Reflections on Craft: Probing the Creative Process of Everyday Knitters

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ABSTRACT
Crafters today blend age-old techniques such as weaving and pottery with new information and communication technologies such as podcasts, online instructions, and blogs. This intersection of tradition and modernity provides an interesting site for understanding the adoption of new technology. We present a qualitative study of seven knitters introduced to Spyn—a system that enables the association of digitally recorded messages with physical locations on knit fabric. We gave knitters Spyn in order to elicit their reflections on their craft practices and learn from their interactions with material, people, and technology. While creating artifacts for friends and loved ones, knitters expanded the creative and communicative potential of their craftwork: knitters envisioned travel journals in knitted potholders and sung lullabies in knitted hats. We describe how these unusual craft activities provide a useful lens onto contemporary technological appropriation.

Author Keywords
Handcraft, craft, creativity, knitting, knitters, crafters, material culture, material, design process, appropiation, adoption.

ACM Classification Keywords
H.5.2. [Information Interfaces]: User Interfaces—input devices and strategies; interaction styles; user-centered design. D.2.2 [Software Engineering]: Design Tools and Techniques—User interfaces. H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Design

INTRODUCTION
Craft—the skilled manipulation of physical materials—evokes romantic notions of handwork and artistry among many in the industrialized world. Indeed, a growing number of crafters emphasize the social and creative aspects of craft [19]. Perhaps most striking is the recent increase in community events, resources, and materials devoted to yarn crafts such as knitting. Both online and offline, knitters gain design inspirations from projects by other knitters: they carefully modify existing patterns from community websites such as Ravelry.com, or get tips from fellow knitting circle members at local yarn stores. As a cultural pastime merging new and old technical practices, knitting provides a valuable perspective on everyday relationships to technology.

In this paper, we contribute a study of seven knitters who used Spyn—a system that associates digital messages with physical locations on knit fabric. Using Spyn, knitters can store and retrieve information in relation to when and where the information was recorded while crafting. We introduced the Spyn system to knitters over a period of three to eight days in order to better understand people's everyday appropriation of technology through craft—the processes by which people make technology their own.

We first present our motivations for investigating the creative process of knitting and related work in the fields of HCI and design. We then introduce the Spyn system and discuss our iterative development of the tool. Lastly, we describe our study of knitters' introduction to, and use of, Spyn. We present several themes that emerged from our observations and interviews, discuss the ways knitters envisioned the use and meaning of the Spyn fabric, and describe how they incorporated the technology into their everyday lives.

BACKGROUND

Creativity & Craft
Today craft has been given a variety of definitions, from the "desire to do a job well for its own sake" [30] to the celebration of social and creative explorations of material [20,24,33]. Common among these conceptions is the partnership between people and technology for the creation of personally meaningful things. Yet researchers have only begun to consider the role of creativity in the craft process. Since late 20th century industrialization, creativity has tended to imply notions of originality separate from craft knowledge, skill or technique. In his recent book *The Craftsman* [30], sociologist Richard Sennett asserts this sentiment: "An eagle-eyed reader will have noticed that the word creativity appears in this book as little as possible.

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This is because the word carries too much Romantic baggage—the mystery of inspiration, the claims of genius."

Notwithstanding romantic associations, creativity is increasingly connected with craftwork in its recent trajectory. Today's crafts have united with Do-it-Yourself (DIY) activity in creative subcultures across America [20]. DIY encompasses a range of personal design activities that have become increasingly prevalent on the pages of blogs and online discussion forums. Using largely public resources such as Instructables.com or Ravelry.com, crafters discuss the intricacies of their work, tell stories around craft, and codify their creative process for others to remake or modify, prompting further customization and reuse. The study of such creative appropriation [3, 12] and *Everyday Creativity* [37] has been an increasingly fruitful area of study for HCI and Design. We introduce the Spyn system to knitters in order to extend this work and investigate the creative experiences of everyday knitters.

Figure 1: Spyn system (top); Web-based Spyn interface for May's potholder (bottom): (clockwise) interactive image of knit, map visualization, and image associated with selected marker on knit. May traveled to parks, breakfast diners and an old apartment (pictured above) to reconstruct a map of the places she spent time with the knit recipient.

Knitting

Knitting differs from many crafts in its flexibility and portability: it can be easily picked up and put down, it can be worked on in long or short stretches, and it can be practiced with little or no dedicated attention. Because of this flexibility, people can knit at home, while waiting for the bus, in transit, or in knitting circles. Knitters can vary the evenness and tightness of each stitch by directly controlling the texture, size, and weight of the series of loops that form knit fabric. A hand knit object reflects the interaction of human senses with physical materials [8]. Each knit is the end result of some play, some caution, and some care.

Today knitters produce a diversity of textiles, from knitted mobile phone cozies to knitted barbed wire fences.[1] This activity is aided by online and offline knitting groups such as *Chicks with Sticks* (or *Stitchn'Bitch* [33])—a global movement of knitters who meet, knit, and converse in knitting stores, at coffee shops, or on blogs. Downloadable podcasts enable knitters to craft at home while connecting with other knitters. Knitters are currently supported by a remarkable range and number of online resources. As such, they provide an intriguing site for technological intervention.

Technology Probes

Technology probes are technological instruments meant to collect information and stimulate reflection within a given environment [15]. Probes have been useful tools for investigating social phenomena in complex and private contexts such living spaces in which information can be difficult to garner using traditional social science methods. Usually preceding the development of a prototype, probes are focused on data collection rather than usability, and meant to help guide future design choices. The Spyn system was sufficiently open-ended to enable different interpretations of its use [28]. We leveraged its ability to collect data about participants to gain insight into their relations to technology, material, and creative work.

Related Work

Underlying the design of Spyn are prior efforts in HCI to carefully consider the relationship between craft and digital technology.

Online Crafting

Researchers have become interested in online resources such as social networking, shopping, and how-to websites that enable the sharing of craft knowledge [3,34,35]. Some have found that contemporary notions of creativity have been transformed due to the merging of online and offline creative cultures [3]. A study of an online quilting forum [15] found that online resources maintained social relations between individual quilters; whereas a study of several online community artist websites [36] discovered tensions

[1] For an example of knitted barbed wire fences, see Lacy Jane Robert's homepage: http://notionnanny.net/news/2007-/06/demo_9058.html.

over perceptions of amateurism on discussion forums. Little research has explored the intersection of these offline and online craft-related activities.

Craft as a Design Method

Researchers have explored how the use of inexpensive, home-accessible physical media such as arts and craft materials and e-textiles can impact the design of computer hardware and software for constructionist learning [4,6]. Some suggest the additional use of computation enhances the expressive capabilities of existing materials and playful invention of ideas [27]. The process of craft has also been used describe a methodology that considers the social and cultural impact of industrial design and production processes [5].

Object and Voice

Ubiquitous computing researchers have investigated how mobile technology can support our interactions with the physical world. Books with Voices [18], created for oral historians, enabled access to video narratives on a PDA via barcode-augmented paper transcripts—enriching users' experience reading historical documents. ButterflyNet [38], a mobile capture and access system for field biologists, was equipped with GPS and a variety of media capturing devices, and became a further inspiration for the design of the Spyn mobile device.

SPYN

The Spyn system was designed to be a lightweight mobile tool for knitters to associate geographic locations, activities and musings to positions on knit fabric while knitting. The system enables knitters to record digital messages while knitting and retrieve those messages using the knit artifact. Our system is comprised of two components: 1) a knitting basket that holds and keeps track of the yarn and 2) the Spyn machine. The knitting basket contains the knitter's yarn and a Phidget rotary encoder. The Spyn machine is 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 [11] (a memory card with WIFI tracking capabilities).

The 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). To record digital messages while knitting, a knitter presses the "Record Media" button on the mobile device, and captures a sound, an image, or a video. Once recorded, Spyn saves the message in connection with the current position of the yarn, the geographic location, and the current time. The knitter can also capture an image using the external camera using the "Capture Image" button.

To preserve the traditional knit aesthetic, we designed Spyn to read (invisible) infrared ink markers printed on the yarn that specify unique locations in knit material (see Figure 3). Knitters choose the digital information they want to associate with locations on the knit fabric (images, video, audio, geographic location), as well as the physical materials they want to use for knitting (yarn, needles, patterns). The specified material locations correlate with media captured while knitting as well as the time and geographic location.

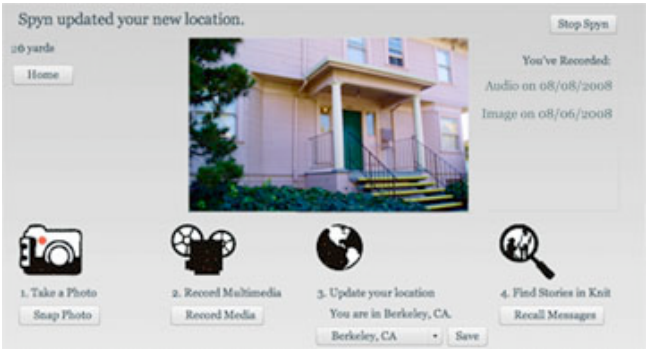

Figure 2: Screenshot of Spyn touch-screen displaying the last photo captured by Spyn.

To recall messages from a knit using the mobile device, a person selects the "Recall Messages" button (see Figure 2). The Spyn screen displays the view in front of the Spyn machine (using the external webcamera). A person moves the mobile device over the knit, and touches the device display. This triggers the system to analyze an IR image of the knit and display markers on top of the knit images. Markers correspond to location along the yarn in which the knitter recorded a message while knitting. In the background, the external IR camera captures an IR image of the knit for the Spyn software to analyze. The system then overlays markers on top of the Spyn display, indicating the location on the knit in which media items were recorded while knitting. When a person selects a marker, the corresponding media item is displayed. We also provided interested participants with a web-based interface to their projects (See Figures 1b and 6). This interface allowed participants to view their messages once the Spyn device was no longer available.

Iterative Development

Our experiences designing our first prototypes of Spyn [28] provided insights into what processes we needed to support and how thoroughly we wanted to support them. We found that participants wanted to use Spyn for a wide range of projects (patterns, yarns, gauge, and fibers). In addition, we needed the system to remain functional and robust in the various locations in which they knit: the knitter's house, car, and back porch.

In the following section, we briefly summarize how we iteratively developed our system to support un-facilitated use for a broad range of knit projects.

Recalling Positions on the Knit

We used infrared ink printed on yarn to locate positions on the yarn. Because our initial vision system did not provide

sufficient accuracy for knits that were too long or oddly shaped to fit into a single camera frame, we experimented with different ink patterns on yarn, and resolved to use a simple, generalizable technique: printing long (5 yards) and short (1 yard) stretches of ink along the length of the un-knit yarn. This created a pattern of thick and thin markers across the width of the knit fabric (see Figure 3, Final Design). This pattern was sufficiently readable across a range of knit patterns and sizes, camera angles, and lighting conditions.

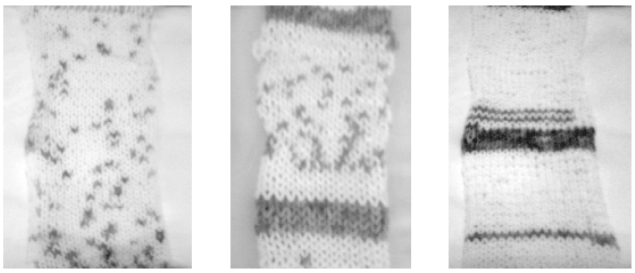

Figure 3: Infrared-enabled camera image of knit yarn

Design Study 1	Design Study 2	Final Design
1 cm dots of ink printing onto the yarn such that the space between each dot increased linearly across the yarn.	The 1 cm dot pattern was repeated at short intervals between thick horizontal markers.	Thin markers act as tick marks placed between thick markers, placed at every 30 yards across the knit.

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). Our 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.

Overall, our vision system was more efficient (took one third the time to process), and more robust (supported all but one participant during field work) than our earlier prototypes [28].

Capturing Indoor Locations

We found knitters' 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* [8] that uses WiFi network positioning to track location. By capturing location data in indoor and outdoor environments, Spyn supported the portability and geographic flexibility of the craft.

PARTICIPANTS AND METHOD

Method

In order to investigate knitters' personal experiences of making, we asked them to use Spyn in their everyday environments—without the physical presence of a researcher. Based on our early fieldwork [28], we expected participants to require time to work with the Spyn system in order to become comfortable using the system on their own. We ran introductory field trials as guided introductions to the system, followed by a period (three to eight days) of independent use.

Before introducing knitters to Spyn, we asked participants to complete two tasks. We asked each knitter to 1) roughly decide on a pattern, (e.g., a hat knit in the round), and 2) to chose a yarn to work with (i.e., the fiber, color, weight and, optionally, brand name). In response, two knitters gave us yarn from their own "stash," the collection of yarn that knitters tuck away for future projects, and three knitters asked to be surprised by the yarn. As one participant explained, "you're more creative when you have something specific to work around."

Each knitter's experience with Spyn consisted of an introduction to the Spyn system, a semi-structured interview after completing a project, and a discussion with the recipient of the knit and the knitter after recalling the data from Spyn. We visited participants whenever possible, and conducted interviews with the knitters' recipients when possible.

Participants

Knitters

We recruited knitters for our study from a local knitting circle, an online knitting site, and through our personal knitting contacts. Two participants used Spyn previously during a half-day study [28]. All participants were female and varied in age from mid-twenties to late sixties. Participants' occupations included high school teacher, freelance designer, freelance grant writer, nurse, graduate student, and a theater designer. We had no previous affiliation with our participants prior to this research.

Participants exhibited different levels of comfort with information technology prior to using Spyn. Six participants

regularly used knitting websites to search for patterns or yarn recommendations, but only four knitters used such sites to regularly connect with other knitters. Three knitters described themselves as 'luddites' and were relatively unfamiliar with, or uninterested in, engaging in online interactions. Three participants were active bloggers, sometimes writing about their knitting projects. Two participants used social networking websites such as Facebook.com or Ravelry.com but were uninterested in blogging.

Knitter	# of Messags	Project	Recipient	Days with Spyn
Ellen	15	Sweater	Friend's Baby Girl	6
Amy	2	Washrags	Twin Cousins	5
Kelly	5	Hat	Son	8
May	10	Potholder	Close Friend Gloria	7
Nora	11	Hat	Close Friend Faye	4
Paula	5	Fingerless gloves	Herself	3
Carolyn	5	Washcloth	Friend's Unborn Baby	6

Table 1: Knitters who created artifacts with Spyn. The "# of Messages" column indicates the number of audio, image, or video messages collected with Spyn

Recipients

We began each study with the understanding that each of the knitters would be willing to connect us with their recipient. In practice, interviewing the knit recipients proved difficult. Two recipients were close friends who lived a significant distance from the knitter, one recipient was a friend preparing to enter into labor, three recipients were children (one knitter created objects for her twin cousins), and one recipient was also the knitter.

Only one recipient was able to physically use Spyn to recall messages from the knit (see Figure 7). As she recalled a message on her hat, she asserted: "I feel I should be more attached to the hat knowing there's this whole history… I mean it's very symbolic. And it's neat how it changes the relationship between the gift giver and recipient because it's so weighted." Other recipients used the website of the project (see Figures 1b and 6) to recall the knitters messages. In general, our access to recipients was limited by their physical distance and timing constraints.

CREATIVE APPROPRIATION

Using Spyn, knitters turned a ball of infrared-ink-patterned yarn into a personally meaningful three-dimensional object. This process resembles processes of technological appropriation by which people make objects their own [23,31]. Silverstone, et al. [31] ascribe appropriation to one stage in a cycle of technological adoption or "domestication" [32] wherein people envision, use, incorporate, and embed technology into their daily lives. Despite participants' limited engagements with Spyn, we watched them form attachments to their Spyn fabric—initiating the first stages of adoption.

Science and Technology scholar Ron Eglash [8] identifies three distinct levels of technological appropriation: *Reinterpretation*—a change in semantic associations, *Adaptation*—a change in semantic association and use, and *Reinvention*—a change in semantic association, use, and structure. Looking to this framework, we present our analysis of knitters' experiences with Spyn across different stages of creative appropriation through craft.

Figure 4: Using Spyn for recall: (clockwise from top left) Ellen retrieved messages embedded in her baby sweater; regular camera photo using Spyn; infrared-enabed camera photo using Spyn; Spyn display after retrieval (pins indicate where messages were associated on knit); same Spyn display after Ellen touched the message. The two bottom images were recorded in video diary by participant.

REINTERPRETATION

Without transforming the knit's function, the Spyn fabric became a place for personal disclosure. Whether describing a complex pattern or a meaningful stitch, knitters discussed particular aspects of their craftwork, and its relationship to the recipient.

Sharing Emotion

> Carolyn [Spyn audio message to employer's new baby]: *"Your baby mcLane on the significance of knitting a butterfly. All the butterflies that are in your scrapbook. All the butterflies on the gifts at the baby shower. To me it seems… the idea of butterflies being able to fly free and that your dreams can go wherever they want to go. "*

Carolyn described recording the meaning of her knitted butterfly pattern in a Spyn video note in order to express her "love and thoughts" for the young recipient. "I'm not a sentimental person," she declared in an interview.

> *Q :How do you normally capture those feelings when you've given a gift?*
>
> Carolyn*: Um. I don't think I have. Most of the time it's just knowledge that I spent the time doing it… So this [pointing at Spyn] is like the next step of just the emotion and thoughts while knitting it.'*

Carolyn spoke of difficulties expressing emotion in person, but found that knitting was a useful alternative: “This [knitting] is my way of saying, yeah, I really do care. I'm not really good at saying it or phrasing it,” she admitted in an interview. Carolyn used the Spyn fabric to combine her words with her physical labor. "So when I was little my parents sung to me,” she recorded in Spyn audio note, and prepared to sing a lullaby. “And while I do not have the best singing voice, I thought it'd be good to embed sleepy things into this for you.” For Caroyln, the Spyn fabric became a form of physical expression critically distinct from face-to-face communication.

While Carolyn appeared to create these recordings, in part, to display her invested efforts, other knitters seemed to care more about entertaining the knit recipient. “Hello this is me again, I'm taking a knitting break to eat this!…[My husband] made it all by himself by turning on the oven,” Ellen declared in a Spyn video as she captured a slice of chocolate cake. Ellen described trying to match the tone of her messages with the “temperament” of the recipient’s father who “was always very funny.” Spyn messages became a means for expressing humor and play with knitting.

Figure 5: A participant knitting with Spyn outside (left); another participant using Spyn to recall a message on her finished knit (right).

Recounting Connections with Recipients

Knitting with Spyn rekindled memories of meaningful interactions with the recipient and related individuals. “I actually really like this,” Nora admitted in a Spyn audio message speaking about her “nubby” green knit hat. “It reminds me of that birthday sweater you worn on your birthday when we had the party over here, with the lace leaf motif.” Knitters often sought out these personal memories by referencing earlier interactions with the recipient. ″So I was just thinking of… some things about [Fujiki],” Ellen recorded in a sweater for her friend Fujiki’s new child, and recounted a childhood memory. “[Your daughter] will have a lot of fun with such fun parents.”

Yet sometimes Ellen found it difficult to produce meaningful notes: “So I thought I'd have a good story to tell about [Fujiki] but I can't think of anything at the moment.” An active blogger, Ellen seemed comfortable using Spyn to acknowledge, mock, and question her role as a storyteller.

Embracing Mistakes

Knitters commonly discussed their crafting mishaps in Spyn messages, particularly when it came to tailoring—fitting needle sizes to new patterns, yarn colors to aesthetic tastes, and hat sizes to heads. “I thought I was making the medium size but ... and it looks like I'm actually making the small size. And now I'm worried about the size of your head,” Nora recorded in a Spyn video note. She demonstrated the odd fit by trying on her unfinished hat in a Spyn video message. Similarly, Ellen showed off a beginning square of her baby sweater: “You're probably thinking, ‘Oh this is way to short!’” she laughed in a Spyn video message. The messages exposed the ways that crafters embraced the approximation necessary for a craftwork. Craft theorist and woodworker David Pye [26] calls this concept the *workmanship of risk*—in which handcrafted forms produce a sense of uncertainty missing from industrial produced, 'idealized' forms. Similarly, knitters used Spyn to rejoice in the time-consuming and precarious nature of their craft.

Exploring Intimate moments

By necessity, knitters were in constant and close proximity to the knit fabric as they crafted. This closeness seemed to affect the digital content they captured with Spyn. “There was just an earthquake while I was knitting and I did not put my knitting down,” Ellen recorded in an audio note while knitting a sweater for her friend’s baby girl. Ellen continually used Spyn recordings to embrace the “instantiations” nature of her knit.

> Ellen [audio message to friend’s baby girl]: “*Hello it's ... Saturday and it's really hot. And I don't want to do anything because it's really hot... In the mean time I'm knitting.”*
>
> Ellen [audio message to friend’s baby girl]: *Hello it's day 3 of working on the sweater and I'm supposed to be at work and I'm here knitting. Luckily I have an understanding boss…echem, me.*

For Kelly, proximity became sentimental: "You fell asleep at the dinner table and went to bed... And we're just sitting here talking about you and how much we love you." Kelly's Spyn video message to her young son produced what she called “a little time capsule”—“here is kind of some images and sounds in the life of 2008. He can look back on it... See it that way,” she reported in an interview.

Finding these intimate moments “mundane”, one knitter expressed disapproval: “It seems like a ridiculous thing to embed into yarn—to tell you I got an email from [another friend],” Nora recorded in a Spyn audio message. “But that's what life is about right now.” Despite her reservations, Nora continued to capture her private, seemingly ordinary ruminations.

ADAPTATION

Appropriating Spyn sometimes involved creatively altering the function and significance of the knit fabric. Whether describing their Spyn knits as a “knitted blog,” a “journey,”

or "emotional blackmail," knitters used familiar concepts in an unfamiliar ways.

Connecting to the Familiar

By comparing their knits to familiar objects and activities, knitters interpreted Spyn's functionality in new ways. "I got creative at the end," Nora declared, alluding to her idea for a "mix-tape" knit—a song compilation associated with specific places on a knit hat. The idea came to Nora as she ended her Spyn hat and recorded an especially nostalgic pop song from a YouTube video. When her recipient Faye recalled the message from the hat, Nora and Faye sung the song together with tears of laughter.

After completing her second project with Spyn, May discussed her process of "writing a story" for her friend Gloria who used to knit with her when they lived in the same city. May carefully planned the sequence of messages and the ways in which Gloria would encounter those messages.

> May [interview]: *The night before I started working it, I started brainstorming in my head. I definitely approached it like I was going to write a story, not necessarily like a fiction, sort of like a journal. I was going to document.*

May took her Spyn knit to parks, cafes, a restaurant, Gloria's old apartment, and, at one point, even a breakfast diner so that she could photograph Gloria's favorite dish—the waffle plate. When Gloria received the potholder, she followed May's nostalgic journey using the online map visualization to guide her (see Figure 1). May described this interaction as creating "conversation" between her and Gloria. A regular blogger, May drew from her writing experience, and thoughtfully managed Gloria's experience of the potholder.

Anchors

Hutchins describes material anchors [14] as the physical structures that act as proxies for complex conceptual structures. The progression of messages in May's knitted map evokes this notion of material attachment. Just as a queue of people is easier to count than a room full of people dancing, the Spyn fabric became a physical anchor for May's journey while crafting.

Ellen's physical anchor came in the form of a button.

> Ellen [video message to friend's baby girl]: *"So that button right here I just got it today from a friend of mine. Her oldest daughter went to pre-school with [my daughter…] and this is the little red button that she gave me so I can use it on my craft project for your daughter.*

In addition to its function as a fastener, and its appealing purple color, the button highlighted Ellen's relationship to friends and family. The knit recipient, her daughter, and the friend who gave Ellen the button were all part of Ellen's making process. By capturing this story in a Spyn video message and associating it with her sweater's button, Ellen used the button to explicitly index these relationships.

Paula similarly used Spyn to transform her fingerless gloves into a patchwork of her travels. Paula began to knit with Spyn after visiting her father in Trinidad where she spent time at the sea and ate Caribbean food. While knitting, Paula took photographs of objects that reminded her of these past moments—an aqua-green gauntlet, a package of snacks from Trinidad. She called her first glove a "recollection" of a previous trip to Trinidad and her second glove a "mental souvenir" of her most recent trip. After completing her knit, Paula spoke the knit's connection to painting: "It's easier to embed memories while you're painting it than it is when you're following a pattern," Paula explained in an interview. "But this really made it more like [painting]." Her Spyn messages—filled with "colors, shapes, and the personal meaning of certain objects"—brought her painting and knitting processes closer together.

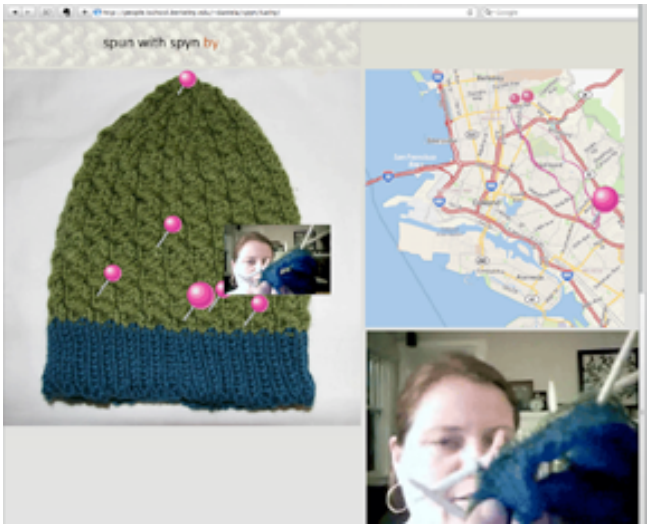

Figure 6. The web-based Spyn interface for Kelly's kit hat: (clockwise) interactive image of knit hat, map visualization, and image associated with selected marker on knit.

Imagined Use

Some knitters envisioned innovative ways they could adapt their Spyn knits in the future. After recalling messages from the knit Nora made for Faye with Spyn, Faye described a set of new transformations. She imagined linking clues to the inside of hats and creating a "ghost blanket" that "people could scan fortunes from." Similarly inspired, Kelly described a glove that she could use to teach her son numbers. She would associate recordings about the number one while knitting the first finger, recordings about the number two on the second finger, and so on. This creative invention is reminiscent of processes of imagination that Silverstone and Haddon [32] have argued are distinct from appropriation: They involve the "contradictory" work of being drawn to an idealized rhetoric that is ripe with potential failure and practical constraints. For our participants, the technology was adopted as part of an imagined experience as a research prototype—limiting the scope of appropriation.

Sharing Craft Values

Three knitters talked about their craftwork in relation to processes of mass and automated production. In these cases, the Spyn fabric was used to assert their attitudes about craft and its social value.

Ellen spoke of using knitting as way to teach her daughter to be "mindful" of the "quality" of craft: "I don't want to teach my daughter…just things can be like consumed and just thrown out," she explained in an interview. "And I think she's […] definitely learning because yesterday […] all the handmade toys she kept. And she got rid of the plastic-y, like, mass-produced ones." Ellen put her daughter to the test in a Spyn video message recorded for her friend's daughter: "Do you want to learn how to knit?" She asked the 4-year-old. Getting no response, Ellen answered: "Yes? Okay, maybe I'll teach you." Once she finished her Spyn sweater, Ellen described feeling conflicted:

> Ellen [interview]: *Knowing there's a story, definitely adds that element of "Oh, I can't give away this because it's super meaningful." But at the same time, I don't want them to feel guilty and keep if out of guilt.*

While Ellen—a young mother—seemed able to influence her daughter's exposure to the values of fast and easy consumption, Amy—a middle-aged woman with two grown children—was more concerned for her two young twin nieces. In a Spyn washrag, Amy used Spyn to imply her preference for handmade over industrially produced goods: "Maybe when and if you want, I'd be glad to teach this to you," Amy recorded in an audio note while knitting a potholder for her young twin cousin. "They buy everything," she asserted in an earlier interview. According to Amy, her knits were the only handmade items her cousins could "appreciate". These sentiments reflected sentiments of the British and American Arts and Crafts movements as well as the 1960s and 1970s craft resurgence. Participants in these craft revivals often saw the process of making inseparable from creative practice of art [8]. Building on the values of crafters before her, Amy used Spyn as a vehicle for passing down her interest in craft.

Other knitters focused on Spyn's role in the production of evidence. The Spyn videos, audio clips, and images chronicled the knitters' investments of time and energy. "She'll remember the time and effort I put in there," one knitter pointed out in an interview. Knitters sometimes affirmed this expended effort in the content of their messages: "I'm kitting here, so you can actually see me knit as proof that I'm knitting for you." In an interview, another knitter described it simply: "Like, 'No, no, no, no! I was really thinking of you while I was knitting this. Here's proof!'"

Although Spyn allowed knitters to "prove" the extent of their crafting efforts—giving credit where credit was due—the documentation induced some concern. "I usually lie to people," Nora explained. "How long did this take? Oh not long—40 hours. I mean that's a workweek, basically. You know, you can't." After receiving the Spyn hat from Nora and recalling messages, Faye poked fun at her increased sense of obligation to appreciate the gift:

> Faye [interview]: *It's not like pressure but it does make it feel more intense... it adds some emotional maybe dimension to it... It's like [Nora's] psyche...I love it. I think it's great and I accept the pressure. This is the next level.*
>
> Nora [interview]: *That's why I chose [Faye]. Because I felt… of all people [Faye]could handle that pressure… I didn't want to burden these people that I'm making baby sweaters for.*

Nora's sentiments echo those of Katie, a participant in an early field study who referred to her knit as "emotional blackmail" [28]. With Spyn, knitters imparted their knowledge of their invested time and energy to recipients, often in more perceptible and understandable ways than through the physical material alone.

Figure 7: (left) A recipient retrieves messages from a knit hat; (right) close up of Spyn display held by recipient over her hat.

REINVENTION

A few participants reported wanting to use the Spyn system to alter the physical form of their knits in addition its purpose. After completing their knits, two knitters mentioned wanting to visually augment the invisible Spyn markers with other physical materials such as beads. Two additional knitters requested more versatility in the type of digital content they recorded—YouTube videos, old family photos—and more flexibility on where on the fabric they could associate those messages to the knit.

Design historians have studied the ways people reinvent materials and resources through Do-it-Yourself (DIY) processes of reuse and customization in which people alter the structure and purpose of goods (see [2]). In his review of DIY practices, Paul Atkinson [1] points to an interesting paradox: though DIY practitioners often react against the values of a mass-produced, industrial society, they simultaneously reinforce the values of that society by emulating their products. Though our participants created uniquely crafted garments, their work still resembled industrial goods. To a naïve eye, Ellen's sweater (see Figure 4), for example, could appear industrially produced. Yet knitters took pride in the differences between their forms and the forms produced by industry. By *digitally* augmenting the Spyn knits around each Spyn message, the knitters began to reinforce the distinction between their work and that of a machine. By augmenting the Spyn knits *physically*, the knitters would make this distinction more transparent.

DISCUSSION

Our findings show the creative and complex ways people used digital tools to connect to friends and loved ones while knitting handmade objects. As knitters began to experiment with the Spyn technology, they became more familiar with its capabilities. They envisioned projects they intended to make such as Faye's ghost-blanket and Kelly's counting-gloves, and found new ways of recording digital messages such as recording a particular song from YouTube.com. Perhaps most importantly, Knitters skillfully manipulated physical and digital materials to create personally meaningful objects—transforming the use and meaning of knit fabric.

As a study of creative practice, our work also presents a useful lens onto knitters' relationships with materials and the people for whom knitters craft. Material culture scholars [19,23,31] have argued that consumption processes—the practices by which people make things their own—have been misunderstood as the central means by which people differentiate themselves from others. Our analysis of knitters' craftwork extends this argument: knitters produced material that helped define them as individuals as well as create ties to the people and places they interacted with using Spyn. As such, our work supports Alfred Gell's [13] suggestion that art objects, in particular, mediate people's relationships with others. Knitters not only created craft identities through physical form by demonstrating their care and expertise; they produced digital annotations on the physical form that further described these relations.

Until recently, social theory has largely supported the notion that the material and immaterial constituents of the social world are distinct [19,23]. Beliefs, for example, were commonly viewed as separate from physical objects. Invoking Thoreau, Webb Keane warns against this binary by considering the ways in which beliefs take on material form such as clothing [17]. Our participants' use of Spyn supports Kean's thesis by blurring the boundaries between physical stitches, digital information, and the knitters' intentions while crafting. Just as clothing distinguishes people from others by marking social orders and distinctions, the Spyn fabric mediated knitters' social dynamics. Using digital annotations, knitters shifted their attention even further away from the binary between knitting materials and the social world. In essence, our design intervention begins to answer archeologist Susanne Küchler's call [19] for a research method that "recognizes not just the role of objects in the production and appropriation of knowledge technology, but that takes the next step to study empirically the future-directed, transformative potential of materials within which technology is embedded."

CONCLUSION

In this paper, we presented the results of fieldwork with seven knitters who used Spyn to create knit garments for friends and family members. We introduced Spyn to inspire knitters' reflections on their craft practices and learn from their interactions with material, people, and things. Whether embedding clues into a knitted shawl, or sharing travel memoirs through fingerless gloves, knitters creatively applied their craft skills and techniques. We discussed the motivations and values of these creative individuals and reported on their reflections while crafting. Our study is a provocation for considering craft practice an important research site for studying technological appropriation. In future work, we hope to further explore the processes of adaption, reinterpretation, and reinvention of physical and digital material in order to extend the creative and communicative potential of technology.

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REFERENCES

1. Atkinson P. (ed.). Do It Yourself: Democracy and Design, In *Journal of Design History* , vol. 19, no. 1, pp. 1–10, 2006.
2. Attfield, J. Wild Things. The Material Culture of Everyday Life. Berg, Oxford–New York, 2000.
3. Bean, J., Rosner, D. Learning from IKEA Hacking: "I'm Not One to Decoupage a Tabletop and Call It a Day." In Proc. *CHI EA '09*, pp. 419-422, 2009.
4. Blauvelt, G., Wrensch, T., and Eisenberg, M. Integrating craft materials and computation. In *Proceedings of the 3rd Conference on Creativity & Cognition*. C&C '99. ACM, New York, NY, pp. 50-56, 1999.
5. Bonanni, L., Parkes, A., and Ishii, H. Future craft: how digital media is transforming product design. In *Extended Abstracts on Human Factors in Computing Systems.* CHI '08. ACM, New York, NY, pp.2553-2564, 2008.
6. Buechley, L., Elumeze, N., and Eisenberg, M. 2006. Electronic/computational textiles and children's crafts. In *Proceedings of the 2006 Conference on interaction Design and Children*. IDC '06. ACM, New York, NY, pp. 49-56, 2006.
7. Craft and Hobby Association, www.hobby.org/eduevents_teach.html (verified on July 28, 2009).
8. Dormer, P. The language and practical philosophy of craft. In *The Culture of Craft*, P. Dormer (ed.). Manchester University Press, Manchester, 1997.
9. Dormer P. *The Meaning of Modern Design–Towards the Twenty-first Century*. London: Thames and Hudson, 1990.
10. Eglash, R. Appropriating Technology: An Introduction, in R. Eglash (ed.) *Appropriating Technology*, pp.vii-xxi. Minneapolis, MN: University of Minnesota Press, 2004.
11. EyeFi http://www.eye.fi/ (verified on July 28, 2009).
12. Forlizzi, J. How robotic products become social products: an ethnographic study of cleaning in the home.Proceedings of HRI 2007, ACM Press, 2007.

Remaking the Way we Make Things. New York: North Point Press, 2002.

13. Gell, A. *Art and Agency*. Oxford: Clarendon Press, 1998.
14. Hutchins, E. Material anchors for conceptual blends. In *Journal of Pragmatics*, 37, pp. 1555–1577, 2005.
15. Hutchinson, H., Mackay, W., et al. Technology Probes: Inspiring Design for and with Families, Proceedings of CHI 2003, ACM Press, 17-24, 2003.
16. Johnson, J. S., Hawley, J. Technology's impact on creative traditions: Pieceful co-existence in quilting. In *Clothing and Textiles Research Journal*, 22(1/2), pp. 69-78, 2004.
17. Keane, W. Signs are Not the Garb of Meaning: On the Social Analysis of Material Things. In *Materiality*, D. Miller (ed.). Duke University Press, pp. 182-205, 2006.
18. Klemmer, S. R., Graham, J., Wolff, G. J., and Landay, J. A. 2003. Books with voices: paper transcripts as a physical interface to oral histories. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. CHI '03. ACM, New York, NY, 89-96, 2003.
19. Küchler, S. Technological Materiality: Beyond the Dualist Paradigm. In *Journal of Theory, Culture & Society*, 25, 101–120, 2008.
20. Levine, F. and Heimerl, C. *Handmade Nation: The Rise of DIY, Art, Craft, and Design*. Princeton Architectural Press, 2008.
21. Macdonald, A.L. *No Idle Hands; The Social History of American Knitting.* New York: Ballentine Books, 1988.
22. McCullough, M. *Abstracting Craft: The Practiced Digital Hand*, MIT Press, 1998.
23. Miller, D. Material Culture and Mass Consumption, New York: Blackwell, 1987.
24. Minahan, S., & Cox, J. W. Stitch' n bitch - cyherferninism, a third place and the new materiality. Journal of Material Culture, 12(1), pp. 5-21, 2007.
25. Prigoda, E., McKenzie, P. J. Purls of wisdom: A collectivist study of human information behaviour in a public library knitting group. In *Journal of Documentation*, 63(1), pp.90-114, 2007.
26. Pye, D. *The Nature and Art of Workmanship*. Herbert Press, London, 1995.
27. Resnick, M., Berg, R., and Eisenberg, M. Beyond Black Boxes: Bringing Transparency and Aesthetics Back to Scientific Investigation. Journal of the Learning Sciences, vol. 9, no. 1, pp. 7-30, 2000.
28. Rosner, D. K., Ryokai, K. Spyn: Augmenting Knitting to Support Storytelling and Reflection. In. *Proceedings of Ubicomp '08.*, pp.340-349, 2008.
29. Schofield-Tomschin, S. and Littrell, M.A. Textile handcraft guild participation: a conduit to successful aging. In *Clothing and Textiles Research Journal*, Vol. 19 No. 2, pp. 41-51, 2001.
30. Sennett, R. *The Craftsman*. Yale University Press, 2008.
31. Silverstone, R., E. Hirsch and D. Morley. Information and Communication Technologies and the Moral Economy of the Household. In *Consuming Technologies: Media and Information in Domestic Spaces*. Silverstone R. and Hirsch E. (eds), pp.115–31. London: Routledge, 1992.
32. Silverstone, R. and L. Haddon. Design and the Domestication of Information and Communication Technologies: Technical Change and Everyday Life. In *Communication by Design*: *The Politics of Information and Communication Technologies*. Mansell R. and Silverstone R. (eds). pp. 44–74. Oxford: Oxford University Press, 1996.
33. Stoller, D. *Stich'nBitch: A Knitter's Handbook.* New York: Workman Publishing, 2003.
34. Torrey, C., Churchill, E., McDonald, D. Learning How: The Search for Craft Knowledge on the Internet. In *Proceedings of CHI'09: ACM Conference on Human Factors in Computing Systems*: pp.1371-1381, 2009.
35. Torrey, C., D. W. McDonald, B. N. Schilit and S. Bly. How-To Pages: Informal Systems of Expertise Sharing. In *Proc. Proceedings of the Tenth European Conference on Computer Supported Cooperative Work '07*. Springer, pp. 391-410, 2007.
36. Turner-Rahman, G. Parallel Practices and the Dialectics of Open Creative Production. Journal of Design History.: 22(4), pp.371-386, 2008.
37. Wakkary, R., and Maestri, L. The resourcefulness of everyday design. In *Proceedings of ACM Creativity and Cognition* 2007, pp. 163–172. New York: ACM Press, 2007.
38. Yeh, R., Liao, C., Klemmer, S. R., Guimbretière, F., Lee, B., Kakaradov, B., Stamberger, J., Paepcke, A. ButterflyNet: A Mobile Capture and Access System for Field Biology Research. *In the Proceedings of CHI 2006: ACM Conference on Human Factors in Computing Systems*: pp. 571–80, 2006.