodology of researching craft for and through design will be reflected on – which addresses what insights were gained by using different research strategies, what roles these strategies can play in design research, and what insights were uncovered about the nature of craft and design. Subsequently, the nature of hybrid craft will be envisioned: what might this practice be and how may it manifest itself in our everyday lives? Finally, two remaining sections discuss to what extent hybrid craft has been established as a 'strong concept' (Höök and Löwgren, 2012); and propose future directions for research.

RESEARCH INTO CRAFT *THROUGH* AND *FOR* INTERACTION DESIGN

As addressed in Chapter 2, interaction design research has recently turned to the study of craft, for example by designing new craft toolkits (e.g. Perner-Wilson et al., 2011, Saul et al., 2010), studying existing craft practice (e.g. Bardzell et al., 2012, Buechley and Perner-Wilson, 2012, Yair and Schwarz, 2011), or understanding craft in relation to design (e.g. Kettley, 2010, Kolko, 2011, Nimkulrat, 2012). However, there are currently no reports on studies that have

developed new designs for craft purely for understanding or developing a new form of craft, and that have reflected on their design research methodology. This thesis contributes to existing methodological knowledge by reflecting on the use of a design research methodology to study craft. This section first addresses the different insights that were gained by using research for design (RfD) and research through design (RtD) strategies (Frayling, 1993), after which it reflects on the nature of craft and design as it was observed in this research from a design practitioner's view. Finally, it discusses the different roles RfD and RtD can play in interaction design research. Making such reflections transparent to the design research community can help other researchers to select which strategy to use in future studies, and can aid design researchers who want to study craft using a similar approach.

INSIGHTS GAINED THROUGH RFD AND RTD

RfD and RtD played different roles in this design research and they led to different findings. Because RfD and RtD were used together, this thesis did not focus on the difference that the one leads to the design of a product and the other to the generation of knowledge (Frayling, 1993); instead it was the interchange of both strategies that led to both a designed artefact, and increased knowledge in the research topic. As addressed in Chapter 3, RfD activities consisted of the interview study with physical and digital crafters, and the formulations of design guidelines, and RtD activities consisted of the design and evaluation of Materialise. The interview study resulted in comprehensive findings around physical and digital craft practices, and a comparison of these practices that led to areas of interest for the design of systems for hybrid craft, such as the combination of existing and new material behaviour for physical and digital craft materials. Research portraits about interview participants were directly used in idea generation activities, through which new ideas were generated and the Materialise design was developed. Because it was difficult to envision beforehand what a design for hybrid craft may be – since hybrid craft is not practiced in its envisioned form – conducting the interview study was very beneficial because it helped to focus to development of a successful design

research artefact through an extension of physical and digital craft findings. Apart from forming an empirical and theoretical research contribution, RfD was thus also indispensable for informing subsequent RtD. The formulated design guidelines form the other component of RfD and are considered a valuable theoretical contribution (Gaver, 2012) for other designers who want to create hybrid craft systems or craft toolkits. These, in turn, could not have been formulated without RtD activities that empirically informed them.

Both the process of design activities in RtD and the evaluation with the resulting prototype benefitted the research. Considering the insight gained through doing design activities, a repeated observation was that extensive idea generation led to new ideas and insights, e.g. ideas around material behaviour of digital media led to follow-up ideas around the behaviour of these materials in combinations with physical elements, and the realisation that new material behaviour can be introduced in hybrid craft practice. Another overarching insight within the design process was that design prototyping is an example of hybrid craft – since it often requires physical and digital elements in process and result – which informed further reflections around design and craft. While creating the prototype it was further realised that one needs to have quite well-developed and diverse skills for hybrid craft, in this case for example hardware programming and CAD modelling. This confirmed the importance of making hybrid craft more accessible to everyday users who may not have these skills. In the design process, skills were used that the designer already had (e.g. sketching, programming), as well as ad hoc generation of new skills (e.g. working with the Gadgeteer platform, and CAD modelling in the Solidworks software); this confirmed the belief that this was a likely learning approach for hybrid craft in general. Further, this ad hoc approach to learning made the process social, as help was sought from experts in the respective areas, and the design was further created with the user in mind throughout the process. Because a broad base of skills is needed for hybrid craft, it was thought that a clear goal or application area may be more crucial for hybrid craft than for other forms of craft, which is why this was included in the design guidelines; it seems a challenging enterprise to embark on just for the desire of 'making something'. It was also a finding

within the design process that Materialise lacked depth on the side of digital creation, which is why it was decided to conduct interviews with digital crafters. In addition, using the Gadgeteer prototyping platform stressed the importance of designing the right physical elements, e.g. having a diversity of components, and having flexible connections. With Gadgeteer there were plenty of limitations in its flexibility that prevented the designer from implementing all desired functionality. Moreover, the physical shape of the blocks was strongly determined by the technology. A designed toolkit such as Materialise is also limited by the provided materials, which is why these need to be carefully designed to be flexible and limit the user as little as possible. Limitations of the technology showed the importance of implementing workarounds for difficulties one may experience; with Materialise this included providing connection blocks with two isolated metal strips that could be used to connect magnets with repelling orientations.

The use of the Materialise prototype in the workshops has also led to indispensable insights that could not have been found without design practice. These insights include the realisation that physical and digital techniques are separated in the set and that working with physical and digital materials should ideally take place in the same realm; that Materialise seems tailored to be a beginners' set; that there was a tension between interactive digital elements, and static physical elements; and that there was limited editing of digital media in the current design. These useful insights informed design guidelines and further design ideas. It is hereby important to acknowledge that these design guidelines, as well as the vision on hybrid craft, present only one possible interpretation of hybrid craft practice, inspired by the designer's vision. This is often the case in interaction design (Gaver and Bowers, 2012), especially when a new practice is envisioned that does not yet exist. Had a different design been realised and used for further ideation, characteristics and design guidelines may have been different. Nevertheless, RfD and RtD strategies formed a powerful combination that incorporated knowledge of existing practices, as well as conceptual knowledge on envisioned practices in order to develop a notion of hybrid craft that is rooted in contemporary everyday craft.

Reflections on the Nature of Craft and Design

Following this thesis' interpretation of what constitutes a craft – a careful practice that can be found in the making activities of everyday life (e.g. Sennett, 2008) – and arguments in the literature that distinctions between craft and design are fading (e.g. Bean and Rosner, 2012, Cardoso, 2010, Kolko, 2011, Myerson, 1997, Shiner, 2012, Veiteberg, 2010, Rees, 1997), the design activities that were done as part of this research can be considered craft. As such, reflecting on using craft and design to study craft can be used to gain insight into the relationship between design and craft. It is important to acknowledge that this section hereby focuses on *interaction design* research and *hybrid craft*. It further limits itself to the observations made in this research process. Within the design process it was realised that the creation of the Materialise prototype was an example of hybrid craft; after all, it required physical (assembling the hardware of the active building blocks and creating a diverse set of other physical building blocks) and digital processes (digitally designing the hardware cases, programming the behaviour of the blocks and creating the software tool for uploading media), and resulted in a physical-digital toolkit. Materialise thus introduces hybrid craft at two levels: the designer level (in creating the set) and the user level (in using the set). Interaction designers often engage in the building of such physical-digital prototypes (e.g. consider the systems in Banks and Sellen, 2009, Bhömer et al., 2010, Golsteijn and Hoven, 2013), even if these do not always incorporate people's personal digital media, as is the focus for Materialise. While the explicit design goal may lie elsewhere, hybrid craft results may be an implicit goal of interaction design. A difference between craft and design can be seen in that while design is typically goal-driven – towards design goals or visions, creating a product, or researching a certain topic (as was done in the creation of Materialise) – craft is usually more 'autotelic' – the process of crafting is an end in itself (Csikszentmihalyi, 2010). Similarly, designers are typically more user-focused (mainly in user-centred design), while crafters work more for themselves and are less led by purpose than by their drive to make (Rees, 1997). However, in both the craft interviews and in the workshops, it was seen that crafters created things specifically for others, and these others had

various levels of involvement ranging from merely seeing the craft results (e.g. exhibitions or online sharing) to being the commissioner for a craft result. Parallels can be drawn between user-centred design and craft, and it seems that as craft includes more involvement with other people, it moves closer to the realm of design.

In their design processes, designers often combine physical and digital materials, techniques, and tools, e.g. combining sketching and physical modelling with CAD modelling and programming. They thus often have a hybrid process in which they use the strengths of the physical and digital realms and negotiate their properties to fit their needs, just like this is done in hybrid craft practice. It thus seems that while hybrid craft in its strictest form – using digital media as craft materials – is a practically non-existing practice for 'everyday people', interaction designers are quite familiar and skilled with hybrid practices, albeit not under this name. While it is envisioned that for a strong integration of physical and digital practices, new material characteristics will be introduced; new physical tools will be created to work with digital media; and techniques for working with physical and digital materials will take place in the same realm, designers have to work with the technologies that are currently available. Interaction designers typically have a broad skill base and pick up skills autonomously and ad hoc within the current needs of the design process. A similar approach to learning is expected in hybrid craft because, just as in design, existing examples are few, and future visions are developed within the process of these inherently innovative practices. Within their broad skill base, designers may encounter fewer difficulties in working across materiality realms with current technologies than everyday crafters. Materialise, and future designs that facilitate hybrid craft, can make hybrid craft practices accessible for everyday users who are not trained in, for example, CAD modelling, programming, or hardware prototyping. As such, they give users the opportunity to be designers and makers, and extend the process of creation of a design into the use phase (Cardoso, 2010). In this way, possibilities and applications of hybrid craft are broadened beyond the realm of interaction design into everyday life. Design and prototyping activities in interaction design thus form some of the very few

existing examples of hybrid craft, and through their empirical engagement with this practice, interaction design researchers are in the ideal position to further develop the understanding of hybrid craft practice and create systems that make it more accessible to everyday users.

THE ROLES OF RFD AND RTD IN THE RESEARCH PROCESS

This discussion now turns to three main insights that were gained on the roles of RfD and RtD in the design research process, namely: what design research topics they may be used for; the phase in the design research process they can be used in; and the level of abstraction of the activity and the knowledge gained.

Design Research Topics

At the start of this design research, a clear vision on hybrid craft had yet to be developed. Because hybrid craft practices were not prevalent in everyday life, it was not possible to go out and ask people how they go about doing their hybrid craft. The design of a system that could facilitate hybrid craft was therefore difficult because so many factors about hybrid craft were still unknown. It was thus difficult to start with a RtD approach because it would be unpredictable if the design would be even successful in uncovering relevant information. Thus, first research had to be done to inform the design that would be the basis of the RtD using a RfD approach. Because there were plenty of existing physical and digital craft practices to learn from, these lent themselves for RfD. By first understanding existing physical and digital craft practices, conclusions could be drawn from a comparison of these practices and anticipate what design features could be implemented that may increase insight in hybrid craft. Thus, it was seen that *RfD is a suitable strategy when the topic of research is already happening or existing* (e.g. physical and digital craft). In this case a suitable research plan can be made to uncover those elements of the research topic that may inform the design of the artefact that is the goal of RfD. On the other hand, *RtD is a particularly apt strategy when the topic of research is new, unexplored, and not currently existing* (e.g. hybrid craft). After all, in such approaches it is difficult for users to envision how they may engage in new practices or use new products if they have never encountered something similar before. Be it through a sketch, a

scenario, or an interactive prototype, design researchers can embody their visions on new practices in the design of artefacts that can help to communicate these visions to the users.

Phases in the Design Research Process

Related to the previous point, it was seen that RfD and RtD could be used in different phases of the design research process. Within the unknown area of research, the researcher felt more comfortable with doing RfD early in the process to gain insights that could inform RtD later in the process. Thus RfD and RtD were used iteratively in phases that informed each other. While a system could have been designed to facilitate hybrid craft at the beginning of the process, based on a vision of hybrid craft, it would not have been informed by any, or only theoretical, knowledge of craft practice, and thus it may not have succeeded in uncovering valuable knowledge on a new craft practice. Instead, it was opted to *empirically inform the design by employing RfD first*. Of course, different strategies are possible and other designers may argue for the creation of design artefacts early in the process, and redesigning them after user feedback in several iterations. There are further different roles for different design artefacts in different phases of the research, e.g. a sketch may trigger more open and conceptual user feedback, while a sophisticated prototype will trigger detailed, technical feedback. Designers can thus consciously chose at what level of detail they want to present their ideas to the users by adapting their medium, and early phase designs may thus be better served with a sketch or a scenario. Embarking on RtD early can be helpful in certain design research processes, for example when there is a clear idea of where design solutions may be sought, but for more complex research areas, empirical research and RfD can be a powerful informant for initial designs.

Level of Abstraction of Activities and Knowledge

Finally, a difference was seen in the level of abstraction with which RfD and RtD activities were carried out, and in the knowledge gained from these activities (Figure 10.1). The crafter interviews took place at a high abstraction level. Although interview questions were partly concrete (e.g. what materials and tools did crafters use), and partly more abstract (e.g. why did they like it, and did they

consider what they did a craft), by going through the interview analysis and looking across participants' stories, findings were abstracted and insights were derived about crafters' practices at a higher level of abstraction. Characteristics of physical and digital craft could then be formulated and compared that looked beyond the concrete details of specific practices, from which insights into hybrid craft could be derived (Chapter 8). On the other hand, the design of Materialise, took place at a low level of abstraction. After having formulated an initial vision on hybrid craft, this vision had to be made concrete in the design of a system. This system may not completely embody all elements of hybrid craft, but it functioned as a concrete example that could make it clear to users what was envisioned for this practice. Because there was a concrete design present, and it was difficult for users to envision what practices they may engage in far beyond this presented design (as was seen clearly in the workshops), findings from RfD initially remained on a concrete level (e.g. feedback on the working of the prototype, or what they may use this specific design for) and it was up to the design researcher to then abstract these findings into a comprehensive vision on hybrid craft (moving to a higher level of abstraction). Subsequently, design guidelines were derived on a high abstraction level, which formed further RfD that may inform future concrete designs for hybrid craft. Figure 10.1 visualises this process. Hybrid craft practice (top centre of the figure) is the new practice in which insight was to be gained on an abstract level. This could not be done directly because users could not be asked directly about this unknown practice. Therefore, a work-around had to be found by informing hybrid craft through different strategies: RfD into other related practices, at a high level of abstraction, that could lead to insight through horizontal (over time) translation of insights; and RtD for hybrid craft, at a low level of abstraction, that could lead to insight through vertical (abstracting) translation of insights. The derived comprehensive notion of hybrid craft led to design guidelines – RfD at a high level of abstraction – which both are informed by the knowledge about hybrid craft, and can further inform hybrid craft through the development of future designs. Note that this figure shows a simplification of reality, i.e. the design research process is usually not a smooth linear process as depicted, and research activities, such as the crafter interviews, can occupy multiple abstraction levels.

Moreover, the research topic is depicted in the horizontal centre of the figure to indicate that knowledge around this topic is gained throughout the process; it is not completely known from the beginning of the process, and design research typically does not end with knowledge of the topic, but extends to applications of this knowledge, e.g. in design guidelines. The circle representing the research topic is therefore also a simplification of reality in its placement, and is loosely connected to the time axis.

Thus, from Figure 10.1 it can be concluded that *RfD can result in both concrete and abstract findings*, depending on how it is used in the research (e.g. concrete or more abstract interview questions can be asked), but *RtD cannot directly result in abstract findings* because there is by definition a concrete design that guides users in their interpretations and feedback, which makes it impossible to reach a high level of abstraction directly. It is the role of the design researcher to afterwards make this translation of RtD to a more abstract level.

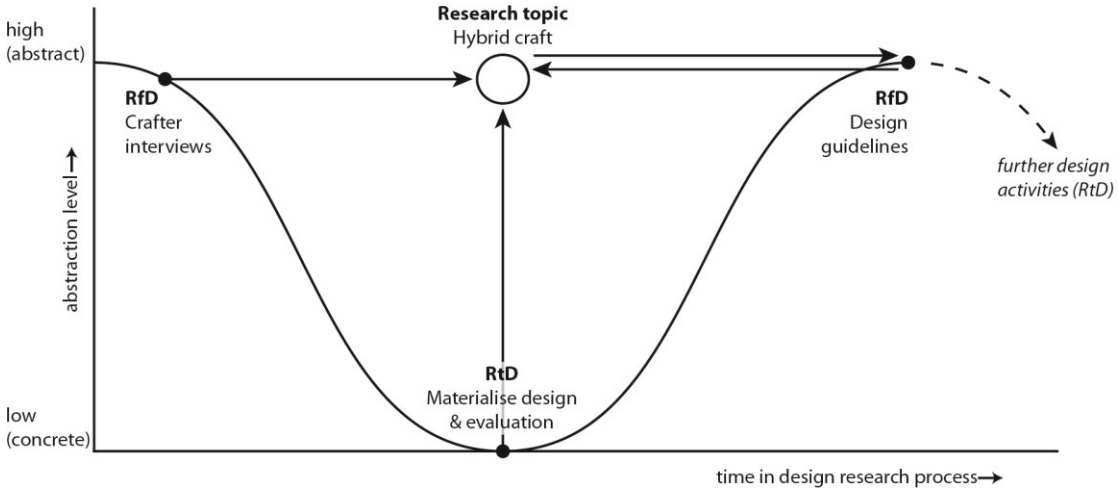


Fig. 10.1 Visualisation of the roles RfD and RtD played in the design research process. Both crafter interviews (RfD at an abstract level) and the Materialise design and evaluation (RtD at a concrete level) were used to inform the research topic, hybrid craft (top centre), through translations of findings over time and over abstraction level. These activities together led to an understanding of hybrid craft (top centre), from which design guidelines were derived (RfD at an abstract level). These design guidelines are both informed by an understanding of hybrid craft, and can increase this understanding, for example through further design activities (further RtD at a concrete level). RfD and RtD thus iteratively inform each other.

As shown, RfD and RtD are not exclusive practices, but instead they can be extremely powerful if they are used together effectively in a process where one strategy informs the other. This research has shown that this is an effective approach for studying topics that are currently non-existing or unexplored because these cannot readily be studied by RfD or RtD by themselves. By consciously reflecting on the design research topic under study; the phase in the design research process; and the level of abstraction of a design research activity and the findings thereof, design researchers can determine their research strategy to include both RfD and RtD accordingly.

ENVISIONED NATURE OF EVERYDAY HYBRID CRAFT

This thesis aims to inform an understanding of what forms a hybrid craft practice may take in everyday life, for everyday crafters. Chapter 1 posed a strict definition of hybrid craft, which dictated that hybrid craft uses both physical and digital materials, techniques, and/or tools, to make physical-digital creations that are interactive (they can be changed over time through user input or automatically). The digital materials in this form of hybrid craft are digital files, such as personal digital media, which are still in their digital form within the hybrid craft result. This form of hybrid craft was aimed for in the design of a system that can support such this new practice because it was believed to be a promising direction for interaction design to let people incorporate their digital information – on abstraction levels that make sense to them (digital files) – in physical craft, e.g. to create mementos around digital media. Although the previous section has shown that hybrid craft in this form is sometimes done by interaction designers and others who work with hardware platforms such as Arduino or .Net Gadgeteer, it is predominantly inaccessible for everyday crafters who are not particularly interested in technology or have skills in these areas. Similarly, while some everyday crafters, for example those in the Maker culture, have engaged in hybrid practices that would fall within a more liberal definition of hybrid craft, e.g. using electronics such as digital displays within physical creations, one still needs certain skills with technology. Hybrid craft with digital

files is thus currently hardly done in everyday life, because there are currently no tools available that make this practice available to those who, for example, do not know how to code. This thesis aims to envision a hybrid craft practice that is accessible and attractive to everyday crafters – who may be more interested in using both their physical and digital materials in this increasingly hybrid age, than in using technology – and explore the design of interactive systems that can facilitate hybrid craft. Materialise, and its design variations in Chapter 9, poses an example of such a system. It was seen in the evaluation of this design that it was not always necessary to combine physical and digital materials, tools, *and* techniques in hybrid craft, e.g. design ideas proposed the use of physical tools to work with physical and digital materials. However, as seen from the limitations in Materialise, a stronger integration of physical and digital realms in all of these aspects results in a more hybrid and 'craftier' practice, e.g. by facilitating hybrid techniques that manipulate physical and digital elements in the same action.

In envisioning hybrid craft as an everyday practice it is first important to reflect on how this practice may form. While it has just been discussed that appropriate tools should become available that can make hybrid craft accessible, it is envisioned that toolkit such as Materialise would only be required to get crafters started and illustrate the possibilities. Ideally, such toolkits can be quite open-ended and leave room for hybrid crafters to develop and appropriate their own tools and materials – e.g. by creating their own tools, or providing open-source resources that can be adapted to crafters' needs – so that as the practice matures, it will not be necessary to acquire dedicated hybrid craft tools or materials. In this way, it is envisioned that the elements necessary for hybrid craft will not be limited to those within a toolkit but instead become part of the collections of everyday objects that can be used in craft practices, e.g. hammers, glue, but also Powerpoint or Photoshop. After all, no matter how successful a toolkit is in facilitating craft practice, the elements in it are designed and implemented by someone else, while for craft it is important that crafters can develop and appropriate their tools and materials in their own, sometimes unconventional, ways. Hybrid craft can then develop to be an autonomous and self-driven craft practice in which crafters pick up the necessary skills online or from peers in

their physical environment. While skill development may be ad hoc at first – as crafters are still exploring possibilities – when the practice matures and more examples become available, it is expected that hybrid crafters can deliberately plan their development. As mentioned, hybrid craft skills do not necessary include programming – although they could – but can be, for example, photo and sound editing and creating, digital art, painting, woodwork, or weaving. Apart from skills within physical and digital realms, hybrid craft further requires creativity in combining particular physical and digital materials, knowledge of how materials can be combined, and creativity around what to make.

It is expected that the hybrid craft process is autotelic because of its opportunities to enable flow (Chapter 8) while offering a combination of those elements that were considered enjoyable in physical and digital craft, e.g. internal and external surprises, challenges, materiality, social factors. Moreover, working with personal digital media in itself offers added benefits, such as providing enjoyment in exploring, serendipitously encountering, and reminiscing with personal digital media (e.g. Stevens et al., 2003, Petrelli and Whittaker, 2010, Bowen and Petrelli, 2011), and 'doing something more with digital media' (e.g. Frohlich et al., 2002). Hybrid craft, both as a process and a result, has potential to offer an alternative to 'lifelogging' (Sellen and Whittaker, 2010, Petrelli and Whittaker, 2010) in encouraging careful selection and creation with digital media that is not like work, but fun and engaging (e.g. Bowen and Petrelli, 2011, Stevens et al., 2003). As such, hybrid craft practice can have beneficial effects on digital media accumulation, consumption, and presentation, and can support our meaning-making by giving us focal points for understanding and communicating our identities, telling our stories, and reminiscing about our experiences (e.g. Dant, 1999, Miller, 1998, Woodward, 2007). Further, it can offer a 'positive vision to making and reusing', and help us to connect with others and actively work on projects that increase our well-being (Gauntlett, 2011, p.57, Sennett, 2008). Hybrid craft thus has potential to be enjoyable both from a craft perspective and a digital media use perspective, and can encourage new forms of creativity that can stimulate people's 'drive to make' (Gauntlett, 2011, p. 222).

Hybrid craft further has a wide range of application areas and possibilities for meaningful craft results that extend those of physical and digital craft, e.g. in the creation of personal mementos, storytelling, tailored gifts, thematic media displays, means for media sharing, or means for unobtrusive communication. Hybrid craft also offers possibilities around sharing and materialising digital elements in craft, which were desired by digital crafters. In the social world of new forms of making (Gauntlett, 2011), hybrid craft systems can be designed to allow for appropriate sharing of craft results on online networks. Hybrid craft results thus become more important because they can be used to connect with others, in the same way digital craft results are used (Gauntlett, 2011). Including digital media in physical creations further provides the necessary means to materialise these media, be it for preserving them, organising them, easily accessing them, or displaying them in one's everyday environment; different forms of hybrid craft results can be created tailored to these needs. Finally, hybrid craft results have the potential to be highly personalised and to be used as tailored gifts, for reminiscing purposes, or even as communication means (e.g. if remote peers can interact with a hybrid creation), or as alternative information filters to online content (e.g. by using hybrid craft creations and the tangible interactions around them to filter which content from social media is displayed). After all, craft can be used to personalise life events and craft artefacts can symbolise social relationships (Massimi and Rosner, 2013). These possibilities for hybrid craft results increase their potential to be cherished, in line with earlier literature that suggests that craft, both as a process and a result, is often cherished (e.g. Jung et al., 2011, Odom et al., 2009, Odom et al., 2011, Golsteijn et al., 2012, Petrelli et al., 2009, Stevens et al., 2003).

This thesis thus proposes a new craft practice that can have beneficial purposes in everyday life, e.g. allowing people to do more with their digital media. It further overlaps the realms of art, craft, and design and thus has a potential to facilitate new forms of creativity in combining materials, tools, techniques, and technologies that could not easily be combined before. It can further have a positive effect on individual well-being and society, e.g. in connecting with others through the sharing of craft results or crafting together (Gauntlett, 2011). Of

course, appropriate systems that can initiate this practice need to be designed, for which this thesis has given guidelines. It is expected that a new craft tradition can form as people learn to create and appropriate the elements required for hybrid craft, and examples of creations and available tools and materials move beyond those provided by a designer.

HYBRID CRAFT AS A 'STRONG CONCEPT'

This chapter now turns to an evaluation of the knowledge gathered in this thesis as a 'strong concept'. Proposed by Höök and Löwgren (2012), strong concepts provide an intermediate level of knowledge that resides between specific design concepts and general design theories; an example of a strong concept is social navigation (making decisions based on the decisions of others). Following the beliefs often held in design research that much theory and knowledge lies in concrete designs (Cross, 2001, Frayling, 1993, Zimmerman et al., 2007), Höök and Löwgren propose that knowledge from these designs can result in strong concepts that are abstracted from concrete designs and thus become applicable to a broader range of situations, and can be generative of new design solutions. At the same time, strong concepts are more specific than general theories, and are thus a closer fit to design practice where too much abstraction can supress the applicability to generative design (Höök and Löwgren, 2012). Since this thesis has provided concrete design examples (Materialise and conceptual design variations), from which it has derived generalised design guidelines for hybrid craft and a comprehensive understanding of hybrid craft practice, it has arguably laid the groundwork for establishing hybrid craft as a strong concept, thus providing a demonstrable intermediate level knowledge contribution to the field of interaction design research. This section evaluates to what extent this has been achieved, and what further work may need to be done, and whether hybrid craft forms a valuable research contribution.

Is Hybrid Craft a Strong Concept?

To develop a strong concept Höök and Löwgren (2012) propose that a potential strong concept is identified from a specific design concept that may have broader applications, or from a design idea that was created to illustrate a theoretical idea. In the case of hybrid craft it was first decided to develop this envisioned practice through design, after which the specific design of Materialise was created to explore the design space; hybrid craft is thus an abstraction from Materialise as much as Materialise is a concretisation of hybrid craft. To be suitable as a strong concept an idea needs to: address interactive behaviour rather than static appearance; reside between technology and people (it proposes a design element but also use practice and behaviour over time); carry a core design idea that can be applied to different situations and application domains; and be an abstraction level up from concrete design instances so that related designs can be worked out in different ways (Höök and Löwgren, 2012). Hybrid craft describes a practice of creating integrated physical-digital craft results. It moreover explicitly aims to explore how hybrid craft results can be interactive and it has presented ideas and guidelines that enable further interactivity with craft results beyond the initial phase of creation. *Hybrid craft thus, first, addresses interactive behaviour*. Second, hybrid craft is proposed to be a practice that lets users explore new making practices using novel technological systems; *it thus occupies a space between technology and people*. It further includes a concrete design element (Materialise) that illustrates the idea. At the same time, design ideas, evaluations, and further reflections have addressed use practices (e.g. in envisioning how Materialise may be used for creating reminiscence objects or personalised gifts) and behaviour over time (e.g. in addressing how hybrid craft skills may be learned, and how different designs could be realised for novices and experts). In the design guidelines specific attention has been paid to make sure designers consider an appropriate application area for hybrid craft, and think about how craft practice may develop over time as crafters progress. Third, *hybrid craft carries a core design idea* – designing for an integrated physical-digital craft practice, embodied in Materialise – that can be transposed to different use situations and application

domains, e.g. creating different craft results within different social set-ups, such as possibilities around materialising media and possibilities for highly personalised creations with personal digital media. Fourth, h*ybrid craft occupies a place in the intermediate knowledge space* as it is one abstraction level up from the concrete design instance of Materialise, but it is not as general as a theory. This abstraction within the RfD and RtD process has been made explicit in the research through the use of annotated portfolios, the development of design guidelines, and the formulation of a vision on hybrid craft. As stressed earlier in this discussion, Materialise is only one example of a hybrid craft concept and by employing the design guidelines and hybrid craft characteristics, other concepts can be generated that embody the same core idea of hybrid craft but present different applications of this idea in practice.

DOES HYBRID CRAFT FORM A VALUABLE RESEARCH CONTRIBUTION?

Based on contemporary views on academic quality criteria in design research, Höök and Löwgren (2012) propose three criteria to assess if a strong concept forms a valuable research contribution: it should be contestable, defensible, and substantive.

Is it contestable?

A strong concept needs to be inventive and novel for interaction design research. *Horizontal grounding* is proposed as a step in the process of establishing a strong concept to ensure that attention has been paid to similarities and differences with similar concepts (Höök and Löwgren, 2012). An extensive literature review into craft in HCI and design has shown that hybrid craft as envisioned in this thesis is a new concept of which no closely related concepts can be found in the field. Craft has remained an unexplored topic in the area of physical-digital integration and tangible interaction research, and no current examples in design research were found of systems that met the criteria for hybrid craft set in this thesis. Hybrid craft forms a strong concept that offers a new view and application area for craft that has not been previously explored, and it does not present a view that is generally held in the field; it is thus contestable.

Is it defensible?

A strong concept further needs to be empirically, analytically, and theoretically grounded, and the research process and reasoning need to be rigorous and criticisable. The notion of hybrid craft has been developed through a process of *reflection, articulation and abstraction* (Höök and Löwgren, 2012) of design work, design evaluations, and empirical research into craft. By employing RfD and RtD approaches, it has employed an iterative approach to abstraction and concretisation to make sure design instances and design guidelines formed a coherent picture and informed hybrid craft. It has thus employed a process of *vertical grounding* in looking for other concrete design instances that may illustrate the strong concept, and general theories that inform it. Since hybrid craft in the form proposed in this thesis is a novel practice, there are no current design examples beyond those presented in this thesis; more downwards vertical grounding should thus be done as more concepts are developed in future design research. Further, while it is based on theories in literature (e.g. employing Gauntlett's (2011) and Sennett's (2008) interpretations of craft, and drawing parallels to Csikszentmihalyi's flow theory (2010)), hybrid craft could benefit from more substantial overall theoretical grounding. The research process has further been conducted to academic standards and has been well-documented in this thesis and in published papers for others to examine and criticise. It is therefore believed that hybrid craft is also defensible.

Is it substantive?

A strong concept finally needs to be relevant to the interaction design community; contribute to better interaction design; and be generative of new concepts. As addressed in Chapter 1, this research combines two important areas in interaction design research: hybridity and craft, which can further understanding in tangible interaction and craft research. Further, it has addressed the importance of studying craft as a cherished activity and result, which may change the ways we use and perceive our digital media. Moreover, it has offered a view on studying craft for and through interaction design research, and insights into the nature of interaction design and craft, which may help designers to think about their practices. Hybrid craft is further generative; this

thesis offers the theoretical contribution of design ideas and guidelines with which designers will be able to develop new concepts for hybrid craft.

In conclusion, although the vertical grounding of hybrid craft can be improved as more design concepts are developed in future research, and as more theoretical grounding is developed, the process carried out in this interaction design thesis was sufficient to establish hybrid craft as a strong concept that offers a demonstrable and valuable contribution to interaction design research.

DIRECTIONS FOR FURTHER RESEARCH

Throughout this thesis design opportunities and directions for further research have been identified. As this research has functioned to open up the design research space of hybrid craft, and has further shed a light on emerging digital craft practices that may be supported with technology, more design and research can increase the knowledge in these areas and can support emerging practices. This section therefore addresses future design research directions in hybrid craft and in digital craft forms.

FUTURE DESIGN RESEARCH FOR HYBRID CRAFT

This thesis has introduced hybrid craft as a novel concept and has used Materialise as an example design to explore hybrid craft in practice. It has further presented conceptual design ideas that may support this practice. Any of the ideas in Chapter 9 could thus be further explored, prototyped and studied. Similarly, new ideas could be generated in the categories addressed in Chapter 9 – the integration of physical and digital materials, tools, and techniques, and interactive hybrid craft – which can help to further understanding in hybrid craft practice. Such new designs could be tailored to study small aspects of hybrid craft, such as the *use of new hybrid craft tools, new material behaviour, quick editing by changing compositions, or tangible techniques for media editing*. Another interesting direction could be the *design of more dynamic physical components* that can change with digital content, such as the creation of movable components and flexible displays (e.g. Alexander et al., 2012, Iwata et al., 2001).

Knowledge gathered in such tailored studies could develop insight into specific hybrid craft mechanisms or interactions in this area, and could subsequently be used by designers who want to design tools or toolkits to support hybrid craft.

Apart from design and research that focuses at specific mechanisms or interactions within hybrid craft, there is also room for studies that explore the bigger picture of the practice. Looking beyond the strict definition of hybrid craft this thesis aimed to design for – which uses digital media as craft materials – there are hybrid practices that are currently done in everyday life, e.g. by people in the Maker culture, and by interaction designers and others who work with technology hardware. Although these practices were not directly studied to inform hybrid craft in this thesis – since it was considered beneficial to study the new (strict) form of hybrid craft by extending knowledge from physical and digital craft and keeping a focused design brief – further research could be carried out in which these existing hybrid practices are studied and findings are used to see how everyday hybrid practices, which currently often focus on electronics and coding, can be extended to the use of digital media; and how designers' hybrid practices can be more accessible to everyday crafters.

There is also room for further exploring hybrid craft practice once it has been established in the form proposed in this thesis. For example, *different application areas and contexts of use* can be explored, and hybrid craft toolkits can be designed accordingly, e.g. for reminiscence, personal gifting, materialising digital media. Further, the *social set-up of hybrid craft* can be explored, and different designs can be realised for different social set-ups. Interesting design opportunities to address are the creation of a social network that coexists alongside crafters' local social networks and that complements these in suitable ways; and the exploration of effective means for sharing hybrid creations that do justice to both physical and digital elements. There is further an opportunity, as design and research in hybrid craft continues and the practice becomes more prevalent, to study the *practices of more experienced hybrid crafters*: how do their practices change, how do they develop their skills, and what may be their arising needs as they improve? Now these questions have been speculated about and

one of the design guidelines urges designers to think about the skill development of their target group, but when experienced hybrid crafters actually come to exist, these research questions can be explored thoroughly.

As a whole it is important for the development of understanding in hybrid craft that *more systems are designed, more prototypes are built, and more evaluations take place in different contexts*. Apart from creative workshops, prototypes need to be employed in the intended use context, e.g. the family home, to be able to evaluate how hybrid craft may fit in everyday lives. The creation of more concrete design examples can further help to vertically ground hybrid craft as a 'strong concept' (Höök and Löwgren, 2012) which increases its worth to the design research community as more inspirational generative material is available to build on.

SUPPORTING DIGITAL CRAFT FORMS

Interviews with digital crafters uncovered two important design opportunities for supporting *digital* craft forms. First, it appeared that although crafters wanted to explore and learn autonomously, they did not always seem to be able to gather all the necessary skills and information online, be it for a lack of time to learn, limited information available, or limitations in means to assess what information is reliable and helpful. Current online information provisions did not seem to support the ways in which people wanted to learn their craft all too well, so there is a design opportunity in the *design of systems or online networks for learning digital craft* that help digital crafters identify useful information, connect with peers, learn from others, share their experience; supporting both ad hoc approaches to learning and planned trajectories for continued learning. Research could look in more detail at how digital crafters learn and gather information and translate this into design requirements for a digital learning environment that supports learning practices.

Second, it appeared that digital craft practice is not well supported by available digital craft tools. Crafters selected and used a limited number of tools, of which

they had limited knowledge, and that were selected for reasons that were not informed by needs of the craft process but rather by time or money constraints. Craft tools often dictated craft processes and results, instead of crafters being able to flexibly select tools ad hoc to suit different needs in different phases of the process. There is therefore an important design opportunity in the *design of more intuitive and effective tools for digital craft*. This thesis has given some ideas in this area, e.g. transposing characteristics from physical tools to digital tools, or making tools physical. More extensive empirical research can be done in digital tool use that can lead to more ideas for the improvement of digital craft tools.

CONCLUDING REMARKS AND SUMMARY

This thesis has introduced hybrid craft as a novel strong concept for interaction design research through a theoretical, empirical, and design grounding. It has studied everyday physical and digital craft practice as a basis for understanding a potential combination of the two realms, and it has used design practice to explore this combination and formulate a vision on hybrid craft practice and design guidelines for the design of interactive products or systems that aim to support this practice. In opening up a design research area that combines the research areas of tangible interaction and craft, this thesis has offered several methodological contributions (introducing narrative interviewing and portraiture to interaction design, developing the 'idea generation through portraiture' method, and researching craft for and through design), empirical and design contributions (providing a multidisciplinary study of physical and digital craft practice, design ideas for hybrid craft, and an evaluation of a hybrid craft toolkit), and theoretical contributions (identifying overarching characteristics of physical and digital craft, introducing hybrid craft as a strong concept, and providing annotated portfolios and design guidelines for hybrid craft) that can progress design research in the areas of tangible interaction and hybridity, craft, cherished objects, and personal digital media use. It has finally highlighted future research directions for craft with the vision that hybrid craft forms a promising area for designers, researchers, and craft practitioners that can open up exciting new possibilities for making practices in our everyday lives.

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List of Publications

PUBLISHED ARTICLES ABOUT THIS RESEARCH

Golsteijn, C., Hoven, E. v. d., Frohlich, D. & Sellen, A. 2014. Hybrid crafting: Towards an integrated practice of crafting with physical and digital components. *Personal and Ubiquitous Computing,* 18 (3)**,** 593-611.

Golsteijn, C. & Wright, S. 2013. Using narrative research and portraiture to inform design research. *In:* KOTZÉ, P., MARSDEN, G., LINDGAARD, G., WESSON, J. & WINCKLER, M. (eds.) *Human-Computer Interaction – INTERACT 2013.* Berlin, Heidelberg: Springer, 298-315.

Golsteijn, C., Hoven, E. v. d., Frohlich, D. & Sellen, A. 2012. Towards a more cherishable digital object. *In: Proc. DIS 2012*. Newcastle Upon Tyne, United Kingdom. ACM Press, 655-664.

Golsteijn, C. 2012. Materializing and crafting cherished digital media. *In: Proc. CHI 2012 Ext. Abstr.* Austin, Texas, United States. ACM Press, 923-926.

WORKSHOP PAPER

Golsteijn, C., Hoven, E. van den, Frohlich, D. and Sellen, A. 2013. Integrating technology in creative practice using 'Materialise'. In: *Proceedings of the workshop 'Crafting Interactive Systems: Learning from Digital Art Practice' at CHI 2013*, 27 April 2013, Paris, France.

A Interview Study Materials

INTERVIEW SCHEDULE

This guide was used loosely and questions were 'narrativise[d]' in the interviews (Hollway and Jefferson, 2000, p.35).

CRAFT

What do you do?
When do you do this? How often? How long?
Professional or recreational? Relation or contrast to profession?
How do you do it, process?
What is the result? What do you do with the result?
How does the result differ from a bought item?

STARTING AND LEARNING

When did you start doing this?
Why did you start doing this?
How did you learn? From whom? How?
What skills do you think you need for your craft? Mental, physical skills?

MATERIALS

What materials do you use? Diversity of materials?
What are the characteristics of these materials; how do you use them?

TOOLS

Do you have your own workspace? Can you describe it?
What tools do you use? Diversity of tools?
What kind of tools; automated, electronic; hand tools?
How do you obtain these tools, e.g. create them yourself, buy them?

MOTIVATION

Why do you do it? Why do you like it?
Process or result? Why?
Do you consider what you do a craft, why/why not? (Only asked in digital craft interviews)

OTHER THEMES TO ASK FOR WHEN ADDRESSED:

Perfectionism
Challenge
Satisfaction
Repair or modifying others'
Modesty
Risk: what risks are involved; what can go wrong? How does this influence the process?
Therapeutic effect
Flow feeling
Social aspects? Do it together with other? Share results with others? Learn from others?

PARTICIPANT INFORMATION SHEET

You are invited to take part in a research study. Before you agree to take part, it is important for you to understand what it will involve. If you have any questions, or if something is unclear, do not hesitate to ask.

WHO IS THE RESEARCH FOR?

My name is Connie Golsteijn and I am a PhD student at the University of Surrey. The research study you are invited to participate in is part of my PhD and the data collected in this study will contribute towards my PhD thesis. My PhD research is sponsored by Microsoft Research and looks into the activities of crafting and creating using physical materials and digital media. During my PhD, I aim to support crafting and creating with a combination of digital media and physical materials by designing and testing new technology.

WHAT'S THE RESEARCH ABOUT?

The interview you will participate in will be used to gain insight in crafting and making activities in the physical and digital world. You have been approached to participate because you either make things digitally, for example using your computer, or physically, using physical tools and materials.

WHAT DO I HAVE TO DO IF I TAKE PART?

The interview will take approximately 45 minutes to an hour and will, where possible, take place at your home or the place where you usually engage in your crafting activities, or remotely via telephone or Skype. Questions in the interview will focus on what kind of things you make, when and how you started doing this, what materials and tools you use, and why you do this. The interview will be audio recorded for analysis purposes. Where possible, I would also like to take photos of your workshop or the place where you craft, or any materials, tools or examples of your work. You will not be photographed in any way that would disclose your identity.

WHAT WILL HAPPEN TO THE INFORMATION I PROVIDE?

Your answers and photographs taken will be used in the writing of the PhD thesis. Findings will further be written up for internal reports and as papers for publication in academic journals, and for presentation at academic conferences and publication in conference proceedings of these conferences, as part of the PhD. Internal reports may be shared within the University of Surrey and Microsoft Research. Data will be anonymised and you will not be identified in any report or publication.

The information you provide, together with the information provided by other participants, will be used to identify research themes about craft. In addition, a research portrait will be written about you as an artist or craftsperson. In this research portrait your answers a combination of verbatim and paraphrased quotes, and observations during the interview, will be used to provide a context to the interview, and present the full picture of the craft practice, such as how, where and why you started, what materials and tools you use, and why you do it. Photographs will only be used in these research portraits, where applicable, to illustrate your answers, by showing examples of the tools or materials you use. Photographs will not be used in any way that may disclose your identity.

You have the option to review materials intended for dissemination in which information you have provided has been used, such as the research portrait written about you, or photographs taken and used in these materials. If wish to do so, please let me know during or after the interview and leave your contact details. I will take into serious consideration any comments or objections you may have after review about research portraits, photographs, or any other materials, and will make adjustments where I deem this appropriate.

All research will be carried out with your prior and informed consent and all data will be held and processed in accordance with the Data Protection Act (1998). To assist the transcription process audio recordings will be made during the interview. Photos will be kept by the principal investigator in order to assist

with transcription and analysis. All data, including photographic data, will be used for the purposes of this research protocol only; as described above through the writing of internal reports, the PhD thesis, and academic publications. However, reports and publications may form the basis for further research and data may be revisited to support further research. Data will be kept securely for 10 years.

WHY SHOULD I TAKE PART?

The research activities provide an opportunity to think creatively about the future of media practice and crafting and the invention of technologies for the home of the future.

WHERE WILL THE INTERVIEW TAKE PLACE?

The interview will where possible take place at your home or the place where you usually engage in your crafting activities, or remotely via telephone or Skype.

WHO WILL I BE INTERVIEWED BY?

You will be interviewed by Connie Golsteijn.

WHAT DO I DO IF I WANT TO WITHDRAW?

You are free to withdraw from the study at any time without needing to justify your decision and without prejudice. You can tell me at any point during the interview if you do not wish to continue, after will the interview will be terminated. You cannot, however, redraw your consent to use any information provided up to the point of withdrawal.

CONCERNS AND COMPLAINTS?

Any concern or complaint about any aspects of the way you have been dealt with during the course of the study will be addressed; please contact Connie Golsteijn or Professor David Frohlich (supervisor), whose details are provided below:

Digital World Research Centre
Faculty of Arts and Human Sciences
University of Surrey
Guildford GU2 7XH

Telephone Connie: 01483 682 793
Email Connie: c.golsteijn@surrey.ac.uk

Telephone Prof Frohlich: 01483 683 973
Email Prof Frohlich: d.frohlich@surrey.ac.uk

FURTHER QUESTIONS?

If you have any further questions, please do not hesitate to contact Connie Golsteijn.

This study has been reviewed and received a favourable opinion from the University of Surrey Ethics Committee.

CONSENT FORM

Please read the following statements. If you are in agreement with them, please provide your signature as directed below.

- I, the undersigned participant, voluntarily agree to take part in this study.
- I have read and understood the Information Sheet provided and acknowledge that a full explanation has been provided by the principal investigator as to the nature, purpose and likely duration of the study. I have had the opportunity to ask questions relating to all aspects of the study and have understood all advice and information provided in response.
- I agree that my personal data may be shared with other researchers or interested parties within the University of Surrey and Microsoft Research, as outlined in the Information Sheet. I understand that all personal data relating to volunteers is held and processed in the strictest confidence, and in accordance with the Data Protection Act (1998).
- I understand that I am giving the University of Surrey consent to record me and to use and make available the content of the recorded discussions within the University of Surrey and Microsoft Research, through the writing of the PhD thesis and internal reports, as well as outside these institutions through external academic publications, as outlined in the Information Sheet. This consent applies to any and all materials originating from the discussions, including any images that were created during the interview. All materials will be kept in secure conditions at the University of Surrey and will be preserved as a permanent reference resource for use in publications including print, audio-visual or electronic for the purposes of further research, conference, symposia, lectures and seminars. I consent to the retainment and use of the information I provide for any ethically approved further research.
- I understand that I have the option to request to review those materials intended for dissemination in which information I provided has been used, and I have read and understood the section of the Information Sheet that outlines the procedure for this.

- I understand that I am free to withdraw from the study at any time without needing to justify my decision and without prejudice, but I cannot withdraw my consent to the University of Surrey the right to copy, publish and to use information given during the discussions up until the point of withdrawal.
- I acknowledge that this study is part of a PhD programme that is sponsored by Microsoft Research.
- I confirm that I have read and understood the above and freely give consent to participating in this study. I have been given adequate time to consider my participation and agree to comply with the instructions and restrictions of the study.

PARTICIPANT:

Name of participant (BLOCK CAPITALS)

……...

Signed …… Date…… | …… |……

PRINCIPAL INVESTIGATOR:

I have fully explained the contents of this document:

Name of researcher (BLOCK CAPITALS)

……...

Signed …… Date…… | …… |……

B Portraits of Physical Crafters

JIM – HAIRDRESSER

Jim is a hairdresser who has his own salon in a city in the south of the Netherlands. In the salon four people are employed, including Jim and his wife, who are frequently complemented with interns from nearby teaching institutes, who need to work at a hairdressing salon as part of their training. Jim considers his salon a vent for his creativity and expressing his personality and considers himself an artist rather than a business man. His creativity is visible in the interior of the salon, what with trendy design chairs, oil barrels as tables, magazine article floor carpeting, chandeliers, pinball machines converted into lights on the walls, and the Christmas tree hanging upside down from the ceiling. Jim explains that he wants the appearance of his salon to communicate his brand and compares his business to hairdressers' chain businesses that have branches in the area: 'with the right qualifications anyone can start up one of those. Just fill out the paper work and they will provide you with some things that make your salon fit the brand image. I don't want that; I do my own thing.' Jim adds that his customers have certain expectations because of the brand image of his salon. That is what they come back for, that is what Jim wants to provide them with.

As I enter the salon to get my dreadlocks tidied up and redone I am greeted by Jim's ten year old daughter who later comes to have a look as Jim is working. She wants dreadlocks too and Jim demonstrates to her the process of tidying up the dreadlocks to convince her to carefully think about this: 'Look, these two dreads have knotted together and I have to separate them. I want you to look at her face

as I pull them apart: it really hurts.' But the child is adamant and keeps coming back from time to time to witness the progress and ask her father, and me, numerous questions. She and her younger brother are still on their Christmas break and come into the salon from time to time to ask their dad questions, cross through with bikes, show their new purchases, and generally pry. Such is the atmosphere in Jim's salon, and I get the feeling that this amicability, that almost gives the idea of witnessing a day, or an hour, in the life of the hairdresser's family, is part of the image and brand that makes customers come back.

Jim's craft is working with hair. Although not all customers come in for extreme creations that require much creativity and design, Jim keeps up with the developments in the field and knows how to give his customers his professional advice. Specifically, I am talking to Jim about making dreadlocks. Jim has been making dreadlocks since 1994 when he joined a friend for a workshop in London after having been interested in the process long before. In this workshop he learned the basic techniques and he has developed his techniques into his own style by experimentation since. In short Jim's process of making dreadlocks involves dividing the hair into tufts by making square partings on the skull after which each tuft is backcombed until the hair stands up from the skull. Each dread is subsequently rolled onto a curler and chemical liquids are applied to perm and fix the hair into the new dread structure. Finally the hair is dried and wax is applied in a circular motion, which the customer has to repeat regularly until the dreadlocks are properly formed. Over the years, Jim has perfected his way of backcombing, e.g. the directions to hold the dreadlock and the comb, where to start, and how to twist the dread while working from all sides, and he has experimented with different methods of making and fixing dreads: 'I have visited other salons and workshops; to fix a dread some use candle-grease, or honey, it's a mess!' Another technique for redoing the roots of dreadlocks is weaving a dreadlock through the root repeatedly: 'I can't work with that if someone has done that. Once you start doing that you have to continue doing that, because I can't backcomb anymore. But it divides the root of the dread and it looks weird.'

Today, Jim is working on existing dreadlocks and he only has to work on the roots of each dreadlock and tidy up dreads that have knotted together. Jim explains to me how different people have different ways of backcombing and that it can be done 'loose' or 'tight': 'I do it quite tight, because I want to have most of the work done and have the dread mostly done before perming. That gives the best results and the dread develops in the best way.' Apart from backcombing the root of the dreadlocks, tidying up the dreads involves weaving loose strands of hair back through the dreads with a needle and backcombing them to make them stick inside. Jim tugs loose and semi-loose strands and carefully checks the original square partings to see which dread to weave them through. From time to time Jim gets help from his colleague, who has helped out with this process once before. Jim shows him again how to do the backcombing and observes his 'student's' work carefully. Eager to learn, and probably aware of Jim's quality demands, the colleague asks for Jim's opinion after finishing his first dread, and from time to time he asks Jim for advice when he is in doubt of the way to proceed. Jim patiently demonstrates and gives advice based on his observations. On a few occasions Jim's colleague starts to follow Jim's instructions during his demonstration and Jim urges him to watch carefully first. But the colleague has his own customers and only helps out now and then within certain steps of the process. I ask Jim if he teaches his techniques, and the whole process, to new people often, but he is resolute: 'No, I don't go around just teaching anyone. It has taken me a long time to perfect my technique and skill and to gain the experience that I have, and I don't want to teach just anybody who just walks out the next day with that new know-how obtained for free. I need to have a good feeling about someone before I teach them.' [I know of one other employee who has been working in Jim's salon for 11 years who was taught the whole process by him.]

As the backcombing takes a good 4.5 hours and the whole process takes about 6-7 hours I ask Jim if he still enjoys doing it after 18 years, or if it has become merely a way of living for him: 'No, I still really enjoy it. You have to; otherwise you can never keep doing this.' Jim explains that it is also an unwritten policy in his salon that wherever possible every employee gets to do whatever hairdos

they like doing most 'because then you can guarantee that bit of extra quality and inspiration customers come here for.' After about an hour and a half of backcombing Jim mentioned to his daughter that he is 'just starting to get into the flow' and I ask him what he means. He explains that at some point he just gets focused on the dreads and getting everything tidy again; he gets into the routine, listening to music at the same time, and just really getting into his work. When I ask him if he values the result or the process he initially mentions 'the result, seeing how everything is tidy again', but quickly adds: 'the whole road, from A to Z'. I ask him if it makes a difference to him if he has made the dreadlocks himself originally, in the case of tidying up, but he comments that he also sees great challenges in home-made dreads and really messy situations: 'Give me some time with that and see what I can do with it.' These kinds of challenges give Jim great satisfaction when he manages to reach a good result.

I notice that the comb Jim is using has half and full pins and I ask him if he buys his combs like this or if he tailors them himself: 'The pins just break off from the backcombing, but actually it works best when not all pins are of the same length; it knots up the hair better. We save up broken combs for backcombing.' Jim uses specific tools for his work that cannot readily be bought, and these tools get perfected through doing the work they are employed for. The material he is using is obviously hair. Every person's hair is different of course, but even on one person's head not all hair is the same and it requires understanding and experience to know this and act accordingly: 'The hair at the back of the head knots more easily and it is therefore easier to backcomb. At the front and top of the head the hair is much smoother and I have to work on that harder. At the same time I'm also more perfectionistic for those parts because they are more in sight.' This perfectionism can be seen in the whole process of Jim's craft: his constant checking if he has sufficiently backcombed and redoing it until it is right according to his high standards; his teaching and observing until his colleague gets it right according to these same standards; and his pride in the result, seven hours after he started, as he shows me the back of my head with a mirror, lifting layers of dreads: 'Look, all neat squares again.' He finally asks his colleague to

take a photo of the result, because with almost twice as many dreadlocks as a person has on average, this was a big job, even for Jim.

JOHN – WOOD AND METAL HOBBYIST

John, a software engineer by profession, likes to tinker with wood and metal. He enjoys making tools, small machines, or furniture, such as garden benches and tables. In addition, he enjoys building small electronic circuits, such as time-controlled circuits and relays circuits for operating machines. Sometimes he uses a combination of materials and electronics to create a 'complete machine' which he finds very rewarding. An overarching theme for his work is that the 'creative element does not lie in it being beautiful or being art, but in the goal and function.' John says he is always working on his projects; if he is not physically busy he is thinking about what to make. He used to be in his workshop daily, but now he is older this has been reduced to a few times a week. He is more active in the summertime, because it is too cold in his workshop for wintertime tinkering.

John tells me he has always been interested in creating things: as a small child his dad had to keep him away from the tools and machinery in his workshop. His parents bought a construction kit for him about which he tells me: 'the examples that came with the kit were not enough; I went in search for extensions and used all materials at hand: cigar boxes, bike lights, tea towels, ropes.' Much in line with this John later followed a mechanical engineering education. Further he tells me about two influential men in his life that have taught him a lot and provided him with a basis from which he could develop his skills: his father, a constructional fitter, who taught him how to work with metal, and his father-in-law, a carpenter, who taught him how to work with wood. Apart from this obviously fortunate combination, John learned how to work with electronics mostly by self-study and experimentation: 'If you are interested, you can learn so much by just doing it.'

An impressive result of John's craving for building can be seen in his garden: a large barn that he has designed and built from scratch. I ask him how he managed to do that when it required skills he did not have before, such as

bricklaying. Again John tells me: 'just start.' He had helped out his sister when she had her house built and learned from the bricklayers that where working there by observing them. 'You build up background knowledge; knowledge you initially don't know how to place it or what to do with it, but it's still there, and all of a sudden that becomes useful.' He adds: 'when I really didn't know how to do something I would go to a professional and say: "this is what I'm doing and this is what I want; what am I doing wrong?" And then I would get advice about the materials, tools or procedure.'

Understanding the importance of learning from others, John passes on his skills and knowledge where possible. Friends and family will ask him how to do certain things, such as putting in a water pipe, 'but not everybody is equally interested; I am sometimes too enthusiastic in my explanations.' It also happens that someone asks him to explain something without showing them, for example in an email or over the phone; 'then I will make a drawing for example or try to explain, but I prefer to just demonstrate it; that is most fun.'

John continues to tell me about the different ways of working with materials. Wood and metal require different tools, such as different drills and files, and wood is more elastic than metal so if it does not fit together perfectly you can still put something together while this is not possible with metal. Also the ways of connecting separate pieces of material are different: 'you wouldn't connect wood with nails or screws if it needs to be beautiful, because you will see those parts, but metal can be screwed and then a screw can be beautiful. Nowadays metal can be glued, but I usually don't use glue in metal constructions; I use welding, screwing, and riveting.' John adds that he likes the challenges of making difficult wood connections because the teeth have to be sawed very carefully. 'It is difficult to connect two pieces of wood in a perfect 90 degree angle. With metal this is dead easy. I make something out of metal because this is beautiful, not because it's a challenge, because it is not.'

John further tells me that he often recycles materials or uses used materials. He likes it when a material is not disposed of but is reused, and the fact that a dirty

piece of wood can become a beautiful new piece of furniture. ‘Often [used] material is also better: if you go to a store and buy wood, you have no idea how this will behave, but if you have used material you know that someone has already thought about this and has carefully selected this material. This [wood] should be a window frame, it has been a window frame, and has served its purpose as a window frame. So then you know: this is good material for a window frame.’

In his extensive workshop John has a large variety of tools, a combination of hand-powered and machine-powered tools. He explains that this is necessary because not only do wood and metal require different tools ‘Metal chisels are much harder than wood chisels; wood chisels need to be razor-sharp, but metal chisels don’t have to be that sharp’, even different metals, such as stainless steel or aluminium, require different tools. ‘I have saws, sanding machines, milling machines and drills in all sorts and sizes, because each job demands its own machine.’ Sometimes John makes his own tools: ‘when you are working on repeated tasks and it is toilsome to do something and there’s a certain repeated pattern, you start thinking: “can I do this differently, smarter, or so that it makes me less tired?” And then it can be a challenge to come up with something for that, and a challenge to make that. And that is very rewarding when you succeed and when it works as you had intended.’ Some things he made turned out to be even better than expected and were even suitable for other purposes, for example a large board with sanding paper he initially made to sand and straighten beehives. He now uses it for all kinds of purposes, for example for providing grip on pieces of wood that are placed on it for sanding with the sanding machine.

I ask John which skills he thinks are needed to do what he does and he tells me one has to have good fine motor skills and plenty of patience. He adds: I’m very precise, that helps too. It’s important for me that it is done decently. I can’t make myself call something done when it is crooked or loose or knocked together. Those are demands I put on myself. I have noticed that when I make something for other people they will easily say “oh, that’s good and finished” but I will say: “no, I just have to do this or adjust that...” My demands are generally higher than

those of the customer.' This perfectionism leads John to underestimate the time it will take him to make things. He attributes this to lack of experience and bad planning skills, but asserts: 'it's not important anyway; it's more important that it's beautiful than that it is quick.'

I ask John why he chooses to create these things, such as pieces of furniture that can also be bought. One motivator is the price: 'if you buy a garden bench that is affordable it is often not good quality and if you buy the material and make it yourself you have a much better bench for the same amount of money.' Moreover, 'it is just good fun to do it yourself!' He explains: 'if you build something, you see something growing and then there is a product and it is very satisfying that you have built something yourself. That provides much motivation to go on and make it better next time.' John also likes getting compliments on his work, which he states is a good reason to make things too. Finally, he tells me how making things is a way to 'switch off': 'sometimes you just don't want to think too much, but just do something. It's a kind of reset function. It gives you a chance to switch off. Worries you may have are forgotten, because you are focussed on hand craft. There is no room for other worries. You are so focussed on trying to get the chisel to take away the right amount of wood that there is no room for psychological worries or puzzles; that is all gone.' He adds that there needs to be a balance between what is going on in his mind and what he can try and put aside by tinkering: 'the reversed is also true; when you are very concerned about big issues, you can't really do anything else, because you can't focus [on craft]. So it needs to be a situation in which you decide: "I cannot solve this problem now, I'm going to tinker a bit" and the next day you can solve the problem in no time.'

John also has had to spend time in a rehabilitation centre because of rheumatic complaints. Craft was used there as a part of the therapy, both to restore people's sense of self-respect in showing them what they can do, and to encourage them to make certain movements. John enjoyed working in the same workshop with others and comparing projects. The general procedure included choosing an example to make out of wood or metal, for example a chandelier, and using a

step-by-step guide and help from supervisors to create this. I ask him if the prescribed techniques that should be doable for novices limited him, but he tells me: 'I'm eager to learn, so even if I had my own way of doing something, I would still try out a new method, because perhaps that is better than my own method.'

In his work as a software engineer John is part of a team that builds software for doing and navigating interactive questionnaires. 'It's also building, with little materials; with software you actually have no materials, you only have tools. And then the challenge is to make a user interface in which the buttons and sliders and inputs are in the right positions and do what you would expect of them; to make it an intuitive tool.' John tells me the challenges also lie in the calculations and procedures, such as quick sorting of data. Sometimes people have already thought of solutions but the environment or language is slightly different and he has to find new ways or adjust existing solutions. Similar to in his metal and wood work John builds tools to do things more efficiently, wherever there is repetition involved: 'because you have the ability to write that tool you will do it; if it is more work to build the tool then to keep doing the task, you won't do it.'

I ask John which is more fun, the 'physical or digital crafting' and he tells me: 'physical is more fun, but makes you physically tired and then the digital crafting is fun. But if I have crafted digitally for a while, I am ready for a physical task, so the mix is best. I have also made electronic devices that needed software to work and that combination is much fun.' Both in the physical and in the digital domain John likes the process as well as the result and in both worlds he enjoys 'the challenge of building something; seeing something beautiful develop, something which people use and enjoy using; that's in software engineering and in furniture making.'

MARY – GLASS ARTIST

Mary works with glass which she sometimes combines with found materials, such as pieces of cable or copper wire. Her work can roughly be divided into two categories: stained glass panels and windows, and glass sculptures. The techniques she uses for making the stained glass panels are in accordance with the traditional methods of medieval times, with some more 'modern gadgets' involved such as electric soldering as opposed to gas. Mary indicates she spends quite some time planning, designing and gathering information for a new piece, such as this piece she is currently making for an exhibition the theme of which is games: 'so I'm interviewing people because I want to have some sort of narrative of what people say and I write that actually on the glass.' After gathering information she comes up with a design, and creates a drawing which she uses to cut the pieces of glass, which are then put together. For the glass sculptures she makes a mould first, which is then filled up with different types of glass from different sources. After that it gets heated in a kiln and it will come out as a 'brick' with the designed pattern in it. This piece gets polished; Mary calls this process 'a bit arduous and tedious'.

As her busy schedule got freed up recently, Mary has since a few weeks decided that she will try and spend two days per week on her glass work, roughly one day for stained glass and one day for glass sculptures. She does not produce many pieces and says to make two things 'of significance' each year, partly because of time constraints, but also because she 'think[s] about it an awful lot.' She illustrates this by an example of a piece: 'coming up to the millennium everyone was making things for the millennium. I was into maths at the time so I made this really complicated design which is based on the golden rectangle and then within the golden rectangle is every aspect of maths you can think of. And it's all sort of in there and it's all layers of glass rather than just one piece of glass, so you'd have to cut more than one piece of glass, so it was quite complicated. And I like that. And it was only... quite small, and that took me six months to think about it and get around to doing it. […] it's just sort of a gentle path.'

One day a week Mary goes to a friend, who has a fully equipped studio for mould making: 'It's an old stable with no windows, so it doesn't matter what the weather is like; we shut the door and that's it. And that's really the only way to do it.' The stained glass work can be done at home, as long as you have a board and a level surface to work on. Mary tells me that she used to have a dedicated place, a spare room set up as a studio, in the home to work on her stained glass, but this has currently been repurposed. Because part of the work is quite messy she is currently setting up a place to work in a shed in the garden she has bought for this purpose.

Mary has always been interested in stained glass and when finishing high school at 17 she wanted to make stained glass windows. However, this was not very open for young women who had been to grammar school and she was expected to do something else. Fifteen years later she took the opportunity to learn it in evening classes and has continued making stained glass since. She adds: 'whenever there's an opportunity to do a qualification part-time I've just taken it, so I've got all sorts of qualifications.' After she stopped working full-time she had the idea to go to college part-time and study ceramics and glass to learn how to make the glass to include in her stained glass windows. She did not finish the degree because she chose to do a PhD, but she completed the first year, in which she did glass blowing and different types of glass work. As such, Mary has been doing glass work since 1980, but has been doing 'craft things' all her life. She tells me she had to learn how to make her own clothes when she was a child, and she was quite good at needlework. Her parents were further involved in setting up a local traditional crafts centre so Mary 'had a go at silversmithing and spinning and weaving and all those sort of traditional things.' This obviously provided a great opportunity for her to explore: 'most things I have been able to do… but you really have to decide to do one because you can't do all of those things; you'd never get anything finished.' She further adds: 'it means that if I have to I can make curtains at home or repair things', which she calls 'a dying skill'.

During the evening classes Mary has met friends who also do glass work. She keeps in touch with these friends and meets them sometimes at exhibitions. She

also enjoys going to work at her friend's studio: 'sometimes it is quite nice to work with someone else; it can be quite lonely if you're just on your own the whole time.' When being in the same location Mary and her friend can chat while working and exchange advice and even spare glass. She adds: 'there can be long moments of silence, when you're working away and concentrating, but it's quite good to have someone else around you can sort of bounce off.' She emphases the importance of that the person she is with is doing the same thing. She tells me it's a 'very sensing, emotional thing' and there has to be a connection with the people she is working with: 'it's not about being in the right mood, it's about the chemistry with people you're working with. […] The dynamics are important; if there's any negativity in it, it comes through in the work.'

When I ask Mary what she likes about the glass work her response has mostly to do with the material she works with: 'I like the feel of it. I like the fact that glass is a continuingly moving substance. I absolutely love glass blowing; the fact that you've got it in your hands, 650 degrees worth of stuff […] physically in your hands, well you've got a wad of wet newspaper between you and it, but when it's at the end of the blowing iron or whatever you're working with, this red hot glass is actually literally in your hands […]. And there is something about shaping and forming that and then transferring that sense of contact with it into that knowledge you have of how the glass behaves, how the different colours behave: how when you add purple it distorts it because the purple is stronger, and if you add pink or yellow… it moves the glass in different ways. And then you can transfer that knowledge into when you're making something in a mould: how you place the glass in the mould, how you place the colours, how to position it.' She tells me you don't learn how the glass behaves in technical or chemical sense in the classes; that is something you need to pick up by trying and exploring. 'Passion is not the right word for it,' she tells me, 'but it's a deepening understanding of the behaviour of this material and just increasing the depth of knowledge. And the tactile nature of it: it's not this sharp, jagged, scary thing that can cut you; it's a colourful, moving thing that you can shape and form, but at the same time it still fights back. So that's probably why I like it.'

With glass being a fragile material there are plenty of risks involved in glass work: 'with stained glass you can make a panel, hold it up, and as you look at it, the piece will crack.[…] You know that it's a fragile thing, it has its own mind, it being a continuously moving, living thing.' Mary seems quite relaxed about this: 'You know it is going to happen so if it does you just have to be philosophical about it. Often other people are more upset than you are. You can always make another one. You can't make another one the same, ever, but you just have to be a little fatalistic about it: okay, it wasn't meant to be.' She does get frustrated if something breaks because of her own carelessness, but generally she does not get extra satisfaction from making something without errors or breaking, because she cannot make the glass do what she wants: 'it's like a stubborn child. Sometimes the glass will just say "I'm not going there" so you'll have to change the shape, or "I'm going to break" so you're going have to do something else with it.' She realises she has to accept that 'there isn't perfection between what you originally decide to do and what you finish with.' Regarding risks, she concludes: 'the only disaster you can have is if you injure yourself; that would be catastrophic because you might not be able to do… You might not be able to lift something or you might lose your eyesight; you need to be a bit careful.'

Mary is quite adamant about her craft as a recreational activity: 'It's not a hobby, in the sense that… I don't see it as a hobby, like gardening or something, it's a bit more than that… Because when people say: "oh you're just a hobbyist" I get quite offended. "No, I'm not"' 'A hobby is something… I'm being a bit of a snob about it, but it's the shades of excellence that you might have in something.' She sees her qualifications as an illustration of her craft being more than a hobby: 'why would I slog away getting a qualification and go to night school to do a fine arts for two years, when I had a baby, and go on summer schools and things […] For me, that's not a hobby, that's becoming more expert in something.' Mary calls herself and artist and puts herself in the professional category, because she could do it as a professional if she chose to do so, she does exhibitions, and sometimes works on commission. Currently she is working on a panel for an exhibition and she says she challenges herself to do a piece like that every year: 'it's like doing a journal article; something you can put on your CV that is equivalent to a journal

article.' Regarding working on commission she says: 'I don't like making windows for people, at all. […] Because they'd say: "oh, I want this, I want that" and I'd think "oh come on."' When people ask her to make something for them she'll ask: 'why do you ask me?' If they just want a window she'll refer them to her friends who do like on commission, but it has happened that people said they like her work specifically, 'so I couldn't really say no, which is very nice as well.'

Related to working on commission is the repair of stained glass windows which Mary is currently doing for a chapel in exchange for the rent of exhibition space. She doesn't enjoy doing this, 'because really the only way you can properly repair a stained glass window is to take it apart and put it together again because it will always look… it's like a darned sock... you know, it just looks... unless you're really good at it […] You know, you really need someone with that sort of skill and patience.' She further adds: 'there is an element of "I didn't design this, therefore I haven't got a feeling for it." […] For me, if I haven't designed it in the first place I'm not really interested in it.' Overall, with all her glasswork, Mary feels that 'if you were going to call [a finished piece] "perfection" it would be in the satisfaction and the professional excellence as a final piece of work.'

LUCY – MIXED MEDIA ARTIST

Lucy, an academic by profession, creates mixed media art using a large variety of materials, such as fabric, images, and metal objects. Much of her mixed media work is based on traditional weaving: 'I do a warp and a weft with fabric and from there I start to weave in, or incorporate into that, mixed media stuff.' She gives me an example of such a work the theme of which was gender and aging: 'I did a piece that was based on the traditional aspects of weaving and I was really interested in these kinds of female crafts, or what I would consider crafts that have been sort of feminised. So the basis is weaving and then I did a series of paper dolls that were woven through it but I also juxtaposed Barbie dolls legs and things like that. So I was bringing in all different kinds of media, so not just stuff that was traditional, but also stuff that was associated with gender but at the same time wasn't necessarily a traditional craft, so it was bringing together

lots of different things. […] And also a lot of the fabric for the weaving was from dish towels cut up, so the whole piece itself, everything that was making the piece was kind of gender, I guess you could say. But also the aging part of it; I went through paper dolls but also domestic things, like cleaning, and then even I also had fashion or the way people thought that they should dress or garishness, so there's all kinds of identities I tried to encapsulate with that piece.' With her mixed media work Lucy tries to bring together 'really sort of disparate objects', 'like I made one for someone that had nails but it also used a lot of lace, and so bringing together things that you wouldn't necessarily think would work together, but into a composition so that it works as a whole.'

Moving on from these weaving-based works Lucy has started creating other mixed media pieces, where she uses photographs of herself and cuts them up to 'break through canvas and put them behind canvas so it is really about the process and reworking the surfaces.' She calls these works 'explorations', not just of her own identity but also of the media she works with: 'I'm really interested in media. I'm really interested in how far we can push a canvas or how far we can… you know, in the materials themselves. So, what will happen with the photograph when we paint on top of it? And stick it to the back of something else and put glue on that and then on top of there put on… I don't know, human hair, and all this kind of stuff. What happens to media, I guess physically but also mentally when we have this really sort of juxtaposition of what I would say are disparate media, bringing them together in disparate form into one canvas.'

Lucy has a background in art; she went to art school and initially had the ambition to become a professional artist. However, she had difficulties achieving this and experienced certain restlessness in other jobs: 'I would be doing things and never really satisfy what I wanted to do. […] I never felt like it was enough.' Moreover, since starting art school, Lucy had had the ambition to teach at a university, which is why she went back to school to do a Master's in Fine Arts after having worked after finishing her undergraduate studies in art. Although she was really disappointed when she was rejected for the course she applied

for, she now calls it 'the best thing that ever happened to me.' Instead she did a Master's in art in education followed by a PhD.

Lucy tells me she had experienced similar restlessness before about not being able to soothe her craving for creation. She has always had a strong drive to make things, which has not always been easy for her: 'Even when I was young I always painted and I was always making things. [….] I remember writing in my journals that the fact that I wanted to do this [making things] was almost… I almost felt cursed in the sense that I couldn't not do it. […] It was something I could never stop. […] I felt like I couldn't do anything else; nothing else satisfied me. So I felt like I was stuck with this… it wasn't even a talent, it was a real desire to produce, to make things.'

In art school Lucy learned to work with different media, but the course was very open: 'we just hang out in the studio and whatever we wanted to do we did, so we had a steel studio, and a painting studio, so all of our classes were very hands-on. If you wanted to be with a professor you hang out with them and they'd help you.' There were no classes that taught specific skills or techniques and most progress was reached through self-learning and exploration. This is also the case for Lucy's mixed media work, it was 'just something [she] always used.' She explains: 'even when I was painting I was always sticking pieces of wood on it […] so I couldn't just paint. […] I'm not interested in paint; it's just a bit flat.'

Lucy expresses a great love for the materials she works with and their materiality. She tells me that during her studies she did mainly sculpture, steel sculpture and pottery, and that her medium has been three-dimensional fabrication and sculpture for a long time. However, after leaving the school environment she found that it was hard to maintain these crafts; due to travelling and moving place of residence often it was hard to set up a studio. Therefore she moved to mixed media art for which she has a dedicated desk in her house, although she guiltily adds: 'but I have only used it twice in the past four months.' She is always gathering materials to include in art works 'so they are there at hand, whether it's just a bunch of scraps, [….] or on my table now is a

set of photocopies of images I want to rework.' In her old studio she similarly had boxes filled with a variety of materials: 'buttons and zippers and feathers and leather, just everything.'

Working mainly with her hands and a glue gun with these mixed media, but also with the materials she used before, the materiality of the media and the process is very important to Lucy: 'my really big draw is making, is actual hands-on… when I do ceramics it's about the feeling of the clay and it's about pushing media… So there's a lot of embodiment in it and tactileness, and this connection between me and media, it's very physical. And it's also conceptual; there are ideas behind it, but the conceptual often comes after the physical for me.' I ask Lucy whether she plans and thinks about what she is going to make before she starts working with the materials. She tells me that the work definitely evolves through the 'doing' and that there is not much planning involved: 'as I start doing the ideas starting flowing in. I'm not a big planner when it comes to this; it happens as a process.' As such, the process of making is more important to Lucy than the result. She concludes: 'I think [the haptic experience] is why I like mixed media so much and, sort of, working with materials because I think I'm definitely a haptic artist, you know, a touch person.'

Lucy does not sell or exhibit her work but sometimes gives it to friends or family members who have put some of her pieces up in their homes. Both process and result seem to be quite individual for Lucy and her motivation seems to come primarily from her own personal drive to make things. As such, she does not discuss her work much with others.

Interestingly, Lucy describes experiencing some mixed emotions regarding her craft. She described to me how 'being in the moment' when making things makes her feel good: 'I think that one of the reasons I feel so good when I'm creating something is that you're in the moment. It's completely consuming […] because you're moving somewhere and pulling things together, and you're thinking and you're doing; I find it very therapeutic, I guess. […] It's all consuming in that you can't be bogged down, at least I'm not, when I'm making things I'm not thinking:

"oh, I have to do this, this, and this", at all, you know "oh, I have to do this tomorrow; I have to call that person", I'm actually in the moment […] You're completely caught up in the present.' This therapeutic effect of craft is clear in her comment: 'even now, when I'm really feeling low, if I make something it completely changes me.' On the other hand, however, Lucy feels that she should spend her time on more meaningful activities: 'I actually really, really miss making stuff, but part of me feels like it's kind of frivolous to indulge in that; that it's not meaningful enough. […] It feels juvenile… or I feel selfish, that you have that time as an individual artist to just work. It doesn't feel like it's giving anything.'

In her profession as an academic Lucy is mainly engaged in visual research, which she feels 'brought all my things together, sort of producing […]: working with communities, doing something I'm really satisfied with and at the same time actually making things.' She recollects: 'when I was doing my PhD I felt like I was too cerebral, I felt like I was too much in my head, and there wasn't enough… I don't know, maybe creativity, or maybe it was a process of making art that I can't put my finger on… it's both physical and cerebral…' However, Lucy finally had the realisation that her research can be seen as a piece of art and the process of making art and doing research are very similar: 'what I finally saw when I was writing and pulling the pieces together and doing fieldwork was that it was like a really big piece of art, a slowly produced, agonising piece of art, where there was all these bits involved. And it was almost like working on a huge canvas or making a big installation […]. Once I started to see it that way, it just sort of came to me, it changed the way I look at research now; it's a very similar process. Just like when you are making, you are not researching it like: "oh, I need to look up all these things" but there is a process of going back and searching, so this researching, whether it is in your mind or whatever it is, it all happens as you're making it. […] You do a certain amount of planning, but at the same time, just as when you're writing, things start to happen.'

However, Lucy still feels the making part has fallen by the wayside a bit because many of the things she creates and the media she works with are digital, such as

making movies together with her participants. About creating things with digital media she says: 'it doesn't excite me as much. I find it too controlled. I find it unforgiving. I find it too linear. I find it… I don't know, I don't think many digital tools lend themselves to, for my way of thinking and for me being more of a haptic person, a touch person, the physical and the embodied, that's what I like about producing. It just doesn't do it for me, at all.' This physicality seems to be crucial, and indeed indispensable for Lucy to enjoy making things, and she adds: 'I do a lot of photography and stuff and sometimes I get lost in that, but not as much as I can when I'm producing mixed media or sculpting or something like that. It's just too two-dimensional for me. I don't know, if I could actually grab bits of data or film or something like that… I probably would have enjoyed it more a long time ago before it was digitised, you know, when we were actually cutting film. Because then I could see it and lay it out, I don't know, and build something. It just feels like too much of an illusion. It bores me. I also don't like being dictated by tools.'

VICKY – SILK PAINTER

My interview with Vicky takes place at her home. As I enter I am immediately impressed by the creative atmosphere of the place: boxes of painting equipment in the hallway, tables and shelves with finished art pieces and work-in-progress, and drawers filled with a large variety of tools and materials. As Vicky apologises for the mess and clears away another piece she was just working on, she verbalises what I was thinking: 'the house is completely taken over by… art and craft and things.'

Vicky's main craft media are hand-painted silk, e.g. scarfs and cards, and fused glass, e.g. coasters and plates, both from which she earns money. Further she does a diversity of activities 'for fun', such as patchwork, knitting, stamping, embroidery, photography. Currently, she is doing an arts and design course to broaden her skill base, which allows her to do a variety of different art things. Alongside this course, which takes up two days a week with an addition of 15 hours of homework, Vicky also teaches music lessons to cellists, violists and

pianists. She mainly does her crafting in the evenings after her music lessons and she emphasises that she does something creative every day, even if it is just 'some random painting'. Her weekends are usually filled with craft fairs, giving talks on silk painting, and running silk painting birthday parties, but also meeting friends, because 'it's nice to be dragged out of your artistic world sometimes.' Vicky further meets up with a silk painters' guild, of which she is the vice-chancellor, once a month, in which they think of a new technique or material to try every time. In this group, knowledge and interests are exchanged, and sometimes collaborative pieces are made, such as an undersea-themed kimono for an art festival.

Vicky first started silk painting in 2001 when she went to a big art and craft fair where small workshops for different crafts were run so that people could try. She recollects trying silk painting in such a workshop: 'it was just completely mind-blowing. I didn't think I could paint and I went on this workshop and discovered I could, and it was awesome!' She adds that it opened up a completely new world to her, because before that she had not done much crafting. About four years ago she got into glass when she participated in a fused glass open studio day. Comparing silk painting and fusing glass she appreciates the fact that with glass you never know what happens when you put it in the kiln: 'I'm getting better at knowing what's going to come out, but sometimes things react in a way you don't expect that is really quite interesting.' Vicky has followed courses for a few years and now owns her own kiln so that she can do her fused glass work at home.

When I ask her how she makes the silk paintings she jumps up and shows me a role of silk, the base material, and a frame on which the silk is stretched to form a tight surface to work on. The process of silk painting starts with creating a design or pattern, for which Vicky sometimes uses the computer: she draws things on paper, scans them in, clears them up, copies patterns and then enlarges and prints them to make real size patterns. The pattern is then transferred onto the silk, for example by placing the pattern underneath the silk and tracing it, or drawing directly onto the silk. After that you can paint, freehand or using an outliner. Vicky explains that the outliner, or gutta, is a resist that is used to

isolate areas for painting to prevent the paint from running. She proceeds to getting out a test panel and demonstrating the use of the outliner. She shows me a few examples of works in which she used different colours of outliner. After painting the silk is fixed; depending on the type of paint fixing is done using steam or ironing. For the painting various sizes and shapes of paint brushes can be used and further all sorts of products and materials can be used in the process, such as salt, salt solution, sugar solution, velvet painting, devore ('defluffing' velvet selectively, making patterns, with two stages of liquid), silk quilting, using beads, palette dips (rolling up the silk and dipping it into a palette with paint). The different stages in the process and the diversity of possibilities are illustrated by a workbook she shows me which she created when making a scarf based on broccoli for a silk painting course. The book contains the shape and pattern studies she has done with broccoli to come up with the final pattern, e.g. looking at colours, textures, rubbings of broccoli, drawings of cross-sections, editing images on the computer.

As with most crafts, things can go wrong while painting silk, for example when using an outliner you have to make sure the lines are closed, otherwise the paint runs. Vicky does not seem to mind so much when things go wrong though: 'I've got things that went horrendously wrong, and it happens. And I keep them and I laugh at them sometimes. Or, the good thing is, you can cut it up and turn it into something else.' She adds: 'the thing is… perfection, what the hell… You know, some of the times, yes, you want to get it absolutely just so. Other times, so it's a bit interesting, run with it. Because, actually, it shows it's handmade. If it came out looking like it came out of a machine, and you can run them off identical, what would be the point?'

When I ask Vicky why she does it, her answer comes quickly and determined: 'I can't not do it.' She explains: 'It makes me happy. It means that… it's the whole satisfaction of having a thing. It's the satisfaction of being to sit and go: "I made that". I think having a physical product… I think it's the difference of working in an office where you are for instance creating virtual things the whole time. It's very rare that you see your work printed out and bound. So you send all these e-

mails and you write all these documents and it all goes off into the internet, or it all goes round in the email system, and very rarely do you see an actual thing.' Being able to schedule her own time, Vicky also appreciates the freedom she has to work on her craft: 'it's also the having the time to make things you are happy with. Because so often you are working towards a deadline and you're thinking: "oh I could have done it like that, if I had the time". So I think it's the satisfaction of being able to work to your own… you know march to your own drum, I guess.' Further, the physical process and result are important to Vicky: 'computers are fine and you can, when you're designing something, get in the zone and really go for it, but I think for me it's not until you've actually got the physical thing, that you really get the satisfaction. And the physical process of making; I like getting my hand dirty. It's the same with gardening. I like gardening, because it's the whole process of getting in there, making a difference and then something happens.'

Interestingly, Vicky perceives her work in a way as a 'record of her life': 'you put so much of yourself into it [while you are making something]. I look at some of these pieces and I can remember what I was doing when I did it, you know. Sometimes they can be a record of your life or your emotional state or whatever. I like pink and purple a lot, so I'll do a lot of stuff in that sort of pink purple colour range, because I like it. But sometimes I think: "I'm having an orange day" and I will do things in bright red and orange and stuff. Sometimes you just want to do that, you know, in the middle of winter you might want to do something really bright. Or you might go and paint outside and the tree decides to drop leafs on your work while it's drying and leave strange patterns, you know, fine. I like having that slight bit of unpredictable in it.' This 'record of life' is really explicit in a bedspread she is making from little squares of painted silk made in the birthday parties she runs: 'it will keep growing as I do the silk painting parties. So I'll have the kind of memories of all the parties I've been and run as a bedspread.'

As such, the process of making is very important to Vicky. While the result is 'awkward' because she then has to sell or store it, she says she 'could sit here and

create all day'. When I ask her where her inspiration comes from she tells me that she keeps a book with ideas that come up in her head all day. If she gets stuck she leafs through the book and picks an idea. Inspiration can come from anywhere, things she thinks about in the middle of the night, something someone is wearing; 'it's there, all the time. You know, I can just look round my room and get an idea. That's one of the reasons I like… [she looks round the room where a diversity of things are placed around her, such as a jar of jam on the window ledge], because if everything was away in cupboards, behind glass, whatever, there's be nothing for my brain to bounce off.' Inspiration can come from nice wrought iron gates, patterns, drain covers, the colour of bricks: 'you can take almost anything and turn it into something.'

Vicky gets a lot of satisfaction from sharing her work and expertise with others: 'I'm now starting to do the big art and craft shows on behalf of the guild […] and we ran "have a go sessions" and we had over a hundred people come and do, paint a silk card, with us over the three days […].' For Vicky much joy lies in transferring knowledge and making a difference: 'it's showing them something new. It seeing them go from "can't paint, won't paint" to "maybe I can". And that is the other thing I love: it's actually helping people to achieve their potential. This is the thing with the teaching; I teach adults as well as kiddies, I've got 6 year olds and I've got people who are retired who come to me for lessons. […] And it's getting them into that "maybe I can" frame of mind, which then frees them and allows them to then go off and make mistakes.' Vicky has also composed her own silk painting kit for her teaching purposes because she found that available paintings kits all had something missing.

As a professional artist Vicky makes money from her work in a number of ways. She runs silk painting parties, in which she uses pre-printed outlines and lets children colour them in; she sells her work, e.g. scarfs, pictures, cards. She teaches silk painting courses from her home and sometimes she does commissions, such as scarfs or 'fancy lettering'. She likes the inspiration she can get from commissions and fairs: 'people come up and ask: "do you do this", and I'm like: "I don't yet…" or "that sounds really awesome, would you like me to

make you one?"' She started off at school fairs and is working her way up through the art and designer market to creative craft shows: 'The thing is, I've got to get myself a core range of stuff that is different to what everyone else does. So I think I'm still in the "I'm experimenting and trying to find my niche" phase. I'm doing okay, but I've got a sideways portfolio rather than a focussed one at the moment. Everything is so exciting. It's very difficult to have the discipline to reign yourself in to doing one thing. That's the trouble I'm having.' She thinks this is important to set an identity as an artist, only using your strengths to do one thing: 'I don't like doing that really. It's so much more fun doing all the other stuff as well.' A recent niche market success she had was a 'geeky card' (she has done a range of these with binary codes and QR codes) for Valentine's Day. This card got into the UK handmade Valentine's showcase, which gave it a lot of exposure and many people were asking for it. She concludes: 'it's amazing how if you get a niche product that no one else is doing, and it gets the right exposure, it will just take off.'

Finally, Vicky takes me to the kitchen where her kiln is located to show me some of her fused glass work, such as bowls and coasters, and a piece for a lamp she has made from an old beer bottle. Next to the kiln there is a small table on which she works. The general process is cutting up pieces of glass using a dedicated glass cutter with a tiny diamond wheel that scores the glass and then using pliers to break it along the line, after which pieces of glass are composed and then melted together in the kiln. But again there are different techniques, for example starting with plain glass, drawing patterns on it with glass powder, using a stencil, using dichroic glass (which contains metals and has a shiny appearance), making pattern bars (which will be cut up with a diamond bladed circular saw), and using glass in different forms, e.g. stripes of glass, powder, frit, sheets. Working with the kiln requires some experimentation and Vicky keeps a firing book in which she keeps track of what she has done in case she wants to make something again and to learn from mistakes. She further has another small sample kiln, which does not get as hot and she for example wants to try raking glass in that.

As we are talking about the glass work one of Vicky's music students shows up for her lesson and as Vicky finishes her interview with me I hear the gentle tones of a cello as the student prepares for her lesson in the upstairs living room. As I later close the front door behind me Vicky has already proceeded to her next creative challenge, a routine which is unlikely to tire her.

CAROL – JEWELLERY DESIGNER

Carol has been designing and making jewellery for four years. This is something she had wanted to do for a long time and an opportunity arose when a jewellery designer moved into her neighbourhood and started up a course. With some encouragement from her partner Carol followed the course and has been reapplying every year since. At this course four to five course members work individually on their pieces while learning new techniques from the teacher. Carol calls this an inspiring environment, because the course members will look at each other's work, get inspired, and exchange experiences. Once or twice a week Carol works on her jewellery for two to three hours in her own workplace in a spare bedroom. She explains that she likes making jewellery to 'be out of [her] head' and as a variation to everyday life; Carol works in health care. It is relaxing for her and she is curious to see what comes out: 'I don't want to recreate something from an image, but just from myself, seeing what comes out. […] It's a drive: I want to make something; and sometimes it is through painting and sometimes it's forging.'

As I start talking with Carol about her craft she seems a bit shy and repeatedly tells me that she is unsure if her answers will be of any use to me. As the interview progresses and she invites me along to see her workplace, she gets inspired by some of her work lying on a table and she shows me several examples: 'Oh, these are the last ones I made; they were much fun too. [My partner] has a new grandchild and I made two kites, one for the youngest child, from silver, and one for the oldest, from cupper. See, with some things dangling from it. That was much fun to do I must say, with their names on it.' As I express my interest she gets more encouraged and later shows me a photo book she has

composed with photos of her work. I comment on the diversity of the work and she adds, with a certain pride in her voice: 'yes, it's not boring uniformity.'

Carol makes jewellery, mostly rings, earrings and bracelets, from copper and silver. These materials have different characteristics which determine the way she works with them and what she can make with them. Copper, for example, requires a higher temperature to melt, and larger pieces require more heat to melt than small ones: 'At the course we have small soldering devices but we also have a big flame with an oxygen tank, and that is very effective.' Carol has learned what she can do with the materials mostly by trying things, which is also evident from a bracelet she shows me, which has a beautiful colour pattern caused by heating the copper several times with a large flame. She uses a variety of techniques but, she says, 'only simple stuff', such as drawing, sawing, forging, soldering, sanding, and polishing. The tools Carol uses for her craft vary from universal tools, such as hammers, files, rulers, but also tools specific for jewellery makings, such a measuring set for ring sizes, and a set of domed moulds for making spherical shapes. On the shelves in her workspace, which are filled with tools she has accumulated over the years, I also see some home-made tools, such as several sizes of round sticks and blocks of wood covered with sanding paper. Carol explains to me that these were made by her partner. She used to share a workspace with him and he regularly comes into her new workspace to have a look what she is doing. Seeing her work, he comments on tools she could use, and makes them for her.

Most of Carol's work she gives away as presents for birthdays and similar occasions. Sometimes she has a fixed idea of who she wants to make something for, but more often she decides after finishing a piece. Carol gets her inspiration from looking at people around her, and books, but once she starts working the inspiration comes mainly 'from within' and something completely different comes out: 'for example with the copper, then I don't have anything specific in mind, but something arises. And then I am hammering and bending, and well... Something just comes into being.'

I ask Carol about the risks involved in jewellery making and she tells me that if the temperature is too high the material melts; 'then it's lost, there is nothing you can do.' This does not happen to Carol often though, because she has gained experience of how to handle the materials. She adds that you also have to be very patient and have to know when to stop: 'sometimes I think: "well, let's leave that for now and try again later." I am not someone who tries something in the same way a hundred times. I start and if it doesn't succeed in a few tries I stop and try again later.' She allows herself to be led by whatever she is able to do at that time, which results also in periods in which she does rougher or finer work: 'sometimes I have a period of working detailed, but sometimes I feel that's not going to happen today and then it will be rougher. That's not a problem for me. For me, it doesn't all have to be perfect, as if it's machine-made. You should be able to see that it's hand-made.'

PAUL – GUITAR BUILDER

Paul, a retired insurance officer, has found a love in building acoustic guitars. I interview Paul at his home where he has an extensive workshop devoted to this passion. As the interview takes place in his workshop, it gets hands-on by default and throughout the interview Paul keeps walking up and down the workshop, opening drawers, taking things from shelves, and handling tools and materials to show me exactly what he is talking about. I get the feeling the workshop further serves as a mental map to give Paul new handles for things to talk about and he visibly enjoys using the half-finished guitar parts lying around as examples.

Paul has always been an avid guitarist and has always liked repairing broken stringed instruments he bought at second-hand markets. After Paul closed down his insurance business 12 years ago he wanted to build a cello and went looking for sources of information to support this goal. Instead he ended up with a company that specialised in electric guitars, where he followed a course and, with partly pre-manufactured parts, built his first acoustic guitar about which he 'wasn't satisfied'. Looking for the next level of building Paul went in search for a book about building acoustic guitars and found a renowned training institute in

Belgium that offered training courses for building guitars and other stringed instruments. Initially he asked them for the book he wanted, but they told him he could come and write it himself, which is exactly what Paul did. As part of the 5 year education Paul undertook to learn how to build acoustic guitars, all students create their own step-by-step guides on how to build an instrument and, as such, Paul has created four of these manuals, for a classical guitar and several types of steel string guitars. These manuals are on a shelf in his workshop and he uses them to show me steps of the building process for which he does not have a physical example at hand.

As I look around the workshop I see, apart from an impressive collection of the obvious tool such as saws, chisels, and files, many devices and tools that are unknown to me. Paul explains to me that he makes these himself to support parts of the process: 'Most of the work involved in building a guitar is precision work and each time you have to measure something there is risk of error, so you start looking for ways to limit this risk and create tools for this.' He modestly adds that the ideas for these tools do not all come from him, but also from colleagues, books and the internet. His self-made tools range from hand-powered tools, such as a large round, slightly hollow sanding disc for sanding the top panel of the guitar's belly, and a compass with a chisel to cut out a circular groove for the rosette around the sound hole, to advanced electronic devices, such as a sanding machine for sanding the large, thin wooden panels for the top and bottom of the belly, and an intricately looking device for bending the thin panels for the sides of the belly with the aid of a heating element. Paul tells me that when you start doing something as a hobby you have to prioritize and choose which devices to get within your financial possibilities. For the rest you have to make do with what you have, and 'what you can do yourself… it is also fun to build that.' He adds: 'sometimes I get so into making a certain tool and when that is finished, you can just sit down, look at it, and enjoy it. That's wonderful. […] When you make something that really works. You are working and you're thinking: that could easily be done like this, would that work? And damn, it works. That's fun.' I ask him about the differences between using hand-powered and electronic tools and he tells me that at his training he had to do everything by hand, for example

using sanding paper, planes, and scrapers, but he now uses electronic devices where possible: 'I had to do it [working by hand] and I am glad I've had to do that, because you still get the feeling of the wood. When you're using a plane on wood or a sanding machine, that's a very different experience. So that has been good, but I think it's slavery.' He does still try to limit risks by using hand-tools, such as using a chisel when making the groove for the rosette: 'some people do it with a milling cutter, but it's risky: it easily takes out chunks of wood.'

Apart from the frets and the strings the whole guitar is made of wood, although Pauls tells me there is great variation in the types of woods that are used and each types has its own characteristics in working with it and in how it sounds as material for a guitar. Most material variation lies in the back panel of the belly and as Paul leafs through sawn backs of guitar bellies standing against the wall he informs me: 'this is from Schwarzwald; it's from a walnut tree. It has a beautiful print so that will be on the back of the guitar. This is cypress; this is used for Flamenco guitars. This is Palisander, from India. This is Cocobolo, from Central America. This is Madagascar Palisander. Padauk, from Africa. And this is Santos Palisander, from America.' He appears to take an interest in the background of his materials and their qualities in functioning as a musical instrument: 'The top panels are usually made from spruce wood. […] This comes from Italy, Germany, Austria, or Czech Republic. There the trees grow on heights over 1000 meters, and because they grow so high they don't grow much in width each year. And that is important because... look at the graining. The annual rings are really close to each other and that gives it its qualities as a sound wood.' He continues to tapping the wood while holding it up between two fingers to let me hear the high pitched tone it produces.

Although most of the guitar building process is precise work, making the neck for example is rough work compared to the process of making the rosettes around the sound hole. These are made from tiny strips of wood that are glued together into small packages, which are then sawn into strips again, and composed into complex patterns around a round mould. Although these rosettes can be bought

pre-manufactured, Paul likes the high precision work as a variation on the 'rougher' work.

Pauls tells me he has made about 15 guitars so far, some by assignment. Working by assignment is a problem, however, because, Paul explains, when you get a new guitar there has to be some sort of connection. In a store you can try a few, but when you build one, that is the result you have to be satisfied with. The sound is very subjective and that is a risk: 'what I like, someone else doesn't necessarily like as well.' Paul's philosophy ties in with that of an American guitar builder who teaches people how to build a guitar that sounds exactly like they want, starting from a sound in their minds and adjusting the construction of the guitar to match that sound. Paul is experimenting with different constructions of internal bracing, constructions of wooden struts inside the belly, which strengthen the panel and determine the sound. He shows me a top panel with the bracing glued to it and taps it, tap tuning being his main test of sound quality: 'The high pitch we heard before [with the panel without the bracing] is gone. But it still resonates; that's good. This one will give a great sound later.' Paul is currently building two guitars with different bracing to see what sound he likes best and will then change the bracing on future models accordingly: 'but I don't experiment with that much, because then you have to build something like 25 guitars and then you can gain that experience. All I can do is use renowned concepts and make some adjustments if I think for example: "there's not enough bass, I'll make the box less deep".'

I ask Paul about the risks involved in guitar building and he tells me it can go wrong in many different places, because the work is very precise and the materials fragile, which requires nonstop concentration. A mistake can for example be to forget a step in putting the guitar together. Fortunately this can often be solved, albeit 'with much extra work and frustration'. The soft wood is also very susceptible to dents and Paul proceeds to getting a piece of wood, hammering a dent into it, and demonstrating how to get the dent out using a drop of water. 'The worst situation is when something breaks; then there's

nothing you can do,' he tells me as he shows me a beautiful side of a belly, the lone remainder of a matching pair.

Paul gives lessons on guitar building for a small amount of money to a maximum of four students at a time. Although he was hesitant at first to start this up, he decided to give it a try because people were interested in learning how to do it and he wanted to share his hobby with others. He says his students, like him, 'don't want a cheap guitar; they want the adventure of building it. They want the experience of the development of that thing and feeling what happens with the wood.' With working with the students and his individual building Paul spends four to five hours a day in his workshop working on his guitars. He makes it very clear that it 'shouldn't start to feel like working'; working every day from 8 until 6 he could build a guitar in a month to six week if he had to, but he would never consider doing that. Similarly, he does repairs on guitars 'if I have time and feel like doing it'. Repairs are very labour-intensive and thus expensive, and Paul asks his customers if the guitar is worth such an investment, but 'sometimes there's emotional value, for example if it is an heirloom' in which case he truly understands the love for the object and will repair it.

Throughout the interview I have gotten a strong feeling for Paul's love for his craft, from the way he talks about it, never running out of topics, the way he handles his materials and tools, and moreover from his appreciation of my interest in his craft. He explains to me that sometimes people come over who just have a glance at his workshop, ask him questions like: 'So, how many guitars do you make a month?' and leave after 15 minutes. 'They should just stay away,' in Paul's opinion. Not me, however, being a guitar-player myself I would have been unable to hide my enthusiasm and appreciation even beyond the scope of this interview and my PhD, much to Paul's liking. As I prepare to leave he repeatedly thanks me for listening and chuckles: 'In 30 years' time, when I've made my 200th guitar, come back and I can tell you much more.'

TINA – PAINT ARTIST

Tina has started painting twenty years ago after two years of drawing courses and activities. Nowadays, she paints once or twice a week for an hour or two. When I ask her why she started drawing and painting she tells me she has always liked to draw and found she was good at it when she tried drawing people as a teenager. She decided she wanted to do more with this: 'then you follow a course and another one, and then you feel like: "now I want to move on to the next level,"' and that is when she moved from drawing to painting. She followed painting courses for years, in which she learned techniques, how to use light and shadow, how to blend colours, perspective, and what materials can be used together. She tells me she gets most of her knowledge from doing, just trying things; she does not like to get this knowledge from books.

Once a week Tina gets together with a group of friends and they paint together. In these 'classes', as she calls them, everyone works on their own paintings and there is large variety in use of materials, techniques, and what they paint. Some people make realistic paintings, some mix realism with surrealism, and some recreate paintings they see in magazines, which Tina 'personally [doesn't] consider art'. Within the group, techniques and tips and tricks are exchanged. The group also provides an inspiring environment for Tina, in which she gets around to actually doing her painting, and in which she feels like she is among equals: 'I really like [painting], I can completely lose myself in it. […] I want to do it when I'm completely alone, I can't do it when my family is around, because I don't want to be distracted. But in that group I can work, as if I feel they are more knowledgeable [than my family]. […] The solidarity with fellow painters is very encouraging.'

Tina started off making realistic paintings, but has moved towards abstract art. She recalls one of her art teachers telling her: '"you are now painting flowers and photographic images, but there will be a time when you don't want to do that anymore; you will want to put your own stuff into it." And then I thought that was nonsense, but it's true. […] For example, I do want to paint a dog, but I want

to do something weird with it,' as is illustrated by a pop art painting she has made of her dog. She gets inspiration mostly from photos, which she then does not 'simply recreate' but from which she derives shapes and colours. She has for example used photos of a sea in Iceland, rice fields in Indonesia, and a branch on the floor in this way. However, inspiration can really come from anywhere for Tina: 'It can also be something I dreamed. […] Or it just pops into my head, or I see something on TV, or I see a stone with a strange shape, or I hear something that reminds me of something.'

Tina prefers to work with oil paints or acrylic paints on wooden panels, but has tried different techniques and materials, such as aquarelle and pastels. She tells me how she once made a painting that came to exist because she had tried how certain colours go together by putting some paint on a piece of paper, and then folding the paper after she was done. This had such a nice effect when unfolding the paper that she used this technique in a painting; 'and that is one my best paintings.' She prefers to work rather precise, but sometimes forces herself to use bigger brushes and work on a larger scale. She further tells me about paintings she has made by gluing different materials, such as sand, cloth, paper, or metal, on a panel and covering them with paint. And in the process of creation everything is allowed to get a desired effect: 'sometimes I use my fingers to make gradients, or a cloth, or I use a piece of paper to scrape paint off again. […] I use everything I have at hand.'

With the paints Tina prefers to use, risk is limited compared to other paints, such as aquarelle, with which a panting is ruined if something goes wrong. With oil paints or acrylic paints there is always time to correct mistakes by painting over them or erasing them. Tina sees mistakes as slightly annoying and frustrating, but also as an opportunity to learn, such as when she discovered that painting on canvas is not her cup of tea after ripping a canvas. Similarly, she considers paintings that do not turn out the way she planned part of the learning process, and recalls being too stubborn to take advice in the past: 'sometimes someone told me not to do something, but I was stubborn and did it anyway, and now I think: "they were right, I shouldn't have done that."'

When she is painting, Tina is 'completely in the flow.' She explains to me what she means by this: 'the moment I start painting [all my worries] are gone. Nothing counts except that shaded part, that coloured patch, that colour transition. I am completely gone for two hours, in my own little world, and only from the moment I get in my car to go home things start coming back. So, that's nice.' This therapeutic effect of forgetting her worries is very clear in Tina's example of creating a painting of her father-in-law. While this started off 'just to see if [she] could do it', the painting became emotionally charged when the depicted person was diagnosed with cancer and was getting more poorly. Tina says she had to force herself at times to sit down and work on the painting: 'It was very difficult. Making an oil painting of a person is very different from a pencil drawing because it is much more about the colour, and it had to resemble the person, and it is a person you love, and he was also dying.' At that time she was still following a painting course and she got mental support from the teacher, who told her that working on the painting was good for handling the situation and venting her frustration. She adds that every time she had worked on the painting and had, for example, 'focussed for two hours on an earlobe' she would be completely exhausted; 'maybe it was because of the emotions.' When the painting was finished - Tina's father-in-law did not live to see the final result - she gave it to his widow, who put it up in her bedroom. Tina adds: 'at some point [my mother-in-law] said to me, and that touched me: "I took a photo of [the painting] and when I go on a holiday I put that photo in my purse and then he's always with me."' While she was pleased the painting was well-received, for Tina the act of creating it was a great support in a difficult time: 'When I was painting I forgot he was dying. When I stopped the lump in my throat returned.'

Tina takes a sense of accomplishment in her work; painting makes her feel good about herself: 'look, this is what I can do.' She considers herself good at what she does: 'I don't mean to brag. My friends and family know what I do and ask about it sometimes. […] That's why I have my own website. If you want to see what I do, go and have a look.' Sometimes people buy her work, or she gets an assignment, and she adds: 'the idea is that I sell my paintings but if I don't, they stay with me.' Tina enjoys exhibiting her work, but indicates that it is always a bit

of a hurdle for her to step forward and approach people who may make this possible. In the past she has also done a few workshop sessions, which she liked because she considers it a challenge to transfer skills and knowledge. She further tells me: 'I have my own business cards. It feels good to be able to give someone a business card. It's more professional.' I ask her if that is important to her, being professional, and what this means, and she tells me: 'I do exhibitions and workshops, I have my own website, if you Google my name you can find me. […] I am not just a lady who messes about with a brush, I am a real artist.'

C Coding Scheme

PHYSICAL AND DIGITAL CRAFT INTERVIEWS

The table on the following pages shows the codes and sub-codes found in the data that were classified in the data overarching categories. This complete scheme was developed by coding the physical craft interviews first, and complementing it later with codes found in the digital craft interviews. Codes in bold contain sub-codes, which means that all data under this code is coded in sub-codes and numbers show the sum of sub-codes. Codes *not* in bold do not contain sub-codes and thus data is directly coded under these code. Codes and sub-codes in *blue* were only found in *physical craft* interviews, and codes and sub-codes in *red* were only found in *digital craft* interviews (and were thus added after coding the digital craft interviews). The last four columns show the number of physical crafters that discussed a theme (P. crafters); the number of digital crafters that discussed a theme (D. crafters); the number of separate references, or excerpts, in the data within this theme mentioned by physical crafters (P. refs); and the number of separate references in the data within this theme mentioned by digital crafters (D. refs).

Category	Code	Sub-code	P. crafters	D. crafters	P. refs	D. refs
Background & Introduction of crafters			**8**	**8**	**63**	**60**
	Description of craft practice		**8**	**8**	**41**	**39**
		Location (where, and impact of location)	8	7	12	8
		Time (when, how long, and how often)	8	8	11	12
		Description of practice	8	8	9	8
		Professional or recreational	8	8	9	11
	Starting		**8**	**8**	**22**	**21**
		When started	7	7	8	8
		How started	7	6	8	6
		Why started	6	7	6	7

Learning & Skills		**8**	**8**	**84**	**76**
	How learned	**8**	**8**	**27**	**31**
	Learning by 'just doing it', 'trial and error'	5	5	7	15
	Courses	6	2	6	2
	Looking at other people's work	5	2	5	2
	Education	3	2	4	3
	Specific people	2	0	2	0
	Books	1	2	1	3
	Internet	1	4	1	4
	Related experience from education or general life	1	2	1	2
	What can go wrong, risks, limitations	**7**	**6**	**26**	**17**
	Limitations in materials or tools	2	3	3	3
	Accidents, not paying attention	3	1	3	1
	Frustration	3	1	3	1
	Being relaxed about mistakes	2	0	3	0
	Irreversible mistakes	2	1	2	1
	Finding and solving mistakes	2	1	2	2
	Emotional state of mind	2	1	2	1
	Creating or using certain tools to limit risks	1	0	2	0
	Lack of know-how	1	1	1	1
	Learning from mistakes	1	0	1	0
	Sometimes you just cannot do it	1	0	1	0
	Negativity from others, not the right chemistry	1	0	1	0
	Injuries	1	0	1	0
	Feeling guilty about making	1	0	1	0
	Maintenance of tools	0	1	0	1
	Don't have the time to learn	0	1	0	1
	Limited knowledge	0	3	0	4
	Time pressure	0	1	0	1
	Continuing development	**6**	**3**	**22**	**5**
	Setting the learning curve, advancing skills	5	2	8	4
	Developing one's own style	2	0	4	0
	Reusing or adjusting existing solutions	2	1	3	1
	Building up background knowledge	2	0	2	0
	Making the next thing better	2	0	2	0
	Creating your own manual	2	0	2	0
	Keeping up with developments in the field	1	0	1	0
	Participant's background general	4	3	5	4
	What skills are needed	**2**	**7**	**4**	**19**

		Patience	2	1	2	2
		Fine motor skills	1	0	1	0
		Precision	1	0	1	0
		Craft-specific skills	0	4	0	6
		Know-how of materials and tools	0	2	0	2
		Being organised	0	1	0	1
		Seeing new angles, new ideas	0	1	0	1
		Problem-solving	0	2	0	2
		Creativity	0	2	0	3
		General skills, not specialised	0	1	0	1
		Procedural thinking	0	1	0	1
Process			**8**	**8**	**39**	**42**
	Description of process		6	7	10	12
	Surprise, ideas evolve in the process		5	5	8	8
	Inspiration		3	5	4	8
	Repairs		3	0	4	0
	Doing research as part of the process		3	1	3	3
	Precise vs. rough		3	0	3	0
	Enjoying the process		2	5	2	5
	The 'step before' the craft process		1	3	2	4
	Staying true to traditional craft		2	0	2	0
	Personal journey		1	1	1	2
Result			**8**	**8**	**30**	**39**
	Selling the result		3	0	5	0
	Description of result		4	5	4	9
	Giving the result away, sharing, duplicating		3	4	4	7
	Exhibitions		3	0	4	0
	Printing, 'materialising' results		1	3	2	3
	Keeping the result stored		2	2	2	2
	Functional result		1	0	2	0
	Results on own website		1	2	1	2
	Enjoying the result		1	4	1	4
	Earning money		1	3	1	3
	Price-quality value of making it yourself		1	0	1	0
	Result is a combination of physical and digital		1	0	1	0
	Results in a physical portfolio, photo book		1	0	1	0
	Result as a record of life		1	0	1	0
	Result on social media		0	4	0	5
	'Identity' or personality of crafter in the result		0	2	0	4
Materials			**8**	**7**	**44**	**19**
	Materiality of the process		5	0	11	0
	Mixing materials		5	0	10	0

	Description of materials	5	5	7	10
	know-how of how material behaves and how to work with it	5	0	6	0
	Materials influence process and result	4	3	4	4
	Tried out different things	3	0	4	0
	Recycling materials	1	0	1	0
	Exploring materials	1	0	1	0
Tools		**8**	**8**	**30**	**54**
	Which tool to use	**6**	**3**	**10**	**4**
	Universal tools	4	0	4	0
	Dedicated tools for materials or crafts	3	0	3	0
	Using anything at hand	2	0	2	0
	Certain tools limit risks	1	0	1	0
	Which tools determine the result	0	1	0	1
	Which tools? desired result & stage in process	0	2	0	2
	Different tools have their own strengths	0	1	0	1
	Description of tools	**7**	**8**	**9**	**19**
	Physical tools	5	8	7	12
	Digital tools	2	4	2	7
	Acquisition of tools	**5**	**6**	**8**	**17**
	Making your own tools	4	0	6	0
	Getting tools that are affordable, financial aspects	1	3	1	4
	Tools get worn in	1	0	1	0
	Already familiar with tools	0	2	0	2
	Doing research about tools	0	3	0	3
	Expensive or new tools do not make a good crafter	0	2	0	5
	Switching tools takes time	0	2	0	2
	Needing the tools and know-how to start	0	1	0	1
	Tools influence process, result, workflow	**2**	**6**	**2**	**10**
	Tools, machines take away craft elements	1	2	1	2
	Tools are remote, or not owned by crafter	1	2	1	3
	Tools, machines provide new possibilities	0	1	0	1
	Tools help with the work, make 'hand-work' easier	0	4	0	4
	Handling tools	**1**	**4**	**1**	**4**
	'Feel' or interaction of tools	1	3	1	3
	Expression of being skilled with tools	0	1	0	1
Social aspects		**8**	**8**	**54**	**53**

	Others are involved with the result	**8**	**8**	**16**	**26**
	Creating something for someone specific, assignment	6	3	7	4
	Giving result to someone after it's finished	3	0	3	0
	Sharing the result with others	2	4	3	7
	Creating something for someone specific, own initiative	1	3	2	5
	Reactions from others	1	2	1	2
	Testing or evaluating with others	0	1	0	1
	Creating something for a larger, unknown audience	0	2	0	7
	Collaborating with others	**7**	**5**	**14**	**14**
	Discussing with peers	5	3	6	5
	Being together with peers while crafting	4	0	5	0
	Collaborating on a piece	2	2	2	5
	Finding collaborators, models, sources, clients	1	4	1	4
	Learning from others	**6**	**5**	**13**	**7**
	Looking at other people's work	5	2	5	2
	Taking, or not taking, advice	3	0	3	0
	Learning from unknown peers	1	4	2	4
	Learning from people in educational setting	2	1	2	1
	Learning from influential people	1	0	1	0
	Teaching others	5	0	9	0
	Competing with others, marketing	**1**	**3**	**1**	**5**
	Publicising oneself	1	3	1	3
	Competition	0	2	0	2
	Presence of non-peers	**1**	**1**	**1**	**1**
	Distraction from others	1	1	1	1
Motivation & Interest		**8**	**8**	**67**	**44**
	Satisfaction	4	2	6	2
	Seeing something come to existence	5	0	6	0
	Feeling with the materials	4	0	6	0
	Expression of fun general	4	5	5	8
	Appreciation from others	4	4	5	4
	Forgetting worries	4	0	5	0
	Drive to make	3	0	5	0
	Has always been interested	4	3	4	3

		Flow feeling	3	1	4	1
		Pride, showing what you can do	4	0	4	0
		What fascinates about it, and what not	3	2	3	6
		Expressions of 'being good at it' or not	2	3	3	6
		Challenge	3	2	3	3
		Therapy, physical activity	1	0	2	0
		Exploring, getting to know oneself	1	1	1	1
		Doing it for others	1	1	1	1
		Making something functional	1	0	1	0
		Incorporating knowledge into practice	1	0	1	0
		Gaining new knowledge from interaction with materials	1	0	1	0
		Freedom and having the time for it	1	0	1	0
		Expressing oneself	0	1	0	1
		Like being creative	0	3	0	5
		Doing it with others	0	1	0	3
Other characteristics of craft & crafters			**7**	**8**	**20**	**38**
		Perfectionism	**6**	**2**	**11**	**6**
		Self-critical, perfectionist	3	2	6	3
		Shyness, modesty	2	1	2	1
		It doesn't have to be perfect	2	0	2	0
		It's not difficult	1	1	1	2
		Identity as a crafter or artist	6	2	8	3
		Is it craft	**0**	**8**	**0**	**29**
		Struggling to answer, not sure	0	3	0	3
		'I'm not good enough'	0	1	0	1
		Comparisons to art	0	2	0	2
		Physicality, with your hands	0	5	0	5
		It's about 'creating something'	0	4	0	4
		Coming up with new ideas, creative process	0	3	0	3
		Using tools differently, making the impossible possible	0	1	0	1
		Know-how of materials and tools	0	1	0	1
		It's a science	0	1	0	2
		Definitely a craft	0	2	0	2
		Skills and techniques, tacit knowledge	0	3	0	3
		Uniqueness	0	1	0	1

D Creative Workshop Materials

PREPARATION REQUEST

This part of the study will be carried out by email correspondence. The participants will be thanked for their agreement to participation and will be sent the information sheet in advance, and will be asked to do the following preparation:

As a preparation for the workshop, please select from your own media, search online, or create, 5-10 digital images that are interesting, meaningful, or beautiful to you. These can be personal photographs, digital artworks, screenshots from online content, etc. Please also select, search online, or create, 1-5 audio files that are in one way or another related to one or more of your images, for example a song that reminds you of a holiday of which you have included a photograph, or a recorded narrative about an image.

The images and audio files will be used in the workshop as input for a creative building activity with physical and digital materials. Given the collaborative nature of the workshop, please do not select any materials you do not want to share with the other participants and researchers during the workshop. **Please bring your images and audio files to the workshop on a USB stick.** Alternatively, send them to me in advance to c.golsteijn@surrey.ac.uk. If you have any queries, please don't hesitate to contact me.

INTERVIEW SCHEDULE

WELCOME AND INTRODUCTION (10 MINUTES)

Hand out information sheets

Explain:
What is this session about?
What do I mean with digital and physical media?
What are we going to do in the session?

This session is part of my PhD project which aims to look at crafting and making practices with physical materials and digital media, such as photographs and audio. Specifically, it aims to design and study new technological tools that allow for the combination of creating things digitally and physically. In other words, tools that allow you to build or make physical things but bring in your digital media. In this workshop we will work with a toolkit that has been created for this goal and we will be building physical constructions as well as using the digital images and audio you have brought in. I will first give a short demonstration of the kit, after which it is your turn to start building. We will close the session with a group discussion about your experiences with this toolkit.

Given the innovative nature of this study, your participation involves keeping confidentiality about the content of this study, and not disclosing, or using for your own purposes, any information and ideas arising from the activities done in the workshop.

Signing consent forms
Introduction of participants

DEMONSTRATION OF THE KIT (20 MINUTES)

The demonstration will be done showing example constructions: something will be build there and then by the researcher, with relevant couplings of digital

media and physical constructions to open up participants' imagination of what may be done with it.

A. Demonstration of the physical building blocks: show the briefcase with building blocks and explain that they can be used in various ways to create physical constructions

B. Demonstration of the software: show how it can be used to compose the building blocks on the screen and rename and upload media.

C. Demonstration of the 'active blocks' functionality: show how they communicate with each other and thus can be used to show related media using a demonstration media set.

D. Explanation of further envisioned possibilities: explain scenarios of further possibilities such as videos, streaming Facebook content, Tweets, etc.

After the demonstration participants are asked their general opinion on the kit.

BREAK AND TECHNOLOGY SET-UP (10 MINUTES)

Participants will have a break with refreshments while the facilitator sets up the laptop with the participants' media, prepares media, and starts up the software.

BUILDING WITH THE KIT AND PARTICIPANTS' MEDIA (40 MINUTES)

A. Participants will be asked to perform a small, specific task to familiarise them with the kit. First they will be asked to compose and upload a fixed set of images and audio using the software. After these images and audio will appear on the physical blocks, participants will be asked to build something that is related to these media, e.g. if the media display a holiday in Paris, participants may build a physical model of the Eiffel tower to incorporate these media in.

The next parts of this section are expected to blend and iterate, and aim to let participants explore creation with their own media.

B. Exploration of software and selection of media: Participants will use the laptop, which is connected to a projector, to select which of their own media will

be used in a collaborative activity, explore how the software works, and start composing the craftwork using the software.
C. Downloading the digital content to the physical devices, building, and creating the physical construction using the toolkit and other available materials.

Manuals of how to use the relevant software will be available to the participants. A variety of tools will further be available for the participants to use in the physical creation phase, e.g. paper, markers, chalk. It is anticipated participants will switch between working with the digital media and physical building (B-C), and that they will try out multiple combinations of physical and digital creations. There is also interest in seeing how participants will negotiate if the physical will be adapted to digital content or vice versa, which is why parts A and B will be introduced simultaneously and participants will be free to determine which to do first and to switch between activities.

GROUP DISCUSSION (30 MINUTES)

After having had first-hand experience with the kit, a group discussion will explore potential use, improvements and extensions of the kit. Discussion will be centred on the following questions:

1. General opinion on the toolkit? *Has your opinion changed after using the kit?*
2. What would you like to use this kit for? *What physical blocks are suitable/desired for this? What would they do with the result? Gifting or personal use?*
3. What digital media would you like to use? In what way? *Draw back to the examples of envisioned possibilities (2D), which would be desired? Would they use it for static creations with existing media or would they value dynamic, streaming media, such as Facebook feeds?*
4. What other building blocks can you think of? *Participants will be given a sheet of paper to design their own extensions of a) passive blocks, and b) active blocks.*

5. What would you change or add to the software? *What would be interesting digital extensions? How would you ideally upload and edit your digital media using the physical kit?*

CLOSING (10 MINUTES)

Thanks, paying incentives, and signing 'payment form'.

PARTICIPANT INFORMATION SHEET

You are invited to take part in a research study. Before you agree to take part, it is important for you to understand what it will involve. If you have any questions, or if something is unclear, do not hesitate to ask.

WHO IS THE RESEARCH FOR?

My name is Connie Golsteijn and I am a PhD student at the University of Surrey. My PhD research is sponsored by Microsoft Research and looks into the activities of crafting and creating using physical materials and digital media. By designing new technology I aim to support crafting and creating with a combination of digital media and physical materials.

WHAT'S THE RESEARCH ABOUT?

The workshop you will participate in will introduce and explore the use of a toolkit for crafting with digital and physical materials created as part of this research. Insights from this workshop will inform the design of a second version of this kit that will be built and evaluated in the final year of my research. *(Note: the PhD plan was later adjusted to focus on conceptual design instead).*

WHAT DO I HAVE TO DO IF I TAKE PART?

The workshop will be a single session lasting two hours, which will take place at the University of Surrey (AD building). As a preparation for the session you will be asked to select and bring to the session a number of digital images and digital audio files. The workshop will start with a demonstration of the developed toolkit. The toolkit consists of physical building blocks that can be used to build physical creations, of which some building blocks can contain and display digital images or digital audio files, and a software tool for uploading digital media to the physical building blocks. Consequently, you will be asked to use this toolkit, together with the other participants in the workshop, to build your own physical creations and incorporate your own digital media, and those of the other

participants. Finally, you will be asked to participate in a group discussion which will address envisioned use and potential improvements and extensions of the toolkit. As part of this group discussion you will be asked to think about, and write or draw, what extensions of the kit you would like. Specifically, the two hour session will be organised as follows: welcome and introduction (10 minutes); demonstration of the kit (20 minutes); short break (10 minutes); building with the toolkit and digital media (40 minutes); group discussion (30 minutes); closing (10 minutes).

What will happen to the information I provide? All research will be carried out with your prior and informed consent and all data will be held and processed in accordance with the Data Protection Act (1998). To assist the transcription process video and audio recordings will be made during the sessions. Copies of photos will be kept by the principal investigator in order to assist with transcription and analysis. Photographic data will be disseminated for the purposes of this research protocol only. Data will be kept securely for 10 years. Data will be used in the PhD and findings will be written up for internal reports and as papers for publication in academic journals. Data will be anonymised and you will not be identified in any report or publication. You have the option to review materials intended for dissemination in which information you have provided has been used. If you wish to do so, please let me know during or after the workshop and leave your contact details. You will be asked to keep confidentiality about the content of this study, and to not disclose, or use for your own purposes, any information and ideas arising from the activities done in the workshop.

WHY SHOULD I TAKE PART?

The research activities provide an opportunity to think creatively about the future of media practice and crafting and the invention of technologies for the home of the future.

WHAT DO I GET IN EXCHANGE FOR MY PARTICIPATION?

You will be paid £20.00 in exchange for your participation.

WHERE WILL THE STUDY TAKE PLACE?

The study will take place at the University of Surrey, AD building. Separate travel expenses will not be offered.

WHO WILL BE PRESENT AT THE STUDY?

The study will be facilitated by Connie Golsteijn and a colleague from the University of Surrey (Digital World Research Centre).

WHAT TO DO IF I WANT TO WITHDRAW?

You are free to withdraw from the study at any time without needing to justify your decision and without prejudice. If you withdraw before completion of the study, the sum you will be paid for participation will be less and at the discretion of the principal investigator.

CONCERNS, COMPLAINTS, OR QUESTIONS?

Any concerns or complaints about the way you have been dealt with will be addressed; please contact Connie Golsteijn or Prof David Frohlich (supervisor):

Telephone Connie: 01483 682 793
Email Connie: c.golsteijn@surrey.ac.uk

Telephone Prof Frohlich: 01483 683 973
Email Prof Frohlich: d.frohlich@surrey.ac.uk

If you have any further questions, please don't hesitate to contact me.

This study has been reviewed and received a favourable opinion from the University of Surrey Ethics Committee.

CONSENT FORM

Please read the following statements. If you are in agreement with them, please provide your signature as directed below.

- I, the undersigned participant, voluntarily agree to take part in this study.
- I have read and understood the Information Sheet provided and acknowledge that a full explanation has been provided by the principal investigator as to the nature, purpose and likely duration of the study. I have had the opportunity to ask questions relating to all aspects of the study and have understood all advice and information provided in response.
- I agree to comply with any instruction given to me during the study and to co-operate fully with the principal investigator.
- I give my consent for the images and audio files I provided prior to or during the session to be held and used for the purposes of transcription and analysis by the principal investigator. I give my permission for these images and audio files to be included in dissemination of findings from this research.
- I consent to my personal data, as outlined in the accompanying information sheet, being used for the research project detailed in the information sheet, and agree that data collected may be shared with other researchers or interested parties. I understand that all personal data relating to volunteers is held and processed in the strictest confidence, and in accordance with the Data Protection Act (1998).
- I understand that I am giving the University of Surrey consent to record me and to use and make available the content of the recorded discussions. This consent applies to any and all materials originating from the discussions, including any images that were created during the session. All materials will be kept in secure conditions at the University of Surrey and will be preserved as a permanent reference resource for use in for use in publications including print, audio-visual or electronic for the purposes of further research, Conference, Symposia, lectures and seminars.
- I understand that I have the option to request to review those materials intended for dissemination in which information I provided has been used,

and I have read and understood the section of the Information Sheet that outlines the procedure for this.

- I understand that I am free to withdraw from the study at any time without needing to justify my decision and without prejudice.
- I agree to keep confidentiality about the content of this study, and to not disclose, or use for my own purposes, any information and ideas arising from the activities done in the session.
- I acknowledge that in consideration for completing the study I shall receive the sum of £20.00. I recognise that the sum would be less, at the discretion of the principal investigator, if I withdraw before completion of the study.
- I acknowledge that this study is part of a PhD programme that is sponsored by Microsoft Research.
- I confirm that I have read and understood the above and freely give consent to participating in this study. I have been given adequate time to consider my participation and agree to comply with the instructions and restrictions of the study.

PARTICIPANT:

Name of participant (BLOCK CAPITALS)

……..

Signed …… Date…… | …… |……

PRINCIPAL INVESTIGATOR:

I have fully explained the contents of this document:

Name of researcher (BLOCK CAPITALS)

……..

Signed …… Date…… | …… |……

TASK SHEET

TASK 1

You have just seen a demonstration of Materialise. We will now try out another example by following the instructions below.

1. Open the folder 'Examples' on your Desktop. You will see a number of images and audio files.
2. Select one or more images and one or more audio files you would like to use in this example.
3. Open the Media Uploader software by clicking the shortcut on your Desktop.
4. Follow the steps in the Media Uploader software manual, under 'Exploring your composition' to display your chosen images on the blocks and add the audio files to the block.
5. Follow the steps in the Media Uploader software manual, under 'Uploading your media' to upload the images and audio files.
6. Press the reload (R) button on the side of each block to load your selected images.
7. Use whatever physical blocks and materials you like to build something that is related to, or contributes to, the media you have selected.

TASK 2

After having explored the functionality of the kit using examples, you will now have the opportunity to build something with your own media. You can use the media you have brought in, look online for more media, or create new media. It is up to you what media and what building blocks you want to use, what you want to do first, and what the relationship between your media and your physical construction will be. Your task is as follows:

In the group, build a creation using both the physical building blocks and digital media files.

Before uploading your media files using the Media Uploader, images will have to be resized to fit the screens of the blocks, and some audio files will have to be adjusted to be playable on the audio block. Please follow the instructions under 'Preparing your media' in the software manual to prepare media files before uploading them with the Media Uploader. *(Note: for time efficiency, this was done by the researcher in the workshops).*

If you want to look for, or create, new media, there are instructions for this in the manual as well.

You are free to try out as many different combinations and constructions as you like.

Good luck and have fun!

SOFTWARE MANUAL

If anything in this manual is unclear or you want to do something that is not in this manual, do not hesitate to ask us.

LOCATING OR CREATING MEDIA

All media that you have brought in, or that will be used in the examples, can be found in folders on the Desktop, for example the folders 'Examples' and 'Participant Media'. If you want to look for media online, you can use Internet Explorer by clicking the icon on the Desktop. If you want to create new images you can use software like Paint, for which a shortcut is also available on the Desktop. For creating new audio files, you can use Audacity, by following the instructions below.

Creating new audio files using Audacity

1. Open the Audacity software (shortcut on the Desktop).
2. Make sure the recorder is set to 'Microphone Array' in the middle of the window.
3. To record an audio file, press the record button in the top of the window (button with a red circle).
4. Record your audio and stop recording by pressing the stop button (button with a yellow square).
5. Save your file by clicking File -> Export.
6. Give your file a name and choose a location to save it, for example Participant Media on the Desktop.
7. Make sure the 'Save as type:' is set to MP3.
8. Click 'Save'.
9. Click Okay in the 'Edit Metadata' window.

PREPARING YOUR MEDIA

All images need to be JPG images, sized 320 x 240 pixels to fit the screen of the screen blocks. Portrait pictures need to be rotated first to portrait and then resized to 320 x 240 pixels. *(Note: for media brought by the participants, this preparation was done by the facilitator).*

Rotating images

1. Right-click the image you want to edit and click Open With -> Microsoft Office 2010.
2. Click one of the 'rotate pictures' buttons (purple icon with arrow) next to the 'Edit pictures' button in the menu in the top of the window to rotate.
3. Save your file by clicking File -> Save as. Give your file a name and choose a location to save it, for example Participant Media on the Desktop.
4. Make sure the file type is set to 'JPEG File Interchange Format'.

Resizing images

1. Right-click the image and click: Open With -> Microsoft Office 2010. By clicking the 'Thumbnail View' button in the top left corner, and selecting all images, you can resize all images at once.
2. Click 'Edit pictures' in the menu in the top of the window.
3. Choose 'Resize' in the menu that has just appeared in the left side of the window.
4. Select the 'custom width x height' option and enter 320 in the first box, and 240 in the second box.
5. Check if under 'Size setting summary' the New size states 320 x 240 pixels. Click Okay. You will see that the image is resized. If your image has a different ratio you will see that the new size is not exactly 320 x 240 pixels. In that case you can crop your image using the instructions below.
6. Save your file by clicking File -> Save as. Give your file a name and choose a location to save it, for example Participant Media on the Desktop.
7. Make sure the file type is set to 'JPEG File Interchange Format'.

Cropping images

1. Right-click the image and click: Open With -> Microsoft Office 2010.
2. Click 'Edit pictures' in the menu in the top of the window.
3. Choose 'Crop' in the menu that has just appeared in the left side of the window.
4. Use the black lines and corners that have appeared around the edges of the image to select which part of the image you want to keep by clicking, dragging and releasing a black line across the image.
5. When you are happy with the crop size, click Okay. The image will be cropped.
6. You can now resize your image using the instructions above, or save your image by following steps 6 and 7 under 'Resizing images'.

Saving images as JPG files

If you want to use images that are not in the JPG folder, for example BMP, PNG or GIF images, you need to save them as JPG images first by following these steps.

1. Right-click the image and click: Open With -> Microsoft Office 2010.
2. Click File->Export.
3. In the menu on the right choose a location and a name for the new file.
4. Under 'Export with this file format' select 'JPEG File Interchange Format (*jpg)'
5. Click Okay. A JPG version of your image has been stored on the location you have chosen.

Saving audio files as MP3 files

Audio files need to be in MP3 format and have a bit rate of 128 kbps or less. If you have audio files you would like to use that are not in MP3 format, for example WMA files, you can use iTunes to save MP3 versions of these files.

1. Open iTunes by clicking the shortcut on the Desktop.
2. Drag and drop your audio files into the centre of the window.
3. If the files are not in the MP3 format, iTunes will show a message that files will automatically be converted to MP3 format. Click 'Convert'.

4. After the conversion has finished (status bar in top of the window) the MP3 files will be saved in the iTunes Media -> Music folder on the Desktop.

Changing the bitrate of MP3 files

If you have MP3 files you want to use that have a bit rate higher than 128 kbps you can use iTunes to change the bitrate of these files.

1. Check the bitrate of your audio files: Open the folder in which your audio file is saved, for example Participant Media on the Desktop. Click the audio file; information about the file will appear in the bottom of the screen. Locate the Bit rate information. If this is more than 128 kbps, do the following steps to change the bitrate.
2. Open iTunes by clicking the shortcut on the Desktop.
3. Drag and drop your audio files into the centre of the window.
4. Select the audio files you want to change.
5. Right-click the selection and choose 'Create MP3 version'.
6. After the conversion has finished (status bar in top of the window) the MP3 files will be saved in the iTunes Media -> Music folder on the Desktop. You can access this folder directly by right-clicking the new file in the iTunes list and clicking 'Show in Windows Explorer'.

EXPLORING YOUR COMPOSITION

You can the Media Uploader software to already start exploring your media composition before uploading media to the blocks.

Moving and rotating blocks

1. Open the Media Uploader software by clicking the shortcut on the Desktop.
2. You will see images of the two screen blocks and the audio block on the screen. You can move these blocks by clicking them and dragging them across the window.
3. A block can be rotated by clicking the arrow in the upper-right corner of and, while holding the mouse button down, moving the mouse.

Adding media to the blocks

1. Double-click on a block. A window will appear titled 'Files for [that block]'.
2. Go to the folder where you have stored the media you want to use, for example 'Participant Media' on the Desktop.
3. Drag and drop the media you want to use into the 'Files for [that block]' window. Please note that only JPG files can be dragged to the Screen blocks, and only MP3 files can be dragged to the Audio block.
4. Click any of the images in the list to display this image on the block.
5. You can use the 'Clear' and 'Clear All' buttons to remover one or all images from the list.
6. You can close the 'Files for..' window if you want to continue moving the blocks.
7. Repeat these steps for the other blocks to add media to these blocks.

UPLOADING YOUR MEDIA

After you are happy with the media you have selected and added to the blocks you can continue with associating related media with each other and uploading the media using the Media Uploader software.

Associating related media: renaming files

Associating related media with each other is done by giving these files the same name on different blocks. For example an image 'castle' on Screen1 can be associated with an image on Screen2 by naming that image 'castle' as well.

1. Double-click on a block. The 'Files for [that block]' window will appear with the media you have added to that block.
2. Each file has a File Name, the location and name on the computer, and a Target, which is the currently proposed name for the file. Click in the Target area of the file you want to rename and select and delete the text.
3. Give the file a name you want to use to identify this set of media, for example 'castle'. Please don't use spaces in the name, this will not work.
4. Repeat these steps for other files, and for the other blocks and give the related media on the different blocks the same names.

UPLOADING YOUR MEDIA

After you have renamed all files you want to relate with other files, and you are happy with your list of files, you can upload these files.

1. Double-click on a block. The 'Files for [that block]' window will appear with the media you have added to that block.
2. You can use the 'Upload' or 'Upload Add' buttons to upload media. The 'Upload' button erases the list that is currently on the block and will make sure only the media you have just added will appear on the block. The 'Upload Add' will keep the current media on the block and will add the media you have just added to what is already on a block.
3. You will see the upload status in the bottom of the window and, after the upload has finished, the message that all files have been uploaded.
4. Repeat these steps for the other blocks.

DOWNLOADING YOUR MEDIA TO THE BLOCKS

1. Click the reload button on the side of the block (R).
2. You will see the 'Reloading images…' message appear on the screen for the image block, or see the orange light followed by the green light flashing for the audio block. Please be patient for this to happen, this may take a short while.
3. Wait until the message disappears and the first image is displayed, or the green and blue lights stop flashing. Again, this may take a while.

E Portraits of Digital Crafters

MARC – PHOTOGRAPHER

Marc has always been interested in photography but when he got made redundant and got quite a big pay-off he 'started to take it a lot more seriously'. He was able to buy equipment he otherwise would not have been able to afford, such as a decent camera, lights, Photoshop software, and a decent PC. Marc has tried landscape and architecture photography but missed 'the soul', so currently he mostly photographs people. He explains that all his photography has 'some level of attitude', and a small part of what he does is naked photography. He explains: 'when you just see general beauty like you might see in Vogue or even if it's a lingerie catalogue, they're often very pink and flowery, aren't they, and even if the woman is stunning, she's lying there not particularly in a provocative way and it's all done very nicely, and I don't really… something in me doesn't particularly like nice. […] I like stuff that has got some real attitude […] and something about nice just doesn't seem to be authentic enough for me.' 'I like the combination of a beautiful person with a bad attitude, if that makes sense.' He later adds: 'what fascinates me about people is their vulnerability. […] seeing someone completely stripped away from any pretence, or in fact, from anything that the majority of the world sees.' He tells me he is fascinated by 'real people' rather than professional models, and one of his projects has him photograph people's faces from up very close, in which he 'found a kind of intimacy'.

Photography is not Marc's full-time job. He tried to have a professional career, but his location outside London didn't help and there was a lot of competition.

Moreover, he admits: 'I wasn't ready, because I just wasn't good enough.' He explains that the only way to make enough money was to photograph weddings which 'bores [him] senseless', and he did not want to do it just for the money, because that would make photography too much like work and would take the joy out of it. Although he used to charge quite well and did much portfolio building for young models, now he doesn't charge for his time because it is for his own projects: 'I can be a lot more fussy about who I photograph […] and now I really only photograph who I want to photograph.'

Marc has been doing photography since he was very young; his parents bought him his first camera when he was 10. His first 'professional set-up' was started when he was made redundant six or seven years ago, when he also started to build a portfolio website and started getting requests. He started off photographing bands; he is a musician and has played in bands himself. He got more and more invites, and then was invited by someone who had just opened a studio and had invited some models, some photographers and some make-up artists, and 'just had a huge studio party'. This was his first experience photographing some 'stunning women': 'and it was so much fun that I moved from doing bands to doing fashion and lifestyle and that kind of stuff. […] And I realised that I was really good at it. And people seem to like what I do, that's the main thing.'

Marc learned to do photography mainly 'just by doing it': 'I didn't wait until I thought I was good enough to go out and do it. I started doing it when I was crap.' He further tells me he bought a book very early on, which taught him the basics such as the shutter speed and white balance settings, 'and then I went out with my camera and started shooting bands and stuff and I started looking more critically at other people's work and how they were doing it and I spotted things I never spotted before. I learned about things like the rule of thirds and all those kind of things that I just never knew about before.' He also looked at non-photographic art: 'I was looking at what other people did and digging from that what fascinates me […] I have no interest in copying anybody but I like using

somebody as an inspiration and what I always do is try and vocalise where that inspiration comes from.'

When I ask him what skills a photographer needs he tells me: 'there's definitely some truth in the cliché that it's more about the eye than about the camera.' He knows some photographers who have really expensive cameras but whose work he still does not like, and some pictures are taken with 'crappy cameras' but they are still stunning images. However, it took him quite a while to realise this: 'It was when I started wondering whether I could do it professionally, and then looking at what the big guys did, it was then that I realised how immature my eye was. […] I think it's very easy to be caught up in buying new gear.'

Apart from the people he shoots, it could be said Marc's craft materials also include the context in which photography takes place. He avoids shooting in a studio: 'how can a studio ever be as inviting as the outside world? I've got a myriad of backdrop available to me anywhere in the world; why would I want to use a studio?' His tools obviously include his camera, about which he tells me: 'I generally do a lot of research but it never went outside of Nikon or Canon. People like Olympus and Fuji just weren't making decent cameras back then. […] And I kept reading that Nikon made the best lenses […] so it was a bit of a no-brainer for me, and then I just went for the best camera I could afford out of their range.' He further bought three good lenses, which might be more important than the camera. Also, he uses tripods, a light meter, and he bought some books on lighting and explains: 'some of the set-ups that some photographers had were absolutely scary: massive amounts of lights. But then I noticed that some of the images I really liked were done with just one light and a reflector. So I bought a reflector, a big lovely, white on one side, gold on the other. So I started out just using that and window light. […] And people always say to me "your lighting is really good." but it's just the sun and a window. So I always try to keep it very simple.' He has recently sold his flash lights because they were unpractical to carry around and because of the amount of current they draw.

After photographs are taken, he uses software - Photoshop CS5 and a few plugins - to edit the digital images, although he edits very selectively, for example some skin smoothening, because his photos are all about 'being raw and what you see is what you get'. 'I see a lot of photographers; when you see the raw image from the camera, what comes out of Photoshop is so different… and that turned me off as well. I didn't really want to do that, I really wanted to get it right in camera. I don't think it's cheating to do it in Photoshop because there is still an artistic eye you need to, to come up with a finished product but it didn't fascinate me as much as being able to do it in the camera.' What happens if I lose Photoshop or my computer? I still want to be able to take good pictures, and I don't want to have to rely on Photoshop to do these things for me.' He learned to use these tools by 'just playing with it' and watching YouTube videos. He further uses plug-ins for things he cannot do himself such as complicated black and white conversions, 'or if I have made a mistake with the lighting and I'm not happy with it. I might change somebody's eyes a little bit but I try to keep it minimal.' He uses a tool called 'Lightroom' - which he heard about through a friend who is a sport photographer - to do his workflow; he takes 500-1000 photos per shoot and he uses this software to go through the images and delete photos. However, he tells me deletes hardly anything – only photos where the model's eyes are closed or that are out of focus. Finally, he adds watermarks so that he can copyright his work.

When photographs are finished, he uploads some of them to his website, which he created himself. He does not upload many photos though, only the things he really likes: 'I'm very self-critical and actually I like very little of what I do, so if it goes on the website that means I really like it. Very little stuff I print as well, which I think is a big mistake. I've printed some of my stuff and had it done properly, not be me with a printer […] and that is a lot more rewarding than seeing it on a screen, I'm not sure why. Seeing your work in your hand on a really good quality paper, there's something… I was going to say tangible. That sounds stupid, of course it is… I don't know what it is, it just seems very different from seeing it on a computer screen.' He further gives photos to his models, and keeps them himself; his photos are backed-up on multiple hard-discs. He also likes the

process of going through old photo shoots and finding new things that fascinate him.

I ask him if he discusses his work with other photographers, which he sometimes does. He tells me he has used to have two Facebook profiles, a personal one and a photography one. On the photography one he had about 1800 friends, of which most were photographers, models, make-up artists and hairstylists. When he deleted that profile the people he became good friends with came across to his personal profile. He is in contact with about four or five photographers he is good friends with.

Marc really enjoys the process of photographing someone: 'If I photograph somebody and I spend three or four hours with them and I don't get a single image that I like, I'm disappointed but actually the most fun part, I actually had.' He talks about an intimate 'conversation' with that happens between the camera and the person, especially in a one-on-one situation between photographer and 'model': 'there's an intimacy, a fake intimacy I might add, but there's also trust […] there's all that kind of stuff going on which I find fascinating and exciting. […] And then it's up to me to portray what I see somehow with a camera, and that whole process of doing that really fascinates me.' He adds: 'there's something about that for me that's more than the result. Maybe having a really good result is like the icing on the cake, but yeah, the actual thing was the process and the creating.' He further tells me he likes the sounds and feel of the shutter clicking, and the fact that 'you know that 250th of a second is never going to happen again in the rest of eternity, and that person is never going to quite pull that same face again, and we just happened to be saying that thing at that time and I got it, that's never going to happen again in the rest of the history of the universe. So there is something very fascinating about hitting that shutter which of course is long gone by the time I'm now in Photoshop or I see it in print. I can think back about what was going on that period but really it's about the interaction that I think I really love.' He compares this feeling to what he communicates with a guitar: 'the instant reaction you get from the audience, there's that conversation as well that goes on, which I guess gives me the same pleasure as the camera.'

When I asked him what it is he likes about photography he tells me it gives him 'a creative outlet': 'It gave me an insight into a world that otherwise I wouldn't get access into, if that makes sense' (while struggling with his sexuality). 'I expressed through my pictures stuff that I failed to express through my music when I was younger, which I couldn't do just because of being afraid and not being bold enough to take risks, but for some reason I found that I could be a lot bolder with a camera than with a guitar, or with anything I've written before as well.' He further likes 'the instantaneousness of a camera and […] how raw it can be.

Marc admits to struggle answering my question if photography is a craft: 'there's something about people pretending they're above their station, and art and craft seem such… they are words that I reserve for people who are elite. So when I think of artists I like and I think of musicians I consider to be artists, they are so far above me. And the same goes for photographer, I guess. So maybe I find it very easy to attribute the word art, or craft, to other photographers but I don't find it easy to do it for myself. […] So I think what I'd prefer is for somebody else to decide whether I'm an artist or not. Because, what does the artist do other than create, really? […] so maybe I am but I still don't find it comfortable to say so.' He adds: 'craft feels to me more like something you do with your hands. Whether you craft a sculpture or maybe you carve wood or something, that sounds like you craft something. But it's still creating isn't it. So I'm thinking that craft, creating, art, maybe they're all wrapped up. Maybe they are different, I don't know. […] 'I guess I am [a crafter/artist], but I won't say it.'

After the interview Marc shows me a roomy cabinet in the garden which partly functions as a photo studio. After seeing his camera he starts up his computer to show me some of his photos, and I end up staying there for half an hour, in which I can clearly see his enthusiasm as he shows me folder after folder, gives numerous anecdotes from those particular shoots, and tells me how he gets in touch with the people he photographs. He illustrates his 'recruitment strategy', which happens very spontaneously with people he meets through others, by asking me if he can take my photograph as well.

TIM – CAD MODELLER AND DESIGNER

Tim is a product designer in a design research lab and CAD modelling – creating 3D models in computer-aided-design software – is a 'very important part of his everyday practice'. He calls this 'a little journey from an idea that pops into your mind and you try to physicalize it to some extent, and you use that physical instantiation to tweak that idea and develop it further.' He tells me that lately he has been doing mostly models for 3D printing, but he also uses other software, such as Adobe Illustrator to use a laser-cutter: 'It really depends how concrete an idea is and how sure I am that I'm on the right track because obviously using the laser-cutter allows you to be a little bit more explorative, compared to the 3D printer […], although these technologies are becoming so far developed that even 3D printing doesn't take that much time anymore.' Because he works remotely he does not have the availability and the instantaneousness of the laser-cutter, so he often uses CAD modelling and sends the models either to his research lab (which has a 3D printer) or to a commercial 3D printing company.

Before he started using CAD tools, he had been making product design models for a long time using wood and other materials. He starting doing CAD models in his last year at university, around 2008, while making a prototype for his graduation project – Tim studied design. He saw other students using the machines and realised he couldn't compete with the quality of the machine. Further, because the turn-around is so quick he realised he could get more work done in the same time: 'it's almost like you can work 24 hours a day, because you can go home and send the stuff to the printer and you wake up and the model is there.' Also, he feels he can be more creative: 'it's almost unlimited what you can do with 3D printing. I'm quite compelled to say… certainly about the skills I have, basically at this point I can make anything. Obviously not in any material, because it's limited what materials you can make, but there's almost no limitation what you make.'

Comparing more traditional model making and CAD modelling he reflects: 'what I think kept me from doing it, is that I really think [model making] is a craft that

you can do with your hands, but at some point you will have to start exploring the craft in laser-cutting and 3D printing because you will never be able to do these things, even with enormous skill. […] It feel to me like I'm going to bin my crafting skills and have a machine do it for me but there's no way you can do it without the machine.' 'At some point you think: "I've reached my limit with what I can do with [hand] craft", end result-wise but also time-wise, and then you want to start using the alternatives.' He later adds that he does consider CAD modelling a craft: 'people approach me to do models for them and it's not just a casing you do, you contribute your ideas, which to my opinion kind of become part of the craft. You think about how you can do this differently, starting with that person's idea and basically pushing the boundaries of laser-cutting and 3D-printing and I think there is craft in that.' He also sees craft value in exploring and being able to make things that could not be using more traditional manufacturing techniques: 'if you think about the fact that so many products can be easily copied in China, what if you make something that is just not easy to mould, where you really need this technique to manufacture the product. […] [T]here's going to be a time when having it made there and then shipping it back is not going to be in favour over printing the stuff. […] I think the craft is […] in making something that uses the technology, pushes the limits, and turns the usage of these technologies into something really creative and novel.' He adds that is also a craft to know which materials to choose for your print and how to design a model so that the model can print it: 'to some extent I think it is craft, knowing the limitations, knowing the different types of printers and laser-cutters you have, and it's almost like… you don't read the manual, right. You don't need a manual to know how to set this device in order to achieve a certain cut or to build something. You kind of fluently know that if you create a fillet that is this big and this wall is this thin, that it's going to work, it's not going to snap. Being able to do that, I would say that is craft to a certain extent.'

Although he followed one course about it in university, Tim tells me he mostly learned CAD modelling through 'trial and error': 'you learn a lot from the web and other people's experiences and you can quite quickly start to build upon those.' Regarding the required skills to be a good modeller he explains that it is

very dependent on what you make: 'even if you specifically look at 3D printing, the amount of different printers you have, different materials that you can use, they all require skill, they all require know-how.' You need to know what material the printer prints and what the qualities and characteristics of these materials are. 'In general, it just requires a lot of practise. And to some extent, it's quite similar to something like woodwork, or being a good miller. You need to get a feel for the machine and the material. […] It's about choosing the right tools for your craft but you're not actually doing the craft because the machine is doing the craft for you.' Apart from the 'trail' in practising, there is the 'error' that may occur. He tells me that a lot can go wrong if you don't have the know-how, for example models can be too weak and can snap if they are not designed right. Further he wonders about the longevity of materials and says that he is not sure how the quality of printed stainless steel or bronze compares to casted versions. He adds: 'you need to maintain these machines as well. If you don't maintain them, you'll run into issues, guaranteed. […] It's like with craft, if you don't maintain your tools… you need to keep your knife sharp or whatever, you have to do the same with 3D printers. If you don't do that it will become less accurate and at some point it will just not perform anymore.'

Tim has some experience 3D-printing with different materials, such as stainless steel, brass, and ceramics, through his use of printers at his university and his current research lab, and commercial printing services. Some materials afford higher quality prints, which influences the design, e.g. how thin the walls can be, and how much detail there can be.: 'you need to try these things and you need to gain experience in […] how you can push the boundaries. And I think that's a disadvantage of using these 3D printing companies, because sometimes they don't allow you to look for these boundaries because they just tell you: "This is not strong enough"'. While many interesting materials are available, such as nylon, ABS, transparent materials, silver, platinum, gold, gold-plated, and bronze, he expects more interesting possibilities when materials can be mixed for 3D printing, e.g. rigid and flexible materials printed in one go and combining them (which is now possible): 'it expands the possibilities for playing around with it and turning it into a craft.' He tells me the printer at his lab prints in a plastic

material that requires quite a bit of sanding and painting to 'make it look decent': 'there's always a little bit of craft involved in order to make it, first, work, but also visually appealing and obviously you can take this really far. You can sand these models and spray-paint them and make sure that it's protected and strong enough.' However, in research he hardly ever reaches this stage, because models only need to be 'practical, need to work, need to hold some electronics.' Only the last year or so he has been working on models that need to look more visually appealing, because he's working on more product-oriented things now.

Apart from the 3D-printer, Tim's main tool is his CAD software. He has used different ones in the past, such as 3D Studio Max and Rhinoceros, but currently he only uses Solidworks. Each of these software tools has its own strengths, for example 3D Studio Max is very useful for creating visual renders and exploring but he is not sure if models can be exported for 3D printing. Solidworks has now caught up with that and it can do the same, but it also allows for putting in exact measurements, which is crucial for 3D printing.

Tim likes both the process of modelling and the result, and 'the step before that is the ideation'. He likes looking at problems from a different perspective and turning ideas into products. The time it takes to make a model varies greatly depending on what it is and the amount of detail: models he makes range from quick form explorations – which would take less than one hour - to products that need to be assembled, screwed, and have mechanical elements – which take much longer. Most time however goes into waiting for the prints. Tim tends to works on about eight projects at the same time so this is not a big problem for him. Furthermore 'it's not the time that I have to invest in it anymore, because the machine is doing it for me and I can do something else, and that's a cool thing.' Tim thinks that currently the ability to use the software and the availability of a 3D printer are the main thresholds that limit more people from trying it. He has the facilities at his research lab that allow him to produce 3D prints, but using commercial printing services, and even home 3D printers which are getting better and cheaper, can be quite affordable and quick: some companies have a 24h turn-round, instead of the usual 2-3 weeks. He predicts

that 3D printing will become much more available for iterative design and everyday applications.

Most of the models Tim creates are intended for printing but sometimes this does not happen eventually because he decides to go for a different design direction. He says he uses modelling quite explorative rather than only to create a final product: 'I think I tend to use Solidworks relatively early on in the process compared to other people […] Because I have been working with it for so long for me it's a really lightweight tool […] I still do a lot of sketching on bits and pieces of paper to explore my ideas a little bit more, and to clear my head the first time, but then after doing these sketches I often quite quickly go into modelling software because I already have the thing in my head, and that is how I want the first iteration to be, and I take it from there. […] And that doesn't necessarily mean that any of the stuff I printed for that project the first round has anything to do with the final outcome, really. So it's very, kind of, hands-on and explorative in that sense.'

All in all, he says about his modelling: 'I really love my job so I'm very lucky to say that I could also be doing the same as a hobby.' And he does; he tells me 3D prints things as presents for friends and family, or he models his own ideas. He uses his skills to solve problems in everyday life, for example when he created a little hook for his granddad's garden tool. He adds that 3D printing has become part of his everyday life so much that his friends joke about it: 'Oh, you can probably 3D print that'. Tim's enthusiasm is captured in his description of why he likes the result of the 3D modelling and printing process: 'when you get this little box [with the printed product] at home and you unwrap the box, it's almost like a little boy getting a present. […] It's just really cool, making your own products.'

EMILY – STOP-MOTION MOVIEMAKER

Together with her ten year old daughter, Emily, a university lecturer and researcher, makes stop-motion animations in her spare time. For these animations they use mainly little toy figures and self-made costumes and backdrops. She calls this ‘very amateurish but really good fun’ and she sees it primarily as something she and her daughter can do together and that ‘makes [them] laugh a lot.’ Although Emily had initially introduced her daughter to stop-motion animation, now it is done mainly on her daughter’s initiative, and it is a joint process: 'So we're at the stage now where we're both involved in setting it up but then I can just leave her shooting a movie, moving the characters and doing what she wanted to do. She can all of that by herself and then I take over and I do the bit of exporting it to the right format and uploading it. We usually put them on YouTube now, and then you can do it as a private link that you just email to just a few people.’ Starting off in the Christmas holidays and doing a movie every six months or so, Emily tells me they have made about five or six films so far, which include a New Year greeting and a trailer for her daughter’s drama group. She adds: ‘We talk about them a lot more then we actually do them […] Talking about what to do, and then me making a tiny little costume of this doll’s house character, cause [the character in a Christmas Carroll] has got to have the night cap and the stripy night shirt, to play the character. And then we’ll make some scenery…’

Although she does not do much else with digital media apart from taking photos and now and then making photo books using a web service, Emily calls herself ‘a bit of a bricoleur’: ‘a bit of a kind of.. making things out of nothing kind of person. So I like making things with the children.’ She adds: ‘the kids and I have always made pictures together, made collages and all those kinds of things. We’ve always done that kind of stuff; junk modelling [...] So this is kind of just part of that, rather than being specifically digital, it’s just a kind of different medium to mock up about and make things out of nothing with.’ When I ask her if it is important to her that her children are making things, she tells me: ‘You can’t force things on children […] but my daughter, she just took to wanting to make

things and create things, it was always what she wanted to do. I don't think my son is as interested and I don't think he will be. If it hasn't got an engine he's not that interested, really. If we could make a robot… he'd be impressed, but the things he wants to make, you can't make out of nothing on the kitchen table, so he's not impressed.'

Emily started making stop-motion animations about 18 months ago after she came across a children's book about how one could become an animator, which she was reading in a bookshop. The book addressed some free software made by an American university project that can help to make animations, and because her kids like animation she decided to download the software. 'It turned out to be incredibly easy to make a little movie.' They started making 'silly movies' using plastic animals her kids had: '[these animals] are not articulated at all, so you can only just move them, take a shot, move it, take a shot, move it. And it just looks as if they are all running around the screen. And we spent ages messing about with them.' Since then they have been 'pursuing their own ideas' and have not ran out of inspiration yet. Emily seems to envision more advanced applications though: 'We could possibly have done with the book to give us more ideas of things to animate and how to animate it. […] It's the film-making side of it, in a way, that you think: "there's a lot more we can do with this than we are actually doing."' She adds: 'I've been trying to explain to my daughter about how the whole idea of stop-motion is you're supposed to be able to make things… do things they can't in real life. […] You make something move that is normally static, or you make something appear as if it's happening by magic. You see those really clever ones where a drawing just kind of emerges, without a hand on it, because it's drawn in stages. I'd be fun to try and do something like that, but […] little people doing things is good enough for the moment.'

The tools for the stop-motion animation consist of a laptop with the software and a webcam. The software shows a split screen of what can be seen through the camera at the moment, and the part of the movie that is finished. 'Where you've got what the webcam is looking at, at the moment, it does what's called onion skinning, […] where it shadows the thing you last did and the thing you're

looking at, at the moment. So you can see if you want to just move a character just a tiny little bit you can actually see sort of simultaneously the before and after […].' With this tool characters can be moved bit by bit, taking shots between moving them. The playback speed of a movie can be adjusted but usually there are about five photos per second and Emily will make about 30 seconds movies: 'that's a couple of hundred frames, which is about the attention span of a ten year old.' The software further provides basic editing tools, and a soundtrack can be recorded and added. All in all the software and getting started is 'pretty straightforward', apart from some trouble she had getting started because she had to use an external webcam – to allow for flexibility in which shots to take – on a laptop that also had an internal webcam, and the software did not use the right webcam. 'I think people see this, they see stop-motion animation and they think: "oh gosh it must be really high tech and difficult," and of course with this software it so isn't. You can very easily make some very amateur movies. It just is so fun.'

The materials used for their stop-motion range from existing plastic toy figures to elaborate self-made costumes and backgrounds. For example, a winter wonderland was created by 'junk, rubbish modelling': 'The backdrop was a white sort of towelling sheet because it was ice and snow […]. I think cardboard boxes with little dolls cut in them and plastic tubs with little dolls cut in them.' For another piece that was a trailer for her daughter's drama production slightly more advanced materials were used: 'I had a fairly small [old-fashioned leather suitcase] so we stood it on its side and it gradually opened up, and then the little characters came running out of it. And then we had a train which was one of my son's toy trains, which unfortunately was Thomas the Tank Engine so it had the face on the front […]. So we had to cover up the front.' Emily tells me how they use 'Bluetack' to make the characters stick on the floor to prevent them falling over. Once a piece of Bluetack was forgotten and could be seen in a shot, which upset her daughter. This highlights the delicacy of the process: 'You kind of only get one go at it, because if you've moved everything you've kind of lost the set-up.' I ask her if they take into account the lighting and shadows and she tells me: 'it kind of bothers me when I look at it and I can see that the lighting has changed.

If it has taken us a couple of hours to do, you can see that, actually, if we've been using natural lighting you can see that the time of day has changed.' These things make the process riskier and sometimes Emily has to supress her perfectionism: 'Sometimes we mess up, something does move, and you think: "oh, do we trash the whole thing or do we just make it as good as we can do?" So I think that's the borderline between keeping it fun for the children. I can be too much of a "prima donna" here, and it would just be… too stressful. […] It is it's definitely something I do with the children so it has to be… enough fun. It has to be something that produces something that's not so crap that [my daughter] can't share it with people and feel good about it.' Further, the goal of doing it together with her children sometimes stands in the way of a smooth process or good result: 'And my son is five and he's too little for this, really, cause they just haven't quite got the motor control to move things precisely enough and he'll then accidently knock everything over.. So a five-year old getting shouted at by a ten-year old… […] He loves the end result. He thinks they're very funny and good, and he likes them. And he likes being involved. But… that's the stressful bit.'

The process has gotten 'a bit more sophisticated' as more movies were made: 'Maybe this is me being the kind of... educative mother, I can't just let it run.. First we did crazy chaotic things, yeah, we would just make it up as we went along, so there was no plot. It started off with a... sound too grand to call it a set, but you know... we'd make a little scene and we'd have some props and the characters and they would do something.. The children would go: "Oh I know, he could climb on his back and then he could fall off, and then he could do this.." And it was completely made up as we went along. But more recently we tried to have a little bit of an idea of what's going to happen before we start doing it.' The most elaborate planning was involved in the trailer for her daughter's drama production, for which a 'casting' was done for the characters: 'We needed three characters to play the children. [My daughter] got the family out of the dolls' house, who actually have articulated arms and legs, they got the sort of wire bendy things. So suddenly we could actually do something proper stop-motion. So we actually planned that one in advance, what we were going to do, so that we had the right characters.' She adds: 'We knew with that one that we were going

to show it to someone who wasn't just us, friends and family. […] it was going to the rest of the drama group […] so we were a bit more organised about that one.' She tells me her daughter eventually even won an award for her efforts for the drama group, after which they made another animation to thank the group for the award: 'it was the little character that was playing my daughter was walking in... reading a book - cause we have this tiny little book from the dolls' house - so she walks in, reading a book, and she bumps into the statue and then kind of falls over going: "owooo". So we actually put the real statue and the little tiny representation of my daughter [in the movie].' She adds: 'and that was the first movie where I actually managed to work out how to make the software let us record sound. So yay, another break-through, finally! […] You learn tiny little bits each time and you think: "oh yeah we can do this, we can do this," always slightly compromised by the fact that I'm trying to work out the software as we go along.'

For Emily it is both about the process and the result and both seem to have to do mostly with social aspects for her: 'the process is nice because it's something we do together and we kind of bounce ideas of each other and it's a very collaborative thing. And now that I've worked out how to use the software it's less stressful than it was to start off with. […] And then the end result, because you can show it, is nice. It gets positive reactions from people.' She adds: 'I don't think it would work as a totally private... Maybe it would but you definitely get something much more out of it by the fact that it's sort of, collaborative in the making, but then also something you share when you've done it.'

Sharing is done by putting the movies on YouTube and sending the links to a selection of people, and by posting them on Facebook. After the interview she shows me the drama production trailer on her Facebook page: 'I've stuck that on my wall and various people have just liked or commented. And these are people I don't talk to very often, you know, so it's kind of... I've shown them something to people that I don't… cause I don't say much [on Facebook]. But somehow I feel able to put things like that on, it's to show a *thing*.' When I ask her what reactions she gets to her movies she tells me: 'People seem to be quite impressed in that is not something that… everybody has taken a photo, everybody has taken a video.

Those are very sort of ubiquitous, mundane things, but this one is a bit quirky, and people don't know how to do it themselves. […] It's not like showing someone your holiday photos, you know. And it's also a bit more quirky than showing them a drawing or a painting your kid has done.' 'I can't work out why it is that it seems to be viewed so differently. It's just that people don't have the resource to do it and they look at it and they think: wow that must be really clever. And it's not.'

Finally, I ask Emily if she would consider stop-motion a craft: 'I think that is probably a good word to use for it. I wouldn't maybe have thought of using that word. But I think it definitely does work. I think of craft as being something that's really quite hands-on. It sounds silly, but although this is digital it also does feel very hands-on. But also craft isn't…. it isn't art. It isn't intimidating in the way that art would be, this is craft, this is something that is made with love by hand, with all its faults and imperfections. And I kind of… I kind of like the idea that in a way you can look at these things and you know the dolls' house family can't really move, you look at them and there's no hiding of the artifice… It is what it is. And I think it's funny because they're endearing, because they are, you know, you're not supposed to believe in it. It's not like you're supposed to watch the Star Wars movie and believe in the stuff. We're not trying to create a world you can believe in. We're just… you know… putting something together to get a smile. Yeah, craft! It is a good word.'

MARGARET – BLOGGER

As an American living in England, Margaret noticed a great mismatch between American perceptions of the British, and vice versa, and her own experiences, which became the topic of her blog that is aimed at 'American Anglophiles': 'One of the big things I see is that British people think that American people look down on them. And they're always ready to think that American people are making fun of them or something like that, but the reverse is absolutely true. In my experience, Americans still see England as the mother country; if you do it there, it's better.' Margaret started blogging in 2009, on the tenth anniversary of

her move to the UK. Earlier she had learned that having a blog is of great importance when you are trying to get a novel published, which got her thinking about setting up her own: 'so, I started this blog, it was three years ago, and at first I didn't know how I was going to do it because a lot of bloggers write something light and personal and maybe, I don't know, 20 lines long every day. And I eventually settled into a pattern of writing more lengthy, fleshed-out articles and they only go up every week or two. That has hurt my reader count because people like to see content more often than that, but that's what I can fit into my schedule and I feel that I'm doing a topic justice if I give it some more research time.' As such, writing a post can take her up to four days, while short ones may only take half a day.

Most of the writing is done at home in her living room, which is divided into a living area and an office area, although sometimes she likes to work in the British Library or Starbucks. It is important to have an internet connection available, however, because the writing process includes doing research: 'I definitely know the difference between scholarly research and popular journalism and I would never use something like Wikipedia for scholarly research, but it's a wonderful place to start. So, I'll start there and I'll go to any number of websites. […] And normally I would never do things like this, but I will call somebody up and say "I'm fact-checking for an article and I need to know…" And they're generally happy to talk to me […].'

Margaret's background is diverse. She tells me she started off getting a Master's degree in chemistry: 'I got shunted into science in an era when if you had a brain, they told you you had to study science and I sort of went along with everything. And I got to graduate school and I thought: "Why am I here? I don't want to do this." So I left with a Master's. Also I wasn't doing very well, which was a new thing for me. I had always been the top of the class and suddenly I wasn't, so I really looked at it and didn't want to do it.' After this degree she wrote software in Silicon Valley for about ten years, after which she got a Master's in liberal arts from Stanford University. She adds: 'I find that when I say to people: I'm a writer or an editor they look at me like: "oh yeah, yeah, sure." But when I say "I'm staff

at the Virginia Wolf Bulletin," you can just see them change their assessment and decide that I'm real.' She has experience writing and editing novels, although blogging is a bit of a change of perspective: 'it has to feel like a complete well-rounded piece in one sitting. There's no long-term plotting or anything. And it has to be…. It's good if it ties into something current, it's more like a kind of journalism than it is like writing fiction.' Further, she tries to take 'a lighter tone', she tries to 'be amusing': 'I try to keep it light, I try to keep it amusing, I don't know that I always succeed but that's my aim, and not everybody's going to find the same thing funny. I try to keep it non-controversial because I want people to come and enjoy being there. There are enough forums in the world where they can discuss politics.' She tells me there have only been a few topics which she has felt a little more strongly about and written about, if they were very much directly on point to the US versus the UK; 'other than that I try to keep a lid on my political opinions and keep it light.' Later she adds another important guideline for writing for blogs: 'the one rule of blogging is: don't be boring. […] I try to break up the text, even for people who are very interested in the subject, I like to break up the text with photos. And I can't go out and photograph everything I'd like, so I use a lot of publically available photos.'

Margaret uses Wordpress software, about which she says she does not know enough about, and has not taken the time to learn the 'ins and outs': 'sometimes it's frustrating because I don't know enough about how it works. I have subscribers and if for a while the subscribers are not getting the column, I don't know why that's happened. And it's not like I'm stupid or I couldn't learn how to do it, it's just that I don't have time for that. I don't want to be in the business of learning to use software.' She tells me that the high learning curves of software and the fact that 'everything has its own way of working' frustrate her: 'I'm just so tired of having to take a whole day, a whole series of days, to learn how to do something. I just want to use it. You know, when you get in a car, you know how to drive it.' Apart from Wordpress she uses Microsoft Word for the actual writing, but the two do not work very well together: 'there are some formatting changes when I import my text from Word into Wordpress: certain formatting stays, certain formatting is stripped… that's not optimal either.'

She gets her ideas from 'just keeping [her] eyes open', by 'always being on the look-out'. She adds: 'the blog also gives me an excuse to go out and do things. If I'm low on ideas I'll look around and see is there a museum, a stately home, an art exhibition, is there something going on and I'll let it be an excuse for me to have a day off and go see it, and then I get a column out of it. But a lot of it is just, you know, there's so much… […] [England and the US have] such different cultures and I'm smacked in the face every day by something that points out the difference. All I have to do is write it down so that I don't forget it.'

As mentioned, Margaret does research for her blog posts, which takes place during the writing: 'I do it throughout. I'm better at it with the blog than with other sorts of writing, but it's difficult to turn loose of it and say it's done, cause it can always be better.' She tells me how the piece she is currently writing about William Blake brought her from a documentary on TV to a performance art library, which she did not know existed. This library is set in this beautiful winery and she would get a column out of going to that winery. 'All you have to do is keep your mind open. You go out there and you just look at their webpage, and they say: "people think it's odd to think of wine grapes growing in the UK, but there have been vineyards here since the romans." The Romans came and they planted vineyards. And that's the kind of thing that my readers, I think, eat up. They think it's really cool.'

Once a post is finished it is uploaded to her website, for which the reader count is usually around 100. On a good day, however, she will get 300 readers. She tells me she usually has more readers around Christmas, because she did a series about Christmas in the early years of the blog, which drew a lot of readers. Readers find her blog mostly through Google: 'I get statistics that show where people come from and now that I have three years' worth of columns up there I get a fair few people because there's some keyword that they searched on that will bring them in.' She tells me about a piece she did on an important country house in the 1920s which gets a reader almost every single day, as well as a post that has a map of the British empire when it was at its broadest expand. 'I also

publicise it using Facebook and Twitter and I get a lot of people who just look at it when I put a post on Facebook.' Sometimes her posts get picked up and publicised, such as when a well-known journalist in the US tweeted her blog, which brought the reader count up to 1300, and when one of her posts was chosen for Wordpress' showcase of recommended blogs. She has thought about collecting all posts into one volume and printing it as a book, although she says about this: 'I haven't yet reconciled myself to the fact that publishing is changing and that... I'll probably be self-publishing it.' In addition, because most of her research starts with web research, she does not hold all the copyrights for the images she uses, which would be difficult for publishing.

Margaret tells me she enjoys it 'almost all the time': 'every once in a while I think: "oh man, I don't want to do it, I don't have any ideas." The rule of thumb all bloggers seem to hold to is: you're never going to work up any readership if you don't post at least twice a week. And I can't do that so I do what I can do, and yes I enjoy it.' She adds that she loves 'finding out more' and the fact that her blog gets her to places that may not be accessible to other people. She has found that when she said she was writing an article, she was shown and told more: 'there's nothing as interesting as backstage, anywhere. It's always more interesting.' When I ask her if it is more about the process or the results she tells me: 'I like the research, and I like the result, and all of that is more fun than the writing itself.' She clarifies this: 'when I say I like the research and then the later part of the process rather than the writing itself, I mean that the hard part is getting the words down in the first place. Then making it read better, more smoothly, maybe with some humour, that's really an editing task, and I like that part much better. I could do that forever. Editing, making music, and programming computers are the three things that I can totally lose track of time doing, just getting engrossed in the task and oblivious of what's going on around where I am.'

I ask Margaret if blogging is a craft, and she answers: 'the writing part I definitely consider a craft. Maybe not so much the research part but writing is definitely a craft, and editing is also very much a craft. […] There are too many people out there who think that anybody can write and that anything you put on paper is

worth being read. It's definitely a craft.' I ask her what makes writing and editing a craft: 'the fact that a lot of the writing is in things that don't so much have to do with rules, but have to do with rhythm and being aware. […] People who use the same word too many times in a text, people who have no sense of the rhythm of words, people who have no sense of the flow of ideas and how you might make the transition from one topic to another. People can write perfectly grammatically and still either write things that are boring, or write things that are awkward and unreadable and they don't know why. I don't know, I think maybe some of these people don't read enough. No one ever sat me down and said: this is how you edit something; this is the difference between good writing and better writing…. I think it's something you hone over the years by reading good prose. I hope that doesn't make me sound very elitist and stuck up.' For blogging in particular, she says, in addition to be able to write well, 'you need to be able to write with a voice that, I think, is personable. And you need to be able to keep your brain turned on to see what's out there to write about. You need to be open to whatever kind of flows in.'

ERIK – ELECTRONIC MUSIC DJ

I meet up with Erik in a pub in London on a Friday afternoon. Today is his day off. It seems fitting to meet up in a pub in this buzzing city, in the city where he aims to do his gigs: with his chin stud and double nose ring, long braids dangling from the bottom of his otherwise shaved head, and his artistic, expressive shirt, Erik's appearance seems to somehow radiate the creativity and eccentricity I hope to talk to him about.

Erik is in an electronic music 'outfit' together with his studio partner. They have been doing this together since 2007 or 2008, before which he was a solo act, from about 2005. Although their music includes vocalists and sometimes guitars in the mix, Erik categorises it as 'electronic-based dance music', and tell me they engage in various styles that are referred to as bass music: 'as long as it's got energy and groove and bass in it, preferable attitude, we're generally all up for that.' Erik has a 32-hour job and he tries to put time into his music next to that.

On weeknights, when he can often be tired from work, he does administrative work, such as answering emails, or updating their Facebook page, while on days off he collaborates with his partner in studio sessions for usually four to six hours a day.

He tells me he started making music when about 15 years ago, although at first he was 'just messing about'. He was part of an experimental band with two others, with which he did some gigs that combined performance art, dance music and band music: 'I liked my sounds a little bit dark back then, I guess you could say. It's a little bit dark now, but it's a bit more musical now than it was back then I think.' He explains that what got him started was his 'love for music'. Eric grew up in the countryside in Australia where he 'didn't have much to do besides chase sheep with a motor bike' and listening to his sister's record collection. He calls his taste in music eclectic, ranging from AC/DC and Iron Maiden to electronic music such as Quadrophonia. He adds that nowadays he does not listen only to dance music; only half of what he listens to is dance music, and other music is rock, industrial or experimental, or 'just weird stuff.'

When I ask him how he learned to make his own music he tells me how he started exploring rhythmic compositions when he bought a sampling keyboard: 'you tap in rhythms to it and they loop, and then you had this function called quantise which would bring your beats in time. So I would just play a loop and then play over the top of that and I'd sit there and tap away at the keys until I had a rhythm that was fairly close to what I wanted. So, first I'd say my skills were primarily rhythmic, and my sense of pitch was very basic. The bass lines were very basic. I wouldn't say that it became musical with thinking about musical scales until much later.' He explains that he likes these early ways of making electronic music: 'it didn't rely on musical passages: it was just sound design, and the rhythm and the bass line and the frequency. So it was almost as much a science as it is art, so it was a mixture of the two.' This science of the music was a large focus of Erik in his development: 'I was trying to get better all the time at mixing and making sure my frequencies had the most impact because that plays a massive part in writing electronic music. If you don't have sounds that have the

right impact and sit in the mix, then that's a difference between a bad track and a good track. Even if the track has an excellent melody to it, if you don't have the right sounds and the right sound design behind it, it's not going to translate through to the audience.'

While some of his friends did sound engineering courses that can teach mixing and sequencing, when Erik started out there was nothing like that: there was limited information available and it was expensive to get a recording studio to get a professional result. With online courses nowadays though, he says, 'you can literally teach yourself'. He uses two websites in particular, and magazines, to get information and continue his development: 'I have a website […] that has tutorials and you can watch a tutorial that might go on an hour or two and it's very in depth and you can learn about all of that and you pick up mixing tricks and things like that along the way.' He adds: 'People in electronic music today have never had it so good really, and they're almost at the point where they have too much information and too much choice. When I started out I just had my sampling keyboard and I had to become inventive and learn that as an instrument in the same way as I guess a guitarist would learn their guitar. It would just be them and their instrument; it was very personal, and you have to learn how to get extremely good at that. Today, as an electronic musician, you're almost in danger of losing that in favour of just using pre-sets or using many synths to make little bits of sounds, much is sort of more work, and makes you less focussed at the end of the day.' He emphases the importance of finding what works best for you, committing to that and sticking with that, 'otherwise you get addicted to just buying new things in the hope that they are going to make your music better, but in fact you're learning a new interface. When you're learning a new interface, imagine in the traditional sense, if you started learning bass for three months and then thought: "Oh that isn't going to give me the sound I want, I'm going to learn guitar for three months", you're going to be okay at all of them, but you're never going to be a master of each of those instruments if you keep on switching. So, with electronic music you do have to sort of narrow it down to your favourite tools […] and eventually your personality will come out of them.'

He tells me that having all those new tools, information and support nowadays does not mean that people need less skill to make music: you still needs a sense of how different sounds go together, and 'understand the key, and the rhythm, and the whole feel of it' which is something he says is taught over time. 'If you're not taking a personal journey, and you definitely wouldn't be if you were just picking up loops here and there and not changing them from sample libraries […], then it's generally not personal. And usually the audience can detect that and so can the listener; […] it's just not as cohesive as something where all the sounds have been designed from the ground up. It just seems to have less impact.' Such tracks are usually less successful, and if they do become popular they are often criticised for their lack of 'artistic integrity': 'people are still really interested in seeing what *you* have to say as a musician, as opposed to what other people write for you.' Although, he later adds, the sense of 'having a favourite band and being "into" them religiously', and finding 'a true form of expression in being able to relate to their sound personally', does not exists so strongly anymore because of the amount of choice in music, and the ease of obtaining it, we have nowadays.

Erik explains that artists have to 'bring a lot more than just music': 'you have an image and you have a philosophy, and people are into you as a person as well as being into your music. It's very hard to do it all but you almost have to create a very strong identity and concept behind your music alongside the music itself to lead into other ways of expressing yourself; whether that be through film or soundtrack or just a cool image to have in a live show.' I ask him if his appearance has to do with putting an image out there for the music and he answers that he does not change what he wears for the music, although there are many acts who wear masks and use performance and theatricality to project their personalities and identities. Although his piercings and hairdo have nothing to do with the music directly, he believes that they, alongside his music, were also part of his journey of finding his identity and communicating this.

Erik makes his music in a studio that is located in the loft of his house which is dedicated to sound. In this room he has his computer and 'a mixture of analogue

and digital gear.' Analogue gear consists of for example synthesisers and mixing pads, for example his 'Sherman filterbank' which 'can do all sorts of squealing and squawking and distorting kind of noises. It's a bit of a mad box: whatever you put into it is not going to sound normal by the time it comes out at the other end.' He tells me he worked in a musical instrument shop for about seven years where he got a lot of insight in electronic music and what certain instruments can do: 'there were certain bits of gears which I lusted after, and there were other bits of gear that I lusted after […] which I realised when I got, wasn't for me.' He tells me that some very expensive instruments can be found but he does not have anything that expensive because he cannot commit to using an instrument often enough to make it worth its money: 'Sometimes I'm just happy with the simplest of tools and working with them and getting inspired within a basic interface, rather than looking to new horizons all the time.' Some of his projects are made exclusively within the computer, until the vocals are recorded, but others use digital as well as analogue input. He explains that using analogue gear, which in essence is 'all transistors and circuits' and sounds different to digital instruments, is considered to give a sense of individuality because it is less common. Digital input consists of plug-ins and because anyone can use these, it is difficult to create an individual music style. He tells me the boundaries between analogue and digital tools are blurring as digital plugins are starting to sound more like analogue tools because of more advanced processing algorithms that simulate electronic circuitry digitally real-time. However 'sometimes the knobs in the interface, having a physical interface, can help you get inspired. I remember when I first got my first analogue synth, I was just tweaking it forever and I didn't know what I was doing but I'd just move all the sliders around and be fascinated by the way the sound twisted and changed. And it's much more predictable with a digital instrument: you almost know what going to happen and you don't get this random chaos that comes from sort of hearing circuitry.' He has found that for them a combination of digital and analogue tools is a flexible and powerful option because he says: 'I've tried making stuff with predominantly analogue sounds and sometimes it works and sometimes it doesn't', but 'it's good to keep a few bits of analogue gear to maintain your individuality, so to speak.' Often they sample analogue sounds for further

processing along with digital sounds in the computer. He then uses one software tool called Ableton Live for mixing the sounds, and doing live performances.

The process of making music can start with many different things: 'Sometimes it can start with lyrical idea and then we try to craft an attitude around that. Or I'll start with a programmed beat or a bass line or something that catches our ear or sound and then we'll expand upon that. Once we have a good sound to work with that inspires us we expand that to a four bar loop, then an eight bar loop, then a sixteen, then a thirty-two […] As long as we start with something that inspires us and that keeps on moving, the track will eventually finish itself.' The input for the loops can come from playing something on the keyboard or singing something 'and then we'll add sounds to there. […] It's just a mix of sticking to what DJs like with their 16 to 32 bar programming but also trying to be flexible in that and creating. […] Sometimes it's a sound that you have in your mind, other times it's a lucky accident that you didn't intend and then you get a really good sound, and it's really surprising. And that might take you in a new direction. We try to keep it within a scale so that we can move forward but also keep an open mind to new ideas and not be afraid to change the track if we find something that we consider to be better.' For Erik it is mostly about the result, though: 'a lot of artists have said it is 1% inspiration and 99% perspiration' in a process of 'break[ing] your own barriers […], a lot of self-development […], analys[ing] and re-invent[ing].' He considers the result – playing his music live – the delivering of all that hard work, which he calls 'ultimately much more satisfying.' When I ask him what he enjoys about making his music he even mentions performing live as the main drive: 'Seeing people react to it is probably the most amazing thing. […] To get that reaction, that rush, that connection with the audience. It's a physical thing and it's a wonderful thing to do. […] We feed of that and it's like this whole recursive energy that flows between us that goes back to the times of early man, I think. Dance music, it's a very primal thing, and once you get into it it's an amazing spiritual connection as well as emotional and physical. It works on so many levels and I think it's very satisfying. It's much more satisfying than my day job currently.' Getting the right reaction from the crowd is crucial to a good gig: 'the energy feeds you at the end of the day. […] If you don't get that energy from

the audience, sometimes it can be very hard […].' When they perform live, Erik will be on the keyboard while his partner is singing. He has a DJ style controller with which he can apply effects and 'juggle and rearrange the beats on the fly' and a 'chaos pad', a touch sensitive pad that generates sounds, which he uses to 'build up sweeps' while simultaneously 'juggling the beats with the effects controller'. The shows are a combination of pre-prepared material and live improvisation and vocals. He tells me about some acts that have only pre-recorded material and pretend to change their tracks live, which he calls 'big fakers': 'I try to change it a bit more than [those fakers], but I think that the more we play live, the more we'll […] learn how to do it freely.'

Playing their music live is something they want to focus on much more in the future. He tells me they have done at least six gigs in the last year, but it is difficult to get the right kind of gig: because they have a singer they often get classified as a band which does not work well for their music. They are currently using these – unpaid – gigs to 'to get [their] skills up' and prepare for 'a nice impactful performance' for when they get club gigs, and to publicise themselves: 'There is a lot of competition: everyone's got home studios, everyone's a DJ, everyone's a producer […] With so many people doing it as a hobby it can sometimes drown the market to the point where it can be very hard for the average consumer to really sit up and take notice of a particular thing unless people are blogging madly about it.' They also use Facebook, Soundcloud, Twitter and their own website to promote themselves. Erik calls their act 'at least semi-pro'; to be fully professional he feels they would need to do it fulltime, do tours, and be 'wrapped up in it almost more than [their] day job[s].'

Erik tells me he 'absolutely' considers his music making a craft: 'we literally sometimes craft sounds from basic sine waves and then work up from there. […] When you get advanced as a producer you start looking at things like harmonics and their relationship in a mix and how it affects the human being. So you really do get very deep into sound design and you need an understanding of harmonics and frequencies to give the best sound. Without that science you need someone else to do it for you. A lot of electronic music acts have one really nerdy kind of

guy who's good with their frequencies and then another guy who's more creative. I'd say we do a bit of both jobs in our in our act […].'

MARTIN – WEB DEVELOPER

Martin is a software developer who specialises in websites and web applications, and mobile applications. One of his recent projects was an online enrolment system for a local student union, which enabled students to register for clubs and societies. Another example is a system for driving instructors with which they can share information with their pupils: 'with that the driving instructors have their own log-ins and the pupils have their own log-ins and they can only see the relevant data to them. We're trying to take that from a kind of a web element into putting it into a mobile app or a tablet form.' Web development is Martin's day job; he has been self-employed for about four years in this area, and before that he used to work as a network manager in a school taking care of the administration of the computers. There, he already 'made a few hours' creating a grade tracker system for the teachers. Martin owns his own company which, next to web development, does also a small amount of computer repairs, although that is limited to a couple hours a week. He is not alone in running the company: 'well, I've got a few helpers, is probably the best word to use. We have students, because we're based in the [university], we've got the students from the IT block which is just across the road. I've got two who come in on various days and help out. One is like a graphic designer as well so when I need a picture or an image I just ask her to kind of put it together.'

Martin mostly works in his office, based in a university. There used to be similar businesses around them, but now they have moved out, which makes it 'a bit lonely'. Before, he was working from home, which he calls 'hard work, because there's a lot of distractions': 'it was very difficult to keep going. You get up to do something, it takes maybe five to ten minutes to get back to the same position you were mentally, understand what you were trying to do. People keep disturbing you, it's hard to straight away find the line you were on in the next few seconds. It's been very important to get a space away from that. I come [into

the office] early in the morning, because I know I will get peace and quiet […].' In addition, 'when we're [the office] I've got the other people in that scene […] you can talk to and get experiences and advice from, the students, I can call them in and get them to do something.'

Making an application, for example the student union project, may take Martin between six to eight weeks to complete. However, he tries to make early versions in about a week to show his clients: 'Just like something that looks interesting. I don't really limit it, but something you can just open in a browser, click it with the mouse, press a few things and you have an idea of what is there.' He tries to work on one project at the time, although this is not always possible. He tells me: 'I've had about three or four on the go at once. It wasn't too hard until you kind of get to the deadlines. It's difficult at that point because you know that you need to deliver it on time but you don't want to let the other customers down on the other systems at the same time.' He adds: 'I could get into that situation in the new year because it looks like there's a few people who wants certain jobs doing, and I can imagine they want them all doing at the same time.' When I ask him how he gets his clients he tells me it is a combination of him approaching people, and now that he has a reputation people have started coming to him, 'but mainly it has been me approaching people saying: "you've got this system", or "you don't have this system" even, "and it would be a good idea to get this system in place I think, because it would be beneficial to your business or society". So, yeah, it has worked like that most of the time that I've pointed out what I think they should be looking for.'

Martin explains to me why he decided to go into the web development line of business: 'I just like solving problems, I guess. When I was a network manager, you see certain problems that keep reappearing and sometimes you think: "wouldn't it be better if we could just program something that prevented that from happening?" So I started doing just basic programming, kind of like windows active directory which would enable to reset passwords etc. And then it builds up all the time.' He adds: 'Fortunately I've managed to do part-time studying. […] I really did learn and understand how to do the programming, and

that kind of clashed with me wanting to leave and wanting to do my own thing, so it just worked really well so far. A bit of exposure and then I realised I could do it, and... I think once I picked up a few clients it was easy enough for me to then step away and say: "yeah, okay, I could run with this."'

Martin tells me that when he was 17 or 18 years old, he did not understand the concept of programming: 'it just didn't work for me basically.' After that, however, he found several avenues that allowed him to learn a lot: 'when I went to do the first year of proper study at university, there was a Bachelor which was called structured programming, I think it was. And that gave me great insight and it inspired me to go and get a book, and from that I started, you know, learning a lot. There were a few people in the class who I've helped out with the book. I'd say that I was about the best one in the class at that point. And from there, what I've found last was a growth on the internet sites, explaining how to this programming as well. I think that's great, if this was ten years ago I'd be stuck with most of it, but it's very easy now to think: "oh how do I do that?" And because of these websites, someone has probably already dealt with that question. It's not always the case that you get the best person to give you an answer previously with the age of the internet, but these days with some of the websites the answers get voted so you know which answers to trust […].' In order to be a good web developer, Martin thinks you need to be organised: 'there's just so many files and frameworks you start using, that everything is all over the place. […] You got to have the back folder structure to put things into, and it's part of when you start doing it in a team as well, it makes life a lot easier when everything is organised.' Further, 'you need to be able to look at things from different angles', and you need to have a 'programming brain': 'I suppose you need to be a problem-solver.' He adds: 'and the key thing, I found, […] is patience. That is the key thing to be a programmer, because, unlike most things in the world it's either going to work or it's not going to work. And if it's doesn't work, it can be very agitating. In the real world, say if you make a phone call and try to make a deal, you might get the deal and you might not but then you can just kind of call again... you know, six month later or whatever. The problem is,

there's so many intricacies, it's different things that could be wrong, it takes so much patience, it really does.'

One of Martin's tools is a PHP framework called 'Zend Framework': 'it's a big learning curve but once you've got your head wrapped around it […], it does make things a lot quicker.' Further, he uses 'jQuery', a library for Javascript, 'which is fairly similar in that it takes a bit of a learning curve and from there… after six months maybe, it's so easy to make things happen very quickly.' He adds: 'we're looking at a few other kind of frameworks, for Android and other things at the minute. I've not decided yet if that's anything I'll use but I'm always looking for ways to work faster.' Apart from an Android application, most of Martin's applications have been made in PHP and Javascript, and he explains why he uses these two: 'the PHP, the main reason for that was that it's a simple way to get a system set up and going. Fortunately for me I have a bit of experience with Linux, so I knew how to kind of set up a webserver and run PHP on it. Whereas with a Microsoft set-up it's a bit more expensive, you have to pay for the Windows licence and other things as well. So that was the main reason. And then also, I prefer the kind of syntax of the PHP call to, it would be ASP on the Windows side, because I'm just more familiar with it I guess. It's the way I've come through learning in university and other things out there. And the Javascript is just a spin-off from that as well because it's again a similar syntax to the PHP, works a similar way. I think Javascript is probably the future for most things actually, there's so many people who know it and have been working with it for so long. It's very powerful now, the services, and frameworks to push people in the right direction. So you're getting less of the kind of hobby coders, people who are a lot more professional about it, it seems, these days.'

Programming web applications is very different from programming mobile applications. A web application, for example, in contrast to a mobile application, does not have to be compiled, which makes it more instant: 'and then once something goes wrong with it as well, it's a lot harder to debug on a mobile app because… it could be certain things, it doesn't make it very clear. With say web stuff it's a lot easier to find what's wrong, normally. You can usually guess. With

the error message you usually find it quickly without having to dig too deep. […] It's just easier to ask for information back out of the system. […] So for example, without going to technical, if you set a query to the database, in the next line you can just ask the system to send it back to you. While in a mobile app it's a bit different in that you have to set up a log somewhere. So then later on you'll have to check that log, scan through the log to find it. It's more interactive feedback, is one way to turn it.' Mobile applications get tested on virtual device emulators, but, Martin adds: 'we've found that once you put the device into somebody's hands it's different. The way you interact with it is, well, unique. Because it's a touch screen and there's different thing you do, rather than just pressing a button, so holding the mouse and clicking and dragging.' In order to test this interaction, Martin's company has invested in an iPad and an Android tablet, and the developers test it on their own mobile phones: 'I've kind of come to the conclusion that you cannot test on everything obviously. You got to decide to be as adaptable as possible, because the screen sizes on all these devices are so different now that it's just impossible to put something out.' Testing mainly takes place within the development team and with the clients, and sometimes with external people: 'I think it's very important what equipment they're using. […] we try to adapt to adapt to the situations in which users find themselves.'

The process of developing an application starts by asking clients what they want. 'I like to be very pro-active though and give them something visual very quickly. I won't get bogged down in specifications, I will just kind of go away and give them the screenshots, or a working prototype, so that they can see the things that are in place, that everything they need is there, before I move on to the next phase. […] I tried to get feedback where possible. […] Sometimes things can get a bit messy from… you can just go back on yourself sometimes because you're doing quite a lot and then people say: "actually we don't like that," so you got to cut that out again. It's hard work.' When something does not work, Martin tells me it is sometimes frustrating, however, 'it's kind of a relief when you get it working, you kind of feel good about it. So I try to take a break, just try to step away from it, try and... if possible, ask someone else what they think. Normally it's something really small you've overlooked, like sometimes it would a semicolon instead of a

proper colon, that sort of little thing and there's not much you can do about it, except be patient, like I said. Getting worked about it, is not going to make things any better, is it?' He adds: 'it is like one of those things where I think sometimes you have to be in the right kind of emotional position to do it. You know, if you're worked up about something else, it's really difficult to do the programming. […] I've had it a few times basically where what's happened is that let's say something got me about something else, […] that kind of… makes me be a bit more aggressive. So I start programming and I become more prone to mistakes. And once you start testing you realise: that's not working, that's not working, you've actually gone backwards rather than forwards because you broke out the thing that was already working. And it could be a rather vicious cycle if you're in that situation.' He tells me this mostly occurs on Monday mornings, when he 'might be a bit upset from the weekend', while on Friday afternoons there is not much else on his mind and he is in a good state of mind for programming.

In the process, Martin also makes use of paper notes; he tends to have a visual idea in his head which he then wants to recreate on the screen, and he scribbles this down on pieces of paper. However, this seems to be more a part of his creative process than a means to document; he says, 'there isn't like a phase where I put that down on paper so that if someone else would come in and take over the idea, that they would be able to look at the idea and understand how I felt about it. […] When you are thinking creatively, I've gotten into the habit of using the pen to draw out your things… I just do it so quick that it's relatively worthless because I can't kind of decode that to look at it, what did I write there, what have I drawn? And that's the next day; it's not like a month later. […] And I find that very difficult. Because when I'm programming I can just kind of react very quickly: right, this is what I've got, and tags and things, really quick on a keyboard, it starts to come alive. But when I put things on paper, I think I'm scared of losing the idea before it gets to the paper and then on to the computer.' He adds: 'I do have folder of kind of sketches and stuff of what I've been doing but most of the time I never go back to them because I just don't understand what I've drawn.' Martin's approach to process and result has changed: 'to begin with I think it was more about having fun but as time goes on and you realise

that you need to make money…. That has definitely become more important, definitely. So I tend to take on projects that I like doing but recently I did have to take one… which maybe last year I wouldn't have done because we needed the money this time.'

Martin enjoys his profession a lot: 'normally, when things are going well, I'm delighted. Sometimes it goes too far the wrong way, but ultimately the responsibility is with me, I'm the person, I just correct the system to make sure it works.' He mainly likes the challenge and trying to fix problems, and adds: 'at the end of the day people might not see what kind of goes on underneath the system but you are trying to make people's lives more convenient and better, that's the idea behind it. […] I enjoy that idea.' Martin does consider programming a craft, while a while ago he thought: 'you make something but it's not actually something you can touch. It's not tangible,' he says he has now completely changed his idea behind that: 'you have to have a skill to do it, not anyone can just think of a computer and start programming. It's like any kind of craft I suppose, there's a lot more to it than you might think. The more experience you get, the more you understand, the better you can become than in future projects. […] It's just the idea that you're putting something together, I suppose. It's like being an architect, you're building something. I supposed more than that, you design it first as an architect and then you got to build it, put it all together. […] There's a lot to it when you think about it, these kinds of systems […].'

ANN – PHOTO COLLAGE MAKER

Ann's craft is the creation of photo collages based on patchwork and quilting patterns, often using photos of flowers and nature. She does this in her spare time, being a university lecturer and researcher by profession. She tells me she likes taking pictures and likes to 'create stuff'. She started in early 2012 when she ran into a book on patchwork. Because she did not like sowing, she came up with the idea of using the principles of patchwork and quilting to create collages out of her digital visuals. For Ann it is important that the pictures she uses for her collages are taken by her. After taking the pictures, making the collage may take

about two or three hours for a relatively simple one. She works on it mostly during holidays, for example a Christmas-themed one in the Christmas break and a few in the summer holidays, and she made one while being on a long flight.

The material for Ann's collages consists of digital photographs. Photos are selected based on the theme of the collage and the colour scheme: 'the pictures also have a theme, although you do not necessarily see that in the collage in the end, because it becomes more abstract.' Sometimes she uses pictures she already has in her collection, and sometimes she goes out to take pictures for a collage in a certain theme. She explains how she went about selecting the photos for her Christmas collage: 'I wanted sort of the basic colours: yellow, red, blue, […] and then I think I also looked at how many I needed for the sides and I think I added an extra one, but I'm not sure. So sometimes depending on sort of the mathematics, I'm never sure… I can never figure it out beforehand but as I go I realise for example that having six colours is not clever so I need to add an extra one or something. But anyway, for that one it was more: I need those primary colours... and then it's a bit of searching of which photos I have […] You can have a plain [patch], but you can also have one that has a lot of detail and that influences very much how it ends up.' Further, a collage very much developed during the making and Ann does know beforehand what the final creation will look like: 'It's interesting: because I haven't done it so often I just have an idea of what it should be, sort of white and blue, or white and pink, and then I'll vary that but then I cannot always predict yet what will happen, also depending on whether it's plain or whether it has these tiny details. So it's also a bit of trial and error, so to speak. […] And sometimes I make one and then I look at it and I think: "hmmm, it's not right yet," and then you figure out that a number of the layer you've put in, you have to put in different bits. So for example you take out those circles that you've put in and for that one you put in a different one because it needs another colour or you need to have another way of contrast or something.'

Ann tells me that what a collage looks like and what she makes is also strongly influenced by the tools she uses. She started off doing collages based on

traditional patchwork, which usually consists of square, mathematical patterns. 'You also have to find the digital tool to do it with, so I looked for some tools and I couldn't really find a good one. In the end I did it with Photoshop, which is rather heavy for what I want to do, but because I want to make all these cuts, and you have to put them in layers so you can still move them about […] With a lot of tools you can't keep those layers, so then it's hard to change it as you're making it.' When she bought an iPad she looked for tools for this device and found a Photoshop app, called Photoshop Touch. This app allowed her to make circular collages easily which she then started doing: 'because it's so easy to make the round things, that influences the ideas you come up with for your designs, so to say. […] And this app is really simple. I mean, very easy to use, so yes, then it becomes easier to do certain things.'

Before she started making collages Ann hardly knew how to use Photoshop. She tells me she learned mostly through 'trial and error': 'I first did a lot of things wrong. […] I'm not one for going through a whole tutorial […] One thing is I need is to cut bits and pieces and I have to position them, and by trial and error I find out also certain other tools that you can use to cut and paste maybe, but you cannot move it about anymore, and that's not useful for what I'm doing. […] I thought I found a useful tool, someone had suggested it to me when I was saying what I was doing and I tried it out and I thought it worked but only after I had been doing it, it took lot of hours too and I don't often have a lot of hours for this. I think I spend a whole afternoon trying something out and then only afterwards I saw that it did something else than I thought it did.' She adds: 'since I have this Photoshop Touch, I haven't made any patchworks in the full Photoshop, because I'm still sort of figuring out what I can do with that, and it goes so much faster than… Photoshop basically is over the top for what I'm trying to do.' Apart from cutting and positioning photos, Ann has not used any other photo editing possibilities such as colour filters or blurring: 'Well, I don't think I have a principle about it, it's just that I still have to learn so much… with what I'm doing there's so much variation that I think that's enough. And I think for what I'm trying to create, I don't see the use yet of a filter or whatever.'

Ann thinks the main skills you need are creativity, a sense of colour, and graphic skills: 'to make sort of the overall lay-out and that includes things like composition.' Designing a composition is inspired by patchwork and quilting: 'with quilts you have a lot of designs that are already very old, so you have books with lots of designs. […] Often the basic patch is square or something and then it's divided up in certain things. […] First I was just trying out stuff to also get a feel for what it would look like, because you can pick a design, but you also have to think cleverly of how many different, in patchwork terms, how many different types of cloth you choose. And what they differ on, do they differ on colour, or on texture, or on pattern, for example, to create certain effect. […] Let's say there are four different types of cloth, or four kind of different pictures for me then, how do I pick those three so that they look nice? I have to decide that myself.' After experimenting with existing patterns, she started making variations on patterns: 'patchworks are made of […] blocks, and then you have different versions. So you've got for example, I don't know what it's formally called, but you've got nine patches, so it's 3 by 3. You can imagine you can do different things with that, and you can also say they could all nine be the same, or for example two different types of ones and you can group them in different ones. So it's a bit of a mathematically puzzle. So you've got designs of these building blocks and then I've got fewer books about what the overall patchwork or quilt looks like. You have design on different levels, so to speak. […] You learn what makes a good single patch and what is interesting if you combine then.' While the colours, texture, designed pattern, and photo selection can all seem right, the combined collage can still be not the desired result, as happened with Ann's Christmas collage: 'the design was nice, it had green, red, you know, Christmas colours. So there you could say the palette was defined by Christmas, both colours and patterns. There were sort of flowers from Christmas time and I had taken pictures of Christmas trees, needle trees, trying to combine that, but it was too… it looked like a card I would only send to my grandmother.'

The basic process is to decide on a theme and design, and then selecting the photos and creating the collage, although it is an iterative process. Which themes and photos are used varies, and Ann goes through 'phases', such as pictures of

seasonal flowers, or macro pictures after she had just bought a macro lens. She likes both the process and result, and adds: 'with those [digital] tools, the process becomes more important, because when I made a card with markers, I can't change it anymore, right, but with these collages I can. Because if I have these layers still, I can still move them around. So I can also make variations of one, especially if you have these sectors, I can move them around, or I can flip them around. […] So I think that because of the tool the process is also important, because you can come up with new ideas when you're already done basically and still do something with it.

Once a collage is done, Ann sometimes sends digital copies out as a card. Usually these are either themed ones, such as the Christmas card, or ones of which she thinks after creating them that they may be nice for someone. She has had ideas of cards to make for specific people in the past, but due to time constraints this usually does not work out: 'I was thinking for my sister's birthday it might be nice... I've never made one, although I've been meaning to, one with bits and pieces of faces. But then it would be nice if I had faces for example also of her family, of her son and her husband, but then I first have to take the pictures because they always have to be my pictures.' She has thought about printing her collages and has tried this using a photo printing service, but the quality was not good enough. Her version of Photoshop also only let her export low resolution images because of license constraints, which were not good enough to print. 'But I would like to also print them out so that I can give them as a card to somebody. So now I sent a digital Christmas card to many people because it's easy but for more personal things… So I make them, well for myself, but also as a sort of card and then... for somebody's birthday it's much nicer if you give them a tangible one. So I would like to print them out but I haven't sorted out yet how to do that. And the other thing is then: if you've made this design: is it nicer if it has a wide edge around it, or a black edge? So that graphical stuff, I haven't sorted out yet. So that's another learning opportunity.' Further, Ann sometimes puts a collage on Facebook: 'it's also nice if you've made something to show, because you also hope that somebody says they like it. So sometimes I put one on the Facebook just like, I think it was after the holidays, that I said: I bought this tool, I've been

trying it out and this is what my first effort looks like, something like that […].' Sometimes people 'like' her collages, but she says these 'likes' sometimes just mean 'I've seen it', but, she concludes 'At least somebody's seen it.'

Ann has always liked being creative, 'painting and drawing and stuff'. She tells me she used to make marker drawings, and before has done aquarelle and oil painting as well. When she bought a new camera she thought about doing something creative with her photos: 'it's a combination of starting to be interested in taking pictures and then seeing an opportunity to do something else with that, or creating something. So now I'm not doing these marker drawings anymore - or I might do in the future, but now I'm playing around with these... so it's nice to make something tangible as well, but something I've created out of other things I've made as well.' She adds: 'I see this as being tangible once I get around to printing them... because in a sense that's also, those other things sometimes I also gave away as cards, as a birthday card or something. It's because I like making it but it's also sometimes that you have a personalised gift, to give to somebody.' These two aspects, 'creating something and being creative', and personalised gifts are the two main reasons Ann highlights for liking what she does.

When I ask her if she considers making photo collages a craft, she is hesitant, wondering about the definition of a craft: 'if you say crafting something is creating something with your hands or something, then yeah, that's what I do... […] Does it need to result in a unique thing? […] So I do make it with my hands, although it's digitally. They could be unique but I can print them out more... So yeah, I think it's a form of craft.'

NICK – SOFTWARE DEVELOPER

As a software developer, Nick says he does not 'have any specific area in which [he has] specialised', which he calls 'one of [his] strong points but also one of [his] weak points, because usually people ask for a specialisation.' Software engineering is his day job, and he tells me he works five days full time, by which

he means more than eight hours a day. In addition, on weekend days he tries to work less than five hours a day. However, he tells me later, in his head he is always working. He has recently bought a Dictaphone to document ideas, which is especially useful when he is cycling; this is when he often gets good ideas. Examples of projects he has worked on the past are a webserver and statistical software, while his current project is an application that registers information, such as temperature, for hospitals and laboratories. Currently he is working on a new version of this system, for which he has also made the previous version. He has been working on the first version of the system on and off since 2003, and on the new version since last year. He tells me that he usually gets bored quickly, but he does not tire of working on the same project for so long because 'the requirements change continuously.' He adds: 'the challenge is to integrate the new requirements into your existing system without breaking it. Sometimes it's trivial and sometimes it's extremely difficult. And if something is difficult, that's interesting. And that's not boring at all, that's what kept it interesting. And the new version of the system is so completely new and exciting for me… no… I can easily imagine I can spend three or four more years on this project without ever getting bored.'

Nick is currently employed but has worked as a freelancer before; he has worked for about six clients before, which were mainly found through word of mouth: 'usually friends of mine or ex-colleagues knew that I had become independent and they said: "we have something you can do for us," and that's how I got most of my jobs.' He usually works on one project at the time, and explains why this is the case: 'if people hire a software engineer as a contractor, 40 hours a week is the absolute minimum. They will not take people that can only work for them for 20 hours. If you do two or three jobs at the same time, it usually means that you're working long hours. Because all your employers usually want you to work for them fulltime, so if you have two jobs, you're working 60-70 hours a week.' He has been working from home for the last 15 years, which he likes because 'you can concentrate fully, there are no distractions. […] Working home is the most efficient way to do it […].When I'm at work, I'm 100% at work and I can do

what I have to do.' However, he adds: 'there are no colleagues; I cannot spar with anybody else, I have to do everything myself.'

Nick became a software engineer in 1988 and started off 'unofficially' doing software engineering work for the company he was working at. His first fascination with computers dates back to a long time before: 'As soon as, as a small boy, I heard of computers and knew what it was, I was fascinated by the concept. But that's a long time ago, and in those days computers were not like they are now, they were big machines and in particular they were really expensive, so I couldn't afford a computer, but I started to learn programming even though I didn't have a computer, just because I thought it was fascinating that a machine could do these things.' He tells me that, as a young boy, he once sent a letter to IBM to ask for some information about their computer, after which he received a phone call from them to tell him all he wanted to know. In high school he did evening classes in programming taught by a teacher who was a programming enthusiast. 'It was a language that had been developed especially for schools, it was called Ecol, and the way it worked was, when you wanted to write a program, you had to write them on these cards, punch cards. You had to do it with your pencil; each letter had to be indicated with a pencil in a small square. It was sent to The Hague and then it was run through a computer, a big computer, and then we got the output back. So turn-around time for one run of a program was about a week or two. […] Those were my first real programs.' He tells me that around that time he bought a small programmable calculator, and later his first 'more or less real computer' was a Spectrum, 'so I could really do some programming straight away, on a television screen actually.' After high school Nick studied electronics and geology in university, and did a major in software engineering.

When I ask Nick what skills you need to be a good software engineer he starts off by telling me that despite what many people think, you do not need good mathematical skills. You do, however, have to be able to 'think procedurally': 'you have to be able to imagine how you want to achieve can be done in steps, because everything works in steps.' Further, 'you have to be creative. It's not the

creative kind like an artist… well and in some ways it's even creative in that way… you just have to be able to come up with creative ideas to do what you want to do. And because, as you can imagine, there's for any problem at least a million solutions […] so you have to find a solution for a problem... […] it has to be maintainable, it has to be simple, and all those things make it difficult. If you read books on software engineering, many things are in concept very simple, the problem is that you have to apply the concepts you read about in your specific problem. And to be able to do that in an efficient maintainable, and for others understandable way, that's the challenge. You have to be able to… build in your mind, a picture of how the things you want to achieve how they will work together.'

Nick mainly uses the programming languages Java and C++, and to a lesser degree C, and a free, open-source IDE (Integrated Development Environment) called Netbeans. He explains to me how this IDE works: 'it has internal knowledge of the software I write. For instance both Java and C++ are object-oriented so there are many objects in the software I write, and at a certain point I need one of those classes and my development environment helps me to find those things. […] Another thing it helps me with is that it indicates in the code I'm writing with a red wriggle beneath a line where there are problems, for instance syntax errors and things like that. It makes it a lot easier to read and to find problems. Also it colours the syntax, so it knows about the language I'm using and it gives certain parts of the language different colours, which also makes it a lot easier. […] It has a lot of options like that. […] And the integrated debugger, for instance […]. And there are always a number of basic steps you always have to do when you start a new class, for instance. I just tell it I want to create a new class and it gives me a framework. So it saves me a lot of time. It can do all kinds of things that before I all had to do by hand […].' He tells me he has played a bit with other IDEs but one of the reason he uses Netbeans is that he started off using it: 'As you can imagine these IDEs are... although they are in principle very simple to use, because of the incredible amount of features they have.. […] it takes quite a while before you're really comfortable using a thing like that. And I have to have a very clear reason to switch, and I haven't had it yet. Because […]

most of the time I work alone on project, I don't have to integrate with other programmers. […]'

The process of creating an application depends in a great deal on the requirements of the employer. Nick tells me that usually the employer does not have clear requirements and only have a 'vague idea of what they need': 'for instance this system I'm working on now, […] in terms of requirements it was two sentences: it has to be new – and of course I had built the old system so he meant it has to be a new version of the system we have right now – and it has to be innovative.' He says that having vague requirements like this is both difficult and great because there is a lot of freedom. For this project, Nick tells me he focussed on ways to be innovative and centred his attention on the user interface: 'and actually I did find something which is quite innovative, and I was amazed myself, I must say.' After forming the idea he built a small demo application to show his employer and when they approved he continued to try 'to come up with ideas to use the new concept for our application, and that was quite difficult, because it's a completely new concept in user interface applications […] and to make an application which fits in that concept you have to start thinking differently.'

In terms of the coding process itself, Nick tells me it is important to him to use 'patterns' and to write his code as generic as possible: 'One very important pattern and a very top-level one is called 'DRY', don't repeat yourself. So that's the general rule, if you write a line of code twice then you have to start to think: can I do this in a more generic way. […] Because the problem is, […] if you have to change something, you have to change it in [multiple] places.'

Another aspect of the software engineering process Nick has to handle is time pressure. Employers usually want a product to be delivered 'yesterday': 'you're always too late, whatever happens. […] The point is that usually […] there's a tension between software development and project development and management. The manager wants to have it ready yesterday and the software developer wants to add all these nice features. […] A project manager thinks

about time to market […] and he has a very good reason to come up with that [deadline], but it may not be, and usually is not, very realistic.' This continuous time pressure bothers Nick: 'I know that my manager is hoping that we will have a working version by the end of next year, I know that's not going to happen, it's just plain impossible. […] [But] I'm working like I'm going to try and do it anyway. […] That's why I'm working seven days a week, basically. That's one reason, I also do it because I just like it, but also they're paying me a lot of money and I want to be worth their money.'

Nick likes both the process and the result: 'you know what your employer wants to achieve basically and you have to come up with ideas about how to do that […] and the challenge is: how can I make it clear to the user what I want him to do? […] In the end [my project lead and me] come up with something, and people are, or are not, happy with it. Usually they are, up to now they've been quite happy.' He tells me he likes sparring with his project lead about ideas, although he is not a programmer. Nick does not have a lot of contact with other programmers, which he misses sometimes. He does talk about writing software with his brother, who is a software engineer but specialises in drivers. They mostly talk about general things though, because the way of programming is very different in their areas. Nick explains why he regrets not having more contact with other programmers: 'the software world […] is really exploding. It's hard, no it's impossible to keep up with the developments. […] I have to come up with my own solutions for everything I do. I can never ask anybody: "how did you do that?" I always have to come up with everything myself. […] I can never ask somebody else: "can you have a look at my code and what do you think of it?" I could well imagine that some of the things I do are maybe not the most efficient way to do it, or the best way to do it, or maybe there are, for some things I do maybe there are tools that can help me even better than my IDE to do what I try to do, etcetera. […]' He tells me he has been working alone for the last 15 years and that even when he was working in a team he often needed to work alone because what he was doing was so different. He does not know many other programmers he can talk to and adds: 'many programmers, they just do their job, and I do not want to disturb them at their job. And some of them, they do not

want to do... they want to do other things in their spare time, so I don't want to disturb them then either with those problems, so that's when I have to do everything myself.'

Nick really enjoys his work, which becomes very clear throughout the interview. He tells me why he likes it so much: 'it's just great if you can do something, if you can have a creative job – a job for which you have to be creative. So, like I said, I have to come up with solutions for everything I want to achieve. So the way it works is, I know what I want to achieve after having though about it a little bit, and then I have to start thinking about the steps I told you about. How am I going to get this done? And there's millions and millions of possible solutions and you want to choose one that is efficient and that works, and that always works, and that other people can understand as well, which is a pretty difficult set of restrictions, I think. But I always say ["my brain is bubbling"], it's just… it's like I have ever fresh water in my head and that's a great feeling, and if it works, it's a very rewarding job for me. If I can build what I want to do, and of course it's nice if other people say: "wow, this was nice". It's just the creative part of it that I like so much.'

When I ask Nick if he considers what he does a craft, he admits that when hearing the word craft he thinks of 'pottery and making pots and things like that.' He adds: 'It's something really manual, and certainly part of my job is manual, that's the programmers' side I think. […] The difference between a software engineer and a programmer is […]: a software engineer comes up with solutions and a programmer builds them. […] Writing software is… yes, it is a craft. But that's only part of [my job], and I don't know how large that part is. […] The creative part of it is not part of the craft I think.' I ask him what makes the programming part of the craft and the thinking not, and his answer, perhaps surprisingly, comes down to straightforward materiality: 'I have to put the letters into my computer using a keyboard, that's craft. I have to build things, I have to… the ideas I have in my head, I have to put them on a… it's called software, but it's still a hard disc. […] In the end it's a hard byte on my disc somewhere and I have to put it there, and that's the craft.'