Modern Craft: Locating the Material in a Digital Age
by
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Abstract

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This dissertation analyzes the form, character, and variety of materials with which specific forms of value are produced and maintained in craft. Two craft sites provide the foundation for the work I present: a bookbinding workshop in Cambridge, UK and a knitting guild in San Francisco, CA. Participant observation and interviews allow for a detailed examination of craft practice. In binding, the durability of the book and respect for the book’s history are two central concerns, continually balanced through human-material interaction. In knitting, care invested in the artifact and anticipation of future use organizes production. Tied to familial pastimes and ancient histories, restored books and knit shawls become agents of recovery — of fading techniques, of cultural traditions, and of intimate interactions. Traces of creation, time, and use are valued for their emotional resonance in addition to the pragmatic goals in which they are embedded.

Reflecting on the practices of bookbinders and knitters, I introduce the analytic category of “material traces” to the study of design and technology. Material traces concretize a unique location in time and space to reveal the dynamic and evocative nature of form. In my conceptualization, they embody and reflect skill, use, and time; they evoke memories and confer value.

In the workshop, binders trace backward: they maintain certain material traces of time and use (creases on a book spine, scent of aged leather) and selectively mask material traces of restoration skill (replaced leather or stained paper) to expose marks of provenance deemed appropriate. In the guild, knitters trace forward: they foretell suitable fits and pleasing patterns through removed or intricate stitches, material traces of time and skill that are often missing or obscured for future recipients of the knit artifact. The relative invisibility of knitting labor enables a sense of ‘cleverness’ or ‘secret society’ that digital technologies (blogs, pod casts,
social networking sites) sometimes threaten to unravel by exposing additional traces of craft production.

Using this analytic category, I develop a heuristic for examining technology that focuses on material traces of *skill, use,* and *time.* The heuristic is put into practice in the analysis of Spyn, mobile phone software that I designed to associate digital records (audio/visual media, text, and geographic data) with physical locations on knit fabric. The heuristic renders visible the stories of technique and spatiotemporal rhythm that imbue the knitted artifact with additional (digital) marks of production. In addition to tracing forward, knitters use Spyn to trace backward.

Taking lessons from this analysis, I then present a framework for design pedagogy — using the lenses of *attributes, entanglements,* and *rhythms* to gain critical purchase on the artifacts being produced. Mobilizing this framework within a classroom, students envisioned evocative relationships to the non-human (rodents), enriched connections to a familial hand, engaged physics learning, and opportunities for reminiscence around breakage. These design examples reveal how the analytic category of material traces comes alive in practice and pedagogy. Based on these insights, I demonstrate a research agenda for design that emphasizes temporality and materiality.
For Jeff, my inspiration
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**Acronyms and abbreviations**

CNC – Computer Numerical Control

CSCW – Computer-Supported Cooperative Work

HCI – Human-Computer Interaction

IS – Information Studies

IT – Information Technology

KG – San Francisco Knitting Guild

STS – Science and Technology Studies

TUI – Tangible User Interface

UCD – User-Centered Design

UX – User Experience

YLEM – San Francisco art collective ("artists using science & technology")
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Introduction

Craft practices are expanding. Knitters join social networking websites to share tips and resources, jewelers use Computer Numerical Control (CNC) machines for digital fabrication, and weavers employ online distribution channels to promote, exchange, and circulate their garments. An extraordinary range of new digital technologies is permeating traditional craft techniques — altering the material ecology of personal production.

In parallel with this shift, craft is widely seen as an ossified cultural form: as a heritage to protect and a process to preserve. However, a small but growing number of people are challenging conventional modes of craftwork, extending and re-defining their traditional forms. Whether we call them “crafters,” “geeks,” “makers,” or “hackers,” they exhibit what Chris Kelty terms “a mode of thinking and working, not an identity” (2008:35); they often “stand outside power” and “find each other, for reasons other than the fact that they share an office, a degree, a language, or a nation” (ibid:35). In the recent film and book *Handmade Nation*, Faith Levin and Cortney Heimerl (2008) document the independent creative work celebrated by this “new generation” of crafters. From building circuitry and upgrading software to shoemaking and screen-printing, crafters “are reshaping how people consume and interpret the handmade” (Levin and Heimerl, 2008:xi). Handwork activities coalesce around mailing lists and Twitter feeds, hacker spaces and faire grounds, often inspired by a “DIY ethos.” By engaging in practices at once digital and physical, they challenge conventional conceptions of the “post-physical” future.

The question is: do these corresponding shifts alter people’s understandings of technology and, if so, what has changed — theoretically, substantively, and practically? How we configure our technologies — and, in turn, how our technologies configure our understandings of ourselves, and our activities — is central to design and technology studies. It is also the primary project of this dissertation. By examining how crafters are shifting and extending the different forms of value ascribed to their work, on the one hand, and how they simultaneously take up and come to understand (and perhaps transform) new information technologies (ITs), on the other, I ask:

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1 Online applications such as YouTube are used to share tips and resources as well as ways of doing (Beuchley, et al., 2009; Torrey, Churchill, and McDonald, 2009).
**material traces**

**SKILL USE TIME**

E.g., a family heirloom that dynamically amplifies the imprint of a child’s hand. When a hand is placed on the local print, the remote print warms up and, in turn, displays colorful material traces of use and time (as growth).

**SKILL USE TIME**

E.g., a sequence of conductive speaker coils that lines the hall of a museum. As visitors walk down the hall, they record and listen to sounds using a magnetic wand, like the game of “telephone.” The sounds produce traces of use and skill.

**SKILL USE TIME**

E.g., a mass-produced, ceramic plate that is coated with rubber and shattered. As the cracks remain intact, they create a distinct aesthetic and unique identifier — material traces of time and use — with which to associate digital records.

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**ATTRIBUTES**

Attributes are dynamic properties that make visible the particular.

**ENTANGLEMENTS**

Entanglements are mutually constituted attributes that reveal contingencies.

**RHYTHMS**

Rhythms are enacted entanglements that expose temporal patterns.

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Figure 1: The design examples described above embody themes that I develop in the dissertation (elaborated in Chapter 7). I use these examples to reveal how the analytic category of material traces comes alive, in practice and pedagogy. Using the analytic, I develop a heuristic for analyzing technology as material traces of time, skill, and use and a framework for design pedagogy that offers the lenses of attributes, entanglements, and rhythms as ways of getting critical purchase on the artifacts being produced.

1. **How might IT affect craft?** Specifically, how do ITs get taken up in craft? And how can insights drawn from technology (in craft) be used to analyze new interactive systems?

2. **How might craft affect IT design?** How do craft artifacts accrue different forms of value? And how can insights drawn from craft be used to design meaningful and enduring technology more generally?

I address these concerns through fieldwork in craft workshops just outside the institutional walls of design corporations in Silicon Valley and Cambridge, UK — where materials, people, and practices collide. I develop a detailed account of craft practice (knitting, bookbinding) that critically reflects on scholarly understandings

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2 The terms “meaningful” and “enduring” are meant to signal a concern for the moral, social, and temporal orders of IT design.
of modern form-giving work and the tools with which that work is achieved. Rooted in these accounts, I rethink the notion of “materiality” as analytical precept and practical modality to propose the analytical category of “material traces” (Figure 1). I use this category to: (1) analyze emerging technologies for craft, and (2) develop a framework for design pedagogy that stresses enduring and “craft-like”³ digital technologies.

In design and technology studies literatures, concepts of “materiality” are often neatly reduced to physical form. Design practitioners describe the materiality of technology as the components that enable users to manipulate digital files and physically manifest computational procedures (“tactile displays,” “tangible user interfaces,” “inputs,” and “outputs”). Scholars of information point to the importance of matter on which digital files and signals are encoded, constrained, and imposed (hard drives, cell phones, copper wire) (Blanchette, 2011; Dourish and Mazmanian, 2011). Among design theorists, materiality takes on a more “immaterial” character, emphasizing the ordering capacity of things, the ways in which things script and organize cultural production⁴ (Verbeek, 1998). Lastly, anthropologists, particularly scholars of material culture, have approached the concept as a primarily semiotic (Keane, 2003) or practical endeavor (Ingold, 2007b),⁵ underscoring the interpretation, breakdown, or use of physical goods (cell phones, laptops, internet cafes) (Burrell, 2012; Horst & Miller, 2006; Miller, 1998; 2005). Yet few concepts of materiality accommodate the ambivalent analytical status of materials; that is, whether digital, or not, materials exhibit different forms of mutability, both practically and analytically.⁶

³ By “craft-like” technologies I draw on the craft discourses of David Pye (1968), Rosemary Joyce (2011), and others (Gowelland, 2011; Terrio, 2000) to indentify the capacity to show (or conceal) temporal and human investments through artifacts, such as the marks that evidence the passing of time and the work of the human hand.

⁴ The term ‘cultural production’ serves to highlight the ways in which people produce and perform culture, as opposed to goods and services, and how materials help people to express norms, customs, or kinship, for example — actions that are otherwise hidden or out of reach.

⁵ Keane draws on Peircean semiotics to suggest that the bundles of signs embodied by objects “shift in their relative value, utility, and relevance across contexts” (2003:414) by indexing human relations, evidencing iconic resemblances, or pointing to future potentiality. Ingold focuses less on the “objectness” of things, and more on the “material flows and formative processes wherein they come into being” (2012:431).

⁶ A wooden table, for example, might seem immutable in some respects; yet, over time, we may find that it decays and erodes, sometimes resulting in breakage. Whereas a digital
The overarching goal of this dissertation is to reconsider recent scholarly formulations of the material as stable and distinct from the digital by closely examining the work of craft in an increasingly digital world. For many, the rise of computation suggests an accelerating transition from physical to digital media. However, the mounting popularity of craft — knitting, sewing, pottery, etc. — asserts a central role for skilled handwork in our digital age. How might the study of craft, which sits at the nexus of labor and leisure, reveal the determinism and rigidity of this reasoning to open up new avenues for creative conceptualization and design?  

Reflecting on the practices of bookbinders and knitters, I find that material traces of *skill, use, and time* evoke memories and confer value. Material traces of *skill* are the marks of craftsmanship produced during creation, such as the tension of stitches on a knitted scarf. Material traces of *use* are the embedded histories of practice that build up through routine engagement, such as the mottling on well-read pages of a book. Material traces of *time* are links to the past that develop without direct human intervention, such as the scent of eroded leather on a book spine, or the effects of air, moisture, and gravity on smells, colors, and textures. These traces tend to intersect and become constitutively linked, as different material elements challenge the categories into which they once belonged.  

In the binding workshop, binders maintain certain material traces of time and use (creases on a book spine, scent of aged leather) and selectively mask material traces of restoration skill (*e.g.*, replacing leather or staining paper in order to reveal or hide the traces of provenance deemed appropriate). In the knitting guild, cryptography key, which may seem highly mutable as code, often remains stable and robust with respect to its lock.

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7 The categories of labor and leisure, and their relation, are not self-evident. Rather, I conceptualize and problematize these distinctions through their social production in the guild, the workshop, and other contexts of craft.

8 One of my contributions is to identify the elasticity of time. To date, time has been underrepresented in the conceptualization of design and technology, with a few notable exceptions, *e.g.*, (Jackson, et al., 2011, and Shove, 2009). The examples I put forth in this dissertation with respect to binders and the knitters reveal the multiplicity of temporal frames played with and enacted through craftwork: *e.g.*, time passed, time past, time spent, time frozen, time unfolding, and so on. Future work will further complicate these concepts.

9 Value, again, is best understood as a process of valuation in which people assert, negotiate, and contest its constitution and assignment (Shove, 2005).

10 The quality of eroded leather, for instance, may be attributed to traces of use, traces of time, or both. See Figure 1 for additional examples in the context of interaction design.
material traces of craft labor (intricate stitches, multiple iterations) are often visible to other knitters but unavoidably missing or obscured for recipients of the knit artifact. The relative invisibility of knitting labor enables a sense of ‘cleverness’ or ‘secret society’ that digital technologies (blogs, pod casts, social networking sites) sometimes threaten to unravel by exposing additional material traces of craft production.

Based on these observations, I develop the analytic category of *material traces* that contributes an alternative view of materiality to the literature in design and technology studies. Incorporating Rosemary Joyce’s (2011; 2012a) archeological (and anthropological) theory of traces, wherein the trace signals provenance, I envision *material traces* as an extension of Walter Benjamin’s (2007 [1968]; 1999; 2008) *aura*, concretizing a unique location in space and time. For Benjamin, aura is principally attributed to the unique essence of an artifact (2008:21) — such as the distinct quality of the Mona Lisa or a sunset over the horizon — jeopardized by techniques of mechanical reproduction. In a digital age — a historical moment in which marks of craftsmanship are widely considered immaterial and, in turn, increasingly difficult to unravel — I look to material traces as that which manifests a specific spatiotemporal location; they inscribe possibilities for action and expose chains of provenance, such as histories of creation, use, and interaction. I use the term *trace* to stress the temporality of these relations and the ephemeral conditions in which they are achieved. By following traces, I attend to how

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11 Aura and trace are interwoven concepts sometimes set in opposition by Benjamin. Salzani compares Benjamin’s artifact to a palimpsest on which traces of history are continuously erased, preserved, revived, and left anew (2007:183). Thus Salzani discusses the “auratic” trace as that which “takes possession of us” (Salzani, 2007:184, quoting Benjamin). Techniques of mechanical reproduction, such as the film camera, thus lack aura but offer new libratory and political possibility.

12 Using techniques of mechanical production, the Mona Lisa may be perfectly duplicated and the sunset may be photographed. Several craft scholars discuss and complicate this modern quality of reproducibility, e.g., (Adamson, 2008, Pye, 1968). In *The Nature and Art of Workmanship*, for example, David Pye (1968) compares the “workmanship of risk” with the “workmanship of certainty,” wherein imperfectly worked craft artifacts are distinguished from perfect copies mechanically produced.

13 The term traces connotes both inscription and discovery: tracing forward and tracing back histories in material form. Much like Akrich and Latour’s notions of inscription and description, traces can ascribe possibilities for future use. Through their discovery — or “entrancing,” traces also produce relationships with the past that allows people to assign different forms of value to material form.
different forms of value are produced, maintained, and obscured over time.\textsuperscript{14} For example, when restoring a family bible, a binder may want to preserve meaningful traces of the book’s past (creases on the spine, handwriting on the margins) while replacing materials that have eroded or decayed (enabling the book to be read and handled by future generations).\textsuperscript{15}

Though we may speak of digital technologies as lacking the \textit{aura} of a work of art, I argue that our relationship to the digital is more complicated. Digital file encodings (\textit{e.g.}, Facebook wall posts or the annotations left on a text document) and technological infrastructures (\textit{e.g.}, cell phones, copper wire) reveal material traces of different kinds.\textsuperscript{16} Some traces may be deliberate while others may not. For instance, we might purposefully leave a digital annotation in a text document yet we might not realize that we are also keeping track of how long or at what time the document was edited. As I discuss in Chapters 7 and 8, these traces can take on a range of forms with which designers and technology scholars may design and analyze new technologies for creative production.

The binders and knitters I studied referred to these traces by other names — \textit{e.g.}, “dog-eared pages” or “missed stitches.” Yet as an analytic category, material traces enables a frame of analysis beyond the purview of physical matter. It focuses on the evidence of workmanship, routine usage, and non-human interactions, such as aging and decay. It also reveals actions that belie the maker's intention, such as discovering a missed stitch in a handmade shawl (revealing a mistake). By identifying material traces, researchers may recognize a range of relations, emphasizing their evocative and fluctuating nature.

These traces do not operate on their own. They are shaped by a range of people, materials, and institutions, often beyond the immediate context of craft. For example, a binder may stain new pages on an older book to give it the look of age. But the texture of the page, the color of the stain, and the ‘spring’ of the brushes with which to apply it are contingent on several factors. They are affected by standardized color codes and factory paper protocols. They are shaped by the

\textsuperscript{14} See Appadurai (1986), Berry (2004), or Dilly (2004) for accounts of material processes in relation to commodity value.

\textsuperscript{15} This work is reminiscent of “inscription” (Akrich, 1992; Latour, 1992) wherein design choices afford different possibilities for use, as I will soon elaborate.

\textsuperscript{16} The Read Wear and Edit Wear systems (Hill, Hollan, Wroblewski, and McCandless, 1992) are early examples of interactive systems designed to enable users to leave traces of use in software over time, drawing on Donald Schön’s (1983) concept of reflection-in-action.
customer's sense for what the book has been through and what it ought to become: a relic of past relationships or a canvas for future use. They guide the binder just as the binder guides them. Ultimately, as we find in Chapters 6 and 7, it is in the negotiation of these traces and the possibilities of their use — the careful balance of historicity and change — that we find a sustainable design practice of an unusual sort, one that sheds some light on how digital technology might evolve over time.\(^{17}\)

After discussing how these traces get produced within different social worlds, I develop a framework for design pedagogy that offers the lenses of attributes, entanglements, and rhythms as ways of getting critical purchase on the artifacts being produced (see Figure and Chapters 2 & 7). Through the lens of attributes, the concept of material traces points to the nuanced particularities of form.\(^{18}\) Emphasizing attributes means taking seriously detailed sensitivities to digital properties, such as delicacy, brittleness, and flexibility, and how the properties are discovered and inscribed. Through the lens of entanglements, the concept of material traces draws out the inextricably linked relationships through which materials come into being. This lens concerns the contingencies that matter between people, substances, and environments, such as the different values embedded in interactions among binder-knife-string or machine-workshop. Through the lens of rhythms, material traces become the temporal patterns of interaction through which different entanglements unfold. They underscore the elastic, undervalued work of repair and maintenance in IT design and the dynamic processes of breakage, wear, and decay. As I describe in Chapter 7, each of these lenses presents different possibilities for the design of digital technologies that trouble the analytic categories of craft and computing, labor and leisure, and historicity and change. The present Introduction begins to ground this analysis in the productive interplay between the maker and her materials.

## Crafting the Research Plan

I first delved into questions of craft, rather paradoxically, amid a hotbed of technological change when I was a User Experience (UX) design intern for the creative software company Adobe, Inc. My task was to observe users’

\(^{17}\) An artifact's intended use and associated resistances have been raised in the design literature on scripting (Verbeek, 1998; Akrich, 1992; Latour 1992) and technological determinism (Jordan, 2008; Smith & Marx, 1994; Tenner, 1997).

\(^{18}\) My focus on techniques and particulars echoes Gell’s (1998) approach to an anthropology of art.
engagements with a suite of “professional” creative software, while other employees studied a suite of “hobbyist” creative software. For both software suites, employees were directed to increase the efficiency and ease of production. The latter suite appeared similar to the former, yet was comprised of larger buttons and fewer discrete functions. As I watched participants interact with the software, I wondered whether creative production was simply a matter of speedy execution, or whether other factors (e.g., pride in workmanship, self-expression) may be shaping people’s formulations of success. Through interviews and lab studies with users, I found the shorthand distinction between hobbyist and professional design too rigid. Some hobbyist participants took pride in their strategies for finding idiosyncratic solutions involving significant care and invested effort, while other professional designers exhibited fluency with a limited number of tools reminiscent of a painter’s use of a paintbrush. I also noticed how the lab environment seemed to configure participants’ strategies and expectations. In several cases, participants were intimidated by the austere white rooms and minimally motivated tasks. Hoping that Adobe might offer them work, participants were sometimes unusually eager to show off their technical proficiency. These observations not only called into question the ecological validity of our studies. Reminiscent of the magazine CRAFT’s short-lived print run, they exposed and challenged an underlying narrative of technological progress deeply informing our understanding of digital tools.

It was not long before I began to look beyond the tools to the people behind them, and beyond the digital sphere to other worlds that seemed to benefit from digital technology. All around me, friends and colleagues were flocking to handcraft. Large festivals like Burning Man and Maker Faire, teaching facilities like the Crucible and Center for the Book, as well as independent studios and hacker spaces seemed to energize a surprising range of personal, “by hand” production. People appeared engaged in handwork as a response to, and an extension of, the culture in which they were embedded. Some turned to craftwork in order to counter notions of ‘planned obsolescence’ (Shove, 2003). Others looked to handwork as a reprieve from monotonous managerial work or as a celebration of specific familial, cultural, or personal ritual. These negotiations played out as people answered customer phone calls and maintained their websites as part of their workday, and continued to develop while incorporating new tools, such as craft-centric social networking sites and online distribution channels. Across these

\[19\] While a resurgence in craft has been documented elsewhere (e.g., see Turney [2009] on knitting), documenting the degree of this interest is neither my aim nor the goal of this dissertation.
contexts, I witnessed the range of practices involving digital technologies, but also the many ways in which those practices where shaped by the crafters’ values and sense of moral order.

Since early research in human-computer interaction (HCI), claims about the unique character of digital representations, interfaces, and systems invariably pervade the design and technology studies literatures (Keye, 1975; Rosko, 1972; Ishii and Ulmer, 1997). Research on tangible and embedded interaction has sought to “bridge” what has been termed the physical-digital divide by physically manifesting digital processes and interactions (Ehn & Linde, 2004; Fitzmaurice, Ishii, & Buxton, 1995; Ishii & Ulmer, 1997; Weiser, 1991). More recently, a stream of research in information studies (IS) and HCI (Blanchette, 2011; Robles & Wiberg 2009, 2011; Rosner, 2012; Rosner, et al., 2012; Wiberg & Robles 2010) has reconsidered distinctions between digital and physical tools to acknowledge a wider array of material arrangements. In particular, they have challenged notions of the “physical-digital divide” for their rendering of digital practice as separate from its physical form. This simplified distinction between atoms and bits paints a partial and misguided picture of the diverse sensory experiences and discursive conditions in which digital work unfolds. As I attempt to show, digital information technologies do not fundamentally redefine human practices, even if they may transform them. Instead, they affect the values imbued in, and the engagements described by, those practices.

Figure 2: Restoration binding and hand knitting. Peter (left) is placing a new piece of leather under old cover leather to strengthen the book spine. G. (right) is learning to knit a Faire Isle hat called a tam by interleaving four colors of yarn.
In order to empirically ground this argument, I turn to the practices of bookbinders and knitters to examine how each produces and sustains relationships with people and cherished artifacts. I discuss a series of fieldwork engagements (two three-month bookbinding apprenticeships and a two-year knitting guild membership), drawing on critical (Dunne & Raby, 2001; Gaver, et al., 1999; Ratto, 2009; Sengers, et al., 2005), observational (Burrell & Toyama, 2009; Gaskell and Bauer, 2000; Kvale, 1996), and auto-ethnographic methods (Sengers, et al. 2012; Ellis & Bochner, 2000). My own experiences learning stitches and techniques of bookbinding inform my discussion of an alternative account of technological development – one that reveals how seemingly individual activities are tied up in social and material relationships with artifacts, people, and workspaces beyond the individual workstation.

While ostensibly distinct from digital design activities, binding and knitting provide a fresh perspective on creative work, both practically and symbolically. Bookbinding is a process of making and maintaining books, some of our most pervasive and enduring information technologies. As such, they trouble our notions of technology and attendant affirmation of the physical-digital divide. As restored artifacts, books prompt sublet and intimate acts of care, such as protection and mindfulness, and accrue specific forms of value, such as utilitarian and emotional worth. In striving to sustain their value, restoration binders maintain some elements of the book while replacing others. Binders balance modern intervention with increased durability, often concealing marks of workmanship. I use these deliberately obscured marks — material traces of skill — to understand how binders conceptualize the “well-made” book.

Bookbinding has also enabled me to surface different modes of attribution by which artifacts maintain value. For example, when a binder needs to replace “end pages” (the first and last pages) of an older book, she first stains modern white sheets of paper with light brown stain to look as if they have been aging over time and then compares the original book pages with the stained sheet and a new white sheet. Important in this process are the three distinct ways in which the binder could treat the pages. First, she could make the pages appear as they would have 100 years ago, when the book was originally bound. Second, she could make the pages appear as they would have if the book had been aging on the shelf for 100 years, turning yellow over time. Finally, she could make the pages appear as they would have if the book had been used and worn down over those 100 years. Each of these possibilities has implications for how people interpret and attribute value to artifacts (books, websites, cell phones).
Through prolonged engagements with digital and non-digital elements, bookbinding has enabled me to attend to more than the technical particularities of material. It has also revealed the entangled relations between binders, tools, and workspaces, and the temporal rhythms of these engagements. As I describe in Chapter 2, these observations offer specific frame for considering material traces in IT design.

Knitting, as a process of looping thread, generally involves the generation rather than restoration of form. Hand knitting involves creating sequential interlocking loops of yarn or thread using needles and hands. The most basic stitches are formed in long columns that, by way of their stacking, form three-dimensional fabrics. Like many crafts, knitting most likely originated for practical reasons. The close-knit patterns, cables, and bobbles in Aran knitting, for example, insulated residents of the Aran Islanders off the coast of Ireland from the cold winter air. The dexterity of the crafter, and the regularity and tension of the stitches, transform the shape, function, and look of the knitted “end product.”

Figure 3: Peter applies brown stain to white pages to give them the look of age. He first measures the new white page against the size of the text block (left); he then cuts down the page and paints it with brown stain to give the page the look of age (right); lastly, he compares the color and quality of each material: the new white page, the original text block, and the newly stained page (middle).

By visiting knitting circles, talking with knitters, and participating in knitting events, I began to discover how a few qualities make knitting rather unique among other handicrafts. For one, the knit fabric enables aspects of the creative process to be read from the final form. The sequence of each stitch is spatially recorded by the fabric's linear structure. The form has a capacity to show how it was produced, a quality Bauhaus instructor Laszlo Moholy-Nagy has referred to as fracture (Phillips, 1989:101; quoted in Adamson 2007:59). Knitting is also both spatially and temporally flexible: it can be achieved in varying durations of time, in numerous physical locations, and with different levels of concentration (depending on the knitter's skill and the complexity of the pattern). This flexibility extends to its spatial stability, as the yarn and needles can be transported from one destination
to another, and put to work en route in buses, trains, and even walks. Partially due to this spatiotemporal suppleness, hand knitting has become a popular activity in urban settings and among younger crafters. This suppleness extends to distributed online forums such as blogs, social networking sites, podcasts and magazines enable practitioners to share curiosities, inspire new ideas, and circulate resources. As a knitter since childhood, I was long familiar with the basic ingredients of the practice; yet, through continued observation, I found knitting newly relevant to considerations of the digital.

![Image of knitting]

Figure 4: Basic knit stitch; continental knitting involves looping thread with two needles. Photograph taken by G. of me learning to knit Faire Isle patterns at the knitting guild.

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20 According to the National NeedleArts Association (2007) 54% of needlecrafts involved knitting in 2006 and the needlecrafts market grew 10%-20% from 2004 to 2006. The Rowan yarn manufacturer approximates that over 11% of the population regularly knits (Turney, 2009).

21 See Knitty.com or Ravelry.com.

22 It is important to note the dual meaning of the term “digital,” as it refers to both the hands (fingers as digits) and computational processes (zeros and ones).
In short, knitting exhibits five qualities distinct from binding of relevance to my project: flexibility (achieved in varying durations of time, physical locations, levels of concentration), portability (easily transported from one destination to another), indexicality (sequentially tracing the process of production and, in effect, the skill of maker); and digitality (in its most basic form, knitting comprises various arrangements of two stitches). Lastly, it presents a view of what might be termed “hobbyist” or “leisure” craft, a craft that is largely taken up by individuals hoping to dabble in, or enjoy the process of, production without becoming a professional or expert craftsperson. In Chapter 6, I leverage these qualities in a series of design interventions intended to prompt responses to digital/material relations.

This dissertation does not claim to characterize the whole of craft practices, distinguish between professional and leisure crafts, or offer a general tour through the histories, politics and techniques of knitting and bookbinding, for such analyses are beyond the scope of this work and several analyses have been offered elsewhere. Rather, through the construction of a book and a knitted object, I reveal how valued traces of time, artistry, and use emerge through detailed engagements with material — e.g., the tension of the stitches, the grain of leather, and the evenness of glue. In the process, I present a relational view of craft, one that contrasts with recent renderings of craft as a universal and homogeneous human impulse (cf. Sennett, 2008; Crawford, 2009). What at the level of skilled execution seem to be similar kinds of practices differ in the manner in which they produce different forms of value. However, based on my analysis, knitting and bookbinding can be connected through the perspective of material traces. Traces inform practices of design and their valuation by rendering visible the particularities of each practice while not loosing the part of the human in those actions. Using the concept of traces design and technology researchers may follow the evocative and fluctuating relations — locating the material in the digital age.

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23 Knitting troubles the digital/physical boundary by attending to the fingers (digits) used to knit and enacting the numerical, often binary, systems through knit and purl stitches, systems which underlie both knitting patterns and computational technologies. While I do not pursue this relation in depth, I discuss its implications for future work in Chapter 8.

24 As I will show, this view does not account for each of the knitters with whom I engaged, as knitting expertise and professional aspiration was plentiful. However, as Torrey, Churchill and McDonald (2009) document in their study of online learning around craft, some knitters do fit this “amateur” profile.

25 See, for example, Turney (2009) for a discussion of knitting.

26 These sentiments, Sennett (2008) makes known, are drawn from Arts and Crafts scholars, such as John Ruskin and William Morris.
Methods: Membership and Apprenticeship as Reflexive Inquiry

To go about studying a binding workshop and a knitting guild, I organized my inquiry through participation and apprenticeship. I was guided by ethnomethodological approaches to research where the observation of a given context has been given primacy over the talk about it (Svensson, et al. 2007). Additionally, my interest in certain bodies of theory (communities of practice theory, feminist science studies) demanded that I attend to the nuances of form, material, and routine labor. Borrowing from Knorr-Cetina (1999), I employed a “comparative optics” approach to understanding handwork: I use one practice to look at the other. I was also informed by what Barad (2007) has termed a diffractive methodology as “a critical practice of engagement, not a distance-learning practice of reflecting from afar” (ibid: p.90). Such a perspective acknowledges how different kinds of material afford very different ways of knowing through their entangled interactions — or “intra-actions.” In bookbinding, for instance, similar interactions with leather and glue suggest recognizing delicacy and intricacy in the digital medium, while different interactions with a knife and machine for thinning leather suggest designing for the unshareable or immobile digital tool. Using this perspective, I built an account of craft practice by taking part in and documenting unfolding relations. In effect, I attended to not only what is seen or heard, but also to my own process of learning how to craft.

This auto-ethnographic approach (Ellis & Bochner, 2000) follows from prior design research that employs the author as research subject by constructing a reflexive autobiographical account of the author’s experience, such as examinations of a naval tactical command and control system (Aoki, 2007), and horseback riding (Höök, 2010). Yet, my methodology draws most closely on anthropological approaches to the study of craft skill, such as Ingold’s sawing of wood (2006), Prentice’s employment in a garment factory (2008), and work by Lave (2011), Coy (1989) and others that suggests apprenticeship gives way to valuable insights into technical and social behavior. Apprenticeship imparts such tacit skills (physical, economic, social) “through long-term observation and experience” (Coy, 1989:xii). In my case, it also became a means of entry into tacit understandings of craftwork with which I could analyze embodied knowledge and formative practice. That is,

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27 Barad coins the term “intra-action” to signify the “mutual constitution of entangled agencies” such that distinct agencies emerge from, rather than precedes practice (2007: 33).
craft is an activity that involves significant tacit knowledge and can be understood in only a very limited way by simply observing and talking to people about it. As Ehn recently wrote of creating a dry passageway for a shower called a duckboard, “Thinking, writing and performing manual tasks become deeds that correspond with each other. (Ehn, 2011: 59).

Anthropologists have long employed embodied subjectivity as an instrument of ethnographic inquiry, “theorizing not only what work means to people, but also what it does to them” (Prentice, 2008:55; emphasis in original). Such analysis considers how the people’s embodied dispositions and practices produce and reify value, affecting how people negotiate identity and personhood. By participating in field sites and observing routine workplace accomplishments, I similarly examine the relation between physical practices and the production of ethnographic knowledge. Such work has enabled ethnographers to become “more nearsighted” (Ehn, 2011:60) by attending to “the properties of the medium [that] shape practice and influence how the broader social world is organized” (O’Connor, 2009:2).

Through continued engagement with materials and tools, my work became a gateway for my social inclusion in the binding workshop and knitting guild. It also broadened my understanding the particularities of craft.

Thus my approach to studying craft is necessarily exploratory, qualitative, and ethnographic. Qualitative methods characterize causal processes, recognize new phenomena, present auxiliary evidence for existing hypotheses, and identify counterexamples (Burrell & Toyama, 2009). Unlike statistical methods, qualitative methods are good at pinpointing what about people’s lived experiences are important and why. Through long-term observation and interviews I examine why people choose to maintain some materials and discard others, and how certain artifacts achieve valued status. I do not make representative claims, test hypotheses, reveal trends, or answer questions of how often and how much craft materials become meaningful – these are the types of questions qualitative methods are ill-suited to address (Bauer and Gaskell, 2000). Instead, I seek to produce “observable-reportable” (Garfinkel and Sacks 1970: 342) understandings of the practical (and practiced) work of craft.

My study begins with observations of bookbinders’ practices in their own environments documented through a combination of video, photos, and detailed fieldnotes. Across two years, I visited three binding workshops in Cambridge, UK and three binding workshops in the San Francisco Bay Area, including annual conventions and monthly meetings of the Hand Bookbinders of California (a loosely affiliated group of books arts, fine binding, and restoration binding enthusiasts and practitioners). Much like prior workplace studies based upon co-
present (Orr 1996) and video-mediated (Suchman and Trigg, 1991) observations, I used a range of materials to record my interactions, including written jottings and memos, digital photos and collected materials (bits of knit and un-knit fabric, bound and unbound books).

Field sites were chosen based on availability, research fit, and my existing ties within each community. The majority of my time was spent in one bookbinding and one knitting guild: a workshop in the UK (run by two middle-aged binders, Sean and Peter28), and a knitting guild (KG) in San Francisco, California (roughly thirty affiliated knitters). I visited the UK bookbinding workshop an average of three days per week over three months, and attended knitting guild meetings an average of every other month for two years.

Semi-structured interviews with crafters and their friends, colleagues and customers complemented my auto-ethnographic work by unearthing the

Figure 5: Sean showing me how to fray new cords on an 18th century dictionary. The image is extracted from video footage taken by a video camera set on a shelf in the bindery over several days.

28 These and all subsequent names have been changed to preserve anonymity.
subjective experiences, values and attitudes of people engaged in craft (e.g., how people discuss and make sense of digital technologies). Interviews were guided by an interview protocol, which I evolved according to what I learned about people’s practices and their relation to technology. I conducted one-to-two hour semi-structured interviews with 13 key participants in the bookbinding community: five professional binders, five hobbyist binders, and three customers. I also conducted semi-structured interviews with 33 knitters, all of which were video-recorded and transcribed (unless otherwise requested by the interviewee). Twenty-nine of these interviews were conducted in-person at knitting locations (cafes, conventions or homes) and four were conducted using instant message with participants in Holland, Britain, Canada, and the Northeast United States. I recruited participants through my participation in knitting circles, a knitting website, and conversations with local contacts. Their ages varied from mid-twenties to mid-eighties; all but three were female, and their occupations ranged from grant writer and teacher, to designer and nurse. Thirteen of the interviews were conducted in the context of field trials with the Spyn system (Chapter 5). Interviews usually lasted one hour, and focused on motivations for knitting activity, the discovery and use of online resources, and participation in social activities around craft. With Spyn, interviews included questions about how knitters responded to the act of encoding digital messages.

This analysis is supported by additional interviews and fieldwork during and after my participation in the knitting guild and binding workshop. In the fall of 2010, I attended binding classes at the US bookbinding workshop roughly one day per week for four months. Then, in the summer of 2011, I conducted 11 interviews with professional crafters (six women, seven men) in the San Francisco craft scene (with a total of 13 interviewees). The purpose of these interviews was to understand how the crafters talked about valued qualities of material beyond the knitting guild and binding workshop. Prior connections through previous research pointed me to well-regarded practitioners working in a broad range of craft mediums: pottery, wood, mosaics, jewelry and metals. The interviewees’ work had been exhibited and included in the permanent collections of several museums throughout the United States, including the Smithsonian Institute and the Museum of Fine Arts Boston. Aside from prestigious exhibitions, their recognition in the local craft scene was sustained through ongoing teaching commitments and online blogging activity. I asked participants about their motivations, career

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29 All but seven of these interviewees hailed from the Bay Area, a particularly vibrant area for needlecrafts (see Levin & Heimerl [2008]).
trajectories, and experiences prior to, and alongside craft. In addition to interviews, I held a series of workshops around material engagements for interaction design (“DIY for CHI”, “fine-bookbinding meets electronics”, “Introduction to e-textiles”), and taught a five-month interaction graduate design course at the California College of the Arts in order to explore applications for computational and traditional design materials in interaction design practice. In each setting, my own participation fed back into my analysis.

To analyze my in-person and video-mediated fieldwork materials, I employed a form of inductive analysis called “grounded theory” (Glaser and Strauss 1967; Strauss and Corbin 1990). This method iteratively generates theories from empirical data by systematically abstracting important relationships and concepts from the collected materials. Through iterative cycles of coding, analysis, and discussion, I synthesized a model of material practice situated in particular instances of craft.

It is worth noting that the form of the representation of my ethnographic work echoes the form of the practices themselves. In the chapters focused on binding, I stay close to the materials and tools, echoing the extent to which binding is a material orienting practice. In the chapters concerned with knitting, I describe the social conditions of the practice, reflecting knitters’ concern with identity, boundary maintenance, and the production of the “well-made.” To foreground my epistemological stance — the interconnection of theory and practice — the shape of my ethnographic accounts embody the inseparability between my observation and analysis, moving freely between the two.30 By intertwining the style and format of my analysis, I notably diverge from conventional anthropological scholarship to draw on analytical traditions from design and technology studies.

**Sites: the Workshop and the Guild**

By following the work of craft across two main sites, the bookbindery and knitting guild, I examine how the sites represented different ways of exploring and assessing concepts of materiality from design and technology studies. In

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30 As the stories threaded throughout this dissertation are pre-framed by the analytical concept of material traces, and could be subject to the critique of anecdotalism, I refer the reader to ethnographers who traverse reflexive and descriptive forms of ethnographic representation, such as Renato Rosaldo (1993), Jean Lave (2011), and Mary Weismantel (1989).
particular, I describe how knitters and binders negotiated salient attributes\textsuperscript{31} of their craft products in relation to the unique cultures of production in which they were embedded. Specific forms of value, and related attributions of quality and “authenticity,” became enacted as different kinds of material traces through their maintenance, extension, or erasure.

**Binding Workshop**

Five months into my guild membership, I moved to Cambridge, UK for an internship at Microsoft Research. I aimed to examine a type of creative practice that embodied intimate and longstanding relationships to tools and materials but performed different roles—affective, practical, and symbolic—for the crafters and craft recipients as compared with knitting. I was also interested in examining a craft practice with which I was less familiar, and visited a series of workshops representing diverse skill sets (carpentry, stone masonry, and letter press studios). Eager to draw connections to IT, I settled on a bookbinding workshop not far from my temporary home where I could examine the making and remaking of IT in its most “traditional” form. There my daily activities involved a range of practices, including finishing the labels on dissertations, practicing the work of using a knife for thinning (or “paring”) leather for book covers, and re-sewing pages on old books that had been broken along the spine. In the US classroom, I took copious notes and touched four books: one book I made from paper, paste, thread, and boards, and three books I took apart and reassembled to different degrees. At each bindery, antiquarian books where continually re-made through detailed engagements with leather, paper, string, and board.

**The Knitting Guild (KG)**

My membership in the knitting guild began in March of 2010 and continues to this day, over two years later. During this period, I amassed over 2,000 yards of yarn and attended just over half of the monthly meetings, participating in social functions (such as excursions to Inverness, Montera, and the Stitches West fiber festival). In all this time, to my surprise, I did relatively little knitting. My membership with the KG was less oriented toward the production of fabric and more focused on learning new techniques (how to crochet hyperbolic planes and achieve fine lace-work by “tatting,” a Victorian knotting technique). Interviews with eight members and meetings and informal conversations informed my analysis. My most rewarding fieldwork experiences included a fieldtrip to a steel yard with

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\textsuperscript{31} Salient attributes ranged from the look of age, such as the “patina” on a metal case, (Muthesius, 2003) to the \textit{inalienable} quality of certain artifacts that cannot be separated from their maker(s) (Leach 2003, Miller, 2001, Myers, 2004).
80-year-old Ellen, where, together, we scavenged for malleable metals with which to crochet luminescent necklaces. Beyond the needles and thread, it was these interpersonal relations I developed with KG members that continued to evolve my understandings of craftsmanship, digital technologies, and their particular material forms. These relationships not only enriched my fieldwork engagements, they also offered a useful light in which to consider the craft landscapes surrounding the guild. They elicited stories of education, ambition, and failure that deeply informed crafters attitudes toward modern technologies. Expanding my focus beyond craft projects, they complemented my prior focus on tactility and embodied practice.

In this chapter, I have grounded my concerns about the concept of materiality in the design and technology studies literatures and described my central line of reasoning: the analytic category material traces, which renders visible traces of time, use, and skill by concretizing a unique location in space and time. I described the development of my research design, justified my choices of methods, and introduced my field sites wherein I consider the relation between craft and value, and the relation between digital and material.

**Dissertation Outline**

By intervening in the craft process, I contribute to the design and technology studies literatures a discussion of how specific forms of value are produced and maintained through craft and how people engaged in craft draw distinctions between the material and the digital. I then show how together these insights contribute to the development of the analytic category of material traces that materializes spatiotemporal distance and renders visible the evocative nature of material form. The next two chapters (Chapters 2 and 3) address questions of materiality in bookbinding, the following two chapters (Chapters 4 and 5) focus on questions of IT in knitting, and the final two chapters (Chapters 6 and 7) translate these concerns for material-digital relations into lessons for interactive systems design (in practice and pedagogy).

Chapter 1 sets the stage for my analysis of craft practices by surveying the literature on materiality and related themes of authenticity, age, and craft skill in technology studies and material culture studies. I find that discussions of materiality in Ubiquitous Computing literature promote an *object bias* and *trope of immateriality* that limit our understandings of digital technology to static and discrete categories of physical matter. I also discuss a gap in the material culture literature regarding how authenticity and age are enacted, and how formulations
of skill figure into their relation. The dissertation seeks to address these limitations by studying how ideas of materiality are negotiated in craft and restoration practices.

Chapter 2 examines the UK bookbindery and the ways in which materials get enrolled in the binding of the book. I show how skilled binding involves tracing links to the past through relationships with very different materials (leather, standing presses, and laptops). I then use specific cases of the binders’ practices to develop the notion of material traces wherein marks of craftsmanship get produced. Returning to the binder’s practice, I find that the same workshop conditions offer different analytical lenses: attributes (fluctuating properties of strings and glue), entanglements (interdependencies derived from interactions between binders and their tools) and rhythms (the temporal patterning of routine binding engagements). I then show how each has consequences for how we materialize work in the digital realm (e.g., recognizing delicacy or intricacy of digital tools).

Chapter 3 asks what aspects of books are worth preserving in the eyes of binders and their customers. Through studies of book restoration, engaging with a range of binders and customers, I discuss how a successful restoration is contingent on embedded stories of personal investment, how they build up through use, and how they get maintained and shared through ideas of authenticity and age.

Chapter 4 examines participation in the San Francisco knitting guild and how different concepts of technology get produced and circulated by tools, programs and people. In the guild, I find that successful craftwork is contingent on marks of craftsmanship produced during creation, some of which do not surface for the craft recipient or customer. I then discuss the digital-material distinction and how the same digital technologies provoke different anxieties and excitement.

Chapter 5 broadens discussions of technology in craft by considering a wider array of knitters and crafters, and how each group talks about their relationships to digital tools. Reflecting on these varied responses, I revisit the material-digital distinction in recent scholarship to show how boundaries become important, both online and off. Craft is perceived as a ‘secret society’ with contingent access and policed open doors (in fact, literally in the case of the knitting guild).

Chapter 6 asks how lessons drawn from craft — and the conditions in which craft is achieved — might help designers develop more meaningful and enduring technology. I introduce a design probe called Spyn with which knitters may associate digital records of their creative process with stitches on their garments. I
show how layering and interleaving subtle and distinct *material traces* (of time, use and skill) may facilitate more meaningful and enduring relationships to technology.

Chapter 7 investigates questions of digital materiality in design pedagogy. I discuss projects from a graduate interaction design studio called (Extra)ordinary materials, a course I developed and taught at the California College of the Arts (CCA) in the fall of 2011. In thinking with materiality, I sought resolve difficulties in the design and technology studies literature around how we engage practice in theory and engage theory in practice — (re)locating the material in the digital realm.

Chapter 8 concludes the dissertation by discussing trajectories for future research, and summarizing my contributions and research agenda. I show how, just as craft practice has learned a good deal from science studies, science studies has much to learn from an analysis of craft practice.
Chapter 1
Materiality in Practice

Over the last few decades, the concept of “materiality” has gained considerable currency in a variety of fields, including anthropology, sociology, archeology, and museum studies. Emerging theories about materiality have challenged the “linguistic turn,” the stream of research in social theory and anthropology emphasizing discursive formulations of the social world. Most broadly, scholars have used the concept of materiality to argue that people cannot interact in the world independently of non-human actors (Tilley 2006). From close examinations of everyday objects (saris, groceries, cell phones) to theoretical debates over materiality as the limits of discourse, concerns for materiality have helped analysts make sense of the social world by taking seriously its entanglement with physical properties (Miller, 2005; Orlikowski, 2010; Tilley, 2006).

This meeting of diverse disciplinary perspectives has given rise to a variety of definitions. Within the fields of science and technology studies (STS) and material culture studies, the concept of materiality does not refer to one set of ideas or approaches to the study of culture. As archeologist Lynn Meskell describes, “[m]ateriality is our physical engagement with the world, our medium for inserting ourselves into the fabric of that world, and our way of constituting and shaping culture in an embodied and external sense” (2004:11). With similar breadth, material culture scholar Christopher Tilley notes that “[i]n employing this term I am not just trying to discuss materials and their processural properties [...] I am attempting to engage with the manner in which the material properties of things profoundly affect human conduct, both enabling and empowering people’s lives and constraining them” (Tilley, 2007:19). A homogeneous and coherent theory of materiality may never fully cohere.

32 It is worth mentioning that my colleagues and I (Rosner, et al. 2012) recently identified three movements related to materiality in IT design: (i) new approaches to the design and engineering of computational materials, (ii) examinations of the physical qualities of digital systems, and (iii) the role of matter in the digital realm, and conceptualizing the materiality of digital bits (often as a challenge to digital-physical binaries). In a recent review of the organizational studies literature, Dourish and Mazmanian (2011) delineate five additional concerns: the material culture of digital goods, the transformative materiality of digital networks, the material conditions of information technology production, the consequential
The breadth of approaches, and the attendant lack of definitional clarity, has led to some debate around its theoretical underpinnings. In a recent conversation in Archeological Dialogues, Ingold described his experience at an anthropological conference session on ‘Materiality’:

“For the most part, I have to confess, I could make neither head nor tail of what they were talking about. As anthropologists, I thought to myself, might we not learn more about the material composition of the inhabited world by engaging quite directly with the stuff we want to understand: by sawing logs, building a wall, knapping a stone or rowing a boat? [...] What academic perversion leads us to speak not of materials and their properties but of the materiality of objects? It seemed to me that the concept of materiality, whatever it might mean, has become a real obstacle to sensible enquiry into materials, their transformation and affordances.” (Ingold, 2007b:2-3).

Ingold’s comment highlights a tension between the theory and practice of materials-focused investigations. As an anthropologist, he seeks an understanding of the material properties of the inhabited environment, by knapping stone and sawing wood, and believes that empirical proximity helps to cultivate such an understanding. This approach can be contrasted with a semiotic materialism, from Webb Keane (2003) and others, wherein material potentiality is reduced to signs. As I will soon describe, seeing the world through its “material traces” involves recognizing what Ingold terms the processional quality of tooling, whereby relations develop as rhythmic, itinerant, improvisations rather than prefigured events (Ingold, 2006; c.f. Joyce, 2011).

**Atoms and Bits**

For many, the work of knapping stone may seem some distance from building digital technology. Knapping stone involves manipulating atoms, the elements of yesteryear, whereas building digital technology entails controlling bits, the ingredients of today. “The change from atoms to bits is irrevocable and unstoppable,” Nicholas Negroponte famously predicted (1995:4). A range of scholarly and popular discourse has since followed this thesis to advance ideas of materiality of information metaphors, and the materiality of information representation. As a whole, the scholarship in these categories speaks to the multiple relationships between physical properties and social practices.
'progress' and ‘freedom’ as corollaries to IT development, casting aside the social and material phenomena in which bits are embedded.\(^{33}\)

Parting ways with futurology, scholars of information studies (Blanchette, 2011; Duguid, 1996) have warned against technological prophesies, reminding technologists that as they have little hope of freeing bits from what Blanchette (2011) calls the “shackles of matter.” From books to encryption algorithms, they show how digital technologies have been heralded by thorny claims of “supersession and liberation” (Duguid, 1996). IT ought not to become the next logical step in the inevitable technological progression. Rather than promote the quickness of change, Duguid encourages the “design [of] robust new artefacts [...] consider, in social and historical terms, the sources of endurance” (Duguid, 1996:65).

The intersection of historical and empirical concerns has already begun to engender useful possibilities for IT design. Attending to the temporality of material, for example, Rattenbury, et al. (2008) introduce the metaphor of plastic, a concept they use to describe how mobile devices are integrated into everyday patterns of activity. Plastic time describes the temporal and spatial rhythms of “unplanned, opportunistic” interaction and how they fit into surrounding events. Their work makes an appeal to concepts of materiality, which this dissertation seeks to extend in more depth. In another promising analysis, Chalmers and Galani consider “seamful interweaving”—the process by which perceivable differences between technological constituents become less important than “the quality of interaction with the whole” (2004:244). In their study of a mixed reality system they found that people’s understanding of the system emerged as part of interconnections between multiple media. Emphasizing the importance of heterogeneity, they suggest that designers attend to the diversity of actors in different “modes” of interaction. The analytic category of material traces advanced in this dissertation furthers this view by suggesting that we not only design for perceptions of seamfulness; we should also design for traces of seamfulness: the capacity of those seams to materialize their actions as they transform, mix, and flow.

Aiming, in part, to rethink dualistic assumptions, design researchers have introduced a range of new constructs to reconcile “the gap between physical and digital materials” (Robles & Wiberg, 2010:139). This work stresses similarity between the digital and physical medium and how the digital is not a distinct or

\(^{33}\) See, for instance, Blown to Bits by Abelson, Ledeen, and Lewis (2008).
exceptional phenomenon. Terms such as *hybrid ecologies* (Crabtree & Rodden, 2008), *computational composites* (Vallgaarda & Redström, 2007) and *inspirational bits* (Sundström, *et al.*, 2011) focus on the crossbred nature of new media compositions.  

The relevance of these constructs to IT design is the analytic shift they are meant to enable. That is, each concept supports a move away from thinking of things as either fundamentally physical or fundamentally digital to understanding all things as material. This move accommodates a widening array of technologies and processes available to interaction designers. Piezoresistive textiles enable new touch sensitive surfaces, shape-changing polymers make possible a range of flexible, sensory rich interactive environments, and conductive thread sewn into fabric create wearable antennas for FM reception (Roh, *et al.*, 2010; Roh, *et al.*, 2011; Rasmussen, *et al.*, 2012).  

However, one central difficulty remains: what do hybrid ecologies and computational composites have to do with the way people experience digital tools? How do these terms account for the perceptions and values of those living and working with different materials, from leather and wood to Twitter feeds and WiFi signals? The pervasive distinction between digital books, for example, and physical books, or the use of digital Wacom tablets in comparison to pencils and paper. Rather than focus on sameness, I draw on diffractive methodologies to interrogate differences between the digital and material. I then examine how these distinctions are drawn in craftwork as part of a sense of craftsmanship, moral order, or even moral threat. The demarcation of technology, I suggest, has less to do with its digital or non-digital nature than how it enables or subverts certain kinds of

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34 *Inspirational bits* are technological parts meant to inspire the design of interactive systems sensitive to “dynamic properties” (Sundström, *et al.*, 2011), *computational composites* suggest the integration of computation within the physical environment, and *texture* takes into account “modes of relation” between digital and physical properties (Robles & Wiberg, 2010:139). See also (Bogost & Montfort, 2007; Bratteteig, 2010; Cramer, Rost, and Holmquist, 2011).

35 While a range of materials have become newly available to designers (Beylerian, Dent, and Moryadas, 2005; Brownell, B. 2010; Lefteri, C. 2002;2003;2004;2006; ), many of these phenomena are not new. For example, certain shape-changing polymers, may suggest new possibilities for prototyping and design, however, older materials, such as corn starch, exhibit similar shape-changing qualities depending on how they are put to use (the mix of corn starch and water acts as a solid when pressure is applied, creating interesting forms while shaken, see the Grid Starch project by Hironori Yoshida [http://cargocollective.com/hybrid-materiality/Grid_starch]).

36 See STS scholars such as Haraway (1988) and Barad (2007).
practices and values (as discussed in Chapters 4 and 5). My ultimate goal is not to reject the digital/material boundary, but to investigate the conditions that make it so — why it exists, for whom, and why it is maintained.

**Trope of Immateriality and Object Bias**

Beyond the practical implications of the digital/material boundary, discussions of materiality in IT design have helped sustain two analytical shortcomings. First, materiality is taken as tantamount to physicality, a conflation that assigns material to a distinct realm of embodied or tangible interaction. The fields of tangible and embedded computing, ubiquitous computing, and physical computing are ripe with projects that seek to “bridge” the established physical-digital divide (Ehn & Linde, 2004; Fitzmaurice, Ishii, & Buxton, 1995; Ishii & Ullmer, 1997; Weiser, 1991). For example, a tool such as Anoto pen (Haller, et al, 2006) integrates notes on paper with digital audio records collected while writing; ButterflyNet (Yeh, et al, 2006) similarly associates paper notes with digital photographs captured during field research in order to seamlessly transition between the virtual and real. These explorations of “digitalphysical artifacts” maintain an ontological separation between atoms and bits. As recent work has begun to address (e.g., Chalmers and Galani, 2004, Rattenbury, 2008), treating material practice as a special case of design places materiality a long way from the digital and risks overlooking important players in IT design, such as valued evidence of ownership, authenticity, or age on digital recipe collection. This treatment exposes the *trope of immateriality* (Blanchette, 2011) wherein digital information is denied its material form.

A second concern for IT design is how we have equated artifacts with the material—“the stuff things are made of” (Ingold, 2007b). While we have usefully highlighted the social and functional roles of artifacts (paper, books, tools), we

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37 Here Büscher’s (2006;2008) extensive research on what she terms palpable computing becomes helpful for considering how computing might be “available to the senses” through visibility, deconstruction, understandability, coherence, stability, user control and difference. Dix and others (2006; Vyas, et al, 2008) have similarly attended to “physicality” by exploring the way artifacts, tools, and appliances can inform the design of more “novel digital and hybrid digital-physical artefacts” (Dix, 2006:1). Although the concept of affordance (e.g., Norman, 2002) has usefully called attention to the ways in which physical objects structure and inform practice, it has been treated with some caution in design, as it sensitizes designers to the sociomaterial dimensions of artifacts as a matter of a perception rather than a matter of situated material engagement (Hutchins, 1996; Svensson, Heath, & Luff, 2007).
have also overlooked the constituents (the grain of paper or shine of plastic) and their continued mixing, changing, combing, and dissolving over time. Within technology studies and IT design, materials are enrolled circuitously: when a particular communicative breakdown arises (Mackenzie & Monk, 2004), a request for information is made (Sellen and Harper, 2003), or defects in operations emerge (Berg, 2000). The material qualities of practice are considered critical to some aspects of action and not others. Additionally, material refers primarily to the tools of the trade — drills, suction instruments, slabs of steel. IT researchers rarely look beyond artifacts to their constituent relations. As Suchman (1987) and others have noted, treating artifacts as uniform actors belies their emergent and constituent nature. This prior work advances an object-bias wherein materials are attended to as fixed forms rather than as heterogeneous enactments. In the knitting guild, for instance, a hand-knit sweater intended to replace a drab but intricate machine-knit sweater is not perceived as a single artifact, but as distinct dynamics of accomplishment, difficulty, and regret (due to the invisibility of the invested human labor and the subsequent lack of appreciation). As we will see, this bias conceals the temporality of material with which we might effectively conceptualize design practice.

**Toward Textility and Intra-action**

Current debates about the work designers do have involved understanding the relationship between designed artifacts and social practices. Within technology studies, particular designed materials such as computer programs or usage manuals are seen to do certain work to shape social interactions. From expert help systems (Suchman, 1987) to mobile phone messaging (Horst & Miller, 2006), technologists “configuring the user” (Woolgar 1991; Grint & Woolgar, 1997) by inscribing artifacts with their vision of the world (Akrich, 1992). For Akrich and

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38 For instance, technology studies and IT design has carefully considered the use of books, paper and physical documents. This includes Harper and Randall’s (1992) descriptions of flight strips in air-traffic control, Berg’s (2000) discussions of paper as a bedside technology, Mackenzie’s (2004) analysis of task cards in programming, and Sellen and Harper’s (2003) discussion of paper in office work.

39 The technology studies literature has examined how artifacts and machinery are brought to bear in the practical accomplishment of a range of tasks, including passing and handling surgical implements (Svensson, Heath, & Luff, 2007), operating a steel plant (Clarke, et al., 2003), the codification of soil samples (Goodwin, 1994), the arrangement of clutter in the home (Swan, et al., 2008), and the communication of knitwear design specifications (Eckert, 2001).
Latour, the definite and specifiable character of such systems suggests a textual analogy. Akrich terms the “end product” of technical work a script, the “specific tastes, competences, motives, aspirations, political prejudices, and the rest” with which human and non-human actors are defined (Akrich 1992: 208). Latour similarly speaks of inscription as something “more basic than writing”, drawing out “all traces, spots, points, histograms, recorded numbers, spectra, peaks, and so on” (Latour & Woolgar, 1979, p.88). Inscription involves translating one’s perspective into a more durable form (Akrich 1992: 208; Callon 1991: 143; Latour, 1992:256).

To take a simple example, consider Woodward’s ethnographic study of London women’s wardrobe assemblages wherein she found that a poncho was used to not only express modesty, but also to make modesty possible (2005). One participant was so wed to a particular appearance that she had “consciously to cultivate such a ‘natural’ untaught look” (Woodward 2005:27). Inscription entails how a poncho, iPhone, or pair of worn blue jean, in part ascribes possibilities for practice.

In contexts of design, the terms of inscription posit the work of demarcation and, in turn, a causal relation between technology design and action. Designed artifacts “establish systems of causality” (Akrich, 1992; 220) in order to stabilize relationships between actors. This causal relation between design and action is one that social anthropologist Tim Ingold (2007:95) and feminist scholar Karen Barad (2007) would likely protest. As we have seen, Ingold asks anthropologists to produce accounts using reflexive, firsthand interactions with material (shaping stone, building a wall). His reading of technology entails an unfolding of action that he coins the processional quality of tool use (Ingold, 2006:67-70).  

This quality consists of recognizable phases that, like walking, become improvisational in character; they are not rigidly specified and do not follow each other in succession, but they are drawn into relation according to an itinerary. Developing this notion further, Ingold describes the textility of making, which stresses the woven quality of making and its emergent, processional character (“at once itinerant, improvisatory and rhythmic”) (Ingold, 2010:91). This lens enables Ingold to challenge the Aristotelian separation of form from matter wherein things are only produced through the combination design plans and material, posing thoughts as

\[\text{Drawing on Rubin, Ingold argues, “we need to think of making in terms not of the simple, mechanical execution of complex structures, but of the form generating potentials of complex processes.” (2001:22)\]

\[\text{As discussed in chapter 6, other scholars draw on the metaphor of texture to describe humans making with materials, but in different ways: to move beyond the invariant “physical-digital divide” in interaction design practice; see Robles & Wiberg, 2010.}\]
separate from physical phenomena. He recognizes the process of making as
dynamic, not static. Our first-hand accounts, then, should not focus on stable
states and forget the dynamic succession of the changes that got us there.

Barad more directly challenges the ontological separation of thought and physical
phenomena by offering the notion of “intra-action,” a process of engagement in
which individual agencies are preceded rather than followed by practice (Barad,
2007: 33). Writings by the theoretical physicist Neil Bohr form the basis for Barad’s
agential realist framework: “according to Bohr [...] we need to attend to the actual
experimental conditions that would enable us to measure and make sense of the
notion of intentional states of mind.” (2007:21-22). Intentions are not prefigured
states assigned to individuals but emergent and “entangled,” lacking an
“independent, self contained existence” (2007:ix). Departing from Bohr’s limited
use of the term phenomena (ibid:427), Barad integrates and broadens his
“philosophy-physics” to ask,

How did language come to be more trustworthy than matter? Why are language
and culture granted their own agency and historicity, while matter is figured as
passive and immutable or at best inherits a potential for change derivatively from
language and culture? How does one even go about inquiring after the material
conditions that have led us to such a brute reversal of naturalist beliefs when
materiality itself is always already figured within a linguistic domain as its
condition of possibility? (Barad, Meeting the Universe Halfway, 2007:132).

The terms of materiality underlie our every effort to understand (and push back
at) the privileging of discursive claims. Knowing is material in nature, emerging
out of our engagements with the world.  

42 Ingold describes this view as the “hylomorphic” model of making. The hylomorphic
model brings together the Greek terms morphe (form) and hyle (matter), a distinction
hailing from Aristotle (Ingold: 2010:92;2012:432)

43 In particular, Barad introduces playwright Christopher Frayling’s account of the Niels
Bohr-Werner Heisenberg encounter to draw attention to our tendency to misconstrue the
nature of nature. She questions moral judgment and accountability (in science, art and
beyond) to reexamine to how people produce their theories, epistemologies and ontologies
toward such judgments. By infusing theory into practice, matter into meaning, knowing into
being, Barad throws consequential differences into question.

44 For Barad, minds are material phenomena, concepts are physical arrangements, and
 theorizing is embodied practice (2007:361).

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Despite a shared distrust of essentialist distinctions between mind and matter, Ingold and Barad have rather little in common: they hail from different disciplinary lineages (anthropology and physics), draw on distinct methodological approaches (empirical and feminist theory), and, arguably, articulate different epistemological goals. Importantly, Ingold is wary of the vocabulary introduced by cultural theorists — terms such as agency, materiality, intentionality, functionality, sociality, spatiality, and embodiment (2007:2); whereas Barad uses this vocabulary to reconsider conventional distinctions between knowledge and being. She employs concepts of agency and intentionality to discuss how phenomena are not pre-existing, but are mutually enacted through their relationships. Phenomena become *intra-actions* spread over space and time, without distinct location, ownership or novelty—"new is the trace of what is yet to come" (Barad, 2007:383).

The title of this chapter, Materiality in Practice, confronts questions raised in Ingold’s and Barad’s articulations of production — namely, how we constitute knowledge through practice. In focusing on the particular material conditions of modern craft, this dissertation draws on Ingold and Barad’s frameworks to suggest that both the making and the understanding of materials shape possibilities for practice and confer value. How a knitter decides to replicate a sweater, or how a binder decides to stain the replacement cover involves technical intricacies, material entanglements, and collective rhythms that bring meaning and matter back together. This treatment of materiality and temporality underpins my rethinking of design practice. How and why we grant material beings agentic

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45 Interestingly, Ingold (2012) draws on Barad’s posthumanist performativity (2003) in his recent *Anthropology Review* article to propose an ecology of materials. For both scholars, materials are “ongoing historicity” (Barad, 2003:821, in Ingold, 2012:439), “an active participant in the world’s becoming” (Barad, 2003:803, in Ingold, 2012:439). While Barad seeks to illuminate “material differences, relationalities and entanglements” (2007:37), Ingold is more resolute: “My aim is to restore things to life and, in so doing, to celebrate the creativity of what Klee (in Ingold, 2007a:73) called ‘going out for a walk.’ This means putting the hylomorphic model into reverse. More specifically, it means reversing a tendency, evident in much of the literature on art and material culture, to read creativity ‘backwards’, starting from an outcome in the form of a novel object and tracing it, through a sequence of antecedent conditions, to an unprecedented idea in the mind of an agent. This backwards trajectory is equivalent to what anthropologist Alfred Gell has called the abduction of agency” (Ingold, 2010:97, emphasis in original).

46 Ingold’s (2012) recent discussion of material in the *Annual Review of Anthropology* makes the case for an ecological perspective to material, while relying on Barad’s (2003) reasoning in *Posthumanist Performativity*. That is, Ingold intertwines his argument with that of Barad to attend to materials as dynamic histories, rather than inert entities with diagnostic features (Ingold, 2012:434).
status not only shapes the values they accrue, but also the material histories they leave behind (Barad, 2007:427).

In order to ground this theoretical argument I turn to empirical work in a binding workshop and knitting guild, domains that consider concepts of materiality through distinct ideas of authenticity and skill. The remainder of this chapter I take a closer look at how these themes are characterized by scholars from cultural anthropology, and material culture studies in particular.

**Age and Authenticity**

According to conventional wisdom, age is a persistent feature of material. Attributes of material can be chemically or physically measured in order to assess a range of qualities, such as time and place of origin, authorship, and techniques of production. Distinguishing age based on material conditions enables art historians to categorize chronologies and archeologists to describe points of origin. Age and authenticity are therefore intimately connected through their naturalization as inherent properties of artifacts.

This claim resonates with early western concerns for antiquated artifacts. At the turn of 19th century, assessments of age and originality became intertwined through the regulation of antiques. Antique dealers began enforcing distinctions between the old and new craftsmanship, refusing to acknowledge a recently produced artifact as “original” (Attfield, 2000:114). Associated with nostalgic visions of the past, age became indicative of domestic moralities, inciting ideas of comfort and habitat; as the writer and art critic John Ruskin wrote of Holman Hunt’s furniture, “fatal newness; nothing there has old thoughts of home upon it” (Ruskin in Muthesius, 2003:233). Material conditions of age, such as the “patina” on a wooden cabinet, could evoke emotional appeal as well as recall memories of past practices, such as particular traces that cast one’s mind back to olden ways of using objects (Muthesius, 2003: 235).

Such perceptions of age rose alongside new craft practices, including “antique shading” and “antique finish,” craft treatments that provided the look rather than the ‘true’ experience of the past (Cescinsky in Attfield, 2000: 114). Within the modern African tourist industry, for example, anthropologist Christopher Steiner (1995) found that artificial aging (making objects appear older than they are) enhanced their desirability. This is no less true in the book trade, where binders have been trained to produce the look of age to increase a book’s perceived
authenticity and, thus, monetary value.\textsuperscript{47} It is both the work of production and valuation — judgments of age, authenticity, and associated notions of quality — that enable binders to successfully market and exchange their products. These qualities, in this sense, are not inextricably tied to material, but configured by precise and selective acts of recognition, rejection or (in)validation.

The identification of age and authenticity hinge on assessments of “old” versus “new” and “real” versus “fake,” naturalized distinctions that several scholars have come to question through a renewed interest in practice (Lave, 2011; Schatzki, Certina & Savigny 2001; Shove 2007). Practice perspectives recognize moral claims as produced, maintained, and enacted through routine work and practical accomplishment. Anthropologist Christina Kreps (2003), for example, has argued that notions of authenticity are produced differently based on the social norms and folk traditions within each culture. In her study of museum-like phenomena outside the West, she found that museum objects were not always precious or made to last through physical preservation.\textsuperscript{48} Instead, the objects were attributed cultural value through practice.

Much remains underdeveloped in these discussions of authenticity, and age, more generally. Concerns persist, for instance, around what Brian Spooner refers to as “the evolving relationship between the search for personal authenticity inside and the search for authenticity in carefully selected things outside” (1986:226). Or how, exactly, a book comes to be known as an “honest book” (Sherman, 2008:164). In a recent analysis, archeologist Siân Jones (2010) suggests approaching questions of authenticity and its production at the nexus of two concerns: the “materialistic” position in which authenticity is inherent in an object, and the “constructivist” perspective, in which authenticity is generated by culture. She suggests that neither view provides an accurate understanding of authenticity; rather authenticity is a network of people, places, and objects through which relationships are mediated. This observation inspires the work of this dissertation, a move into production through knitting as well as restoration and reproduction through bookbinding.

\textsuperscript{47} Also see Theodor Adorno’s (2003 [1973]) views on the “jargon” of authenticity, which he uses to critique Heidegger (ibid:6).

Restoration and Craft Skill

Within the book trade, restoration and its history has been difficult to unravel, in no small part due to the intricate nature of its documentation and the ways in which restorative practices are often neglected as subjects of study (Benton, 2000:163). Book restoration has involved everything from replacing a deteriorated sewing thread to “cleaning” a mottled margin by washing, bleaching, or trimming the page. Though it has been met with some ambivalence by modern authors (Sherman, 2008:158), human intervention has been largely denigrated by book historians (e.g., characterizing the annotation of books as “dubious methods” (ibid:158)). Among book collectors, notes written in a book’s margins (marginalia) were viewed as an “asset” in the book trade up until 1820 (Jackson quoted in Sherman, 2008:164-5), but then became popular again a century later as they were “dignified by descriptions” (Slive 2003 quoted in Sherman, 2008:165). The ink, typography, page formats, and all other “textual phenomena” were seen as effecting the interpretation and value of the text—whether or not one was aware (McGann 1991: 13-14). In order to interpret the traces of binding work, and locate them in past practice, one requires an understanding of particular craft skills.

Within IT design, a small but vibrant ethnographic tradition has emerged around the study of everyday maintenance. Steve Jackson (forthcoming) credits this scholarship as “some of the most consequential work” in early HCI ethnography. For instance, Lucy Suchman, Julian Orr, and colleagues turned to the lives of photocopy machine repair workers to illuminate the limitations of codifying maintenance techniques (Suchman 1987, Orr 1996). Orr’s influential accounts of individual diagnoses exposed skilled service work as “necessarily improvised, at least in diagnosis, and centered on the creation and maintenance of control and understanding” (Orr 1996, p.161). Orr showed how repair workers not only use manuals and codified organizational knowledge; they also rely on the retelling of “war stories” — personal accounts from the field often shared over lunch or informal meetings. Each repair activity involves situated actions whose intent, in Suchman’s terms, “must be contingent on the circumstantial and interactional particulars of actual situations” (Suchman 1987, p.186). Star and Strauss have examined the invisibility of “articulation work,” the reparatory activities that “accommodate unexpected contingencies” by getting work “back ’on track” (Star 1991:275, quoted in Star & Strauss, 1999: 10; Straus, 1988). Others have studied the arcana of free software through the continuously rewritten fabric of the Internet (Kelty 2008). Most recently, Jackson (2011) explores what he terms “repair worlds” in Sub-Saharan Africa to rethink how different information technology infrastructures are routinely maintained and extended.
Beyond the curatorial work of restoration, concerns for craft skill have re-surfaced as part of a broader refiguring of leisure as a critical facet of everyday practice (Panzar & Shove, 2005). Alongside the modern “visionary” (Harper, 1987:172) and “imaginative” (Dant, 2010:7) talents of car mechanics, scholars have observed the “obsessive” diligence of motorcycle repairmen (Crawford, 2010) and the varied competences of DIY activities (Watson and Shove, 2005). These practices underscore a pride in workmanship and bricolage (drawn from Levi-Strauss) that Sennett (2008), Crawford (2010) and others (Harper, 1987; Sturt, 1963) ultimately use to build a case for working with one’s hands. They suggest such work offers a retreat from an increasingly “rationalized” and management-driven workplace that inhibits pride in workmanship and accountability. Conventional office work is seen as contributing to fading skill acquisition and failed fantasies of mastery. Consumer electronics are viewed as black-boxing what was once instrumental to repair. For Harper (1987), craft skills are intricately connected with cultural change (Harper, 1987:201).

More broadly, questions of cultural change situate observations of skill as an emergent and fluctuating dimension of material culture. As Tim Ingold suggests, embodied skill “demands an ecological approach” (Ingold, 2001:21; c.f. Ingold, 2012) through which we observe its emergent, improvisational character (Ingold, 2006). Theorizing from an archeological perspective, Michael Schiffer (2001) emphasizes the traces of skilled production, such as the relations of compromise between the creators and users of objects. Shiffer’s notion of performance characteristics (Schiffer 2001:172) captures the interactional qualities of an artifact that emerge through use and enable the archeologist, like the repairman, to understand the life history of things. Such marks of action work more to express “a series of stories” rather than an attribute (Ingold 2006:72) as they get brought into use through sensory corrections. These corrections cannot be described as a technique of the body and cannot be reduced to formula (Rubin, 1988 discussed in Ingold, 2001). Looking upon this human-technology relationship opportunistically, Malcolm McCullough writes:

“Tools and technologies have both assisted and opposed the hand throughout history; the relation is not necessarily adversarial. […] As part of developing more engaging technology, as well as developing a more receptive attitude toward new opportunities raised by technology, we must understand what matters in traditional notions of practical, form-giving work.” (1996:19).

As apparent from McCullough’s comment, there is still some ambiguity in how formulations of skill figure into the relation between authenticity, age, and distinct forms of value. Deciding how something ought to be created or restored involves
not only readjusting one’s relationship to the tools and materials of production but also renegotiating the craft techniques themselves. How valued qualities of the book are woven into the *textility* of making (Ingold, 2010) — the fabric of improvisation and rhythmic responsiveness — is where my work begins.

In summary, this chapter has surveyed the literature on materiality and related themes of authenticity, age, restoration, and craft skill in technology studies and material culture studies. I found that discussions of materiality in IT design promote an *object bias* and *trope of immateriality* that limit our understandings of digital technology to static and discrete categories of physical matter. I also discovered a gap in the material culture literature regarding how ideas of authenticity and age are enacted in relation to formulations of skill. The following chapter begins to address these limitations by studying how ideas of materiality are negotiated in practice.
Chapter 2 Material Traces

Set against the intellectual backdrop of Cambridge University in a quiet cul-de-sac at the edge of the city, what was once an industrial district that produced everything from house construction materials to milking machinery has recently become an “Enterprise Centre” — a set of buildings split into smaller workshops and office spaces. The residing entrepreneurs include a bike mechanic, a graphic design studio, a letterpress workshop and the largest remaining restoration bookbindery in Cambridge.

The bookbindery has a close relationship with many of the city’s bibliophiles. Rare book collectors with sophisticated knowledge of a book’s condition may call on the specialization of restorative skills, such as the reproduction of worn “re-backing” cloth or the gold tooling applied to leather-bound books. Less discriminating clients may simply hope to receive a solid bind: an encased doctoral dissertation, a repaired family bible, or a re-covered cookbook. Thus, as part of the range of services provided, restoration in its many forms has been a core component of the bookbindery for some time. Their routine work involves the mending of torn pages, the replacement of cords along a decayed spine, and the strengthening of the joint between the cover boards and text block, each essential constituents of the book. Deeply ingrained in the practices of the bindery is a sensitivity to the material attributes that enable the book’s longevity and use.

Figure 6: (left to right) Sean uses a hand-tool to place a title on a book spine; Peter and a student examine the mottled pages of old books; the binders at work.

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The rise of the “Enterprise Center” has a lengthy history that I do not have the space to elaborate on in this chapter — for a summary of the historical archive available online see <www.historicaldirectories.org> as well as <http://www.colc.co.uk/cambridge/gwydir/house2325.htm>.
With these ideas in mind — of time and decay, on the one hand, and use and wear, on the other — I begin to delineate specific ways of approaching craft materials and their relationship to new digital technologies, a project that evolved out of my early design research employing techniques from user-centered design (UCD). In the bindery, books develop from parts and pieces into encased archival objects through a series of discrete activities: folding, sawing, sewing, pressing, gluing, chopping, rounding, backing, lining, paring, staining, covering, and finishing. Performed sequentially, these activities form the backbone of the book as well as of this chapter; that is, I work my way from the detailed use of materials and tools to their situated use in the collaborative environment of the workshop. I then show how each stage of binding has qualities that contrast with our ways of describing and analyzing digital technologies.

Figure 7: Sewing around the chords on an 18th century book I restored with Sean and Peter’s guidance (left); book after spine restoration (right).

Following on Ingold’s call to engage with the material (“the stuff things are made of”) by sawing logs, building walls, or knapping stone,50 this chapter uses my firsthand experiences observing and learning to bind books to develop the analytic category of material traces to understand production and use of meaningful and enduring digital tools. I introduce this idea by showing how the binders trace backward: materials offer the binders different possibilities for experiencing a point in time and space, recalling Benjamin’s (2007 [1968]) notion of aura associated with the unique quality of a work of art.

Alongside my analysis, I introduce three lenses on material traces that shed light on craftsmanship and related concepts of value. I first suggest that we focus on

50 For a discussion of Ingold see chapter 1.
material *attributes*: the constituent elements (digital and non-digital) that combine to exhibit specific propensities, such as frailty, firmness, or pushiness. I then suggest that we examine material *entanglements*: how the interrelation of different materials shifts the assignment of value(s) (*e.g.*, more or less tool-like and machine-like instruments). I finally reflect on material *rhythms*, the temporal patterning of work that often extends into the digital medium. I reveal how the binders’ materials not only frame but also enlist the binders in particular types of skilled work.\(^{51}\)

### Learning to Bind

Sean is the founder, owner, and operator of the bindery, and employs his long-time business partner Peter. While Sean is a loquacious character, eager to chat with new customers or visitors, Peter is more reserved and disciplined in his interactions, attending to the task at hand and leaving most of the client relations to Sean. One might say that Sean's workshop represents a disappearing site in the bookbinding industry. Three bookbinders and five bookstores closed in the city over the last five months. For the binders, repair and restoration work has diminished due to a decreasing number of clientele, such as secondhand book dealers, who find themselves with increasing competition from online booksellers and e-book markets. Declining book sales have been attributed to the emergence of self-publishing companies\(^{52}\) and online journals, which displaced what was once the binders’ “bread and butter” work.

Yet the bindery is far from decline. Much like workshops of the 19th and early 20th centuries, it has amassed several loyal local patrons and book collectors—enthusiasts seeking to learn more about the trade. The workshop also runs with remarkable ease: Sean handles the book decoration, the client relations and the orchestration of jobs; Peter handles the majority of casing, backing, and fine restoration work. Given the smooth hand-off between them, it is of little surprise that they have known each other for 38 years. Their two roles roughly follow the 19th century separation of binding tasks into forwarding and finishing. Forwarding refers to the steps of sewing together the sections of the book and attaching covers to the resulting book block. Finishing describes the process of decorating the outside of the book (*e.g.*, through gold tooling). Remedial jobs such as over-

\(^{51}\) Related papers include (Rosner, 2012; Rosner & Taylor, 2010).
\(^{52}\) Online self-publishing companies such as lulu.com or shutterfly.com offer comparatively inexpensive products, in small quantities, and with comparatively quick turn around.
sewing the text block on a sewing machine, cleaning the shop and fetching milk for tea are filled by M., a part-time employee or “dodge boy,” as Sean likes to call him.

The workshop’s layout and physical arrangements convey more about the practices and relationships that characterize the bindery. The workshop is composed of two rooms: a smaller room with tables along the walls and a larger room with tables down the center. Two open doors and a long window separate the rooms. Peter handles the majority of forwarding work in the small room, and Sean does much of the finishing in the larger room, along with other organizational tasks. The equipment residing in each room reflects this division. The smaller room houses a machine designed for cutting large stacks of paper (appropriately called a guillotine), the rounding and backing machine (for creating the book spine), and the board chopper (for cutting down materials such as board covers). The larger room contains tools used for setting type and decorations, a file cabinet of business records, and the tools that facilitate Sean’s correspondence with customers (his cellular phone, laptop, and the oft-ringing front door). Like materials and tools, the workshop and its contents help order ongoing activity—separating Peter’s forwarding from Sean’s finishing work, and circumscribing the hand off of activities between them.

Alongside 19th century guillotines and standing presses, new tools also entered the workspace over the last few years. A laptop connected to wireless Internet gives Sean immediate access to business inquiries and other correspondence. Word processing software enables the design and printing of labels for book spines. And a mobile service provides sophisticated means of coordinating jobs: if Sean misses a call on his phone, the call is automatically routed to Peter’s phone, and vice versa, until the call is picked up. Such accessibility extends to their website where a family friend has posted a brief introduction to the workshop’s services and history. It was this website that led me to the bindery.

**Beginnings of a book**

*I insert my saw into the spine of the text block, angling it backward as I pull it across the sections of the spine. I stop. The saw does not want to move back up the sections. Instead, it wavers, and the sections waver with it. I readjust the saw in my hand, curving my thumb around top of the handle, aligning my body over the block. I pull down, hit the bottom of the spine, and reinsert the teeth at the top once more. I repeat: pull down, realign, pull down. Aware that I am only sawing in one direction, I try to move the saw up the groove on the block. The block begins to wobble, and I stop. “Not deep enough,” Sean says, leaning down to check how far the groove has come. I reinsert the saw at the*
top and apply more downward force. The groove looks thick and contorted; far messier than the thin mark Sean created a few inches to the left.

– Field notes, July 13, 2010

The above excerpt describes my experience sawing into a book spine, one of the first activities in my restoration process. Here sawing follows a coarsely defined trail, once again echoing Ingold’s (2006) discussion of the processional quality of tool use in reference to sawing a plank of wood. This quality consists of recognizable phases that, like walking, are not rigidly specified and do not follow each other in succession; instead they have an improvisational character.

In the context of the bookbindery, my sawing produces further associations. As one of the first steps in bookbinding, sawing creates a groove along the text block that marks locations for sewing by other hands. As an intervention, sawing becomes a successive stage in the lifecycle of use and assembly; for example: catalogues are produced by a company, collected by an enthusiast, and now arranged by me for rebinding. In this respect, sawing begins to unveil a set of different relations around handwork practice of relevance to interaction design. It is easy to see this detailed engagement as individual, i.e., cutting through thin layers of brittle coated paper involves two hands and a saw. Yet, as we will soon observe, sawing reveals itself as part of a range of social and material activities beyond this immediate context. Sawing presents a possibility — the beginnings of a book.

Figure 8: Fraying chords on 18th century dictionary.

**Materials**

I first learned to appreciate the binders’ skill by studying how they engage the properties of their material. After creating saw grooves, thick strings called “cords” are inserted along those grooves and a needle and thread pass around the cords to
secure the gathered pages (see Figure 8). In the next example from my field notes, Peter demonstrates how to fray the ends of cords so that they eventually lie flat under the cover.

*Peter frays the cords that adhere the sections of the 18th century book. As his knife moves along the cord, he is sensitive to how his thumb creates resistance with the knife, grooming the material down to a thin, flexible form. As it is worked, the crisp end thus gradually loses its shape, turning flat, malleable, and increasingly thin. “Feel the ends,” he instructs, taking a moment to let me rub the material. The cord has a silky texture. As Peter continues, a small cloud of beige material builds around the knife, obscuring my view of his hands. Peter stops again to fold the end of the cord over the book’s spine, pressing it flat against the bare cover board. Some fuzz has fallen to the floor and I can see the cord’s remains: a fine wisp. The once tight, brittle form is now a delicate lock of thread.*

*Peter hands me the knife: “Your turn.”*

Fraying a cord is one of the first techniques I learned at the bindery because it highlights some of the ways in which materials hold the book together. On older books, cords are used to secure the pages by creating thick bands along the spine, which threads are sewn around (see Figure 8). To ensure the book’s strength and smooth look, the cord’s middle must remain strong (securing the pages), while its edges must become weak (so that they lie flat and imperceptible under a cover board). As such, the cord’s properties must be changed: its round shape turned flat, its brittleness made smooth and flexible, and its solid mass converted into a cloud of fuzz. Peter is attending to each of these changes by pressing his thumb between the cord and paring knife, a small hand tool used to thin leather (Figure 10). He concurrently monitors the knife’s movement and the cord’s tactile qualities to respecify the book’s look and durability. The ability to manipulate material is therefore not an all-encompassing skill. A material may give the binder hints as to how it should be sawed, sewed or pressed, but it will challenge and surprise the binder, too. Consequently, much like Schön’s (1983) notion of reflective conversation, the binders’ materials are often described as having a say in the binding process; and sometimes they even need convincing. “Persuade the sections out” was Peter’s way of telling me to separate the sections of the text block while I rounded a spine. Similarly, when an assistant wanted to set letters on a spine, he asked: “Does it want to be capital?” Thus, though materials are inherently oriented toward performing one way or another, binders can negotiate a way forward through careful manipulation of tools in response to the needs of the material.
Yet Peter’s work involves additional concerns beyond the book. He is aware of my presence, asking me to take part in actively monitoring the cord myself. He is also attending to his next job (a stack of theses that await new bindings) and the subsequent work for this book (pressing and then handing it to Sean). Fraying cords involves interweaving these seemingly discrete activities. Like the sawing that came before, it is not a solitary event; rather it is entrenched in the broader spatiotemporal arrangements in the workplace.

Before the next stage of binding, let us first briefly consider the relevance of this work to interaction design. For starters, we see how the binders engage the particularities of material. By identifying material properties (flexibility, brittleness, roundness, strength) we might similarly interact with specificities of the digital. When we talk of e-readers, for example, to what extent do we invoke ideas of delicacy or intricacy? Do we refer to the metal case, the processor, the e-reader software, the digital file, or all of the above? The terms with which we refer to our computational devices are often vague and non-descript, whether we speak of readers, pads, and monitors or clouds and grids. Such ambiguity suggests an ambivalence toward their digital particularities and an understanding of the digital as metaphor.

Understanding how materials affect our interactions means attending to the material properties of digital content: the ways digital elements mutate and degrade over time, how they get encoded and stored as well as how people fine-tune their configurations. We also recall from the interplay between knife and leather that materials have a “say” in the process. The materials tell us they are not passively confined to the things made from them but have their own propensities for mixing, mutating, swelling, or shrinking. In this sense, materials are not imbued with agency but exhibit agency by revealing other properties. The cloud of fuzz is no longer a cord but a result of the formation of a flexible and flat wisp. This suggests we consider how digital materials have an equal say in work practices, and how their preference emerge in and through different contexts of use.

Additional elements figure into these material assemblages, including tools and instruments, the elements that enable such manipulation. In my interactions with tools, I became aware of the interplay between the materials and the binders — how the materials are not just worked upon but also act as a guide to how they should be altered.

**Tools**
The tools of bookbinding tend to resemble common household implements: scissors, knives, rulers, hammers, and so on. They also reflect the breadth of
techniques involved in binding, much like Sanchez Svensson, et al.’s ecology of surgical instruments “suited to the specifics of particular interventions and procedures” (Svensson, 2007:44). For instance, the bookbinding hammer has a rounded rather than flat face so that it does not indent the paper (while “rounding” a spine). Each tool is put to use in order to accomplish a particular task— sharpen a corner, trim an edge, fray a cord. Next we see how a round brush is used to apply glue to a piece of cloth that will soon be attached to the book cover.

“Splunge!” Peter instructs, glancing over my shoulder. “Let your brush dance across the page.” My left hand (holding the cloth) jiggles with each paint stroke. I move the brush more quickly, but it pulls at the surface. “Hold the page still. Don’t let it move,” Peter directs. I readjust the position of the cloth with my right forefinger and continue to paint, paying close attention to the thickness of the glue across the surface. Peter’s voices reemerges: “not too thick!” The glue refuses uniformity. The brush coats parts of the surface that I was not aiming to cover, unevenly distributing the glue across the surface. “Here, here and here,” Peter points, calling attention to bits of dry cloth, areas where my brush had not traveled. Frustrated, I scrape the surface with the brush, changing my brush marks from dots into lines. I carefully lift the cloth and remove the newsprint below.

Figure 9: Peter shows me his “splunging” (brushing) technique whereby glue is applied to a flat surface. Here he splunges a new end page (the first/last page) of an older book.
Here my interactions with the brush, glue and book reveal something more about Peter’s direction. By pointing out the look of the surface, the feel of the spring, and the pace of my movement, Peter is sensitizing me to the various elements of binding. Like the fraying and sawing that came before, splunging is entangled with the next stages of binding as well as my role in the workshop, as a student. Once again we observe my brushwork as not a static or solitary achievement, but as embedded in material engagements distributed over time. In this routine activity we find the ingredients of what Barad (2007) refers to as intra-activity, the mutual constitution of entangled form, wherein propensities of the hand, glue, and brush emerge through rather than precede their entanglement.

![Figure 10](image1.jpg)

Figure 10: Peter using a “paring knife” (left) to thin leather for a new book spine and a “paring machine” (right) to thin leather for new corners on a “half-leather” book.

These apparently simple instruments, and their use while binding, also highlight the ways in which different tools become more or less tool-like through their situated use in specific environments. While the tool has long been contrasted with the machine (McCullough, 1998), neither concept refers to a particular set of devices in the bindery. Rather, these concepts are evocative of certain values embedded in different devices at different times. Recall Peter’s paring knife (Figure 10a)—the tool he used to fray the cords along the book spine. The knife is a standalone metal blade designed for thinning (or “paring”) leather, e.g., that will cover a box or book. The paring machine (Figure 10b) is also designed for thinning leather, but it is attached to a bench, requiring the binder to move the material rather than the tool. Despite its name, the paring machine has few conventionally machinelike qualities: it is simple and lightweight, has no moving parts, and is not mechanically or electrically powered. For a novice, the machine is more difficult to use than the knife and cannot fray cords or sprinkle paint. The machine serves one purpose, remains in one spot, and is one of a kind in the
workshop. The knife, by contrast, serves multiple purposes, moves around the workshop, and is one knife among many. Each binder not only has his own knife, but the metal blade is often so thoroughly worn in that using another binder’s knife is uncomfortable or unfeasible. The difference between machinery and hand-tools is thus attributed to how they enable or constrain the specialized needs of the binder. The guillotine serves additional purposes, such as handing off material (see Figure 11). By virtue of its weight and size, the guillotine becomes a stable and predictable location in the bindery, making its flat surface suitable for exchanging unfinished books. Sean stacks sewn books for Peter to re-cover while Peter stacks bound books for Sean to decorate. Yet this use of the guillotine is transitory because the machine is frequently required for cutting paper. Like the paring instruments, the guillotine emphasizes the layered spatiotemporal quality of binding activity.

It is the un-shareable, mobile character of the paring knife, and the shareable, immobile character of the paring machine and guillotine, that suggest some interesting possibilities for flexibility and stability in the digital realm. Designing digital tools for un-shareability might entail the design of software that can become “worn in”: the more it is used the more it becomes assigned to one person or another. Designing for immobile devices involves adjusting material properties (weight, size, plasticity) in response to a given situation: for example, a sharp or dangerous device that changes its weight to become stationary when it nears a small child. By attending to the temporal aspects of tooling, we might rethink sociomaterial possibilities for flexibility and ownership.

Figure 11: Peter uses the guillotine to hand-off unfinished books to Sean (left) and trim the edges of book pages (right).

Workshop
Over several months in the workshop, I found that different activities require different working habits and routines. The bindery is usually unlocked and open to walk-in customers (although not particularly easy to find). The door to the
workshop is kept shut and does not face the street. When left ajar the door rings loudly and lengthily, cueing Sean of someone’s arrival. This ringing occurs several times per day: short rings when someone enters, and long rings when someone exits and invariably fails to shut the door. Sean, who is hard of hearing, uses the bell to keep track of incoming and outgoing activity. The bell necessarily disrupts his “finishing” work – the application of text and decorative elements to the cover (such as clasps and gold leaf). These infrastructural arrangements order the binders’ concentration and workshop activity. In the next example, Sean is deciding how he wants to decorate a wedding album:

Figure 12: Sean arranges decoration for an album cover.

Sean: It needs something else there, doesn’t it? It needs something else there just to bring it down to a nice little point. You wouldn’t know what I’m going on about, do you?

Me: Yeah.

Sean: Do you? Alright, what should we use then. Should we use, should we use...Should we use that? Should we that? Or should we use...

Me: I like this one.

Sean: Oh I’ll—I’ll tell you what we use. No, no, no, no, no. They’re lovers, they’re in love. They’re getting married. We need something unique. [Phone rings] Good morning, [removed] binders... Yeah we can do, no problems at all. Yeah,
we can do that…. Well I’m here till half past seven tonight... Friday I’m here till have past four, so we’re here quarter to say quarter to 8 til half past, til half past four . Okay, super, thank you. Bye. Like that? Fancy that?

Me: That’s nice.

Sean: Of course it is. And they’re flying away together! Are you going to get married, or are you going to live in sin?!?

After binding, before delivery, finishing requires dedicated attention to hand tools that can be easily picked up and put back down, enabling Sean to keep an eye and ear on the work around him. In this typical exchange between Sean and me, Sean is able to flexibly integrate a range of activities into the task at hand: a new customer’s phone call, an old customer’s wedding album, and my ostensible assistance to this work (see Figure 12). Sean points to the location on the cover he wants printed, removes a few decorative metal elements from the drawer, and hands me both to consider. When his mobile phone rings, this flow of activity is not broken; instead he humorously inserts pause and delay. This temporal patterning is reflected in other workshop activities, such as when Sean taunts an anxious graduate student picking up her thesis: “You here to pick up your thesis? Give us another week,” or “We found a few errors and corrected them.” It also echoes the pauses that arise from infrastructural arrangements, such as how the laptop is pulled out from under the bench to check email at 9:00, 11:00, and 1:00 each day. Email — or as Sean aptly calls it, “the post” — is limited to certain places and times even though wireless Internet is continually available throughout the workshop. This somewhat paradoxical combination of limitation and access, efficiency and delay, is critical to preserving Sean’s awareness and control of workshop activities.

Figure 13: Sean checks email at his computer.
In assessing implications for design research, a few aspects of Sean’s workshop activity become important. First, his insertion of pauses and delay inspires other ways of thinking about the pace of workplace practices. For example, enabling our email clients to receive mail for certain durations and times (hours of the day, days of the week) suggests accommodating a range of actions undervalued by IT designers, such as lingering, hesitation, dwelling, and patience. We also find that the spatial stabilization and visibility of a digital font shapes Sean’s desired results. Similarly, the encoding of data in JPEG file formats entails perceptually indistinguishable changes that result in irretrievably lost information (Blanchette, 2011). Digital information thus deals with similar material constraints to that of leather or glue—in this case constraints of storage. The limitations then offer different possibilities for how the digital is produced, maintained and shared. Like leather and cords, digital properties transform over time, sometimes becoming unusable. Given Sean’s restorative intentions, collaborative software might also selectively visualize this complexity—indicating cross-platform shifts and the spatial stability of dependencies and file encodings.

Figure 14: Patterns of glue that built up on the side of the workbench, below a press.

Before we leave the workshop, let us consider one last concern. Each instrument in the workshop perilously left around the bindery, including the laptop, accumulates grease, dirt, paint, and even intricate patterns of glue (see Figure 14). Though visitors often comment on the beauty of the glue marks, the binders see them as mundane traces of production. The way these traces locate specific practices in time and space, though seemingly inconsequential, is central to how materials effectively communicate their provenance to the binders. Here the interplay between different material elements — how work environments leave traces on
materials, which reciprocally leave traces on the materials themselves — foretells different possibilities for storytelling and “authentic memory” (Leslie:1998:11).

**Developing Material Traces**

The capacity to evoke “authentic memory,” and to do so in different ways, recalls Benjamin's influential concept of aura. The concept was notably captured in his volume *Illuminations* wherein Benjamin likens experiencing aura to looking at an artifact imbued with the ability to look back at you — a transposed gaze.\(^{53}\) Aura gives an object its authority and authenticity by imparting the “essence” of some other place.\(^{54}\) As Benjamin explains in his celebrated essay *The Work of Art in the Age of Mechanical Reproduction*:\(^{55}\)

> “Even the most perfect reproduction of a work of art is missing in one element: its presence in time and space, its existence at the place where it happens to be. [...] This includes the changes which it may have suffered in physical condition over the years as well as the various changes in its ownership. The traces of the first can be revealed only by chemical or physical analysis which it is impossible to perform on a reproduction; changes of ownership are subject to a tradition which must be traced from the situation of the original.”

(2007 [1968]: 220)

Tracing here connotes the action of following back, a move through which location, circumstance, and the passage of time can be practically mapped. For example, signs of decay or wear on an antiquarian book may suggest its old age or prior treatment. Some traces can be physically diagnosed (revealing its

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\(^{53}\) As Benjamin notes in his essay ‘On Some Motifs in Baudelaire’ within *Illuminations*: “Experience of the aura thus rests on the transposition of a response common in human relationships to the relationship between the inanimate or natural object and man. The person we look at, or who feels he is being looked at, looks at us in turn. To perceive the aura of an object we look at means to invest it with the ability to look at us in return” (2007 [1968]:188).

\(^{54}\) In other writing, Benjamin discusses aura as “the essence of all that is transmissible from its beginning” (2007 [1968]: 221) and a “unique manifestation of a distance” (ibid:188). Aura is at once approachable and unapproachable.

\(^{55}\) This essay has been widely taken up in design theory and art criticism. See, for example, John A. Walker's *Design History and the History of Design* (Pluto Press, London, 1989).
provenience), while others may not (changes in ownership). In each case, tracing conjures up a sense of requisite distance from the associated source.

Looking more specifically at the historicity of material, the archeologist Rosemary Joyce (2012a;2012b) has examined the emergent character of craft objects. She considers scholarly usage of provenience and provenance, related terms that specify an object’s source of origin. In archeology provenience designates the specific location in which an object is found, whereas in museology and art history provenance is best understood as the chain of ownership or itinerary of an object, “ideally beginning with the creation of the object” (in press). Joyce introduces the notion of “object itineraries” for tracing the progress of things (2012b). A particular point of intervention is not seen as occupying higher moral ground. Traces of the object situation are, instead, seen as continually conditioned through time and use.

By drawing on concepts of provenance, Joyce has developed a theory of traces that foregrounds the active and historical character of material form (2011;2012a). Her traces are enmeshed in methodological approaches of a distinctly archaeological bent. Thus, to understand Joyce’s traces, we must also understand how she interprets the project of 20th-century anthropological archeology, and its relation to material culture.

As a discipline concerned with investigating the past based on its remains, archeology, for Joyce, is uniquely suited to consider the historicity of material culture (Joyce, 2011:1). Following a mid-20th-century interest in “evidence,” the field bore witness to contested claims of equivalence and naturalization. Archeologists’ use of “conventionalizations” (Joyce, 2012a:122), such as a ‘posthole’ or ‘pot’ — the naming practices that permit archeologists to reference a historicized entity according to contemporary terms and normative claims — became a slippery method for understanding archeological work. Such universalizing language eclipsed the situated actors and practices historicized by the excavated site (ibid:122).

Here it is the trace that helps Joyce recover the past in relation to her work as an archeologist. Rather than understanding history based merely on its residues, Joyce calls for acknowledging the work of archeology and the archeologist in reconstituting the excavated material (ibid:121). As opposed to “evidence,” the stuff of arguments, Joyce attends to the conditions of “indices,” the marks that signify a past (Joyce, 2011:1). The trace becomes “a sign of history, not a thing recaptured from a past lived experience and revived in our present circumstances” (Joyce 2012a:122). Yet, the trace does more than index: “traces are not just the
physical remains we can see and collect; they include any sign of a contrast that we can construe as evidence” (Joyce 2010:7). Traces are the perceivable difference—the residues that matter.56

I build on Joyce’s historicized trace to move both backward and forward through material. That is, I begin to develop the analytic category of material traces suited to the project of design by attending to past action and future possibility. Shared among these notions is a concern for embodiment and emergence that differs from the “traces” rendered by Benjamin. His trace allows us to possess a thing, often inert, while Joyce’s trace signifies social practices and its actors.57 Yet Benjamin further elaborates the quality of aura to consider the signifying power of traces within the same volume, Illuminations, in his essay ‘On Some Motifs in Baudelaire.’

If we designate as aura the associations which, at home in the memoire illvolontaire, tend to cluster around the object of a perception, then its analogue in the case of a utilitarian object is the experience which has left traces of the practiced hand. (Benjamin, 2007 [1968]:186).

Here aura is likened to practical work: interpreting skilled labor from the traces it leaves behind. While concepts of craft, handwork, and touch feature prominently in Benjamin’s writings, this reference to ideas of tracing and aura deserves particular attention. Benjamin connects the perceptible phenomena (aura) with the capacity to move through and with phenomena (the trace). For instance, Peter’s materials (paper, chords, leather) trace his use of the paring knife for a variety of purposes within the bindery, such as to reproduce the look of age (through removing coating, fraying, thinning). This intricate link between Benjamin’s traces and aura points to the relational quality of value and how it

56 As Joyce explains, “treating every materially perceptible difference as a potential trace” (2011:2) enables the scholar to acknowledge their role in tracing—to “adopt a point of view.” Joyce’s characterization of “perceptible difference” recalls Bateson’s well-recognized definition of information: “a difference that make a difference” (Bateson: 1972). Or, in Barad’s words, the “diffractive” traces, which are “not differences in any absolute sense, but about the entangled nature of differences that matter” (2007: 381).

57 Benjamin’s entry in Arcades Project connects aura and traces, drawing a proximal analogy: “The trace is appearance of a nearness, however far removed the thing that left it behind may be. The aura is appearance of a distance, however close the thing that causes it forth. In the trace, we gain possession of the thing; in the aura, it takes possession of us.” (in Joyce, 2011:5).
figures into processes of decay and maintenance, wherein traces of the hand are selectively revealed or masked by artifice.

Where I diverge from Benjamin in my analytic stance is the manner in which I situate humans as central in the perceptibility and use of the trace. As it is my aim to inform both design theory and practice, I conceptualize tracing as a human endeavor. In my accounts, however, I do not privilege the human (crafter, customer, recipient) over the material (or, for that matter, the material over the human); after Latour (2005), I recognize both the humans and non-humans as social actors (actants) within the broader social ecology of craft.

The category of material trace thus incorporates and extends Benjamin’s concept of aura by concretizing the unique location of the material in time and space, and highlighting the human’s role in recognizing that distance. By tracing backward, the researcher follows different material relations and identifies the evocative and elastic character of material practice and time. By tracing forward, the designer renders material relations visible and enables new possibilities for facilitating meaningful and enduring engagements. The trace underlies our every effort to design for human vitality: “living means leaving traces” (Benjamin, 2007 [1968]: 169).

The Bindery as Sociotechnical System

We have seen so far how the bookbindery is an archetypical workshop, inviting us to reconsider how we understand the long-term prospects for digital technology — in both non-office work environments and the practices of systems designers. The unfolding of skill occurs as materials reveal their itinerary to people through, and as part of, their engagements with the workshop environment. But what does this mean for digital systems design? How might this formulation of tools, as something materially salient but socially unremarkable, enable us to understand computing?

To begin with, we found that the binders engage the particularities of material and those materials have a “say” in the process. Becoming sensitive to delicacy of a digital file, like a cord or a piece of leather, might involve identifying the fragile, or the intricate, by acknowledging the integration between different layers of the computational process. This activity conveys the first of three modalities of material traces: material attributes, or how the constituent elements (digital and non-digital) combine to exhibit specific dependencies and propensities, such as frailty, firmness, or pushiness.
When tools come into play, we saw how they demonstrate a bounded shareable and mobile character that affects their flexibility and use in the workplace. The specific attributes of tools (e.g., the unshareable knife and immobile machine) suggest design opportunities for the spatially inflexible or temporally unshareable wherein a digital tool is assigned to one person or another through continued wear and use. This observation suggests taking seriously a second form of material traces: material entanglements (Orlikowski, 2007, Barad, 2003, 2007), or how different materials are imbued with specific values (e.g., more or less tool-like and machine-like) through their interrelation (or intra-action — after Barad [2007]).

As we examined the larger rhythms of workshop activity, we observed the patterned pauses involved in integrating different resources into work — both inside and outside the workshop. Like Sean’s metaphor of the “post,” this suggests we might design for the productive combination of limitation and access by enabling email clients or social networking sites to reveal materials according to spatially situated tempos and durations.58 We also found that the degree to which these materials and their properties become visible and stable can change through ongoing practice. As the materials move and interact they leave traces on their surroundings workspaces, which equally shape the materials themselves. Digital tools also manifest varying amounts of spatiotemporal stability. This productive interplay between the invisible elements of workspace and its material parts exposes material rhythms, a third modality of material traces.59 By following practices across time, we can foreground the generative processes and evocative histories of material.

The multiple traces that emerged in the bindery prompt us to think critically about the temporal patterning of work and how our materials help guide and configure their unfolding rhythms. As our personal and professional landscapes exhibit increasing signs of busyness, how we perceive the passage of time might be shaped not only by the design of our software or services, but also by the traces they leave behind. Instead of distinguishing the digital from the physical, this work suggests we consider the vast range of material practices. What might appear to be slow ‘by hand’ activity — Peter’s cord fraying or Sean’s typesetting — is tightly interwoven with the varying rhythms of tools, people, and workspaces

58 A few existing tools, such as the Firefox LeechBlock Addon, purposefully limit use: https://addons.mozilla.org/en-US/firefox/addon/leechblock/.

59 See Jackson, et al. (2011) for a discussion of collaborative rhythms of relevance to interactive systems design more broadly.
with which one works. Craft materials are not fixed in time but consist of a spread of events. In the practices of binding we find a different view of material — one that emphasizes the active multiplicity of traces.

The UK bookbindery has, thus, invited us to consider how binders trace *backward*: the ways in which materials get enrolled in the work of the hand to recall bygone events and practices. I have shown how tracing links to the past involves engaging with a range of materials, including leather, standing presses, and laptops. Using specific cases of the binders’ practices, I then developed the notion of *material traces* wherein marks of craftsmanship are conceptualized through three analytical lenses: *attributes* — fluctuating properties of material, such as string and glue, *entanglements* — interdependencies derived from interactions between the binders and their tools, and *rhythms* — the temporal patterning of routine binding engagements. As we have seen, each mode of inquiry has consequences for how we understand materiality in a digital age.
Chapter 3 Restoring

While physical evidence of spatial and temporal distance has remained of interest to a range of scholars, from archeologists to historians, considerations of authenticity and age have been a pervasive but under-theorized topic among studies of craft. Recalling our discussion of Benjamin (2007 [1968]) from the previous chapter, tracing the situation of the original is neither easy nor always desirable. Partially this is due to the ways in which traces of use have long been tied up with assessments of value, sometimes prompting depreciation. Within the book trade, historians have expressed animosity for material intervention by characterizing the annotation of books as “dubious methods” (Sherman, 2008:158). Bill Sherman notes that while some modern authors celebrate “jelly smeared” pages, others decry rain-damage pages (2008:158). “What makes the decision of what to preserve, what to repair and what to discard so difficult,” he explains, “is that the value of particular types of physical evidence is not always clear and is subject to change through time” (Sherman 2008:165). Citing the fluctuating assessment of physical evidence, Sherman calls attention to two concepts closely aligned with the material trace: authenticity and longevity.

The goal of this chapter is to further develop the category of material traces from Chapter 2 by considering concepts of authenticity and longevity within restoration binding. I ask simply: how do the binders produce and maintain specific forms of value? Conversely, what is it about aged artifacts that the binders and their customers want to preserve? Based on interviews with a range of binders and customers, I show how valued qualities of age and authenticity are sustained through traces of skill, use, and time.

What is restoration?

Restoration, as I experienced it in the bookbindery, entailed a set of productive activities that transformed an existing information technology into something evocative of its former self — “bringing something back into use,” Thomas, a restoration binder once explained. When asked how he would characterize his practice, another binder responded:

Adam: You know how these books can survive even when they’re neglected for hundreds of years? I mean, it’s an amazing—historically—it’s an amazing technology. Isn’t it really? As a way of passing on information. You know, a book
can be so durable that leather can fall off, the spine can fall off, the headbands can go, the first two pages can get torn. But as long as those corners are on strong and those boards are good, and it doesn’t get damp, you know? That can knock around even for a couple of hundred years just like that, can’t it? It’s great.

The binders I spoke with appreciated the ways in which a book is made to last through its reconstruction. Their concern for durability was demonstrated through binding activities and aesthetic choices. It was also revealed through the binders’ language, such as the terms “square,” “evenly coated,” or “flat,” which refers to aesthetic symmetry as well as how a book is held tight and strong by evenly coated materials (board, thread, leather). In the workshop, books were observed passing through several stages of production, including manual activities, such as folding paper, tooling activities, such as sawing and sewing, mechanical activities, such as chopping (on the guillotine) and typesetting (on a blocking machine), and even digital activities, such as creating labels (using a laptop and printer). Each stage of restoration was readjusted based on several interwoven factors, such as the age of the book. For a 16th century manuscript with an elaborate but deteriorating gold leaf title, a binder might keep the remaining gold leaf or overlay additional gold leaf by hand. Whereas for a compilation of 19th century machine-bound books whose labels had fallen off, a binder might digitally design the label on a PC, print out several copies, and paste one on each book. A book’s original binding informed the approach to rebinding. Other influential factors included: cost of the materials and labor, time and effort available to the binder or customer, physical condition of the book (deteriorating spine, pages falling out) and existing materials (brittleness of the paper, grain of the leather), style of binding (cloth case, half-leather, sew on chords, and so on), and—most importantly—the binder and customer’s ideas of authenticity.

**Balancing Authenticity and Longevity**

Strengthening older books often entailed adding modern parts and pieces and using new tools and techniques, threatening ideas of originality. Striking a balance was important, but also difficult to define.

*I asked Kate if she ever sawed into the spine of a book. She gasped. I thought something had gone terribly wrong, but she was reacting to my question. “No, we don’t ever saw books.” She explained that sawing the books was meant for putting cords in the books to keep the books flat, but that sawing is no longer necessary because flat tapes are now available. She let me feel the tapes, which were a distinctly modern material—flexible and strong. She would never do anything to harm the books if she didn’t have to, she said.*
As a binder, Kate is concerned with preserving as much of the book as she can. She
is referring to a 19th century practice of sawing grooves into the spine of books for
recessing cords in sewing, the subsequent stage of binding. While to one binder
certain coated pages could not be bound without sawing, to another binder sawing
books at the head (top) and tail (bottom) of the spine mitigated damage to the
book while sewing. Kate disagreed with both claims. For her, restoration should be
“reversible.” Having recently finished a set of catalogues for a customer who
requested case-bindings (hardbound books), Kate and her co-workers proudly
showed off their finished work: structurally supportive but removable dust jackets.
To Kate, the jacket solved the customer’s problem (increasing the book’s longevity)
while “respecting” the book (preserving its authenticity).

In working out how to balance authenticity and longevity we thus find
contradictory ideas of appropriateness in restoration practice. Offering an
informative parallel, recall Kreps’s (2003) analysis of how some museum artefacts
are understood not as artifacts behind glass cases, but through their interactions in
the social world. Or Küchler’s (1988) examination of Mallangan, wherein memory
practices allow certain imagery to continue to live on in Melanesian society. Kate’s
“reversible” restoration work—much like keeping a cultural artifact behind a case—
might be seen as just one construction of authenticity. While Kate’s sense of
authenticity does not, in itself, constitute an intervention, her production of the
catalogues without case-bindings altered her customers’ relationships to the
catalogues and book. Her physically reversible work, thus, produced an irreversible
intervention. This paradox in practice reveals a shared understanding of
authenticity: one remade through binding.

**Producing a Well-Restored Book**

“When you close the book it should have a sense of weight about it. And that’s the
way it should be [...] So I made the decision that I’d like to see—about to the
longevity of it, as you know—in my collection of books. If it had been for a customer
than I would go along with what the customer wants.”

Throughout the restoration process, binders sought to increase the longevity of the
book. The language of “following what the customer wants” was frequently invoked
when choices were justified after binding. However, in practice, routine judgments
emerged in dialogue with the binders and their materials, mediated by their tools
and manual use of them.
“It shouldn’t fall apart on the first reading. It shouldn’t fall apart on the hundredth reading. It should look as good as it did the first time it was picked up. And most books now, obviously fail. […] You walk into a bookshop and you couldn’t preserve them if even if you wanted to. If you actually read them you’d destroy them on the first reading. And even the really big prestigious books - cloth covered, and hard boards, case bindings - they fall to pieces. You know, it’s sad.”

As my survey of the literature in Chapter 1 suggests, attitudes toward restoration have remained a contentious issue within the fields of Art History and Architecture over the last two centuries. Recall Morris’ imagery of “stripping [from] a building of some of its most interesting material feature.” When he suggests some artefacts should be protected from modern processes he also introduces a familiar paradox of restoration: books must change in order to feel the same. It is this same paradox that underlies design for longevity: materials must decay in order to last. That is, technologies designed for endurance may also gracefully evolve or degrade along with our routines of practice.

**Creating Age**

The sense that longevity is a quality for which to design was echoed throughout my interviews with binders.

“My ideal is, if I bind a row of books, they look like that [points to restored 17th century book]. And you think: are they old, are they new? […] So if you have new materials that resist being eroded by time, then you could have something that would last almost indefinitely at certain levels.”

How to enable a restoration to live on, and how to sustain a certain look of age, was an equal part of this negotiation. Does restoring a 400-year-old book with a deteriorating spine entail re-binding the book as it would have been originally bound? Does it mean re-binding the book so that it appears in its original condition? Or does it mean creating a jacket and slipcase so that the book remains untouched? A previously restored book raises further questions. How these questions are answered in the process of binding had implications for what constitute both successful craftsmanship and ideas of age.

While working on a 19th century leather-bound book, for example, Peter needed to replace “red rot,” the deteriorated leather that turns red over time. What was the original color? Peter saw green. Sean saw dark brown; and I saw black. The book was eventually covered in Nigerian goatskin, stained dark brown, and “sprinkled” with black paint (a 17th century technique for creating the “look of age”). These negotiations are reminiscent of how STS scholar Charles Goodwin described
chemists’ classification of color categories—working out what it means for something to be “jet black” (Goodwin, 1997). Choosing how to make a book look old involved not only finding the appropriate balance between preserving what exists and extending the longevity of the book, but also attending to the material elements of the book that exposed some seeable quality of its past—grain, color and stain. If parts of a book were deteriorating, in need of repair or readjustment, some original materials might have been replaced while others might remain untouched. In this remaking of historical techniques ideas of age are reworked as well.

**Traces of Skill, Use, and Time**

For the binders I spoke with, restoration entailed balancing two distinct goals: preserving the physical qualities of the book that make it an evocative sentimental object (preserving uniqueness) and replacing materials that give the book a longer life in use (increasing longevity). Peter described this process simply:

> There’s a point at which you have to make a decision. Am I going to have that repaired before the damage gets any worse? And that’s the decision you have to make. As a collector you can’t always conserve things just by leaving them alone in a box or a safe or an archive because sooner or later they are going to deteriorate. After all, the sewing on most ancient books—15, 16, 1700s—they would’ve been sewing them with silk or cotton. You know, not like modern sewing threads. So, therefore, it’s going to rot. Paper might be okay, but sewing will rot. Fall apart. You then have a book that’s going to cost a great deal to repair. Better to have it done beforehand, stop the problem, and get the book back together.

This depiction of the decision of whether or not to restore a book rings true in abstract terms, but belies the difficulty of interpreting a book owner’s daily use of the book based on material remains. In my observations, reasons for restoration varied widely, from pragmatic goals (a book was unreadable in its current state) to emotive motivations (a book no longer felt as it once did). Pages of books and handprints on covers triggered memories of particular settings from childhood, such as reading behind a grandmother’s rocking chair, or celebratory moments such as college graduation. What it takes for a book to be worth restoring, and which aspects of the book one wants to restore, were carefully worked out in practice. Sean’s replacement of the exterior of a failing dictionary reveals one aspect of this process:
“Can you see all these grubby lines here?” [Sean] is pointing to the joint of a recently repaired mid-century book [the place where the spine meets the cover boards]. He turns the book over to inspect the outside cover on both sides. “It’s a little bit darker here. This little pitty [sic] bit here - the residue of the Sellotape. You see, over it. Down there.” He moves his finger along the book spine, exhibiting its sticky, splotchy texture. “We were able to get a little bit over here. So we’ve got some of it off. But we can’t get it all off. If you start getting it all off, all this - all this lettering starts falling out. So you’ve got to be very careful to balance that.”

– Interview excerpt August 05, 2010

The book Sean holds is a dictionary. It belonged to a customer who had used the dictionary to solve crossword puzzles with his grandfather as a child. Buying another copy would only cost a few pounds and the restoration would cost 60. But the client wanted his own copy revived. Its pages were beginning to un hinge at the spine and the Sellotape around the back was loosening its tack. Without the repair, the book would soon have been rendered unusable. Aware of this attachment to the materials of the bind, Sean took on this job with an awareness of how to “balance” two seemingly conflicting goals: preserving the physical qualities of the book that make it evocative as a sentimental object and strengthening the materials so as to enable comfortable legibility. As clear from Sean’s discussion of the “pitty bits” and “grubby lines” left by a customer’s self-made bind, repairing such work involved practical and careful readjustment, enabling the materials to cover up and remove marks of time. Each of these marks reveals an evocative trace of use.

When the customer represented an institution, such sentimental traces became less salient. In the next excerpt I followed Sean to drop off a batch of rebound books to a librarian for the Royal Society who has been Sean’s customer for several years:

Sean: Someone said to me why don’t you [put your name in the book]. And I, I always feel it’s an intrusion on the library. The library wants to keep it discreet. They have a history of it.

A: Yeah, I suppose you’ve become part of the history of the book as well, haven’t you really?

Sean: Yeah, true. Very true. I’ll start doing it actually. I’ll put a library stamp on it. I’ll sign it. I’ll sign the books. I’ll put our stamp in it. No, because sometimes I
feel that they don't look appropriate for, uh, for the book. [...] I don't think it's appropriate sometimes to put your name in a, in a book.

Interviewer: Why is that?

Sean: I don't know. It's an old book. If you put a modern binder's name in it, it just doesn't look quite right.

A: Well, but yeah, but as I was gonna say, you've kind of now done the work, haven't you? And that's not the binding that it was in a hundred years ago...

Sean: Yeah, originally, yeah, yeah. If put I put a new one in... If I save the old book, I leave it as it is. If I save the old boards, I leave it as it is. If I put a new cover on it - and I just put a little - I got - I got a little <removed> Binders stamp I can put in blinded pressure so it doesn't look - hit you in the face. I'll see what it looks like.

—Interview excerpt July 22, 2010

Here Sean and his customer, the librarian, are negotiating the binder's place in the restoration process. Though Sean suspects the stamp with his name on it may not look “quite right” on an older book, he nevertheless agrees to try it out. However, Sean has no intention of following through on his promise. Just after leaving the librarian, he explains to me that he does not “want to show off” by adding his name. “I'm a discreet chap,” he explains with some pride. Sean does not what to adulterate this antiquarian book with evidence of his personal identity or functional intervention. He believes that projecting his personal identity onto the book would sully it (regardless of its prior condition). It is this authentic quality that he sees as worthy of preservation, and modern hands should not be seen to interfere.

The librarian sees a different form of authenticity emerge from the codex. She notes how Sean's restoration work distinctly transformed the artifact, differentiating it from what it might have become without the “intervention.” Thus, she takes note of how the binder comes to be a “part of” the book's history. For the librarian, inscribing Sean's name on the book would not only clarify this development for future generations, it would enlist Sean in the remaking of the book's design. Such a recognition of Sean's contribution to the book draws a different picture of what constitutes its authenticity from what Sean has come to know. The book is no longer an aged object that becomes durable through its remaking. Rather, the book is seen to evolve through its engagement and reassembly within the environment.
Here we find different modes of attribution by which Sean and the librarian valuate the authenticity of the book. For Sean, inserting his stamp would negate his purpose: to maintain the book’s history through hidden reconstruction. His competence as a book restorer involves reducing his signature so that existing traces of provenance take precedence. Benjamin scholar Esther Leslie describes a similar set of markings for Benjamin’s potter,

“Fingerprints and the handprints of the potter are not signatures; such traces differ from the individuating, authenticating autographs of high art. Their virtue lies in their hinge with actuality, not their market value.” (Leslie, 1998:9).

Traces of Sean’s restoration work, his delicate hands and polished competencies, might be seen as a genuine “fragment” of practice (Benjamin:2007 [1968]:46) rather than a form of authorship. Foucault problematizes the status of the author and the author’s individuality to identify what he terms the “author function,” how authorship is produced as a “mode of existence, circulation, and functioning of discourses within a society” (1997:228). By suggesting that different kinds of discourse entail different commitments and relations to the author, Foucault acknowledges the recent invention of authorship as coupled with claims to originality and legal authority. Sean’s discursive recognition of authorship involves making claim to his invisible place in the book’s history. He wishes to leave out (or deemphasize) evidence of his craft — material traces of skill — to reveal a sense of authenticity grounded in decay and wear — material traces of time and use. The incongruent opinions of the customer and Sean, the book restorer, thus complicate Sean’s sense of authenticity and related ideas of authorship to expose the multivariante character of the trace: a mark indexing multiple moments in time and experiences of use perceptible to the book owner or restoration binder, perhaps, but invisible to the person on the street.

Unlike the librarian or the owner of the dictionary, not all customers were satisfied with the binders’ work and not all books were treated the same. Near the end of my fieldwork in Cambridge, I met Vernaz, a former customer of Sean who had two books be repaired by Sean and Peter:

[Vernaz] shows me the first of two books [...]. He tells me the cover boards are noticeably warped and shakes his head in disapproval. These are the original boards. I can also see that the spine has been re-sewn but most other materials (covers, end pages, fly leaves) have been left intact. He pulls out the second book. “This book had already been with me for about 20 years,” he says and opens the book to his favorite piece. He observes that the page is naturally bookmarked by the creases along the spine and the mottling on the page reveals its heavy use. “I
don’t know how he fixed the corner here,” he says, pointing to a new piece of board and cover clothes. This second book is repaired similarly to the first: re-sewn and only partially re-covered. He then asks that I smell the books, describing the first as “stale,” and the second as “sweet.”

— Excerpt from fieldnotes July 11, 2010

As Vernaz’s experience illustrates, books can behave differently despite similar repairs. Vernaz’s first book, which documented the life of a distant ancestor, was a relatively rare 18th century text that Vernaz bought off an online retailer. He had never read the book (though he hoped to read it someday) and had little attachment to its material form or the conditions of its prior use. The second book was a common machine-bound book that contained musical scores from which Vernaz learned to play the piano. The book’s distinctive scent, which he called “sweet” as he took in the smell, reminded him of the many years he used the book to play piano. The library label on the inside of the front cover disclosed the book’s origins: a school library from which Vernaz stole the book when he was 13. Not only had the book endured everyday use (he continued to play from the book daily), it represented and embodied meaningful facets of his past. As he explained,

“I remember when this [book] was falling apart and I started tossing [it] around. [...] I could have replaced it with another book. This book had already been with me for about 20 years so I thought well, you know, it’s difficult to find.”

While this book was theoretically easy to find, as he could have bought another copy online, in actuality it was difficult—indeed, impossible—to find again. Vernaz wanted his book restored, and not reprint of the same text. It was this book as entangled material and content that held sentimental value.

Here two types of material traces come alive through restoration. Vernaz expected Sean to preserve the age of the first book (material traces of time), and extend the emotional appeal of the second book (material traces of use) - e.g., by retaining the distinct smell of decaying leather and the mottling on the margins of his most coveted song. Unaware of Vernaz’s differing relationships to the books, Sean treated them both the same: he preserved as much of the deteriorating material as possible and, in doing so, retained likeness with the original books. Vernaz’s relationship to the books challenged Sean’s valuation of an “appropriate” bind. Judgments of skill and respect were at stake in Sean’s decision to preserve different traces than the customer desired.
Incorporating Digital Technologies

Digital technologies were often viewed as useful for speeding up communication with customers or creating cover labels for mass-produced books. The difficulty of this work was evident on several occasions, as when Sean ran into trouble while using word-processing software to create a new label for a 19th century machine-bound book:

[Sean] finds a serif font to match the original label, noting, “it just looks right.” After typing the title, he struggles to find a tool that allows him to add a line underneath it and tells me that his son usually helps. As he talks, he moves the mouse over a “tools” menu, then “format” menu, then the “tools” menu again. Finding nothing, he returns to the keyboard and inserts dashes one by one. The next day [Sean] shows me the printed label. Individual dashes have been replaced with a solid line and the font is bold and modern, no longer matching the original book. I ask [Sean] why the font has changed. With some delight, he explains that his wife fixed the label on their home computer that evening, a computer with different fonts.

Here we find Sean is less familiar with the software than other instruments, such as the blocking machine. He has trouble finding digital resources to create a desired effect (the solid line) and enrolls human resources outside the workshop to help out (his son and wife). But people are not the only actors shaping the printed result. Sean encodes his work in a particular file format (.doc) that depends on font files stored on his laptop. When Sean copies the file to his home computer, the file is unable to access the same font, and retrieves another font instead. The .doc file therefore spatially stabilizes some aspects of Sean’s work and not others.

Online (Mis)communication

When online, the binders I spoke with cared less about stabilizing digital files, and more about communicating techniques and managing social ties. Consider Sean’s experience at the laptop.

Sean stands at his laptop messaging with a woman on Facebook. He slowly enters each letter individually and, noticing that I am watching, asks how well I can type. “Pretty well,” I say and ask what his is typing. He is reminding a woman of a run-in they had at a local pub over the weekend. She denies seeing him.

The woman clearly saw him, Sean explains, but she didn’t say hello.
As Sean vents his irritation, he intermittently checks on my gold foil decoration, distractedly commenting on its sloppiness. He also keeps track of other binding projects in the room, including a student’s sewing work on the spine of a photo album. When he returns to the laptop, I look over his shoulder at the webpage. Sean has been writing for close to an hour, but only four lines of conversation have been exchanged.

In the above exchange, Sean seems exacerbated, truly bothered, by what he perceives as falseness. His frustrations at the computer arose from an interaction he had outside the workshop, which he then revisited through Facebook. The degree of his annoyance was unusual. Personable and good-humored, Sean typically maintains congenial connections easily, and takes many opportunities to do so: open houses, weekly classes, even drinks at the pub. His affable character is also apparent from how he arranges his laptop in the workshop so that he can see and interact with each of the people and elements in the room.

Yet the laptop, and Facebook in particular, appeared to prompt a shift in Sean’s disposition. They enabled the exchange of mistaken words and missed connections. What might have been otherwise resolvable outside of this context became a source of escalating frustration. Sean’s practical needs in the workshop (attending to students around him) were trumped by his concerns for honesty and respect. This attempts to reconcile his friendship also dragged out in ways that contrast with Sean typically quick workmanship and pithy banter. Much like when Sean uses the Word Processor to create labels for a modern machine-bound spine, typing on Facebook involved several failed attempts. The online exchange seemed to interrupt Sean’s working rhythms.

Among the San Francisco binders I spoke with, online miscommunication was more common among binders and their customers: “Typically with email there are three of us looking at the same grouping of emails, shaking our head with no idea what we’re seeing,” Thomas, a San Francisco binder told me. “They’re trying to maintain the power of the conversation.” Even after several exchanges, Thomas had trouble figuring out what most of his customers desired partially due to the short length and poor detail of customers’ messages. In response, he considered installing a webcam to facilitate a discussion of options – a show and tell for restoration. “We’re trying to sort of out tech the techies,” he joked. Although Internet access introduced hurdles and interruptions, it also provided opportunities for rethinking the boundaries of workspace activity.

**Perceiving Material Traces of Use**
During college Thomas majored in philosophy while working at an antiquarian bookstore. Once a month a customer would come into the bookstore to pick up
damaged books and return them the next month beautifully rebound. “It was just something that stuck out in my mind,” he now remarks. Years later, and after several stints in the restaurant industry, Thomas returned to books. He took a few binding lessons, promptly bought a small bindery, and continued his training. The business slowly grew into one of the largest (and only) trade binderies in the Bay Area. However, book repair is not his only preoccupation. Given the clientele in this area, recent work includes the production of restaurant menus and e-reader covers. Reflecting on these changes, Thomas explains,

So if you brought your mother’s cookbook to us, you want it to have the generally feeling it always had. But you really want to be able to open it up and handle it. And bringing it back so it’s exactly the same condition or style that it was when it was first published is not really that important. [...] And in a sense, once again, that ties into the very books that I think are most important to us. And the ones that I think will ultimately be lost with the advent of the digital medium. Because your first child, children’s book, you know, someday may be a digital book with pictures. My girlfriend does a lot of cooking off of recipes she gets on the Internet. No granddaughter of hers is ever going to handle some book and say, “Grandma [Erica] had this.” It’s not going to happen.

Thomas anticipates that books will be displaced by the “digital medium” and, as that happens, they will lose their status as heirloom objects. For him, an online recipe has no features to be repaired or sustained. It has little ability to invoke memories of the past. Regardless of its usefulness or emotional resonance, the online recipe does not seem to endure over time.

Although the book and the digital bookmark may be conceptually linked, they offer different possibilities for tracing back. A cookbook might survive another generation of repair by retaining traces of how it was used, held, and cared for. A collection of online recipes may remain intact through it distribution across files, network protocols, and servers. A server goes down or a user’s online account expires, and the recipes disappear without a trace. Digital recipes degrade and change, just like paper, but those changes are difficult to see and trace back. Material traces of use (and their differences) are perceived differently from how they are lived.

**Conclusions**

In sum, I found that what customers wanted to preserve from the book were three types of material traces, which the binders selectively aimed to mask, reproduce, or
highlight through their restoration work. Customers first sought to retain material traces of *skill*: the unique features of the book that evidenced craftsmanship, such as Sean's invisible stamp. Second, customers wanted to hold onto material traces of *use*: the marks of ownership and the stories those marks indexed, such as the dictionary pages used for crossword puzzles. Lastly, customers hoped to see material traces of *time*: evidence of age through decay and non-human intervention, which plays out differently not only for different binders and clients, but also for different books belonging to the same client, as exhibited by Vernaz. While using digital tools, binders expressed some ambivalence and frustration with regard to these traces and their visibility (tractable, tactile, and aesthetic). Binders expressed concerns for what they saw as the relative hidden character of wear and decay in the digital medium. In the bookbindery, material traces of skill, use, and time emerge as useful delineations of craft processes that have some bearing on the production and maintenance of value (moral, social, institutional, *etc.*) vis-à-vis their perceptibility and persistence.
Chapter 4 Knitting

The bright ray of the projection reflected back onto the knitting guild members sitting around a long table, their hands frantically moving reflective needles. W, a lace knitter I befriended on a recent guild excursion, sat near the front of the room knitting a delicate shawl. B, the guild founder, sat at the back of the table, far enough away that I could just barely make out her needles in the dark. The police station’s community center, the location of this (and other) monthly meetings, was usually lit by bright florescent lights and frequented by on-duty officers (and sometimes their detainees). With the light turned off and the door shut tight, the room transformed into something much more intimate: the platform for my talk.

As I began my presentation the room fell silent. Vignettes from my research, images of conductive textiles, and examples of “yarn-bombing” (graffiti inspired knitting for outdoor and urban spaces) filled the screen in succession. I spoke slowly, trying to make out faces in the small audience and determine who might be interested to learn more, if anyone at all.

During the course of my presentation, the audience expresses a range of emotions. W. called the presentation “scary,” and later explained, “I was getting anxious and I got a little paranoid ... I was sort of like, why are people doing this? Why are they invading?” C, the guild president, asked, “What is your goal for it? What do you want to have happen?” A, the only guild member without an email account, began to snore ten minutes into the presentation. The members of the knitting guild were unsure whether new technologies were relevant to their practice. On the other hand, seemingly paradoxically, I discovered that many of these same knitters used information technology in their everyday knitting practice.

— Compilation of fieldnotes from October 12, 2010.

It was in this moment, seven months into my membership in the knitting guild (KG), that my research turned on its head. Until then I had planned to introduce new information technologies to crafters in order to understand how they use, adapt, and make sense of digital tools. This guild was not like other knitting groups in that each monthly meeting was highly scripted. Several text documents prescribed each monthly guild activity, from methods for mentoring new members, to the elements of making “stone soup” for a weekend excursion. For the
first hour of every meeting, a president lead the group through agenda items, a secretary took minutes, and each officer delivered updates. Then in a segment called “cheers and challenges,” the order began to unravel. Stories of mistaken stitches, newborn babies, and intricate lace patterns were relived as knit fabrics passed around the room. After our cheers and challenges, a presentation would ensue in the last hour of each meeting. Members would continue to tell stories, describing a tip or trick, a complicated technique, or a piece of history. And not long into my membership, it was my turn to give a presentation.

![Image](image_url)

Figure 15: Knitting Guild (KG) class on Faire Isle Tams.

I had aimed to take the opportunity to consider how knitters might respond to the introduction of modern technologies. And, more centrally, I asked, what meanings and responses emerge through the combination of knitting and modern techniques? My goal for the presentation was to understand how knitters made sense of technological interventions – both in the urban landscape and materials themselves. There were some existing examples that helped me talk about material traces. For example, I showed them electronic textiles, such as the knit fabric stretch sensor — conductive thread woven into knit material such that a light flickers according to the change in resistance triggered by a stretch. I also showed them examples of yarn bombing wherein old sweaters and scarves are applied to trees and lamp poles. Yarn bombing is language taken from graffiti and often reserved for the “knitterati,” or the knitting elite, as one knitter explained.

Judging from the responses to my talk, I realized the members of the knitting guild were unsure whether technology was relevant to their practice. My
presentation described a set of techniques and tools rather different from those introduced during previous meetings. Technical, computational, and electrical, the tools muddled definitions and crossed boundaries.

On the surface, the walls of the community center, the location of this meeting, seemed to represent an environment still untouched by digital information technologies. Agenda items were written on the blackboard in chalk, membership dues were accounted for in binders, meeting notes were scribbled on notepads. Surrounding each agenda item were stitch techniques achieved “by hand.” When social networking sites entered the KG, they were met with some cynicism, a few tears, and two lost members. A few years before I joined the guild, C. explained to me that two new members had put the KG online, creating a KG Facebook page and Ravelry group (Figure 17). This unprompted move provoked disgruntled responses; some members fought back and demanded that the sites be taken down (B. the guild founder, and W. and E. among others). Offended and embarrassed, the two new members never made it back to a meeting.

However, beneath this façade of distrust, many KG members were equally curious and knowledgeable about information technologies. 70-year old S. had worked as one of the first female computer programmers for nearly 30 years and, in her retirement, developed databases for her knitting as well as for a non-profit organization. E. frequently crocheted with electronic-luminescent yarn. Soon after this program, E. and W. met with me regularly to find out more about the introduction of electronics in craft, learning to weaving simple circuits into fabric. Our meetings, later dubbed the “e-textiles club,” became bi-monthly sessions between W., E., and myself in which we discussed, developed, and tinkered with electronics in fiber. Computational tools were off-putting but also intriguing.

Given this apparent interest in IT, why did two members leave the guild? Was the response to my presentation any different from members’ concerns for Ravelry or Facebook? How did the confusion exhibited by W., C., and A. speak to and challenge their relations to knitting and technology? How was my presentation relevant to members’ understandings of technology and craft? What, for that matter, was the technology of craft? Their response to my KG program further complicated my project.

60 See Leah Buechley’s work (2006, 2008), for instance, for a discussion of how the work of e-textiles — weaving electronics into fabric — has been introduced to classrooms for computational learning.
This chapter considers questions of technology and material and, crucially, their interrelation in the context of the knitting guild, a group for whom financial ambitions were less central than the process of maintaining and evolving knitting practice. Following on the binder’s use of (and attitudes toward) material in Chapters 2 and 3, I use fieldwork materials collected from my membership in the knitting guild to analyze the relationship between *material traces* and digital tools. In particular, I ask: how might people involved in craft draw a distinction between the digital and material?

![Image of two women at a table with knitting materials]

**Figure 16:** During an “e-textiles club” meeting at Ellen’s house, Ellen showed Wanda and I her dynamic patterns of color-changing ink, which she painted on paper. The piece was inspired by my demonstration of thermochromic pigment with conductive thread, batteries, and paper. Other materials on the table include copper and silver thread, acrylic paint, tatted decorations (Victorian knotted lace), cookies, and tea.

In considering practices among KG members, I find that resistance to technology has little to do with “technophobia,” or how this group may seem “set in their ways” by fearing change. Rather, members’ hostility was enacted as commentary on the irreverence of youth, a territorial concern for recognition, and the difficulty of aesthetic expression. To consider these responses, this chapter unfolds in two parts. I first examine *material traces* of knitting practice — traces that are less
visible and robust — and how those traces get assigned different kinds of value. I then turn to knitters’ relationships to digital technologies and describe how members share, disregard, and police the use of digital technologies to maintain the social coherence of the group. I find that KG members come to articulate an easy separation between digital technologies and other materials, which affects the values imbued in the different artifacts they produce. Members’ attitudes toward technology are produced in relation to an existing moral order and specific interpersonal alignments within the guild. To set the stage for this analysis, I first describe the broader context of the guild: its members and my enrollment.

**Participating in the KG**

In October of 2009, I received an email from R – an impulsive and inquisitive character and self-titled ‘education coordinator’ of the KG. She explained that she had read about my work in a popular craft magazine and invited me to give a talk at one of her guild’s monthly meetings. Though it took several months of rescheduling, R and I finally met for lunch. R described herself as an “out-of-the-box thinker,” who enjoyed standing out in the fairly conventional environment of a multi-national health care corporation. Her days are frequently interspersed with hallway conversation with her female colleagues in which window-shopping, online clothing retailers, reality TV shows, and celebrities are favorite subjects.

As we dug into our lunch salads, she described her hunger for the day she might observe the fine work of French ateliers as they fit garments to their customers. Three thousand dollar suits are sometimes worth the money, she said, because “they fit like skin.” She then lamented the poor workmanship of women’s clothing sold at American chain stores, mentioning one knit sweater that she recently saw was selling for over 200 dollars but was made of “plastic.” By plastic she referred to acrylic yarn – a cheap and uncomfortable fiber that does not breath, according to R. She said that near the end of her mother’s life she finally convinced her mother to wear a wool blend rather than polyester so that her mother could be more comfortable.

Over the course of getting to know R she continued to exhibit a deep appreciation for not just handmade goods, but the meticulous care with which such goods were produced – the quality of execution and the evidence of expert craftsmanship. Her curiosity was her pride and joy, and it seemed to lead her to observe relationships that others could not. As she explained, “the best compliment I’ve gotten is, ‘a company is like a forest, you can be in charge of a bush, you can be in charge of a tree, or a group.’ But this guy said to me ‘you are in charge of a bush but
have the ability to look at how this bush relates to a bush on the other side of the forest.’ I have the ability to see relationships, to make connections, to see the whole.” As I would soon discover, this ability to see the whole — to understand visibility as an embodied, tactile, and aesthetic experience — was central to the guild members’ achievements. It was this concern for aesthetic experience that brought R to the guild.

The guild began ten years earlier, in January of 1999, when B. was looking for something more from her knitting. She designed a sheet of four postcards, detailing the whereabouts of a meeting of local knitters. B. worked as an occupational therapist and was interested in the therapeutic dimensions of hand knitting. She addressed the postcards to members of The National Knitting Guild Association (TKGA) in the hopes of creating a local chapter. She included a set of proposed motivations in the postcards: “Meet fellow knitters who have a similar passion. Come share your ideas. Bring a project to work on while we talk.” On February 4, 1999 the first meeting of the KG took place in a small café in B.’s neighborhood. Eight women brought their knitting and their ideas for consolidating their teaching efforts. According to the group’s archive of “KG history,” the following items were discussed: “support from group to keep projects; field trips; indulge in knitting passion with like-minded people; learn from others; personal, individual help from others; share knowledge; get information about local resources.” From the beginning, the group’s mission was both educational and personal.

Every member had an opportunity to lead a “program” at the guild (the knitting presentation that occurs in the second half of each meeting); though the term opportunity may be best characterized as responsibility, as most members were reluctant to volunteer. Prior programs involved showing samples of a particular knit stitch (argyle, “ethnic” stitches), explanations of how to achieve a new technique (“PK knitting,” which uses the neck as well as hands), introducing practical tips (“weaving in ends” to conceal the ends of yarn), or descriptions of needlecraft history (lacework, pattern recording).

Over the course of the first six months I participated in monthly meetings and met individually with guild members. I kept track of how the group was organizing weekly meetings and making progress on their work. Members tended to knit during meetings, bobbing their heads up and down as they participated and attended to their stitch work. I fumbled with my notebook, trying to knit along with the group while detailing the practices of E., W., and C., and their exchanges with other knitters. As I spent more time with members, particularly E. and W., I learned that several members had been using social networking tools, such as
Facebook, in their “freetime” or retirement, searching for the right complementary colors of yarn online, or even posting annotated images of their knit stitches. In addition to browsing Knitty.com and Flickr.com, members shared patterns and organized their stash – collections of yarn – on Ravelry.com, a social networking site for knitters. A few members developed new practices, such as ‘sock wars’ wherein a geographically distributed group of knitters challenge themselves to finish a pattern first. Other sites such as online tutorials — Instructables.com and Youtube videos — enabled them to recall forgotten techniques or pick up new tricks online that they would subsequently share with guild members in person. As we will see, each of these online instructional techniques, ordering practices, and shared narratives where rendered irrelevant or valuable through guild activities.

Figure 17. Ravelry is an online resource for organizing materials and projects, sharing resources, and connecting with people around yarn crafts.

The knitters in the excerpts that follow include M. and B., former guild presidents and respected knitters. B. is also the guild’s proud founder and a regular knitting teacher of classes such as “design to fit,” wherein knitters learn to knit for different body sizes. G. is just out of college with a Bachelor’s degree in architecture. W. is a lace knitter who taught me a Victorian knotted-lace technique called tatting. Lastly there is E., an early participant in the mail-art and “YLEM” scientific art movements and an well-regarded innovator when it came to incorporating craft techniques with unconventional and electrical materials (more on this below). C., B., M. and W. were middle-aged knitters, as were of the majority of the guild
Obscured Traces: the Machine-Made Sweater

At each meeting, KG members were encouraged to show their work to other members. This portion of the program was called “cheers and challenges” and, as noted above, involved lengthy stories of triumph or tribulation (“I took me three weeks to get to the underarms... you know, my attention wanders off”). Members lamented their choice of yarn or celebrated a finishing technique. Partially- or fully-finished garments passed around the tables represented noteworthy accomplishments, and demanded responses to match: expressions of awe and empathy. Oohing and ahhing were par for the course. Such was the response to Marla, a long-time guild member and former president, when she showed off her half-completed pink sweater:

Marla explains that she has taken on this challenge in part because she did not recognize its scope before she committed. She is certain she will not take on a project like this again. She is knitting a sweater commissioned by a woman she met at a knitting store. The woman asked Marla to reproduce the woman’s favorite clothing item: a machine-knit sweater made of cheap yarn—a “horrid acrylic beast,” according to Marla. The customer’s machine-made sweater seemed simple enough. The tightly looped light pink looked like a basic purl and knit variation. But as Marla further experimented with the yarn she realized this was not standard stitch for the hand. Indeed, nothing was as it seemed. What appeared to be light pink was a combination of two thinner yarns: one dark pink and one white. The stitch itself was a multi-step process, far more complicated than a series of knit-purls. This sweater originally knit on a knitting machine was difficult if not impossible to replicate by hand. In order to replicate the particular yarn and stitch—reverse engineering the sweater—Marla had to use two lace-weight yarns (i.e. very thin), and tiny needles (size two). Marla dislikes the color, the yarn, and the knitting technique. Marla is knitting 200 stitches per row, and 20 rows per inch. In two months of continuous knitting she has finished half of the sweater’s front side. To make matters worse, Marla had bought several skeins expensive angora wool to knit with (as she couldn’t bear using another acrylic yarn). The room swells with frustration toward the customer and sympathy for Marla.
The softness of a yarn, the size and tension of the needles, the pale color of a used sweater. Each of these qualities featured prominently in Marla’s stitch work yet was also relatively invisible to the customer with whom she dealt. It was common for a knitter’s work to be received by someone other than the knitter herself. Sometimes, as in this case, the recipient was a stranger commissioning a specific piece. In many instances, the intricacies of workmanship concealed evidence of the human hand.

As the members recognized through words of sympathy, knitting enables a convenient fiction: the knit object is hard to see, and thus signifies a lower degree workmanship and financial worth. Attempts to assess its value are foiled by the purported simplicity of the stitch. A well-versed knitter might be capable of making out the complexity of Marla’s work, but the average customer or recipient might not. Marla is aware that several aspects of her knitting process will not be appreciated because they will not be perceived (or traced) through her stitches. She amplified her efforts but obscured their material trace.

This imperceptible trace was not singular but multiple. It involved thoughtful selection of color and fiber (angora), even stitch work, and long stretches of time. As we will see in Chapter 6, extending and connecting these obscured traces opens up design opportunities for recognizing the work of craft wherein digital traces of labor reveal additional investments of time and effort, intensifying expectations for appreciation in the context of gift exchange. Such material traces help distinguish human labor from machine production but complicate obligations for reciprocity.

Figure 18: G.’s Faire Isle swatch (left), a pattern hailing from the Shetland Islands that consists of multicolor geometric designs; Joy’s Faire Isle Tams (right), which she brought to the guild as samples.
**Ephemeral Traces: The Faire Isle Swatch**
The value sequence is a combination of light and dark colors, each of which describe how a pattern moves from dark to light or light to dark in a Faire Isle knit, comprising multicolor geometric designs (see Figure 18). The colors in each row must contrast for the Faire Isle pattern to show, and are therefore referred to as background and foreground. Translating a color pattern (or “colorway”) into actionable knitting technique requires a fairly sophisticated use of spatial reasoning. I first encountered the value sequence in our annual knitting class. Joy, a hired knitting teacher, spent a full Saturday walking us through a type of Faire Isle hat called a tam.

“This is a problem,” Joy says again. “The colors are being knit in the same row.” I notice the room is completely silent. People are intently listening to Joy. A phone playing classical music goes off and S. jumps up to find its owner, a guest at the KG who stepped out of the room briefly. S. looks perturbed.

“Pick your favorite color out,” Joy instructed. “That’s the background. I’m red […] If you don’t like what you see: work through it, like you work through the pain on a treadmill. Nobody is ever going to see the failed swatch. Any craftsperson has to know how their tools work together. The colors are your tools.”

There was chatter around me as the members sorted through their colors. Many of them did not know what color to choose. A. makes a comment about feeling stressed about not being told what to do. The group laughs.

“You want to find the optimal gauge – between 7 and 9 stitches perimeter,” Joy explains. “Don’t try to change yourself. Find a needle that fits. A lot of it depends on how much change do you like and what kind of climate do you live in?”

“Seems to me there can be a computer program to do all of this for you,” a KG guest commented across from me. She receives hostile glares from a few KG members.

“And take away all the fun?” Joy responds. “My dream version is I don’t need a book, I don’t need a computer, I prefer the lowest-tech version. When I finish a row I mark it off with a pencil. I don’t want to redo that row, life’s hard enough.”

— compilation of field notes May 21, 2011
Joy was not looking to complicate the project. She discouraged us from getting too worried, or focusing on the consequences: there was no “right” needle size, no “right” yarn, and no grand vision – it’s silly to think that making the tam “will change the world.” The process could not be controlled by any one source, as knitting could change based on a knitter’s stress level, mood, energy level, or even the temperature in the room. Knitting could never be under the knitter’s complete control. When a problem arose (e.g., the tensions of the stitches are too tight, or size of the garment is too large), Joy suggested the knitter change up the needles and not the knitting. Her philosophy involved “working through” any trouble that may arise.

When Joy instructs the KG members to expel “their editorial voice” she is referring to the “modern” sensibility to anticipate outcomes, and present-day expectations of control. As an antidote, she suggests serendipity. Within knitting lies a tension between anticipation and serendipity. As Joy said in comparing the paper chart to an automatic program for choosing color,

“I really love serendipity with this kind of knitting. The thing we think will work doesn’t. Kick that critical editorial voice out the door. It’s nice to be free from technology [...] With Fair Isle, so much fun stuff happens that you can’t anticipate. And I do feel our modern life directs us to anticipate.”

Figure 19: Joy, the knitting instructor, describes the Faire Isle Tam.
Serendipity represented the “lowest-tech” manual sensibilities vis-à-vis hard lines, strict codes, and efficient computer processing. Digital calculation or machine-production could help map the value sequence. Yet Joy did not want us to use a computer program for conceptualizing and planning. Simple tools and difficult stitches — no matter how difficult or dull — became core to the satisfaction of knitting.

The swatch, and its relations to the value sequence, was not only a guide by which knitters momentarily approached their materials; it was also an invisible record of technical work. It involved visionary design and detailed approximation. As Joy pointed out: “Nobody is ever going to see the failed swatch.” As an arrangement and combination of colors, the swatch enabled guided improvisation. It became an ephemeral trace: a resource through which knitters could prototype and temporarily materialize their ideas and mistakes.

We have seen so far two very different traces arise in the guild. One was largely obscured due to the efforts of transforming a machine-knit sweater into a hand made facsimile. The second was made ephemeral by its situated enrollment in work that was yet to come. In both cases we sense a concern for serendipity and care, an approach that was directed toward future performance, toward how the knit artifact might be used or how the color, shape, and pattern might unfold. This tracing forward, wherein the knitter anticipates how relationships with their products develop, entailed investments of time and care that were used to distinguish knitting from automated production. This distinguishing quality will become important as we consider the wider use of technologies in the guild.

**Conceptualizing Technology:**

**Distance from the Source**

Most KG members were sufficiently old enough to remember the rise of the web. They could recall their first email accounts and describe when they learned to use their first digital camera. As the technologies changed, so did the members’ capacity to “keep up.” After guild meetings, or during the week, I would sometimes receive emails or calls requesting help removing the formatting from a text document or copying files off a digital camera. At other times members seemed uncomfortable with the technical terms they uttered: “smart” technology, “GPS knitting,” “email upload.” The word “download” tended to refer to email attachments, and the word “technology” often stood in for Internet access. “It’s nice to be free from technology,” Joy had said with regard to the advantages of keeping track of patterns using a paper chart instead of Ravelry.
The KG took over five years to configure their first online mailing list, and the list was still relatively inactive one year after I joined. Members preferred to be contacted individually by phone or email, such that most email threads contained a list of 25-30 “carbon copied” addresses. Characteristics such as technical skill, length of membership, and officer position (president, treasurer, secretary, archivist, etc.) were critical to member relations, but difficult to represent online. The aesthetics of yarn were equally hard to represent, as G., a 20-something KG member explained to me over dinner:

*I would almost be more willing to say, hey you, who has the yarn in front of you, which four colors do you think go best together. And I would be more willing to take that gamble than to take the gamble of me picking it based on the colors on the screen. So, and that - and that’s what’s made me so hesitant about buying it. I mean I’ve been debating it for like two months now. Then I’m like, maybe I’ll just go to, you know, [a local knitting store] and look at what they have because it would be less stressful for me. Because I’m not going to spend 30 dollars on something that, oh well, that’s not the color I wanted.*

G.’s comment highlights the amount of time and care invested in the selection of materials, and the corresponding hesitancy to make rash selections based on online representations. Assessing knitting material based on digital imagery was seen as a “gamble” and thus distinct from other material endeavors. The work of steeking, for example, is a challenging (and often terrifying) process of altering a garment’s size through cutting. A mere stitch out of place can ensure that the entire garment falls apart. Consider how L. describes online interactions in comparison to this process of fitting a hand knit shawl to a recipient’s body:

*The actual design was not on the Internet. The work that went into it wasn’t through the technology. [...] Yes, you can go on and you can do math and you figure out how you’re knitting it. But the sitting down, the steeking, and the interaction between two human beings; the fitting, the figuring out what was gonna work; the exchange of being personally together in the same room. You can’t get on the Internet. You can’t get through the technology.*

Steeking involves co-located engagements with the recipient of the garment and the embodied activity of cutting and sewing — two resolutely offline endeavors, in L.’s mind. These aspects of knitting a knitter “can’t get on the Internet.” The perceived distinction between craft and technology was real, but also marked a moral and discursive separation between material forms, reinforced by additional perceived differences, such as age.
Defending Turf: Wanda the Invisible Knitter

Wanda was vocally resistant to information technology entering the KG. When two new members left the guild in tears, Wanda had seemed to contribute to the loss by denouncing their attempts to create an online presence for the KG. However, after my KG program, it was Wanda who expressed the most interest in learning more about electronics in needlecraft. Her distrust of the digital medium was neither absolute nor one-dimensional. During a gathering at my house, she articulated this concern:

> When we first talked about having [KG] be, you know, online, or you know, the Yahoo Group. I resisted it really strongly. Because I was like: “oh my god, you mean we got to be in front of the computer for that much longer?” I mean, what is the point of that? You know, and I really honestly didn’t see the point. [...] Part of that hesitation and resistance is a response you get from younger people. You know, because, you are — I am beginning to experience — I’m becoming invisible. It’s kind of hard to explain. Because people don’t respond to me the same way that they used to. It’s hard to give an example of that. [...] When you have a young person doing really innovative, interesting things, or something that’s really, really complicated, or whatever, that’s great. But when you have an older person who’s doing really innovative things, or really complicated, it’s like: “oh well, of course they’re doing that, so what?”[...] There’s not that much enthusiasm when I want to learn something. Teaching an older person, there’s like, well it’s like, there isn’t that much point in teaching an older person, they’re not going to be around that long. [...] But I never thought of being older. And so, now that I’m older, I realize, oh my goodness, this is a whole other thing. Now I realize that people my age, we’re just as curious about stuff, and we just look like we are older and know everything already.

Wanda’s resistance to technology had little to do with fear. She was not scared to learn new tools or concerned for what they might expose and enable (bank fraud, scamming, etc.). Nor was she responding to a sense of isolation: feeling outside certain networks of communication. Wanda was connected to many artists and designers in her artist-loft residence in San Francisco, a longstanding non-profit community.

Wanda was more concerned with how particular networks of craft were established, maintained, and reassembled without taking much notice in her work. She was in the network, but invisible. She was getting older, and not ready to “feel” old. As she explained:
I’m afraid to let my gray hair grow out. Doesn’t that sound funny? But I just know that I’m going to find a different response from people.

Yet this “different response” was nothing new; Wanda had encountered feelings of difference before. When she was 35 she began carrying a walking stick after a complicated knee surgery. With a cane in hand, Wanda noticed an immediate change in how others treated her:

Men don’t ogle you anymore when you’re carrying a cane. And not that I want that, good god, you know — I spent my youth rebelling against that stuff, right? But, you just sort of realize, I just started carrying a walking stick, now I am a disabled or elderly person.

Though she was afraid to show signs of age, Wanda began defending her turf by taking a stand: effecting a distinction between online communities and knitting, electronics and yarn. Wanda’s hostility toward the digital medium was a type of boundary work (Star & Griesemer, 1989; Bowker & Star 1999), maintaining distinctions that enabled communication across different social worlds. This boundary maintenance extended to aesthetic form:

My aesthetic takes a little bit of a beating when I’m looking at, you know: how can I fit my aesthetic into what’s cool and groovy now? [...] I mean I like the EL [electro luminescent] wire stuff, but I don’t particularly care for the big, kind of chunky, you know, that’s not my aesthetic. I like things that are a little more refined.

This concern for taste and popular aesthetic was important to maintaining coherence between KG members and other makers in the Bay Area. The EL wire Wanda referred to was novel and exciting to Ellen, who used it to crochet necklaces, but its thick and “clunky” appearance did not convey the same detailed refinement that Wanda valued. The electronic materials were meant to reflect Wanda’s aesthetic, but they were insufficient for distinguishing lace knitting from a simpler stockinette stitch. They produced inaccurate material traces of skill.

These inaccuracies were exacerbated while posting a few projects on Ravelry. Although she accumulated a wealth of electrical knowledge as lighting designer for theater for fifteen years, the digital medium could make Wanda feel as though she was “just taking baby steps,” as she explained while reflecting on a recent experience trying to post a project to Ravelry:
I got the concept that I have to do [the uploading] through iPhoto if I want to keep all my pictures in the same, you know, kind of format and the same, file, and all that. So I do have some pictures that are in the image browser thing that came with the Canon. So I guess I have to switch them over or I just have to remember that that’s where they are. They’re not as easy to manipulate. [...] And the photo] can’t be bigger than, I can’t remember what it is at this point. Or you could link to your Flickr account. Okay! Another stumbling block. No Flickr account! <laughs> It’s like, oh shit. Now I’ve got to get a Flickr account. So I just stop. I just get tired. This is not the way I want to spend my free time. I want to knit.

In craving to knit, Wanda seemed to reinforce a separation between digital and material phenomena. Her craving emerged in response to frustrations with a string of demands imposed by software. iPhoto, an image browser, and “whatever came with my Canon Sure shot,” her digital camera, were each uniquely complicating Ravelry’s upload tool. The camera software was incompatible with iPhoto software, the iPhoto software did not reveal where her images were stored, Ravelry expected its users to have a Flickr account with low-resolution images, and Flickr no doubt wanted more. Wanda’s ideas, desires, and expectations were not considered or represented by these resources: she was invisible. For her, hostility toward the digital medium was less an admission of fear than a reclaiming of territory.

**Creative Calculus: Ellen the digital native**

Ellen was a notable exception to the narrative of the “digital native.” At age 80, she was known for her unconventional dumpster diving\(^\text{61}\)\(^,*\) and the flickering crochet necklaces made of EL wire. In addition to using unusual materials, she maintained a Facebook account that flooded my inbox. I received updates about Ellen’s uploaded images, new messages, and posted links, often more than once a day. In what was to be the first of many interview meetings, Ellen shared with me her passion for making exciting and interesting work, regardless of the materials or techniques. Her interest was in making her “mark” and looking at the world around her in a new way.

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\(^{61}\) Dumpster-diving refers to the practice of sifting through trash to find useful or valuable items, foods, materials, etc..

\(^{62}\) An art movement emerging in the 1970s, “Xerox art” involved producing often ethereal and surreal images by placing a variety of things – in Ellen’s case, honey, fruit, and other objects – on the glass of a copy machine.
Ellen was born and raised in San Francisco to a family with a history of political ties. Her grandfather was a California senator, and many members of her family were engaged in politics. When she enrolled as an undergraduate at Radcliffe her proclivity for literature, and eventual declaration of a major in English, was unsurprising. Her creative interests quickly expanded after college into an amalgam of artistic practices, from “mail art” to figure painting. Ellen had a hard time criticizing or categorizing her work. In response to established distinctions between drawing, Xeroxing, or computer use, she recognized each as a different form of “mark making.” Leaving a mark is what mattered. After renting out a Xerox machine for her apartment, and learning to “paint” with light in the 1970s, she began exploring pixels — manipulating imagery in computer paint programs and printing out the bits.

It was not until the 1990s that Ellen turned to knitting. As she explained to me, “I got sort of hungry to do something with my hands again.” For Ellen, the pixels on her Apple IIe computer looked so much like stitches that she began to print out the images to use as knitting patterns. As the screen resolution increased, creating finer and finer pixels, “it got more boring,” she explained. She turned to a fellow member of YLEM (a group devoted to exploring intersections between science and art) to ask for interference patterns she could knit instead. Soon after knitting with the soft wool, she became bored again, and took up wire as a raw material for needlework. The wire was difficult to knit with but easier to crochet, and hyperbolic planes and choral reeves soon began to flow off her hook. Electroluminescent wire followed close behind, enabling Ellen to create florescent necklaces and adorns for friends.

While for the majority of KG members, notions of technology were more obscure, Ellen’s approach to making posited a connection between knitting needles and computers. On many occasions, Ellen would tell me she believed that artists should have available to them the best tools of their era — the way Rembrandt was able to engrave and etch by using jewelers’ tools. The computer should be no different. It was in this tradition, she would say, that computers and digital media should be accessible to artists. “And all kinds of other things, like Xerox... video, everything.”

Though Ellen was consistently attracted to emerging craft materials, she was more hesitant to consider other practical changes: hook up printers, join groups on Ravelry, or sign up for new mailing lists. Indeed, one KG member explained to me that Ellen was also partially responsible for the loss of members some two years earlier; Ellen did not want her information available without her permission and
had requested that a newly created KG group on Ravelry be deleted. She did not want additional traces of craft labor publically available.

**Conclusions**

Reflecting on L.’s concern for the body, and Wanda and Ellen’s rejection of an online knitting group, we find that digital information technologies (social networking sites, Twitter feeds, cell phones) do not inherently redefine material practices. What is particular to them is not just what they can do or perform. Rather, what is distinct is also how people came to articulate an easy separation between them and what came before: ‘smart’ material versus ‘traditional’ material, ‘low’-tech versus ‘high’-tech, and ‘virtual’ versus ‘real.’ These terms, and the claims they perpetuate, affect the values imbued in and the engagements described by materiality.

The digital-physical dualism emerges here as a form of boundary maintenance that the guild members perform and perpetuate in order to make claims to the territory of needlecraft. They aim to distinguish their aesthetic tastes and competencies from that of others (non-knitters and less dedicated or skilled knitters) and celebrate the “skilled vision” involved in craft (Grasseni, 2004). Categorical differences between technology and craft arise as part of assigning value to distinct modes of being. This work resonates with Mary Douglas’ (2003 [1966]) discussion of cultural dualisms in *Purity and Danger*, wherein binary distinctions enable the emergence of specific cultural meanings in relation to social order. In Somaliland, for example, the separation of spiritual and secular power vests spiritual power in the physically weak and, thus, disrupts Somali’s ideas about social authority (2003:111-113).

In the knitting guild, it was this cultural distinction between IT and material that became useful for understanding members’ relationship to craft as a set of material traces. Material traces came about through the processes of making human investments visible and invisible (e.g., through removal, destruction, correction, or reproduction of knit fabric). In the cases I presented, the hand plays a special role in these processes, making traces of knitting labor understandable as rhythmic and embodied endeavors. Among digital tools, such traces were more difficult to perceive, complicating members’ relations to the hand. They also introduced new and unfamiliar traces of the knitting guild, which left some members resistant and others feeling vulnerable and at risk.
Revisiting my program at the KG, the digital tools I presented at the start of this chapter did not compel the expansion of craft material that I anticipated (Buechley, et al., 2008). Rather, they introduced a desired (and enforced) boundary between the physical and the digital. Not all guild members had a clear way of articulating this sense of moral threat, but it was a threat none-the-less: “Why are people doing this? Why are they invading?” Wanda had inquired after my presentation. For some, the intrusion of technology in knitting became an opportunity for younger crafters to push out members of the KG, a group of mostly middle-aged women already occupying the fringes of society. Resistance to this intrusion became commentary on the irreverence of youth. The hesitation expressed by KG members was motivated by territorial claims, to be sure, but also involved feelings of exposure through unfamiliar traces of craft labor. We thus find a multiply articulated rejection of technology in craft. In the next chapter, I examine the manner in which this opposition is negotiated among crafters inside and outside the knitting guild.

63 DIY and maker movements, for example, were comprised of crafters eager to introduce emerging materials and techniques to craft. For some KG members, these movements perpetuated a discourse of novelty and youth, best captured by the phrase “this is not your grandmother’s craft,” a common refrain on online craft blogs. Future work might more fully unpack this reverence for youth and innovation.
Chapter 5 Negotiating Technology Use in Craft

You can’t hammer a nail over the Internet.

—Economist Alan Blinder, Princeton Affairs, quoted in Crawford (2010)

Digital properties are hard to see: they are eclipsed by the metaphors with which their “containers” are discussed (e.g., the “cloud,” the “grid,” digital “media,” digital “content”, “high” tech) and by the computing resources intended to reduce the production and use of physical components. In the knitting guild, these metaphors prefigured resistance to digital technology, enacting social boundaries and moralizing discourse. In the binding workshop, digital technology provoked frustration and opportunity. These varying responses prompt me to ask: how do people involved in craft beyond the workshop and guild articulate the relationship between digital technologies and material?

This chapter builds on my discussion of guild members in Chapter 4 to further investigate technology’s uneasy resting place in craft. Drawing on interviews conducted with “technology savvy” knitters, and a range of professional San Francisco crafters (potters, mosaicists, carpenters), I examine how crafters embrace, ignore, and problematize the (op)position of craft and digital technology. I investigate crafters’ relationships and responses to digital tools as they participate in craft-centered social networking websites and online distribution channels.

The Joys of Craft

Across participants, manual labor was valued for its connections with the human body. “Honest effort in, honest sweater out,” Maple said in reference to her knitting. Manual labor embodied integrity and perceptibility: removing the unnecessary elements of work so that only the “honest” materials and techniques remain, as Penny explained,
Penny: “I don’t really care if people think it’s craft or art. It doesn’t matter. What matters is that it has integrity.”

Such language signified a way of seeing and working with materials involving virtue and respect:

_It is an honest way to live, it is tangible. You can’t lie with yarn. And you can’t shortcut._

In this regard, craftsmanship connoted a kind “special” expertise — “the ‘Wow, clever me’ aspect of the crafting thing,” as one knitter explained.

_Janus: “In some ways I feel knitting is almost a secret society in that it is often only knitters who understand the work that has gone into producing something.”_

Knitters had little interest in sharing their work with everyone, as became possible on social networking sites like Facebook and Ravelry. Rather it was their special talent or “cleverness” they enjoyed most. Effortful artifacts such as mosaics, pots, and knits represented a “secret society” of knowledge.

**Mending and Correcting**

Problem solving was essential to knitters’ craft even as their work became monotonous or messy. For example, when a novice knitter in Sarah’s knitting group discovered a problem, she enthusiastically proclaimed: “As ye knit so shall ye rip!” Sara’s old-fashioned language stresses the inevitability of mistakes. Mending was unavoidable but pleasurable — as when it became a source of innovation. Penny, a potter living in Arcata, a few hours north of San Francisco, made a similar point:

_Oh yes. I wanted to come [up] with another way of putting texture without using glaze. So I started just using the wire brush. I could hold it on the inside and brush away clay when it is leather hard, and then I can feel how close I am getting to going all the way through without going all the way through. So that gave me you know another way to make the pot thin without having to trim so much off of it._

Here Penny described using a metal wire brush to create coarse textures on the inner surface of her pots. This technique was applied to “functional” pottery (pots with the capacity to hold water). For the pottery to remain functional, however, Penny could not puncture the clay as she worked with the surface. Breaking through to the other side would create a hole and render the pot unusable. To
ensure the impermeability of the vessel, Penny must “feel” her proximity to the surface as she moves her hand over the clay. While applying the wire brush, she preferred to work with hard, relatively dry clay since a wetter surface would not provide the same sensitivity. Feeling, in this sense, involved not only engaging with the tool, but also navigating the technique.

As craft progressed, participants described the process of finding their way. Jill, another ceramic crafter, discussed her experience creating a wall installation without a precise plan:

Jill: “[I]nstead of having this preconceived idea of how it’s going to look on this large piece, one item... I wonder how I can change the configuration so I actually have an interesting collection of work that’s related but not the same. It was a little hard for me to make ten swirl pieces and I don’t want them to be all the same size and the same color and everything. I want there to be some interest. So, that’s where again I sort of let my material help me to figure out how I’m going to make the piece work.”

Yet Jill was also unsure how she should produce a desired result. Much like Joy’s Fair Isle lessons in the knitting guild, she had no “preconceived idea,” no clear vision of what lay ahead. Instead she was using her materials and tools to think with: deciding what she wanted them with do and how in the course of craft. Similar to how the binders’ described the materials “having a say,” Jill recognized her materials as collaborators, “helping” her form an idea of what her installation may become.

This speculative and indeterminate progression is reminiscent of Suchman’s (1987) formulation of situated action: “you effectively abandon a plan and fall back on whatever skills are available to you” (Suchman 1987:52). It also resembles what Tim Ingold (2007) has termed “wayfinding” vis-à-vis navigation: feeling one’s way rather than using a map. In urban planning, wayfinding involves more than simply finding one’s way, but also looking for clues in the landscape (using signage, landmarks, indicators); Joy, in this sense, is instructing us to look for clues in the material. Feeling becomes an active search.

In *Ways of the Hand*, the ethnomethodologist David Sudnow describes a similar sense of learned improvisation. While humming along to a Charlie Parker song, Sundow ignores the “particularities of the notes;” after learning how to improvise jazz music, he then thought, “what had I in fact been listening to as a jazz fan all these years?” (Sudnow 1978:17) Without performing the notes, he was unable to recognize and pay attention to melodic and tonal qualities. Craftsmanship, in this
sense, involves perceptibility: removing the unnecessary elements of work so that only the “honest” materials and techniques remain.

**Judgment and Quality**

For a piece to be unique to the crafter it must be uniquely associated with the crafter’s experience of creation. Rachel was “not sure how to describe” what she sees and knows is successful but she is able to work through relationships between different properties of the material. Her ideas of proper proportion were accompanied by self-critique:

“Well, I criticize myself all the time. I criticize the forms first of all, the proportion. I criticize where I place, say, the wire, how does that work with the form. Texture, how does it work with that, color. My own judgment—but I'm not really sure where that comes from. It's just you know when it's right; it just feels right. I'm not sure how to describe that.”

Relying on what “just feels right” was a common theme. It was difficult to express successful interactions, but rather their expressions surfaced through continued handwork engagements. Attendance to color, texture and form revealed certain intuitive understandings of desired aesthetics. As Paige, another ceramicist, explained:

“It depends on what your goal is. I don't have a holier than thou, thou shalt not ... This would look stupid if it was all beat up, right? That would look cold, so if it wasn’t, so it has to balance.”

Concerns for balance expose how participants view the substance of their goals in relation to the forms they are making. The products of handwork cannot look too geometric and “cold,” nor should they appear too sloppy or unkempt. The quality of work thus depends on the balance between efficiency and uniqueness and how sensory interactions produce evidence of workmanship.

**Independence and Risk Taking**

Through its doing, craft entailed independence — from home life, from consumer culture, and from the hustle and bustle of the modern workday world. Distancing handwork from more typical contemporary work took the form of physical isolation as well as expressions of individuality and artistry. In Luke’s words:

“[B]eing able to scribe out your own time... [B]eing able to live that lifestyle. Being able to kind of choose the way that you live your life and I don't think it comes without risk.”
The ability to choose, for Luke, is key to working as a sculptor. Luke is self-employed and able to flexibly arrange how activities develop in his studio. He describes being able to go surfing when the waves are at their peak, dedicate sculptures to ending relationships, and fund his artistic practice through architectural commissions. He values the possibilities for experiencing his “own time” through deliberate choices. In his eyes the work of a crafter offers a free and precarious way of life—an element of risk missing in other professions. For some this sense of risk was achieved, at least in part, through innovative use of materials. Take Henrietta, a charismatic crafter who enjoys rethinking and reusing scraps of tin, such as old lunch boxes and pop cans. She describes a tin UPC code that she reused as the clasp for a clutch, a small purse.

“I am a risk taker. I think that’s what it is, if I have to say why do I do it. I work really hard but I am just a risk taker. I’m just really not willing to stay in safe territory. Working with recyclable materials is not safe territory and making, stepping out like this is definitely not safe.”

Henrietta’s ‘risk taking’ is not the final product per se; she is instead interested in the labor of laminating plastic and the innovative repurposing of material. What has become ‘unsafe’ is her act of leaving the collective to be alone: using unconventional materials such as the UPC code as commentary on consumerism. She sees herself as a “misfit”—someone who thinks differently about her environment and seeks to share her views with others. Each piece is intended to show and communicate something new. Alongside this interest is a fondness for the aesthetics of (re)invention. As Penny explained,

“[I]t was really nice to see something, that material looks so mundane it’s everywhere. To see it and treat it in a different way, makes you feel better.”

Innovation in this way was realized through careful engagements with material; it was appreciated as an emergent conditioning of success rather than a fixed outcome.

Using Technology: Maintaining Social Ties and Adapting Expertise

Participants have so far expressed shared concerns for embodied handwork, cleverness, and appreciation for particular qualities of “honest” workmanship. However, among interviews with Ravelry users, knitters beyond the knitting guild, we find a comfortable reliance on digital tools.
Q: How did you discover these communities?
A knitter: "On the internet. How does anyone discover these things?"

Knitters used digital technologies to produce and maintain lasting relationships, though to different degrees and for different purposes. For one knitter, personal connections on Ravelry “energized” her craft:

[O]ne of the groups I belong to is “the Harry Potter Knitting Crochet House Cup” - we get sorted and make crafted objects for points for our houses. So, everyone has some common interests... and some folks just sound like me - use similar vocabulary, make admirable projects, respond to my posts... and then, boom, I realize that a certain handful of crafters are people I check in with every day - send packages and cards to - ask for advice - and arrange to meet now and then!

A special interest or disposition distinguished different online users and configured Ravelry as a bounded space. Only accessible to members, Ravelry required that user accounts be individually approved, leaving applicants sometimes waiting days or weeks for access. This brief exclusivity fostered a sense of community among members. As one of its founders explained:

The feel of the community on Ravelry, it started pretty open and friendly. We really wanted to make sure it had that kind of feel to it. But also having a way to kind of break it down from like the huge masses of people – you know, a million plus people – to smaller, cozier areas. So [...] you can get to know people and make those connections.

Ravelry maintained an “in-between” space: more private than a public blog, but still somewhat visible to strangers. Since knitters often used Ravelry to advertise knitting circles, online membership effectively filtered offline participation.

The knitting circle surfaced as a well-known mode of handwork. But depending on the precise type of work, connecting online took multiple forms. Before and after knitting, knitters discussed posting photos of a project on Ravelry, “messaging” with other Ravelry users about their choice of pattern, technique, or yarn, and organizing knitting activities like the “Knit-Along” – a project wherein each knitter creates the same article at the same time. A few participants used Ravelry to make international contacts on their travels to Chile and Canada: by messaging other Ravelry users they found yarn stores and planned to meet-up with “like-minded” people abroad. Knitters often spoke of posting craft-related updates on Facebook for other knitters to see. Karla, for example, was proud to find a photo of her friend’s little girl wearing a yellow hat that Karla had recently created for her
friend. But in comparison to Ravelry and Facebook, “It’s with the blogs you really get to know and talk with the others,” one knitter said.

When blogs proved unsatisfactory, some knitters would go online to find a knitting circle. Elie looked online for a “Chicks with Sticks” meeting when she “got a hankering” to knit:

**Elie: When I first started knitting it was just me... And that’s why I liked going there: because I’d be around people that knit or crocheted.**

Elie was not looking for other knitters because she needed urgent advice. She, like many other knitters, desired supportive, likeminded companionship. Cultivating friendships was part of the pleasure of knitting, and online resources facilitated such off-line relationships.

**Difficulty and Problem Solving**

When it came to digital technologies, work that demanded less skill was seen as easier to accomplish and, thus, not as interesting. Amber, a San Francisco screen printer, tried to make her prints look less “graphic” after default functions in her graphics software produced clean lines far easier than lines that appear hand-drawn. As she explained,

*I mean back then [in college] you were doing anything to make it not look like screen printing, anything to make it not look flat, but now that there is digital printing, what people want out of screen printing is flat, simple.*

Digital printing introduces new possibilities for the screen-printed medium as well as different levels of difficulty, shifting regimes of expertise and taste. Responding to how tastes have “come completely around,” Mike similarly enjoyed applying his glaze techniques in new ways.

**At first, ceramics just seemed sort of ... like basket weaving you know just something you just don’t really think of it as requiring a lot of in depth thought. It turns out that it’s working with material and then especially working with this solubles is quite challenging. There are many, many problems that have to be solved along the way.**

After professional career as a software developer, Mike translated his background in chemistry, computer graphics, and engineering into a small ceramics company. As a child, Mike watched his mother as a professional potter, intrigued by “how she approached the material.” When she passed away some years back, Mike and his wife decided to enroll in a local (raku) pottery class. Though he had previously
shown little interest in the craft, this “dabbling” with clay and glaze led to some interesting experiments. He began working with soluble metals that transformed transparent liquid into vibrant blues, reds, and oranges in the kiln. Not just the heat, but also the shape of the ceramic vase, affected the patterns and colors that appeared: “So you have to do a lot of testing and figure out how to pull it off.” The pottery demanded purposeful material exploration. “It’s the kind of challenge I like to take on, being an engineer,” he explained. When asked what it meant to be an engineer, Mike responded:

*I love to solve problems you know. That’s, I love that’s the thing I do take on difficult problems; things that haven’t been done before. Figure out how to pull them off.*

In this regard, Mike’s pottery and engineering interests seemed to coalesce around similar interactions: distance from the end product and dedicated problem solving. Mike’s software had been compiled into transistors on a graphics chip that he could later only view through a magnifying paperweight that sat on his desk. Still, he viewed his engineering differently from pottery. The engineering “*just seems … totally virtual. It all exists in your imagination,*” he said.

Even as engineering and pottery involved similar forms of problem solving, they exhibited different traces of technique. Examining his completed graphics chip, Mike could just barely make out his own work: the sections he designed for over two years were barely visible through a magnifying paper weight. With his pottery, Mike developed his expertise by looking at the numerous “test tiles” he created before the full vase. The tiles materialized traces of handwork (dotting, patterning, layering) that enabled Mike to assess his choices and further develop his techniques. Though his glaze application became visible through careful experimentation, it was not apparent to other ceramicists:

*I think it would be hard to share everything about it. Yeah, it’s not that easy to come with the techniques that we’re… Doing a workshop and showing everybody everything we’re doing would be hard to do for me.*

Mike’s desire for concealment arguably contrasts with the availability of online craft resources. “*It’s too much,*” two knitting guild members told me in reference to the work of chronicling craft processes in blogs and online social networking sites. When faced with opportunities for sharing technique, crafters expressed an appreciation for secrecy.
Resistance to Digital Technology

Understandings of digital technology emerged in parallel to social and pedagogical desires. Yet there were also important ways in which crafters were weary of, and even opposed to ideas of digital technology. For instance, when asked about the relationship between knitting and technology, Julia replied:

*I’m wearing a scarf I made with two sticks is how I think about it... I mean if the shit hit the fan—excuse my language—where would we be? If I didn’t have an iPhone, could I make it around the city? Probably not... And it scares me sometimes. So things like gardening and knitting bring me a little bit back to earth, you know? Teaches you to appreciate how lazy we’ve become.*

Julia was reprehensive of her Smartphone, as it represented a pervasive laziness in society at large. Another knitter connected digital technology to crime: “Society is hardening, there is a lot of aggression, sometimes you don’t even know your neighbors.” Still, the utility of computational technology could be appealing when it came to monotonous replication.

*Maple: I have written a draft of a new pattern and I’m not sure whether the instructions exactly lead the knitter to produce the object in my imagination—I have to spend about three weeks to actually make it. If I could push a button and go to bed, go to work, feed the kids and [come] back and find the finishe[d] [...] object, then [I] would be able to see if the pattern were as I had hoped or needed re-writing.*

When confronted with a choice between finishing “drafts” of a knitting pattern and attending to other parental responsibilities, Maple appreciated the ease of computer automation. Yet in the context of creating knits, these tools introduced disadvantages: “I wouldn’t have the feeling of yarn in my hands. It wouldn’t be the same thing passed down for generations.” For Maple, handwork demanded human connections — historical and physical — embodied in the feeling of yarn. It was these relations to the hand that she expected technologies to disrupt.

Despite these trepidations, knitters continued to integrate digital tools into handwork activity. When meeting a deadline, Yali — a semi-professional knitter with osteoarthritis — enjoyed how her knitting machine “speeds stuff up.” However, she also drew limits:

*Color, form, appearance, that is part of the process between the person I work for and me, I couldn’t let that be random... maybe I’m partly control freak?*
Yali links her knitting machine to a disruption of the types of human relationships based on collaboration and co-production. The association of automation with randomness underscores crafters’ concern for human selection and judgment. Working with one’s hands was viewed as a social responsibility. Avoiding physical tasks through the “shortcut” of mechanical automation could seem immoral.

**Authenticity and Soulfulness**

Much like our discussion of authenticity in Chapter 1, and Benjamin’s (2007 [1968]) ruminations on mechanical reproduction, in particular, several participants discussed a reduced sense of authenticity with regard to digital artifacts:

Luke: “I think a lot of the digital mediums are soulless and in most cases, I would say in every case the digital medium has to be massaged somehow to make it a viable product for media.”

For many, digital artifacts were less able to embody the essence of manual labor. Work using digital technology demonstrated a “soulless” quality, suggesting that vitality depends, in part, on skilled human intervention. As Maple explained:

*When I can see and touch the things which I’ve made, then I have evidence that I exist.*

The ability to touch, feel, and interpret human labor represented the *humanity* of craftwork. Such processes enabled participants to feel a sense of personhood and subsistence. Recalling of Marla’s obscured stitch work, traces of craft seemed further concealed in the digital medium; without physical “evidence” of workmanship, human achievement was more difficult to perceive. These traces instead exposed an abstracted, perhaps modest, trace of the hand.  

**Rhythms of Digital Production**

Much like the subtle pleasures of working with clay, the rhythmic motion of knitting was often depicted as “meditative” and therapeutic. The slower and non-linear patterning to work seemed to offer an alternative to fast-paced urban surroundings. As one knitter said,

Jinny: “I like that it takes hours of work to have a finished item because that alludes to my patience and ability to commit to my craft.”

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64 In Benjamin’s words, “The role of the hand in production has become more modest- and the place it filled in storytelling lies waste.” (Benjamin, 2007 [1968]:108).
In contrast to the long hours spent with yarn or clay, crafters discussed their deliberate attempts to control hours at the computer. Like Sean in the bindery, Jill’s daily email activities, for instance, entailed two hours in the morning and two hours at night. Rachel checked email over coffee in the morning. “Work before play,” she said. Such rhythms of handwork were subject to change; they were based on what their bodies, materials, and customers demanded. “When you have that capability, it’s very, very difficult to not use it,” Paige noted.

Although participants saw something appealing in reducing the time it takes to make things (or, as one said, “making something that is being made while you’re sleeping”), when it came to purposeful production, they valued investing and transcending time. As Rachel described in reference to housework: “Like I try and keep it [the house] neat, but I can just like transcend things and it’s bad sometimes.” The term transcendence implies rising above that which is directly in front of the maker and her surrounding environment. If this is not accomplished in daily activity it could perhaps be invoked through handwork and skill. “I doubt I would feel as clever if it only took 10 minutes,” a knitter explained. Transcendence depended on the investment of time and skill.

Luke: “I don’t know how much you could look at a graphic image created by a computer and hang it on your wall and be happy looking at it, whereas being made by hand has a certain kind of timeliness to it, not timeliness, timelessness to it and I don’t think computer stuff can do that.”

Things made by machines or computers do not surface the same “timeless” characteristic as human-manipulated metal or wood. Crafters voiced concerns for sustaining traces of interaction, noting limitations to the digital medium.

**Conclusions**

This chapter discussed the range of ways that crafters view and use digital technologies in craft. We found that material traces among digital technologies do not represent the same historical record of labor, emotions, and environment as traditional craft materials. Digital tools often obscured and dissolved these relations while exposing a “secret-society” of craft. Through the language of secrecy, soulfulness, and timelessness this chapter suggests a discursive, embodied, and moral separation between the digital and non-digital medium. Hidden traces of craft labor reinforce a sense of ‘cleverness’ that digital technologies appear to jeopardize by revealing additional traces of craft production. Material traces speak to the moral orders of craft and a sense of
impending threat to society at large. In the next few chapters, I synthesize for design a framework inspired by these subtle and contested rhythms.
Chapter 6
Designing Traces

The preceding chapters offered practice-centric accounts of craft environments in which I uncovered a range of material traces. Taking lessons from these first-hand encounters, this chapter asks how insights drawn from technology in craft — i.e., the category of material traces — might be used to interrogate new digital tools for craft? To address this question, I turn to field trials with a system call Spyn. Spyn is mobile phone software that associates digital records — audio/visual media, text, and geographic data — with physical locations on handmade fabric. Over three years, I iteratively designed and developed Spyn to prompt responses to the relationship between digital technologies and craft. Knitters used Spyn to communicate directly with their recipients and explore multiple creative dimensions of fabric. It is through these and similar occurrences that I consider two dimensions of digital technology: firstly, the role digital systems play in the production of meaningful traces; and, secondly, how design interventions might reveal alternative relationships between digital systems and material culture.

Using material traces as an analytic category for understanding Spyn, I find that what distinguishes Spyn from other tools for craft (digital or otherwise) is its ability to trace a unique location in time and space, both backward and hierarchically. Knitters needed Spyn to trace back the durations and rhythms of surrounding activity, as well as the locations in which they crafted — an aspect of knitting that is difficult, if impossible, to diagnose without special equipment or knowledge. Using Spyn, knitters also layered multiple stories, reflections, and actions: traces of use (stories of interaction around Spyn) overlaid traces of time (encoded time stamps, e.g., digital metadata associated with digital images), and traces of time overlaid traces of skill (the technical craft, or “fracture” Adamson [2007], revealed by the evenness and order of stitches). Each of these elements could then be traced forward and backward in relation. As we will see, Spyn enabled a range of experiences that extended and transformed the kinds of value ascribed to knit artifacts.

65 Related papers include (Rosner & Ryokai, 2008; 2009; 2010).
Building a Probe

Technology probes are technological instruments meant to collect information and stimulate reflection within a given environment (Hutchinson, et al. 2003). Probes have been useful tools for investigating social phenomena in situations where gathering data can be difficult using traditional social science methods, such homes and living spaces. Usually preceding the development of a prototype, probes are focused on data collection rather than usability; they are meant to help guide future choices, but not make them.

![Spyn displays digital records recorded while crafting over the knit artifact](image)

Figure 20: Spyn displays digital records recorded while crafting over the knit artifact

66 Gaver and Dunne (1999) coined the phrase “cultural probe” to refer to the packets of maps, photo albums, and postcards used to reveal insights into the aesthetics, attitudes, and desires of a group of elders. The approach was inspired by a “tradition of cultural provocation” derived from Surrealist, Situationalist, and Dada art movements, which leveraged ambiguity, absurdity, and opacity to challenge conventional cultural modes (Gaver and Dunne, 1999:602).
Much like a technology probe, I developed the Spyn system as a lightweight mobile tool for knitters to associate geographic locations, digital imagery, and textual musings to positions on knit fabric. Spyn enables knitters to record digital messages while crafting and retrieve those messages using the knit artifact. As a tool for digital annotation, the system configures the knit as a canvas onto which digital records can be associated. In deploying Spyn, I leveraged this ability to collect data about participants in order to gain insight into their relations to technology, material, and craft.

![Image showing development of Spyn system from prototypes to mobile application](image_url)

Figure 21: Over three years, Spyn developed from a series of prototypes into a mobile phone application.

Based on early fieldwork with knitters, I distilled five design principles for Spyn: 1) Portability - knitters craft in diverse locations; technology should remain mobile and enable knitters to record the places and times of craft activity; 2) Process and Invested Time - knitters enjoyed the process of handwork as much as its product; technology should help knitters keep track of progress and make the process visible. 3) Occasions and Opportunities - knitters were motivated by a variety of
social and cultural phenomena; technology should help them celebrate those motivations by enabling the capture of digital media. 4) Annotation - knitters annotated their projects on note cards, notebooks and websites; technology should enable knitters take notes while crafting. 5) Tactility - knitters enjoyed the rhythm created by hands, needles and soft materials; technology should remain lightweight, and preserve the existing aesthetic of knitters’ tools and materials. Using these principles, I aimed to preserve existing rhythms of craft while enhancing the creative process through digital media.

Figure 22: Spyn records and recalls digital records in relation to locations on knit fabric.
Drawing on Ubiquitous Computing research (c.f. Abowd and Mynatt, 2000), the Spyn prototypes were originally designed to “capture” experiences around craftwork by enabling knitters to record their geographic location, timestamp, yarn yardage, and digital media, and then digitally associate that data to locations on fabric. Yet, as the project continued, it became clear that Spyn enabled knitters to re-conceptualize their fabric in a variety of ways. By associating the knit fabric with digital records of portability, process, opportunities, and annotation, the fabric became a site for layering and interleaving traces of skill, time and use.

Figure 23: (left to right) (a) Gina using scanning guide to pin her knit; (b) the Spyn “kit.” The kit contained support materials for the Spyn software and a journal for documenting daily activity with Spyn. Support materials included barcode “buttons” (for switching projects), a scanning guide (for gauging the viewfinder’s distance from the garment), and instructions for using Spyn.

**Developing the Technology**

Over the course of four years, Spyn developed from a series of prototypes into a mobile phone application. To preserve the knit aesthetic, Spyn was designed to read (invisible) infrared ink markers printed on the yarn that specify unique locations in knit material. In first prototypes, the connection between the fabric and digital records was achieved by correlating the position of the yarn (tracked by a rotary encoder) with locations on fabric (marked by patterns of infrared ink, invisible to the naked eye). As such, the system was comprised of two components: 1) a knitting basket that holds and keeps track of the yarn and 2) the Spyn machine. The knitting basket contained the knitter’s yarn and a Phidget rotary encoder. The Spyn machine was comprised of a mobile device (Asus Ultra Mobile PC with a touch screen interface, an internal web camera, and an internal GPS), two external cameras (a web camera and an infrared enabled camera), and an Eye-Fi card (a memory card with WIFI tracking capabilities). Using these techniques, Spyn system automatically keeps track of the knitter’s yardage (how many yards of yarn were pulled through the Phidget rotary encoder), and the knitter’s
geographic position (using a combination of WIFI network positioning and GPS data).

**Computer Vision Techniques**
The first prototypes used infrared ink printed on yarn to locate positions on the yarn. I experimented with different ink patterns on yarn, and resolved to use a simple and generalizable technique: printing long (5 yards) and short (1 yard) stretches of ink along the length of the unknit yarn. This created a pattern of thick and thin markers across the width of the knit fabric. This pattern was sufficiently readable across a range of knit patterns and sizes, camera angles, and lighting conditions.

Thick markers were placed at 30-yard increments across the yarn, providing a reference for the scale of the knit. Thin markers were placed in between thick markers. The number (n) of thin markers between a pair of thick marker indicated the approximate yardage at the thick markers (30*n), as well as the orientation of the knit (thin markers were always placed closer to the first thick knit marker). My improved technique requires the knitter to specify the rough width of the knit (requested as stitches per inch) and requires the captured IR image to contain at least two 6-yard markers. Surprisingly, this was rarely a problem for participants since every project used more than 12-yards of yarn. The length of the thick and thin markers required additional adjustments for especially wide or thin knits.

In practice, the system faced challenges. Shadows caused by the texture of yarn and the knitting pattern still prevented knitters from consistently recalling messages. The most unfortunate outcome resulted from one participant opening more than one Spyn program at the same time, which prevented her from accessing most of her data while knitting. Additional issues included difficulties manipulating the device’s touch screen, loud noises from the device’s fan that interfered slightly with audio and video recording, and the unpleasant smell and texture of the yarn during a brief period in which a particular solvent was used for printing.67

67 I should also note the practical circumstance of these field trials: while visiting knitters at their homes I found that most often crafted indoors and preferred to knit on a comfortable couch or chair. Because GPS signals were often too weak to record the knitters’ indoor locations in earlier field trials, we used a combination of GPS and the Eye-Fi Explorer SD Card that uses WiFi network positioning to track location. By capturing location data in indoor and outdoor environments, I designed Spyn to support the portability and geographic flexibility of the craft.
From these early prototypes, I learned a few lessons that informed the design of the mobile application. First, I found that — despite its relatively compact size — the entire system (basket, cameras, rotary encoder and Ultra Mobile PC) was still too bulky for knitters to comfortably carry to different locations. In response, I redesigned the software for mobile phones. Second, I found that IR ink was impractical for long-term deployment; the ink solvent was non-permanent, and the preparation of ink posed significant demands on my time. Thus, I replaced the IR ink with a vision technique for reading stitches on the garment. The row count produced by my vision algorithm (a more useful cue for knit work) also eliminated the use of the rotary encoder to track yardage. Finally, I extended the functionality of Spyn to enable knitters to a) delete and edit each Spyn entry (called a memory), b) create and customize multiple projects (by changing the title, background image, knit or crochet stitch), c) automatically associate row count (along with the date and location) to each Spyn memory d) associate multiple media items to each Spyn memory (short text, long text, photograph, video, and audio) (see Figure 24), e) distinguish between projects (or project parts) using 1cm diameter buttons with unique barcodes, and f) easily switch between projects (or project parts) by scanning the barcode buttons attached to fabric.

![Image of Spyn project for Nicki](image)

Figure 24: Screenshots of Kyla's Spyn project for her sister Nicki (left to right) (a) Spyn home screen, (b) pinning garment, (c) creating a new Spyn memory, and (d) viewing the Spyn memory.

**Mobile Application**

The mobile phone software had four main functions: **Pin**, **View**, **Find**, and **Map**. **Pin** associates information with a location on the fabric. **View** displayed pinned memories over an image of the garment; each pin links to the content associated with that memory. **Find** opened and switched Spyn projects (using barcode buttons) and retrieve memories associated with that project. **Map** displayed
pinned memories on a map; each pin links to the content associated with that memory.

**Pinning “Memories”**. In order to pin a memory (Spyn entry) to fabric, a knitter would capture or select a photograph of the garment and then touched the screen at the location he or she would like to add the information (Figure 24b). This opens the “Create Memory” screen (Figure 24c) where the knitter could create a title (short text), description (long text) and/or media items (still image, video, audio). Once created, the memory was automatically associated with the location on fabric (knit or crochet row and x-location), geographic location (when available), and timestamp. The computer vision algorithms that automatically associate locations on fabric with digital information used simple edge detection to count rows on images of sockinette stitch (a basic knitting stitch). Each knitter was instructed to capture images roughly six inches from the garment; they were also provided a “scanning guide” for accurately gauging that distance (Figure 23). I adjusted the row count for other stitches and yarns. If the knit was too large to fit under the viewfinder at six inches from the garment, the user took multiple images of the fabric. The system analyzed each image separately and then combined these images in the viewfinder.

**Methods and Participants**

Over the course of three years, I delivered the software to more than 30 knitters. Based on early field trials, I became interested in the ways people might integrate Spyn with their existing practices of “co-creation” – wherein the recipient also shaped the result of craft. This lead to a focus on the process of gift exchange, and how the recipient may distinctly interpret the Spyn artifact. I therefore recruited twelve knitters and twelve recipients in order to understand the acts of production and reception while creating an item for someone else with Spyn.68

68 Research questions framing my most recent field trials involved included: What types of information do people capture with Spyn when creating a gift for someone else? How does using Spyn affect the creator’s process of crafting? How do recipients of the craft object respond to the digital messages associated with the object and how do the digital messages affect the recipient’s relationship to the creator? See (Rosner & Ryokai, 2010) for elaborated research questions and a discussion of the study methods.
Participants

I recruited twenty-four participants for the study focused on gift exchange: 12 creators and 12 recipients (Figure 25). Since one creator was unable to complete her project due to time constraints, I was only able to interview and observe 11 creator-recipient pairs. Creators were recruited from several sources, including community-based craft events, craft social networking websites and through referrals from local contacts. I then asked creators to gift their Spyn knit to someone local so that I could interview them. Recipients were thus recruited based on their availability and their relationship to the creator, rather than their familiarity with needlecraft. I made this decision based on lessons from our previous fieldwork where accessing recipients proved difficult. Although this limited the creator’s selection of a recipient, I met with each person who received a Spyn gift. Participants had no previous exposure to the Spyn system or affiliation.
with the researchers before beginning this work. Creators were all female and active in the knitting or crochet crafts. They ranged in age (early 20s to late 50s), nationality (US, Argentina, and Russia), number of years knitting or crocheting (16 years on average), and comfort level with various technologies. Their occupations also exemplified this technical diversity: professions ranged from web-master (“I’m pretty tech savvy”) to stay-at-home mother and nurse practitioner (“For a non-technical person, I did okay!”). Recipients were coworkers, friends, family members, and a romantic partner of the creator. Seven recipients were female and four recipients were male.

**Study Design**

The study was designed to intervene in the existing practices of needle-crafters in order to understand the role of annotation technology in the process of craftwork and gift exchange. I asked creators to complete one craft project, and five participants chose to create two or more projects.\(^{69}\) I also tried to give participants as much flexibility as possible to determine the creative and temporal constraints of the craft project. In order to compare aspects of the craft process across subjects, I asked creators to use Spyn for at least two weeks, and to log their activity in a journal every day (whether or not they used Spyn). Paper diaries were used to gain more insight into the creators’ experiences with Spyn when I was not present and provoke reflection on their use of Spyn. Questions included: “How comfortable were you using Spyn today?” and “How do you think the recipient of your craftwork will interpret these memories?” The diaries effectively provided me with data surrounding the two-to-four week creation process, such as how their understanding of the system changed over time.

More specifically, the study was composed of five phases that took place over seven weeks. *Phase 1* involved an introduction to the goals of the study. I spoke with creators by email, phone or face-to-face conversation, asking them to use Spyn for at least two weeks to make a gift for someone else — a recipient with whom I could also speak in-person. Creators intending to use unusual stitches were instructed to bring me sample swatches or inform us of their pattern choice before *Phase 2* so that I could optimize the vision software. *Phase 2* involved an introduction to Spyn and semi-structured interview. I met with each creator individually for 1-2 hour(s) in a quiet location of the creator’s choosing: the creator’s home, the researcher’s home, the creator’s workplace, or a nearby café. Creators were introduced to the Spyn functionality and received an Android G1 phone and

\(^{69}\) This independent activity indicated a desire to use Spyn that was not directly prompted by the study protocol.
a Spyn “kit” containing support materials (Figure 23b). Phase 3 comprised creators’ use of Spyn on their own for two or more weeks. I offered creators technical support by email, by phone, and in face-to-face meetings. During this period I also created and maintained an online how-to website which was kept up-to-date with answers to creators’ questions. Phase 4 consisted of the gift exchange and related semi-structured interviews with the creator and recipient in a quiet location of the their choosing: a café, the creator’s home, the creator’s workplace, or the recipient’s home. I also provided participants with a pencil and paper survey prior to interviews. Phase 5 involved a final recipient survey sent by email 3-to-7 days after Phase 4. Sessions were video taped and later transcribed.\textsuperscript{70}

Field Trials with Spyn

On average, creators used Spyn for three weeks; one person (Fay) used Spyn for 14 days and one person (Carrie) used Spyn for 28 days. Most participants appeared to take their projects to heart: creators spent significant time creating and managing their Spyn entries, and recipients expressed appreciation for the creators’ efforts. Two participants continued to email the researchers (un-prompted) about their craft experiences after the end of the study. For some, the act of making and receiving their Spyn projects was highly emotional, as evidenced by two creators and two recipients who shed tears just before or during the gift exchange sessions. For others, the projects became a way for recipients to learn about the lives of some they love.\textsuperscript{71} In the following sections I first discuss the content and form of the Spyn memories. I then describe the ways that creators and recipients attributed meaning to the process of craft, the creator-recipient relationship and the craft product while using Spyn.

Spyn Memories

Overall, Spyn memories varied considerably in sentiment and style. Creators recorded and saved a total of 161 individual Spyn memories, the majority of which described the creators’ subjective experiences at the time of capture or earlier that day. For example, in a memory for her friend, Qwara, Erin described her surroundings while knitting in her garden:

\begin{quote}

\end{quote}

\textsuperscript{70} For more detail on the study design see (Rosner & Ryokai, 2010).

\textsuperscript{71} During the course of the three-week study, participants dealt with professional deadlines, moving homes, romantic stresses, and childcare. Despite pressing life events, all but one participant finished at least one Spyn project. In total, 11 creators completed one project, five of whom started one or more additional project(s).
[Spyn video] I'm enjoying the weather, and enjoying the blue of my princess tree. And I'm thinking, gosh, it's a good time to be alive. [...] And I'm thinking, gosh, I bet this is what <Qwara> feels when she's in Mariposa.

Erin’s video excerpt gave her recipient access to what her life was like while knitting. Unlike an instant message or a status update, the communication was asynchronous and the content was intended to last. This message was also typical of 14% of Spyn memories that discussed the outdoors or pleasures of nature, and 26% of Spyn memories that detailed events or situations related to the recipient. As we will see, this message also relates the technical perk of row counting (material traces of skill) with feeling that a live conversation is taking place using Spyn (material traces of use).

A variety of phenomena prompted creators’ thoughts of the recipient, including everyday objects (lottery tickets “made me think of [Ursula]”), a lunch conversation with a friend (the Spyn scarf “sparked my conversation” about the recipient), and even a bad day: “[I’m] having a crappy monday but i know as soon as i see you, all that crappiness will disappear,” Irene wrote in a memory pinned to her boyfriend’s scarf.

Before using Spyn, all creators discussed thinking of a recipient before (“usually right at the beginning and that’s it”) or after their craftwork. But while using Spyn, creators communicated directly to the recipient, even in the recipient’s absence, as evidenced by the third of memories that addressed recipients directly. Gina (creator) shyly summarized this sense in a final interview: “I felt like I was talking to <my recipient>. Is that weird?” Three participants frequently used the term “talking” to refer to their interactions with Spyn: “What was fun was definitely talking to the person while making the project for them [...] Why you made the project, and what made you think of that person while you were doing it.”

In addition to “talking” to their recipients with Spyn, creators recorded needlecraft-related subject matter in roughly half of all memories: they attempted to keep track of craft progress in a quarter of their messages (“I'm a little over halfway done.”), and sometimes related to yarn color or choices (“these are the fibers and colors I'm using”), or used messages to consider craft setup or planning (“ [...] different designs of hats. Making my lists and perhaps I'll show you them tomorrow.”). Two creators described having “trouble having the emotive journey” while crafting with Spyn; they preferred to keep track of progress (by creating a Spyn entry each time they finished a garment section) rather than tell stories or connect with their recipient. Carrie, for example, described being most “excited” by Spyn’s automatic row count “because sometimes counting rows can be a pain in the
ass. Like when you’re creating a scarf and you’re on row 500, counting is like—[crinkled face].” Her recipient, Owen, noted accordingly, “yours is the quest, it’s not the journey.” Unlike other participants, Carrie was uninterested in recording the social context surrounding her craft; instead, she preferred to document her progress (and, thus, overlay multiple material traces of skill).

Creators’ affinities for certain audio/visual media formats also differed. Among all memories, 98% contained text, 60% contained still images, 20% contained audio clips, 20% contained no audio/visual media (only text), and 17% contained video clips. Two creators, Gina and Irene, discussed feeling uncomfortable recording audio messages (“I don’t like the sound of my voice so I deleted it”) but comfortable recording text and images, whereas Laura, a novelist, was surprised to find she recorded mostly audio. Creators discussed using the video to capture multiple images in a scene “to just kind of scan a whole area” of a garden or to show more than they could or should express in words: “you don’t want to type out too much on the keyboard.” While three creators reported favoring video (“I felt like the video was [...] killing two birds with one stone”), two creators felt their video was “too shaky” or unpolished, and multiple images would suffice. Using material traces as a lens, we find each medium provided a different level of engagement with recorded media. Text and images described moments in space and time, as seen through attributes of material traces; video relayed the temporal flows of social practice, as seen through rhythms of material traces; and the combination of multiple media produced intricate stories, such as Jane’s little “puzzle” below, as seen through entanglements of material traces. In the following three examples, we find the layering material traces assigned very different forms of value to creators’ stitches.

**Jane: Flexible Traces**

Jane and Victor are colleagues at a yarn store, appreciating each other’s respective crocheting and knitting talents. Jane describes herself as a shy but unusually inventive crocheter. She tends not to rely on patterns and creates outrageous animal-head scarves (wolf, fox, squid or alligator heads pop out of a simple sweater or cowl). When I ask what inspires her, she says she has “always enjoyed being creative and solving problems creatively.” It was this quality she wants Spyn to convey.

Figure 26: Jane’s flexible traces
Approached with Spyn, Jane immediately begins sketching — determined to create a compelling use for the tool. She seems eager to expose her talents to her coworker Victor while challenging her technical skills. As she explains:

“...like the “making of,” you know? Like when I watch a DVD, I always want to know how they made the sets and costume... I don’t know why I like that. Just that it’s more—it makes it more meaningful and maybe people will understand me better”.

Jane uses Spyn to compose what she refers to as a “puzzle” in a one-shouldered-vest. She takes photos of bits of found type: words she stumbles upon in packages, scraps of paper, or signage on her way to work. In a record titled “secret message,” Jane captures an image of the handwritten word “WHERE’S” (see Figure 26). Ambiguous on its own, the word “WHERE’S” is associated with other images of words Jane collected while knitting, eventually revealing a sentence dispersed throughout her vest. In the attendant text, Jane elaborates her intent: “I am going to create a message for you word by word using the photos I attach.” This is her first Spyn message, and foretells the flexible tracing yet to come.

When Victor receives the vest, he describes his first impressions:

_It’s almost another tool to kind of like enhance the creativity of it. It kind of almost turns it into a 4D project instead of, like, instead of just having an object, you have a timeline to go with it._

The fourth dimension to which Victor is referring is comprised of layers of inscribed meaning (conveyed by Jane’s words, images of recent travel, and audio recordings of friends at work); the interconnected expressions Jane has digitally recorded and anchored to the scarf. Depending on how Victor encounters the Spyn records, he discovers a different semantic configuration — or “secret message.” Multiple readings of the vest incur multiple interpretations of Jane’s work. Jane arranged the placement of text on the garment, and the garment reciprocally influenced Jane’s arrangement. Though the vest became something other than an animal, it did not lose its capacity to shape and transform how Victor might use and read its message. The vest reinforces Jane’s sense of creative play, and signifies a flexibility particular to the Spyn device: a hierarchy of material traces (of skill, use, and time).

**Katie: Stabilizing Ephemera**

Katie decides to knit for someone with whom she is emotionally close but physically distant. Katie and Jordan have been romantic partners for over ten
years but live in different cities, a few hundred miles apart. This arrangement entails frequent mediated chats (phone calls, emails, blog posts, and Facebook updates), and makes intimate connections rather challenging.

Yeah, so one thing I ended up thinking about was kind of the process of knitting and the kinds of things I think about and talk about while knitting with my friends is really separate from the types of things that I do with [Jordan]. So it was like, the memories, because it was for him, they weren’t really about the knitting. It was more like, things I thought about while knitting. Like what could I attach to this and then I could go do that. […] it’s almost like a little bit of pressure because it’s like you know people are going to be looking at it. Are you clever enough? Do you have enough interesting memories? Yeah, because normally you don’t have an audience who are going to be looking at your work in that much detail.

In the above excerpt from the interview transcripts, Katie is first describing how she reconciles her relationship to Jordan with her knitting. She talks of recording the things she was thinking about while knitting, rather than the knitting itself. However, in approaching her work, she also notes a sense of “pressure” to perform for others. She is aware of presenting her work to Jordan as well as the wider audience the study entailed (myself, as researcher, and the community surrounding my research). Despite self-conscious feelings, Katie’s use of Spyn seems to involve serious reflection on her relationship with Jordan.

Upon receiving the finished Spyn scarf, Jordan interprets the scarf as something rather different from his usual mediated exchange. As he explained,

There’s lots of electronically mediated stuff that we have that’s completely disembodied. Like once I save an email that’s she’s given me away, I may never think of it again, right?[…] I get physical objects, but the physical objects I get, generally, they don’t have memories connected to them that I’m not present for […] But now every time I look at this scarf, I’ll think about that photograph up on Alamo Hill [a park in San Francisco]. Which is not something that trivially occurred. And we obviously could have mimicked it. I mean if she gave this to me on Alamo Hill, right, that would’ve created some context for it. But this took a set of sort of more or less discontinuous memories and attached them to a physical object.

Jordan is describing an image Katie collected when she had walked her Spyn project up to Alamo Hill, a park with a view of downtown San Francisco, and Katie’s favorite location in the city. For her, this location represented why she loved her city, and why she chose to live so far from Jordan. In interpreting this message,
Jordan reveals how Katie’s “attachment” of the messages to fabric seems to stabilize what is for him more ephemeral. Katie had collected small tokens of her appreciation of Jordan: a video of her travels on the bus, which would remind Jordan of another video he enjoys; a photograph of Bob Dylan, an artist Jordan introduced her to, even a video of her hands knitting because, she explained, “[Jordan] loves hands - their anatomy, the way they work.” Jordan contrasted the “electronically mediated stuff” with the more “physical” Spyn project. Katie’s previously “discontinuous memories” were at once specific to Jordan and the scarf, imbuing the scarf with a sense of appreciation for Jordan and the reasoning for their distance.

Also of note is Katie’s choice of pattern. As an experienced knitter, Katie has taken on a pattern that would provide stitches sufficiently interpretable by the Spyn’s computer vision system. This system becomes a restrictive element in her needlework, shaping not only the resulting stitches but also Jordan’s admiration for the work. In this sense, the knit incorporated the constraints and preferences of Jordan, her yarn, and the Spyn vision system. Katie carefully wove together her social, material, and technical relations.

**Irene: Marking Ends**

In the next example, a knitter describes what it was like to review her Spyn messages.

> So I go through all these memories and they’re all sweet, like I’m cooking at his house, and I, you know, pinned one [message] there, and I had lunch with Rebecca and she said she loved him—he’s a keeper—and, you know, all these sweet memories, and then—bam! I’m stuck I’m totally stuck.

Irene is referring to a moment when events in her life took a turn for the worse. She began the study intending to knit a scarf for her boyfriend. However, while “sneak knitting” under her desk at work, her boyfriend called to end their relationship. In the middle of her workday and her knitting, she hung up the phone and recorded a final Spyn message: “can't seem to figure out what to do...” Irene was now creating a scarf that marked the remains of a failed relationship.

Not long after the breakup, Irene decides to finish her knitting in the hopes of moving on from the project and the relationship. That Irene chooses not to destroy or cast the scarf aside suggests its persisting value. Part of her remains deeply bound up in the garment, even after she finishes, and probably long after it is out of her hands. This paradox of gifting — the unshakable, inalienable quality of the gifted knit — was echoed throughout my fieldwork with knitters. “I believe that
there is a rule in knitting that you don’t get rid of the hand knits without permission,” one knitter explained when she arranged for a gifted baby dress to be returned to her after the baby grew out of the garment. Yet Irene expresses reverse sentiments. Instead of holding onto the knit, she warns of her own uncertainty: “It’d probably be better if I gave it to someone I didn’t know.” She decides to post a general call on Facebook asking if someone would like the scarf. As a scarf laced with disappointing Spyn messages, there was little left to do but separate its material traces: those of failure from those of craft.

**Tracing Backward: Interleaving Material Traces**

As I have described, individual Spyn memories revealed a variety of personal moments while crafting. Associated with a handmade garment, these memories became more than discrete reminders of past experiences; they connected accounts of the crafter’s subjective experiences at the time and place of production with the products of craftwork. Digital records associated with yarn seemed to amplify recipients’ appreciation of the process and products of craftwork.

After delivering this software to more than 30 knitters, I found that knitters used Spyn to communicate directly with recipients and symbolically transform marked stitches. Jane turned a vest into a “puzzle”, another knitter turned a fingerless glove into a “travel journal,” another turned a scarf into a “recipe,” and another turned a hat into a “mix tape.” Semantic associations varied in positive and negative valance, as we may recall from Irene’s “breakup scarf.” One participant referred to the knit product as “emotional blackmail,” suggesting that the labor revealed through Spyn enhanced expectations for appreciation.

When knitters traced forward in Chapters 4 and 5, their attention was on the future — at the approximation of fit, the appropriateness of the yarn, the feel of the fabric against the skin. While using Spyn, knitters began to design for reflection by recording and narrating back. Much like the binders, they were selectively revealing and concealing traces. In addition to tracing forward, the knitters were tracing backward.

These historicized traces of knitting practice enabled knitters and their recipients to interpret the digital content as lasting messages rather than ephemeral communication, equating the knit artifacts to a “hand-written letter” or “time capsule.” As Penny noted when she received her Spyn hat:
Rather than viewing the gift as a single object, I felt as if I was given the present of captured time.

By connecting accounts of their social worlds (material traces of time) with the construction of an artifact (material traces of skill), knitters produced an artifact that was no longer singular but multiple; it retained multiple traces its past. Penny’s words bear striking resemblance to Benjamin’s characterization of the “unique manifestation of a distance” (2007 [1968]:188) perceptible among handmade artifacts. Individual Spyn memories did more than reveal a collection of discrete personal moments while crafting. Associated with a physical garment, they revealed a flow of activity altered by the interaction of human intentions with material form.

In ordering these traces, participants found new ways to relate to the environment around them. Recall how Jane was able to use Spyn produce trace three different traces. One conveyed her handwork techniques — her technical skills in crafting the one-shouldered “wolf vest.” A second trace told the story of her geographic journey while crafting (a boating tour in northern California). A third trace connected the pieces of “found type” in her surroundings (a sentence woven into the fabric). By creating a modular sentence within a crochet vest, her work both extended the medium of crochet and demonstrated her inventive artistry. Her awareness and creative use of environmental traces appeared to be a distinguishing characteristic of their work.

Participants’ craft was reconfigured, too, by traces of time and use. We saw how, amid engagements with Spyn, Katie and Irene created scarves for their romantic partners, each anticipating the communication of care and appreciation. Their divergent circumstances, a reunion and a break up, shaped the resultant traces in strikingly different ways. Katie rendered a set of “discontinuous memories” more durable by associating captured media with Jordan’s scarf; whereas Irene produced a series of somewhat transient reflections by giving her garment away without the associated media. Irene’s scarf was, thus, put to work as a functional garment rather than a sentimental gesture or recollection. The interwoven nature of these material traces prompted knitters to respond in noticeably different ways.

Wanda Orlikowski’s notion of “sociomaterial entanglements” (2007: 1440) helps frame how a specific technology, medium or material is made successful (or unsuccessful). Rather than predetermine distinctions (or similarities) between the digital and the manual work of craft, we ought to design for craft relationships (with various people, materials and tools) through the traces they produce, maintain and leave behind. Recent research in human-computer interaction, craft
theory, and cultural anthropology has separately considered the role digital tools might play in a range of productive practices, from quilting to car repair, finding handwork a reprieve from a culture of busyness (Crawford 2009; Harper 1987). Others have looked at the material culture of craft and knitting in particular, suggesting we turn to critical modes of interpretation (Turney, 2009). Operating at the intersection of these fields, I find that knitting ascribes certain values, symbolism and meaning to the process of craft that cannot be separated from material circumstances in which they develop. It is by looking at how craft, as both ideology and praxis, produces shared meaning by enabling processes of tracing material backward and forward that we might shed light on the elements of practice that designate an artifact worthwhile.
Chapter 7: 
Thinking with Materiality

I have thus far discussed the ways in which different people, substances, and tools get enrolled in craftwork by tracing material form. However, the relationship between craftwork and interactive systems design — how craft presents alternative heuristics for IT design and its assessment — remains less thoroughly explored. How do craft practices help us think about both the early stages of design, such as prototyping and needs assessment, and design activity later in the lifecycle of an artifact, such as usability testing? What might it mean to engage design, and interaction design in particular, using this perspective on material traces? How could we employ this theoretical analytic to advance a more sustainable design practice (Blevis, 2007)?

This chapter begins to close the loop between craft and interaction design practices by further examining questions of provenance in the digital realm. I consider what it might be like to put the advanced heuristic of traces into so-called practice to produce more evocative and enduring material form. My focus is three case studies from a graduate interaction design studio called (Extra)ordinary Materials, a course that I developed and taught at the California College of the Arts (CCA) in the fall of 2011. I first describe how material traces were used to guide explorations of color and temperature, a topic covered in the first third of the course concerned with material attributes. I then discuss how material traces prompted explorations of interactions between sound and fabric, a topic covered in the second third of the course concerned with material entanglements. I end by discussing a project related to breakage, a topic covered in the final third of the course concerned with material rhythms. The chapter ends with a discussion of the role of material traces in rethinking routine design practices and identifying new affordances in form-giving work.

(Extra)ordinary Materials: Learning with Traces

I developed and deployed the (Extra)ordinary Materials curriculum in an attempt to understand whether my evolving analytic framework offered any guidance for interaction design practice. The framework entailed the interrogation of material traces — following a unique location in time and space — using three analytical
lenses: attributes, entanglements, and rhythms. As we will see, each of these lenses enabled a particular approach to studying and realizing new material traces in interactive systems design.

**Studio Structure**

The four-month studio was divided into three phases wherein students investigated a different set of materials every week. In each phase, I prompted students to consider a different lens on their analysis. Attributes of color, shape, and temperature framed the first phase of analysis. Entanglements (*or intra-actions*, after Barad [2007]) of a) fabric and sound, b) wood and light, and c) paper and movement constituted the next phase of analysis. Finally, rhythms of a) customization and re-use, b) wear, breakage and decay, and c) restoration, preservation and repair made up the last phase of analysis. I choose this subset of materials and topics based on their commonplace role in everyday environments and relative absence in interaction design practice.

![Figure 27: A selection of projects from the (Extra)ordinary Materials studio (left to right, top to bottom). A pop-up book that enables electronics learning through storytelling with objects; large-scale architectural movement; interactive tableware, enhancing small gestures with sound; a seresponic watering system; studies in textiles, emotion and thermochromic ink; studies in woven circuitry.](image)
Over the course of three months, students developed a range of projects, from fabric speakers and musical clay, to electrically illuminated books and potentiometer tableware (see Figure 27). Following a particular time and location prompted a consideration of provenance, or the chains of creation, use, and ownership. As both raw stuff and skilled undertakings, our design materials were used to critically engage undervalued attributes, entangled interactions, and hidden rhythms. By thinking with materiality (as analytic precept and practical modality), students considered new sources of innovation in the domain of interactive systems design. I center my analysis on examples (product, installation, and probe) from each phase of the (Extra)ordinary Materials studio (attributes, entanglements, rhythms), beginning with attributes.72

Attributes

The following analysis focuses on a particular (Extra)ordinary Materials class dedicated to attributes of color-changing materials. As part of their study, I asked students to combine two substrates: a thermochromic ink that changes hue according to its exposure to heat, and a translucent film that turns opaque depending on how much pressure is applied to its surface (amid a limited spectrum of low pressure). While the thermochromic ink is dynamic, continually transforming according to its temperature, the changes to the pressure sensitive material cannot be reversed (much like carbon paper, one layer of the surface transfers ink to the layer below). As such, one color-changing attribute seems ephemeral whereas the other appears relatively durable. During explorations with the materials, students discovered a range of additional properties, best exemplified by the “mousetrack” and the “handprint.”

Mousetrack

The mousetrack was conceptualized as a playful and sustainable alternative to the mousetrap used to capture mice in domestic interiors. Covered in pressure and temperature sensitive inks, the track is left on the floor to create textile patterns that display the recorded movements and temporal proximity of a mouse. Without employing a computer, the patterns become more saturated with color according to the recency of the mouse’s scurrying and more intricate depending on the spatial diversity of the mouse’s patterns of movement. Much like the History

72 While it could be argued each of these design concepts — product, installation, probe — presents important ethical questions and privacy concerns (e.g., telephone invites profanity or “mis-use”); the nature of these exploration was to chart out different possibilities for design in each domain rather than develop deployable products.
Tablecloth (Gaver, et al., 2006), which reveals the movement of objects over a table surface by dynamically illuminating the tablecloth beneath it, the mousetrack helps transform the domestic environment into a lively canvas of rodent activity by exposing changes in motion, heat, and pressure.

**Handprint**

The handprint was envisioned as a family heirloom that amplifies the imprint of a child’s hand, most commonly recorded in clay. As gifts to grandparents or remote family members, such marks gain significance over time, mainly for their capacity to preserve and commemorate child development. The handprint consists of two parts: a local print made of pressure sensitive ink and a remote print made of thermochromic ink. Behind both prints are piezoresistive fabric and a microcontroller that enable a wireless connection between the two. When a hand is placed on the local print hung on the wall, the remote print warms up and, in turn, displays a colorful hand hung on the remote wall. Depending on the amount of pressure applied to the local surface, the remote surface changes in hue. A sensory connection between the two locations is extended by the process of creating bodily signatures over time, introducing opportunities for reflecting on human growth through remote presence.\(^3\)

**Fixity and Transience**

The two color-changing explorations serve to highlight a few important features of material. For one, each project exhibits elements of fixity and ephemerality. The scurrying movements of the mouse are affixed to the floor, just as the imprint of the hand is made visible on the local wall. Through connections between different actors—human and mouse, child and family member—the properties of material remain intact over time. The material is able to trace animal actions and document human growth and aging through its integration in practice.

Yet each exploration reveals these properties in different ways. The mousetrack, for example, took advantage of the limited spectrum of pressure sensitivity, enabling lightweight mice to color the floor while heavy human footsteps could not. The handprint, by contrast, took advantage of the warmth of human hands. To create connections between family members, a warm hand must reengage with the imprint, pressing it once again. Each property realized relations between different social actors (people and mice) and social conditions (people in different locations) in distinct ways.

\(^3\) This project affords a sympathetic awareness reminiscent the Affector system's ineffable quality, as discussed by Boehner, Sengers, and Warner (2008).
Furthermore, the seemingly stable properties of the material were also in flux. Though the pressure sensitive inks were ‘permanent’ as applied to the handprint, they were also evolving and developing over time, acquiring more pressure, and more color. Leveraging the dynamism of mice, the mousetrack brings together a disparate set of materials to create a timeline and a spatial map. Each project consists of a different collection of additional parts—piezoresistive fabric, copper tape, batteries, microcontrollers, people, and mice—that together assembled a diversity of material connections. In combination the materials came to life.

Lastly, though both projects dealt with concerns for transience and fixity, computational components were not included in the mousetrack, but were critical to the handprint. The relative stability of computational materials reveal how encoding processes and their physical expression become entwined: the movement of electricity through piezoresistive fabric communicate the presence of a person, and this messages can only be re-recorded through its reconfiguration in and among the other material parts. Digital and non-digital, electrical and non-electrical, material cannot be understood without its involvement in the social environment.

**Inscription and De-scription**

The mousetrack and handprint exemplify two ways in which material traces render and revisit different forms of value ascribed to artifacts and environments. Inscription and description are not universal, but rather two of several processes through which material attributes develop.

The concept of material inscription emphasizes the temporal fixity of form by combining Akrich’s notion of “inscription” (1992), wherein one translates a program of action into technological form, with Ingold’s discussion of tooling (2006; 2012),

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74 Brown and Duguid (2002) develop the notion of “fixity” to examine the immutable nature of documents. Drawing on media scholar Herald Innis’ (Innis, 1951; quoted in Brown and Duguid, 2002) distinction between time-binding and space-binding, the stability of communication across time and space, they suggest: “the lure of space binding has made time binding irrelevant” (2002:201). That is, fixity is reduced over time because the mobility of new ITs (email, electronic records) has come at the expense of their longevity. Turning to systems design, this chapter suggests that tooling in digital contexts might engage new aspects of material stability. Imagine emailing ten years into the future or designing communications technologies that favor time-binding to reveal new expressions of material engagement, growth, or evolution.
in which he considers making as a process of growth and ontogenesis\textsuperscript{75} (Ingold, 2012: 431-3). Seeing the trace as inscription entails understanding how the development of products generates a range of traces over time. As the handprint and mousetrack suggest, these traces are not specific to digital material. Inscriptions are also not stable, but rather enacted by the generative interplay between material stability and instability. Returning to the mousetrack and handprint exercises, we find that each material produced distinct histories of interaction that could configure human experience. Once placed in the home, for example, the pressure sensitive material under the mousetrack may describe the rodent movements and affect how a resident interacts in and with the space. Through the visualization of shared experience, the material also draws connections between the rodent and surrounding residents. Thus the material trace reveals an object history, a story of how the technology was conditioned over time.

When the material trace is the active recipient of inscription, recording behavior, it emerges as a form of de-scription. Recall the two color changing substrates: the pressure sensitive film was unable to respond to high amounts of pressure and the thermochromic ink continually changed according to temperature. The former became helpful for documenting the lightweight movement of a mouse and the sensitive print of a hand; the latter produced traces of use afforded by a sensitivity to time. Through their involvement in the mousetrack and handprint, each attribute surfaced new design possibilities. By examining how particular materials are introduced and arranged in practice, we have begun to see how their properties develop in varied and surprising ways. Let us now consider how these interactions become enacted and traced, through their entanglement.

Entanglements

The second phase of (Extra)ordinary Materials examined the entanglement of different attributes traced through material interactions. By attending to entanglements, I drew on recent theoretical scholarship in STS that characterizes interacting entities as constituted through relations of materiality (Barad, 2007; Orlikowski, 2007). This view challenges the ontological separation of interacting entities, which presupposes some \textit{a priori} distinction. In Barad’s words, \textit{“To be entangled is not simply to be intertwined with another, as in the joining of separate entities, but to lack an independent, self-contained existence”} (2007.ix). Thus I used

\textsuperscript{75} For Ingold, ontogenesis connotes a development process wherein “form is ever emergent rather than given in advance” (Ingold, 2012: 433).
the concept of entanglement to analyze how material traces get produced through their constitutive interactions. I then asked students to consider what alternative spaces might open up for interactive systems design using this frame of analysis.

Our first class dealing with entanglements investigated the combination of sound and cloth in the creation of fabric speakers. Early in these explorations, students identified a range of attributes associated with their materials: sound quality, volume, resistivity, magnetism, voltage, length and width of a conductive material. The attributes not only shaped, but also emerged out of the resulting sound. For example, when the conductive thread used to wind the coil was longer, it would create more resistance, weakening the magnetic field, and thus decreasing the volume and consistency of the speaker’s sound. Or when the conductive coil was sewn into a flexible but stable surface, such as stiff cloth or canvas, the surface moved with the electromagnetic vibrations, and thus produced a louder and clearer acoustic signal. The attributes of different materials (fabric, conductive thread, magnets, and batteries) were not prefigured events, but enacted through their entanglements.

During the course of explorations, students created a range of fabric speakers by winding or stitching conductive coils into fabric. By moving magnets over the coils, they explored how proximity and orientation altered the sound waves. To test their speakers, students dissembled “talking” paper greeting cards, removed the microchip, and connected it to the coils. Once students finished basic prototypes, I asked them to conceptualize embedded interactive systems that similarly combined fabric and sound. The telephone was one such project.

**Telephone**
The telephone was envisioned as a playful educational game installed in the halls of a museum. The fabric became wallpaper lining the walls of the hall. On the surface of the fabric lay a sequence of flat conductive coils, of different sizes, alternating between a speaker and a microphone. Museumgoers walking down the hall would carry a magnetic “magic wand,” which could be used to record and listen to sounds. By interchangeably recording a phrase that they had just heard, the museumgoers would create new sentences. Once having listened to the phrase “playing telephone,” for example, a museumgoer might hear “paying tornado,” and then re-record that phrase for the next listener to decode.

Inspired by the well-known children’s game “telephone,” involving a chain of whispering people, these acoustic material traces were designed to provoke curiosity and conviviality around physics learning. By translating spontaneous messages, the fabric speaker remained open to interpretation and playful
possibility (Senger and Gaver, 2006; Blythe, Overbeeke, Monk, and Wright, 2003). Using the telephone, museumgoers might express silly or subversive sentiments while exploring electricity and magnetism. By examining the entanglement of sound and fabric, students conceptualized an unusual and compelling museum installation.

As part of their design process, the students took several entanglements into account. First, they found the size and density of the coils affected the fidelity of the resulting sound, thus entangling the form and acoustic character of the coil. Second, students discovered the strength of the magnetic field and the sound quality were mutually produced as a result of their proximity; that is, as the magnetic wand approached the center of the coil, the sound fidelity increased. They used this entanglement to invite audience participation, as it as enabled the sound to evolve according to the placement of the magic wand. Lastly, students noted the peculiar character of the sound emanating from the fabric. Replete with fluctuating volume and static, the sound seemed to confuse and abstract, hearkening back to Marla’s obscured material traces embodied by the machine-made replica (Chapter 4). In the telephone, a game-like spontaneity emerged from the entanglement of volume and static.

We have so far discussed how people attend to attributes and entanglements, and how each becomes traceable through materials in time and space. Yet, how do people make sense of these events? How do attributes and entanglements develop in everyday contexts of creation and use? What form, character, and variety of material traces prompt such entangled acts? To answer these questions I turn to an exploration of rhythms, a final installment of (Extra)ordinary Materials.

**Rhythms**

In the third phase of (Extra)ordinary Materials, students examined the rhythms of a range of phenomena, from re-use and customization to restoration and repair (c.f. Jackson, et al., 2011). Through readings and in-class exercises, we considered questions of technology and degradation: how our technologies may avoid the landfill — the resting place for many a toy, instrument and, most recently, computational device — if and when they break. We asked what might be made of such refuse if we were to take a second look; how we could use rhythms of

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76 For example, changes in the size of the coil and the position of the magnetic affected sound quality and volume.
breakage, wear, and decay to elicit meaningful and longer lasting relationships with artifacts in our everyday environments.

In an early class, students were asked to examine attributes of Sugru, a substance designed for customization and repair: mending broken bikes, repairing surfaces, or customizing furniture. For a limited duration (12-24 hours), Sugru remains malleable and mixable, much like Play-Doh. But once dry, the surface irreversibly hardens, preventing the substance from detaching from another surface. When I prompted students to imagine another place for the substance to live, one student shattered an IKEA plate and then fully reassembled it using Sugru (see Figure 28). From this initial experiment, she launched a series of Broken Probes intended to prompt responses to material traces of breakage and repair.

**Broken Probes**

In a piece called “do break” by Peter van der Jagt and Frank Tjepkema of Droog Design, a ceramic vase can be thrown against the wall to shatter its surface while keeping the form of the vase intact due to its rubber-coated interior. The artifact is used to provoke an unusual experience: the integration of longevity with breakage or, put another way, “vestiges of aggression” (Ramakers, 2002: 68). By manipulating the social impetus for breaking, as reflected in the cracked form of the vase, the act of self-expression through breakage is used to confront questions of endurance in rich and provocative ways.

Like “do break,” the cracks of the IKEA plate began to change the aesthetic quality of the surface. The artifact was no longer generic; it became an artifact with a story, reminiscent of Benjamin’s (2007 [1968]) formulation of storytelling as...
It called to mind recent ruminations on “evocative,” (Turkle, 2007) and “biographical” (Hoskin, 1998; 2006) objects wherein artifacts evoke salient memories and embody the stories of their owners. The plate became an object with “itineraries,” evidencing past actions and actors as historicized traces of human presence (Joyce, 2011; 2012a; 2012b).

The original technique for reassembling shattered pieces by hand was visually impressive but laborious. Evolving this project for her Master’s thesis,78 the student replaced this technique with another: she took a generic piece of IKEA tableware and coated the backside with a liquid rubber (polyurethane). Once the material was completely dry, the rubber became firm but still pliable. This technique enabled the plates to be cracked while remaining whole and, thus, theoretically usable. The process also left a gold or greenish glaze-like surface that felt rubbery to the touch. The artifact was given out to people to break and annotate with digital inscriptions, transforming the pristine generic tableware into uniquely customized traces of breakage. Simple computer vision techniques were used to correlate physical marks of creation, decay, (re)use and attrition with digital records of material engagement — ascribing new value to invariably discarded goods.

The cracks not only recorded past activity, they were continually changing due to ongoing attrition and associated media. The object’s journey was at once personal and perceptible by analyzing its material condition. The cracks therefore played a role similar to the one that the stitches performed in the Spyn prototypes (see Figure 29). While with the stitches I looked at the patterns of ink on fabric, in this case the artifact produced an even clearer unique signature. The cracks remained uniquely identifiable even as they expanded through further wear. As became apparent through field trials, the process of breakage and annotation became an opportunity for self-reflection and reminiscence. The cracks made the object unique to the person, often enhancing its value, while bringing to light personal histories and future trajectories related to the broken form. As I attempt to show in

77 The storytelling embedded in practice is “an artisan form of communication” (Benjamin, 1968: 91). In contrast to established forms of storytelling in information visualization (e.g., Segel & Heer, 2010), Benjamin differentiates the story from information: “[Storytelling] does not aim to convey the pure essence of the thing, like information or a report. It sinks the thing into the life of the storyteller, in order to bring it out of him again” (ibid: 91).

78 Miwa Ikeyima’s Master’s thesis was co-advised by Martin Venezky and me: “The Living Object” http://thelivingobject.tumblr.com/.
the following examples, material traces of breakage prompted participants’ ruminations on broken metaphors, repaired relationships, and upcoming change.

**The Incompleteness of Material Traces**
People used the probe’s capacity to render a form incomplete to consider the personalization of the digital artifacts. As one participant said in reference to the approachable nature of the artifact, “I feel like it has a story just inherently. The thing about this by itself is that, I feel like it had a story and then when I assign photos to it, I’m personalizing it. I mean that’s basically it, I’m making it more personal to me.” In contrast to a finished artifact, the cracked surface had a story left to tell. As we incorporate an increasing number of devices and media into our everyday environments, the openness and incompleteness of each element may engender new paths for digital inscription and personalization.

![Image](image.png)

**Figure 29:** The cracks become uniquely identifiable features on each artifact, much like the knit stitches in the Spyn study. As the broken artifacts continue to crack the original identifiable signatures remain intact. Image courtesy of Miwa Ikemiya.

**The Imperfection of Material Traces**
Several participants used imagery of their artwork to connect marks of wear with specific visual competencies. Yet, when artful elements went awry, skilled practitioners were less keen to share their work. One participant, a photographer working entirely with digital images, chose not to use his digital photography to tell his story and, instead, associated images he found on the Internet and screenshots of “random” quotations. He discussed feeling as if people would not be able to properly view his work given the resolution of his mobile phone screen. The
contrast between this participant and others suggests that enabling multiple, varied resolutions per digital display helps people distill a sense of craftsmanship and, thus, effortful investment and care.

**The Impermanence of Material Traces**

Participants moved between the cracks digitally, symbolically, and practically. Some saw figures in the white ‘in between’ spaces, such as an image of South Africa; others used the cracks to inspire creative curation, such as one participant who used the cracks as tree branches to anchor a family tree. In each case, the probes exposed different metaphors of breakage, enabling participants to look to

Figure 30: a) P1’s *quotations*: P1 associated photographs off the internet and screenshots of quotations to different cracks; b) P2’s *haiku*: P2 extracted passages from a series of haikus he wrote over the previous year and associated them with parts of the broken vessel; c) P3’s *beverages*: P3 saw his broken cup as a representation of other cups he had used to drink out of in recent months and associated it with images of his drinks and their circumstances; d) P4’s *family tree*: P4 decided to associate digitized family photographs clockwise around the cup with cracks so that the images could be viewed backward through the generations; e) P5’s *transitions*: by annotating her plate with images of her artwork, P5 used the cracks as an analogue for temporal and geographic change; f) P6’s *connections to men*: P6 viewed her plate as an analogue for her fractured past with me, and the silicon as her role keeping the various pieces together. Image courtesy of Miwa Ikemiya.
the pieces as a whole rather than as discrete and disjointed parts (see Figure 30).

Because there was no ‘right’ way to break the vessels, participants tended to relinquish control while still feeling ownership. In the words of one participant:

“Breaking it was freeing and kind of felt like playing and so it was more of an opening to be a creative story teller rather than someone who was self-conscious about what kind of image they are going to portray.”

There was an element of serendipity and happenstance to each moment of change, much like the swatch for Fair Isle knitting. Yet, unlike a knit artifact, the broken probes did not offer the possibility to reverse or undo actions; the cracks became permanent. This sense of permanence around impermanence suggests a productive interplay between material stability and instability in the design of interactive systems.

**Rhythms of Breakage**

Abstracting further from these experiences, we see how the concept of breakage elicits a range of temporal patterns, developing from family histories, emotional upheaval, and anticipated transitions. In interweaving these rhythms, we see the subtle interplay between guidance and improvisation (see Ingold, 2001), a temporal mode that suggests we consider alternative mechanisms for enabling non-linear narratives. Valued ceramic forms developed through layered relationships with the past, independent of the particular order in which they were viewed. Just as the probes themselves became pivotal to the types of stories participants told, we might design for annotations that follow signposts rather than limitless possibilities. As one participant said, “I don't think I would have come up with the same thing at all if I wouldn't have had the plate to kind of be my guide.” By attending to traces of breakage, we might design artifacts that enable the identification of multiple layers of metaphor and material.

Material traces became a suitable analytic category for drawing out minute differences between temporal, social, and material effects of breakage. Broken Probes participants produced social narratives with visible residue across time and space. What sustained specific forms of value was not found in slick and pristine form, but in the emergent relationships between material traces, personal memories, and shared histories. The Broken Probes project drew attention to the evocative nature of attrition and the possibilities for its fluctuation. Through asking questions with materials (digital or otherwise), participants considered the significance of the incomplete, the imperfect, and the impermanent. Crucially, these qualities of the *material trace* formulate breakage as an increasingly relevant
concern in the digital age, as our new devices and digital artifacts (photos, Twitter feeds) produce signs of workmanship that are difficult to recognize and contrast. This study points again to the process of tracing whereby we might following the intersecting histories of time, skill, and use (or mis-use). It was by identifying and interweaving various material traces that people transformed what was once inconsequential (a generic white plate) into something evocative and new.

Conclusions

Attributes of the handprint and mousetrack called attention to the stability and instability of traces, and their possibilities for inscription and de-description. Entanglements of fabric and sound opened up opportunities for public engagement and physics learning through the telephone. Rhythms of the Broken Probes project helped draw attention to the value of impermanence, imperfection, and incompleteness. Whether products, installations, or probes, we found that each analytical lens afforded the design of meaningful and enduring tools — enlivening social/environmental connections, activating pedagogical resources, and revealing alternative sources of invention. Each lens on interaction did not operate on its own. Temporal rhythms were realized in attributes of the handprint and mousetrack,79 and material attributes were apparent in our analysis of the telephone and Broken Probes project (magnetism and voltage, variety of cracks). By attending to the attributes, entanglements, and rhythms of material traces, we discovered different ways of thinking with materiality for design.

My analysis of a design probe in Chapter 6 followed a linear progression from the documentation of my observations, to the extrapolation of design principles, the iterative development of the tool, and finally the tool’s deployment and purported adoption. In this chapter I took a slightly different tack by considering experiences of design students. I asked students to use materials as critical tools to analyze and proactively engage their environments. In response, they muddied design techniques and destroyed artifacts that were pristine and new. The aim of this chapter was not to redefine material, nor to frame materiality as something wholly separate from, or superior to, other theoretical approaches to design. Rather I have sought to expose the ways in which the heuristic of material traces presented

79 See Jackson, et al. (2011) for a discussion of collaborative rhythms of relevance to interactive systems design: e.g., we find phenomenal rhythms of scurrying rodents and biological rhythms of human growth in the (Extra)ordinary Materials classroom.
opportunities for design students to reflect on their medium.\textsuperscript{80} In each case, the lenses of attributes, entanglements, and rhythms provoked analysis of material traces: evocative relationships to the non-human (rodents), enriched connections to a familial hand, and valued lines of breakage enlisting reflections on personhood and self-expression. In the mousetrack, the arrangement of film reflects a move from displacement to preservation, transforming design resources. In the handprint, evidence of social presence becomes transient, enlivening intimate relations across space. Among fabric speakers, playful interactions become opportunities for learning and, in Broken Probes, inscribed moments of breakdown offered possibilities to rethink change and regression. These opportunities are significant, not only for the interactions they enable, but for the evocative histories they leave behind.

\textsuperscript{80} Related questions of creativity, learning, and social practice have been taken up by recent research on design pedagogy, including investigations of the studio environment as a place for collaborative learning (Shaffer, 1997), the contrasting material ecologies of interaction design (Fernaeus & Sundströmi, 2012; Goodman, Stolterman, and Wakkary, 2011) and other social, political, and infrastructural factors that contribute to design explorations (Bjögvinnsson, Ehn, and Hillgren, 2012).
Chapter 8 Revisiting Modern Craft

In 2005, the computer book publishing company O’Reilly Media launched CRAFT, a project-based magazine “dedicated to the renaissance that’s occurring within the world of crafts.” From knitted iPod cozies to hand-stitched robots (Figure 31), CRAFT magazine promoted a range of projects that blend traditional crafting and modern technology through the ethos of Do-It-Yourself (DIY) design. Its tagline — “transforming traditional craft” — suggested a break from a bygone era, a familiar progress narrative perpetuated by technology enthusiasts and entrepreneurs alike. Clean typography, bright colors, and bold graphical layout reinforced the sense of impending reinvention: “this is not your grandmother’s knitting.”

This sentiment can be usefully contrasted with the words of one knitter: “You know what? My grandmother did unbelievably beautiful needlepoint. I don’t see why there has to be this wholesale rejecting of what’s gone on before.” The knitters in the guild, the binders in the workshop, and the mosaicist, ceramicist, and screen printer in San Francisco had not taken up this craft renaissance. In binding, durability respect for the history of the book, age-old information technology, are two central concerns,

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81 Excerpt from CRAFT magazine, visited on July 11, 2012: http://craftzine.com/about/

82 Much to the surprise of its evangelists, CRAFT had not garnered the same interest as MAKE, a “sister” publication with an eye toward technology customization in backyards, garages, and basements. Four years after its founding, CRAFT magazine shut down its print production to publish exclusively online.
continually balanced through the discovery and erasure of its material traces. In knitting, evenness of the stitch work and anticipation of the knit artifact’s use inscribe silent traces and bounded spaces that were often threatened by information technology. Throughout the dissertation, craft reveals itself as a set of complex and contested practices that sharply contrast with those represented by O'Reilly's CRAFT magazine.

This fieldwork thus throws into question two underlying claims of the craft “renaissance”: (1) people are increasingly introducing technology into contexts of craft, and (2) the introduction of digital technology fundamentally changes craft production. Through re-binding books and knitting fabrics I find that binders and knitters are not universally receptive (or resistant) to IT. Instead, their activities unveil multiply articulated responses to the digital medium and opportunities for its rethinking. As a mode of tracing, digital practices become occasions for inscription and decription, reflexes of action altered by the interaction of human intentions with moments in time and space. Craft aesthetics represented in software — e.g., digital photographs filtered to give the look of age — offer the guise of digital patina without the corresponding material traces that such image-making entails. These pixelated expressions cannot be traced backward or forward; they index singular rather multiple moments and depict one of many materialities. It is by enabling us to look at IT through the varied lenses of its material traces that we may more effectively facilitate enduring material attachment in a digital age.

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83 In reframing materiality for the project of IT design, I do not aim to dismiss or conceal salient cultural distinctions produced by a recurring reification of the digital/material dualism. On the contrary, I seek to further analyze these distinctions. In a recent Atlantic article, for example, Jurgenson (2012) calls for some way of talking about the process of translating idioms from the digital realm into wood, paint, or metal. Consider a screen-printed space invader image or the mouse-pointer-arrow charm necklace. The translation he speaks of is visual and iconic; it is less concerned with the mechanics of software applications and interfaces, as the particular meanings they convey. By identifying screen-based aesthetic tropes in other mediums, Jurgenson reinforces another dualism: the separation of message and medium. As I will soon describe, understanding these shifting references in relation to conceptions of materiality deserves deeper examination.

84 These filters are, for instance, readily available to users of the popular photo distribution applications Instagram and Hipstamatic.
Directions for Future Work:
Boundaries, Interventions, and Time

Through fieldwork, design, and pedagogy, the dissertation has opened the doors to a number of research trajectories, three of which I wish to highlight for future work in design and technology studies: (i) the contested physical/digital boundary; (ii) how design interventions might reveal alternative relationships between people, tools, and materials; and (iii) how time has been under represented in the conceptualization of artifacts and their design.

I raise the first of these issues — the digital/material boundary — as a way of more fully addressing the politics, values, and moral claims invoked by computational elements. The dissertation was concerned with how different forms of value continue to evolve alongside craft practices. Though I have discussed and summarized the literature that engages and critiques the physical/digital boundary, I did not attack this boundary head on. Instead, I have shown what staying close to the action and not relying on the digital/physical boundary can reveal. I assert that handcraft activities embody a distinctly human notion of work; they exemplify aspects of human pace, physical effort, and expressions of care. Given the introduction of digital tools and materials, it is the nature of this production — craft as a verb, rather than a noun — that begins to shift and complicate the values ascribed to products of IT design. Future work might take on these discourses more directly by, for instance, considering the role of the hand and the body in dexterous programming or circuit hacking, further complicating the duality between bits and atoms.

My second concern for future work involves methods for imagining alternative relationships to computational elements through interference and interjection — another research trajectory that I term design interventions. I define the design intervention as the purposeful and selective work of altering social relationships through the introduction different material configurations. Intervention raises itself within both of the domains that I studied, as my introduction in the binders work environments exposed narratives of technological development, and as Spyn became a resource for revealing insights into guild members’ relationships to digital tools. It also appears in the context of engineering: in a recent intervention at a design conference, I introduced computer engineers to techniques of fine binding (Rosner, et al, 2010). By learning about paper grain and leather thickness, participants reconsidered how material expressions of age and wear might become useful resources for the design of new technology to enrich human-object
relations. While this dissertation introduced issues of intervention, the process and products of such work can be more fully examined.

Lastly, I have identified temporality as not single but multiply authored concept that offers underexplored ways of analyzing the design of technology. The binders selectively stabilized ephemeral moments by tracing backward. The knitters experienced time in action, tracing forward to accomplish a perfect fit or complementary pattern. While using Spyn, other knitters changed directions: shifting their ongoing temporal frame by recording and narrating back. Time, evoked in an artifact, was projected into the artifact, and then extracted out of it. Where binders played with time, the knitters enacted time. The examples that I have hitherto discussed reveal time as an elastic concept. In future work such elasticity and its grammatical forms — time passed, time past, time spent, time unfolded — may be further explored. In concluding this dissertation I explore what this might mean for the design of digital technologies.

**Materializing Provenance**

Across my fieldwork with binders and knitters, I found that material conditions often shaped the recognition of provenance. Meaningful traces were left on artifacts, naturally shaping them over time. This arguably contrasts with various experiences with computational technology. Many of us exchange our mobile phones for newer models, even if they are not falling apart, or repair broken laptops when screens unhinge or crack, but do not care (or hope) to get the same laptops back. In addition to focusing on recycling and reuse, designers might benefit from considering the provenance of our technological goods. In valuing some materials over others, crafters do not distinguish between form and function, content and container, or even digital bits and tangible atoms. Rather, they attend to how the expression of different materialities through chains of ownership and use enables certain constructions of value. It is through our continued interactions with material, and the impressions we leave behind, that deeper attachments evolve. For example, how might we look at the interactional qualities of hardware (a mobile phone), software (tools for digital content generation) or digital content (images, videos or type) as a binder attends to those of paper, such as its grain, color, or thickness? Just as we might cherish a grandmother’s afghan, we also treasure a particular laptop, graphics card, or digital photo? By tracing skill, use and time through material — revealing multiple temporalities with and in our technological practices — perhaps we can foster more meaningful interaction histories and enduring material expressions.
Designing for Longevity

Following from prior anthropological scholarship on authenticity and skill (e.g., Kreps 2003; Ingold 2007; Joyce, 2012), I found that the longevity of an artifact was not only made through materials, but also through its integration in social practice. Here I stress the nuanced social configurations that enabled continued celebrations of ritual, not through static technologies but through (inter-)actions surrounding and remaking those technologies. We may want to revisit a professional email differently from an email written by a deceased parent, or use a different emulator to experience an Apple IIe graphics program than to play an Atari arcade game. Alongside existing digital archives, perhaps we can facilitate new modes for recollection through familiar mechanisms and resourceful reinventions — e.g., an antiquarian book retrofitted as an e-reader, a telestereograph machine used as a digital input device. My observations suggest that everyday objects may be seen as part of a process of actively constituting our connections to the past. As we consider the memory practices that carry us into the future (Bowker, 2005), it becomes important to consider how we might design for and with the things that remain.

Conclusions

This dissertation has described and demonstrated an approach to the study of design and technology that is sensitive to ideas of provenance, endurance, and ways of the hand. What it is that makes a technology functional and evocative is invariably intertwined with how the technology gets created, worn, and remade over time. By recognizing how materials play into craft processes, by tracing forward and backward, designers may better understand the potential they do or no not bring to their materials, and scholars may more fully analyze the production and use of designed products.

For the anthropology of craft, this dissertation puts questions of moral value in dialogue with concerns for making and maintaining material form (digital or otherwise). My discussion of material traces, in particular, exposes the multiple temporal frames in which different forms of value unfold through the aesthetic and embodied of recognition craft labor.

For STS, focusing on knitting and bookbinding resurrects the notion of digits as fingers and information technology as books to complicate the ontological status of the “digital” and the analytical frames in which it operates. My introduction of material traces suggests that STS scholarship take seriously the multiple materialities entailed in processes of design and inscription: how expressions of
skill, use, and time get obscured, lost, hidden, policed, maintained, repaired, revealed and (de)stabilized across different design mediums.

For IT design and HCI, my focus on craft troubles established categories of designer and user, professional and hobbyist, and digital and physical to reveal alternative relationships between bodies, technologies, and environments. Material traces, in this context, contribute a heuristic for analyzing designed artifacts — emphasizing the dynamic nature of material form — and three lenses for learning how to design: attributes, entanglements, and rhythms. Restored books and lace shawls embody fading techniques, cultural traditions, and intimate interactions. Traces of skill, time, and use are valued for their emotional resonance in addition to the pragmatic goals in which they are embedded. Whether the creases on a book spine or the marks of wear on a mobile phone, they matter in terms of the specific meanings they convey, the mistakes they unveil and the educational opportunities they afford.

My role in the design process, as I went from designer to PhD student, transformed from eliciting design implications to discovering the range of emotions (unease, amiability, accomplishment) prompted by material engagements. Based on this work, I presented an agenda for design and technology studies that interweaves epistemological, practical, and pedagogical concerns. The dissertation reflected on and fed back to theory on materiality; it offered pedagogical framings that may be taken up by technologists; and it provided insights into how to do design differently, grounded in examples from an interaction design studio. The category of material traces was introduced to help scholars of design and technology lay the groundwork for developing a common and productive understanding of material — bringing meaning and matter, knowing and doing, back together. This treatment of materiality and temporality underpins a rethinking of design practice. How and why we grant material beings epistemic status not only shapes the values they accrue, but also the material histories they leave behind. It is by looking back through these traces that we may be able to move our pressing concerns into the future of design.
References


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