Rise of the Expert Amateur:
DIY Projects, Communities, and Cultures

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ABSTRACT

This paper presents a large-scale study of Do-It-Yourself (DIY) communities, cultures and projects. We focus on the adoption and appropriation of human-computer interaction and collaboration technologies and their role in motivating and sustaining communities of builders, crafters and makers. Our survey of over 2600 individuals across a range of DIY communities (Instructables, Dorkbot, Craftster, Ravelry, Etsy, and Adafruit) reveals a unique set of values, emphasizing open sharing, learning, and creativity over profit and social capital. We derive design implications to embed these values into other everyday practices, and hope that our work serves to engage CHI practitioners with DIY expert amateurs.

Author Keywords

DIY, online communities, motivations of contributors

INTRODUCTION

DIY (Do It Yourself) practice predates recorded history as human survival itself often relied on the ability to repair and repurpose tools and materials. For hundreds of years, people have been fixing water leaks, remodeling their homes and decorating their clothes without hiring professional plumbers, architects or designers. Modern societies oppose the principle of self-reliance with mass-production and consumer economy. Tangible things can be bought. Professionals can be hired to build and repair. Artists can be employed to decorate or customize. Nevertheless, people all over the world continue to create and modify objects with their own hands, ranging from knitting, to gadgets, music, and software.

We define DIY as any creation, modification or repair of objects without the aid of paid professionals. We use the term "amateur" not as a reflection on a hobbyists' skills, which are often quite advanced, but rather, to emphasize that most of DIY culture is not motivated by commercial purposes. Over the past few decades, the integration of

Figure 1. Amateur radio operator in 1920's (left) and typical punk culture zines from 1970's (right).

social computing, online sharing tools, and other HCI collaboration technologies has facilitated a renewed interest and wider adoption of DIY cultures and practices through (1) easy access to and affordability of tools and (2) the emergence of new sharing mechanisms. We begin this paper with a brief historic overview of DIY cultures. We then present a study of six modern DIY communities, providing insight into DIY as cultural movement and the technologies that support it. We highlight opportunities for HCI researchers to engage with DIY practices, suggesting design implications in the domains of physical and digital identity management, expressive knowledge transfer and design studio culture.

DIY CUTLURES: HISTORIC OVERVIEW

One of the earliest "modern era" DIY communities formed among amateur radio hobbyists in the 1920's (Figure 1). These hobbyists relied on amateur handbooks, which stressed "imagination and an open mind" nearly as much as the technical aspects of radio communication [20]. Ham radio enthusiasts often met in person to discuss their work as well as unrelated social subjects. They continued to thrive rebelliously during World War II, when a ban was placed on amateur radio communication. Rebellious attitudes continued to pervade pirate radio stations of the 1960's and handmade 'zines' expressing the punk aesthetic in the 1970s' (Figure 1) [37].

Later in the 1980's, low-cost MIDI equipment enabled people without formal training to record electronic music, evolving into the rave culture of the 1990's [26]. During this time, computer hobbyists also formed communities to create, explore and exploit software systems, resulting in the Hacker culture. Today's DIY cultures reflect the anticonsumerism, rebelliousness, and creativity of earlier
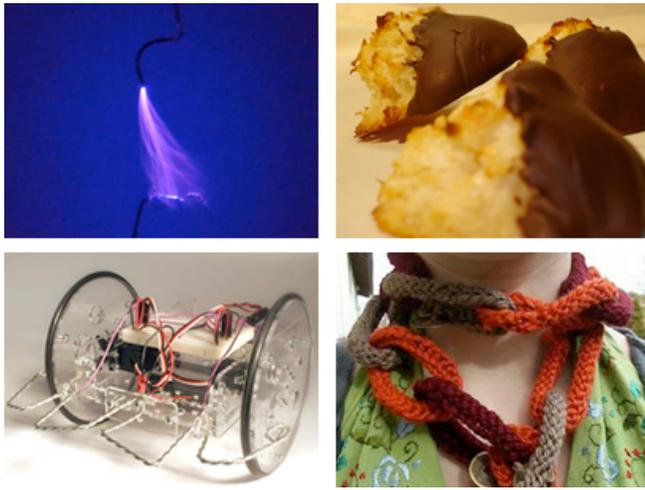
Figure 2. Images from DIY Communities: 'electric discharge through air', presented at Dorkpot Sydney (top left), chocolate dipped macaroons sold on Etsy (top right), Instructables tutorial for an Arduino-controlled servo robot (bottom left), "Chain of Command" scarf on Craftster (bottom right).

DIY initiatives, supporting the ideology that people can create rather than buy the things they want.

Modern DIY Communities

Recent breakthroughs in technology afford sharing such that anyone can quickly document and showcase their DIY projects to a large audience. An emerging body of tools allows enthusiasts to collaboratively critique, brainstorm and troubleshoot their work, often in real-time [*e.g.* 1,11,32]. This accessibility and decentralization has enabled large communities to form around the transfer of DIY information, attracting individuals who are curious, passionate and/or heavily involved in DIY work.

Thousands of DIY communities exist today, varying in size, organization and project structure. Some allow members to contribute asynchronously on a variety of topics [22], while others focus on specific projects such as knitting, crocheting [32] or hip craft [11]. Some revolve around smaller in-person gatherings [12] and some enable hobbyists to trade or sell their projects [14].

RELATED WORK

An extensive body of work explores online communities in the domains of gaming (World of Warcraft), compiling objective knowledge (Wikipdia), open source software, and social networking (Facebook, MySpace), to name a few [3,13,24,28]. Although there has been no large-scale study of online DIY communities, we draw from several prior findings, focusing on communities that produce 'artifacts'- tangible or digital objects such as documents, software, or images. Such artifacts can be compared to DIY 'objects'- items that are created, modified or refurbished by hobbyists and non-experts.

Open source software is an artifact created and maintained by decentralized contributors, usually as a hobby. According to the Free/Libre and Open Source Software

(FLOSS) study of 2,784 open source developers, the majority of respondents contribute in order to "learn and develop new skills" [18], as well as to share "their knowledge and skills" and improve "FS/OS products of other developers". Wikipedia showcases another collection of artifacts: millions of encyclopedia-style articles. A survey by Nov classifies motivations of contributors into six categories, suggesting that fun and ideology ("information should be free") are the top two motivations of contributors [30]. Seti@Home harnesses volunteers' computers to analyze data in search of extraterrestrial activity, with members creating an intangible artifact of largescale computation. Over 58% of SETI participants indicate that they contribute to "find ET for the good of humanity", while over 17% emphasize "keeping my computer productive"[1].

Lastly, we draw a parallel between DIY objects and more personal, digital artifacts created through blogging and image tagging. Ames' and Naaman's study of tagging patterns in Flickr and ZoneTag suggests a taxonomy of motivations [2], including personal organization, communication with other community members, and organization for the general public. Nardi, *et al.* emphasize five motivations of bloggers, among them: personal documentation, emotional outlet, muse (formulating ideas in writing), and supporting specific communities such as poets or musicians [29].

We hypothesize that DIY communities are also driven by scientific pursuit, personal organization, community values and intrinsic enjoyment of creating DIY objects. However, unlike communities that revolve around the creation of digital *artifacts* such software, encyclopedia articles, or blogs, DIY communities showcase *meta* information: personal experiences and knowledge from creating physical *objects,* projected into the public sphere.

Prior Work Exploring DIY Practices

Tailoring communities surrounding CAD environment, software and PC customization focus on personal knowledge sharing. However, unlike DIY communities, which embrace sharing by professionals and amateurs alike, knowledge in tailoring communities (*e.g.* customization files) is dissipated by a few experts, while the majority of users merely adapt this information to their needs [17,25,36]. A popular workshop held at CHI2009 initiated an early dialog between the HCI and DIY communities [8]. In addition, prior work provides insight into DIY practices: Torrey *et al.* explore information seeking among crafters [34], while O'Connor provides an ethnographic study of glassblowing [31]. Buechley *et al.* integrate hardware electronics into textiles to make e-textile technology available to non-experts [7], and Rosner, *et al.* explore IKEA hacking practices [33].

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[1] Seti@Home. http://seticlassic.ssl.berkeley.edu/polls.html, accessed May 5, 2010.

Lastly, Torrey *et al.* focus on How-To documentation [35], identifying several motivations for sharing: personal documentation, online identity, and finding employment. Unlike prior work, which focuses on one DIY community or skillset, our research explores DIY as a broad phenomenon spanning a variety of domains- art, electronics, craft, music, etc.

RESEARCH SCOPE

We present the motivations, practices and sharing mechanisms that support DIY as a cultural movement. Driven by non-experts, this movement embodies creation, sharing and discussion of DIY practices from crocheting and design to robotics and auto repair. We formally define *community* as a group of people who share common goals and interests- communicating through mediums online and in person. We focus on six communities as a sample of the diverse materials, practices and sharing mechanisms among DIY practitioners. In selecting these communities we hope to capture DIY as a multi-faceted movement which invites all practitioners- knitters, roboticists, fire artists, mechanics, designers, hackers, musicians, etc.- to share ideas through a variety of mediums, including forums, instructions, images, video, and face-to-face meetings. We detail the specific structure and focus of each selected community below.

Instructables

Self-described as a "web-based documentation platform where passionate people share what they do and how they do it", Instructables was launched in 2005 by Eric Wilhelm of MIT Media Lab [22]. DIY projects are shared in a step-by-step instruction format, often accompanied by images and video. With over half a million users, projects range from educational, to practical, to whimsical, including "Building a Medieval Gauntlet", "Making Simple PVC Flute", "Controlling an Arduino Microcontroller with a Cellphone" or "How to Kiss". Users are able to rate, critique, question and comment on each project, leave forum posts, and submit general public questions and answers. Moreover, each member profile contains an "Orangeboard" allowing users to post comments to each other. The site hosts several special-interest contests every month, awarding winners with online badges, T-shirts and sometimes equipment.

Dorkbot

Dorkbot consists of groups of people who meet in person to discuss projects ranging from 'electronic art' to new gadgets [12]. The first Dorkbot was founded by Douglas Repetto of Columbia University Computer Music Center in 2000, and has grown to include sixty six active chapters located all over the world, at the time of writing. During meetings, several speakers (who are selected by meeting coordinators) present their work, followed by questions, critique and discussion. The motto of Dorkbot, "people doing strange things with electricity" is applicable to most speakers who include fire artists, electronics enthusiasts, industrial designers, hackers, and musicians.

Adafruit

Founded by Limor Fried, Adafruit is an online distributor (seller) of electronic parts and kits. These items are also featured at ladyada.net [1], a sister site hosting images and descriptions of projects that are documented by Limor herself. Adafruit hosts a number of general tutorials, with an emphasis on low-cost materials and easy-to-follow methods. The site thus serves as a portal for nearly 8,000 registered users who are curious about or struggling with electronics projects. A collection of forums enables members to discuss and troubleshoot their work.

Ravelry

Founded by Casey and Jessica Forbes in 2007, Ravelry is an online community of knitters, crocheters, and other artists who work with yarn and dyes. The site aims to help enthusiasts "keep track of their yarn, tools, and pattern information, and look to others for ideas and inspiration" [32]. Unlike other communities, Ravelry content is visible only to registered users. The site boasts over 300,000 registered users despite that fact that one must receive an invitation in order to join. Members can upload images and descriptions of their projects, as well as purchase and sell related supplies such as yarn and dyes. Numerous forums also host general discussion and questions.

Craftster

This online community also revolves around craft such as knitting and crocheting, with an emphasis on sharing "hip, off-beat, crafty DIY projects" [11]. Founded by Leah Kramer in 2007, Craftster allows everyone to view the contents of the site, and boasts over 700,000 unique readers every month, and more than 170,000 registered users. All communication occurs through forums, which are classified into thirty major categories, including pottery, cooking, crochet, jewelry and trinkets, and image reproduction techniques. Members can share their work by uploading photos, descriptions and tutorials, as well as commenting and asking questions about other projects, ideas and techniques. In addition, Craftster often organizes challenges with winning projects shown as "Featured Projects" on the front page.

Etsy

Etsy is self-described as an "online marketplace for buying & selling all things handmade" [14], striving to financially empower DIY enthusiasts. Projects are thus posted as catalogue items with images, descriptions, and prices. Initiated by Robert Kalin in 2005, the site has more than 70,000 registered users. In November of 2007, 300,000 items were bought through Etsy, amounting to more than $4.3 billion dollars in sales[1]. Etsy also offers a variety of community resources, including forums, live chat, a news blog, and portals to bring DIY'ers together

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[1] http://www.nytimes.com/2007/12/16/magazine/16Crafts-t.html?_r=3&oref=slogin&ref=magazine&pagewanted=all, accessed May 9, 2010.

based on interests and location. Moreover, Etsy's Virtual Labs offer weekly online classes on a variety of topics.

STUDY METHODOLOGY

Our methods consist of an online survey distributed to the six selected DIY communities, followed by a detailed questionnaire sent to a random subset of participants. Our survey, designed to be completed within 10 minutes (all questions optional), was publicized through a variety of mediums, including message boards, mailing lists and forum posts in each of the six DIY communities. We now discuss our data collected from 2608 respondents over the course of 14 months (with the bulk of the responses arriving within the first 2 weeks of posting the survey). In addition, we leverage 5 qualitative responses to our follow-up questionnaire to explore some of the more fascinating aspects of our numeric survey data. We introduce our results by first discussing our participants. We then detail our findings across 3 areas: (1) participatory involvement in and motivations for contributing to DIY communities, (2) DIY projects and practices, and (3) sharing DIY projects with DIY communities.

PARTICIPANTS

We collected 2608 responses, with participants' ages from 18 to 95. The response rate is overwhelmingly female (2287 female, 186 male, 11 transgender), perhaps due to the large number of respondents from knitting and crocheting communities, and we address this phenomenon in the limitations section. About half (49%) of the respondents hold an undergraduate degree, 21% completed a Masters, 23% finished high school, and just over 6% earned a higher degree (PhD, JD, or M.D.). Educational backgrounds range from nursing, theatre, engineering, art and zoology to name a few.

Overlap across DIY Communities

Figure 3 shows the number of survey respondents by time involved in each of the six DIY communities. Despite the large response pool, less than 20 participants belong exclusively to only one of Instructables, Adafruit, Dorkbot or Etsy. Respondents from Ravelry and Craftster are somewhat separable (149 and 75 unique members respectively), but their data reflects trends of the group at large. Moreover, participants from all six of the studied communities indicate involvement in other DIY groups, including Flickr, LiveJournal, Yahoo Groups, ThreadBanger, Make Magazine, Knitter's Review, deviantART, Cut Out + Keep, and Crochetville. Qualitative data from our follow-up questions offers insight into this overlap. One participant emphasizes the value of idea exchange amongst people of diverse backgrounds involved in different DIY communities:

"One of the benefits of being involved in more than one DIY community is to be able to [ex]change ideas with so many different persons, with different technical, artistic and professional backgrounds."
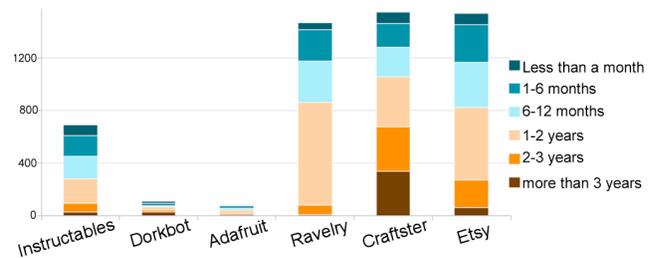

Figure 3. Number of respondents involved in each community, by time involved.

Another respondent highlights that communities provide different 'audiences', which in turn allow develop both creative and business goals:

"I use some communities to connect with other business owners. It makes exchanging ideas easier, promoting products since we can cross promote or pool our designs together to create a larger promotional event. Other communities I use to better connect with my end users or buyers. Site where I can post my creations and get feedback from the community."

Lastly, one participant notes the importance of size:

"Each has its own 'personality,' for example, one is more a group of friends who happen to knit, so we do it together. From that group, I get not only knitting support and advice, but life advice and companionship... As for an online community (Ravelry), that's just a window into the entire world... I get new, different, fancy, fun, perspective, enlightenment."

Since our results are not separable by community, we present survey data as a reflection of the DIY movement at large- a phenomenon that spans a variety of domains and sharing mechanisms (and we discuss the limitations of this approach later).

CONTRIBUTIONS TO DIY COMMUNITIES

Over 90% of our respondents contribute to DIY communities through questions, comments and answers, with 45% of participants responding to others' questions and 43% posting comments or questions on a daily or weekly basis (Figure 4). While nearly 87% of participants also post images of their projects at least once a year, much fewer respondents showcase personal work through step-by-step instructions and videos. In particular, videos are the rarest contribution (more rare than in-person interactions) with less than 8% of participants sharing videos at all, and only 2% sharing videos on a daily, weekly or monthly basis. Surprisingly, despite the fact that only 5% of respondents are members of Dorkbot, the only community that officially revolves around in-person meetings, a third of respondents (34%) attend in-person meetings and over a quarter (26%) present their work in-person at least several times a year. Qualitative responses suggest that these meetings range from "*a group of*
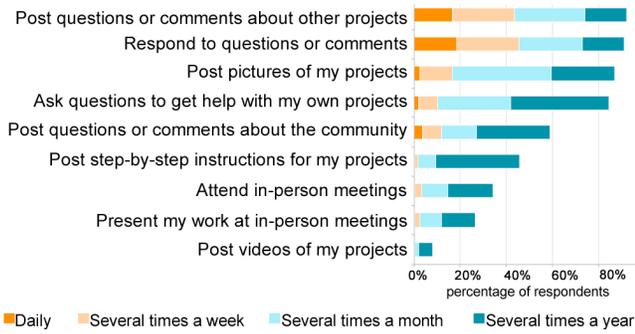
Figure 4. Contributions to DIY communities, by frequency.

Figure 6. Participants' DIY project categories.

friends" to informal "*knit-along's*", to larger "*evening gathering[s] for the community*", often organized outside of the six communities from our study.

Motivations for Contributing to DIY Communities

Above all else, our participants contribute to DIY communities in order to get "inspiration and new ideas for future projects" (81% strongly agree, 16% agree) and to "learn new concepts" (68% strongly agree, 29% agree). Participants also highlight motivations revolving around information exchange: receiving feedback on personal projects and educating others and both supported by 77% of respondents. Surprisingly, while meeting people with similar interests is the third *most* supported motivation (79% agree or strongly agree), giving back to the community is the third *least* supported, with only 51% of all respondents agreeing or strongly agreeing. A large portion of free responses emphasizes fun as a motivation: "*have fun!*" or "*it's fun!*" Other comments revolve around learning, for instance: "*to learn new techniques*", and community bonds: to "*socialize*" or "*to feel connected to other like-minded people*". The majority of participants are not driven by "finding employment" or "improving online reputation", with 68% and 60% disagreeing with each motivation, respectively.

Question Answering as an Instrument of Learning

How is responding to others' questions (most frequent contribution) related to learning and inspiration (most supported motivations)? Following up with our respondents, we simply asked: why do you answer questions in DIY communities? One participant explained:
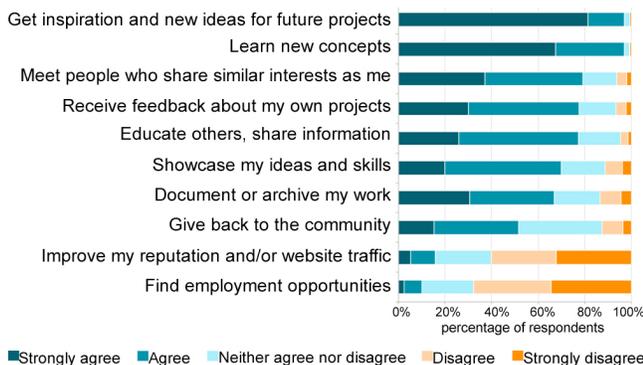
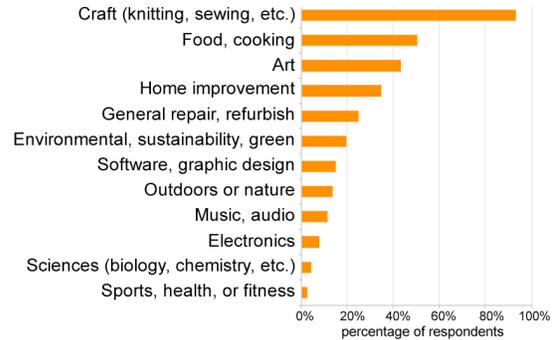> "*By responding, I have also gotten feedback on what I posted, and in at least 2 cases, was able to correct technique that (it turns out) I was doing wrong.*"

In fact all respondents suggested that the act of answering questions helps learning. Another participant explains:

> "*It's like that saying that you learn more by teaching and sharing with others. Every time I pass on a little bit of information to someone else, it helps to ingrain that knowledge in my head, even spur on a desire to learn more.*"

In addition, participants also highlighted the value of teaching others ("*the other reason I respond to questions/comments is that my approach may help someone else*"), as well as connecting with people in the community ("*to pass on a little bit of wisdom or knowledge*").

DIY WORK AND PROJECTS

In the second phase of our study, we explore the practices and motivations behind DIY work. The vast majority of our respondents (90%, 2285 in total) contribute to DIY projects. The majority (94%) of participants who do DIY work contribute to craft projects such as knitting or sewing (Figure 6). Other popular categories include food/cooking (51%), art (44%), and home improvement (35%). Most respondents contribute to more than one category, and all categories significantly overlap with craft (by 70% or more) and cooking (58% or more). Electronics is an exception, overlapping with craft by only
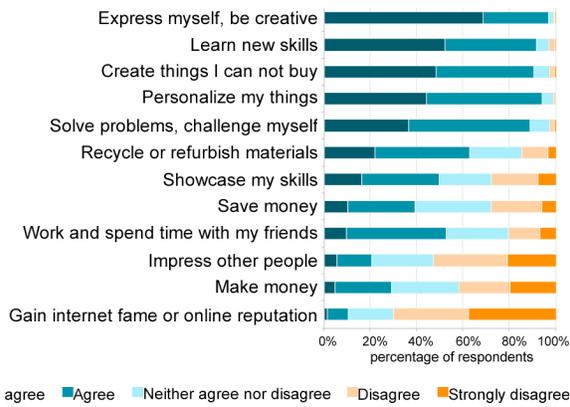

Figure 5. Motivations for contributing to DIY communities.

Figure 7. Costs and earnings per typical DYI project.

Figure 8. Motivations for contributing to DIY projects.

Figure 10. Deterrents for sharing DIY work with DIY communities.

43% and cooking by 40%. Free response project categories range from "*gardening*" to "*photography*" to "*automotive*" among others.

Nearly two thirds of respondents spend between $11 and $50 on a typical project, and the vast majority (84%) does not get paid for their projects (Figure 7). Project cost correlates with project completion time (more than 87% of participants who spend under $25 on a project finish it in under 30 hours, while more than half of projects that cost above $500 require over 100 hours to finish). Conversely, *how often* participants work on DIY projects does not vary with project cost, such that 40% of all participants contribute to DIY projects a few times a week and another 40% do DIY work at least once a day, regardless of project cost. For 66% of respondents, a typical project takes less than 30 hours to finish (with 21% of respondents spending 1-5 hours, 24% spending 6-10 hours, and 31% spending 11-30 hours). There is no direct correlation between the time spent and amount earned per project.

Motivations for Contributing to DIY Projects
An overwhelming majority (97%) of our participants work on DIY projects in order to "Express myself/be creative", with over 68% strongly agreeing with this motivation (Figure 8). "Learn new skills" is the second most supported motivation for doing DIY work (52% agree, 39% strongly agree). The least popular reason is to "Gain internet fame or reputation" with more than 70% of respondents disagreeing or strongly disagreeing with this motivation. "Make money" is the second least popular motivation (25% disagree, 15% strongly disagree).
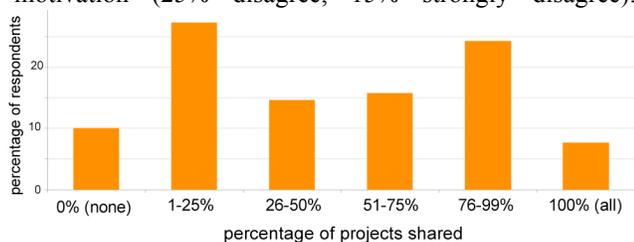
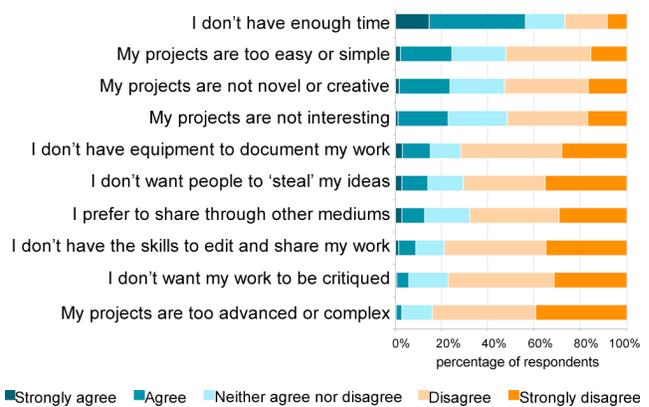

Figure 9. DIY projects shared with DIY communities.

Interestingly, only 40% of participants contribute to DIY *projects* to work/spend time with friends, despite the fact that nearly 80% of respondents contribute to DIY *communities* in order to meet people with similar interests. One participant offers insight into this discrepancy during our follow-up correspondence:

> "*Working alone allows you full expression of your individual creativity. Sharing it with other people with similar interests can provide constructive criticism from people who understand what you want to do.*"

Another respondent suggests that the complexity of a project determines if she works alone or with others:

> "*Personally, I waffle between wanting to practice my craft alone and practicing in the company of others. It depends on the project I have going. Easy projects lend themselves to schmoozing; more complicated projects require 'me time.'*"

SHARING PROJECTS WITH DIY COMMUNITIES
More than 90% of respondents who work on DIY projects share at least some of their projects (Figure 9). Our data suggests a correlation between the percentage of projects shared and the amount of time spent on a typical project: less than 70% of participants who spend under 5 hours on typical projects share any of their work, while over 95% of respondents who work on longer projects (more than 30 hours) tend to share, with more than 10% sharing all their work.

Lack of time is the primary reason for not sharing DIY projects with DIY communities, as indicated by over half of our responded (Figure 10). Other common deterrents are respondents' negative assessments of their projects (lack of creativity, novelty or complexity), each selected by about 23% of respondents. Less than 10% cite poor editing or uploading skills as a reason for not sharing, and slightly more respondents (15%) indicate that they do not have the right equipment to document their work.
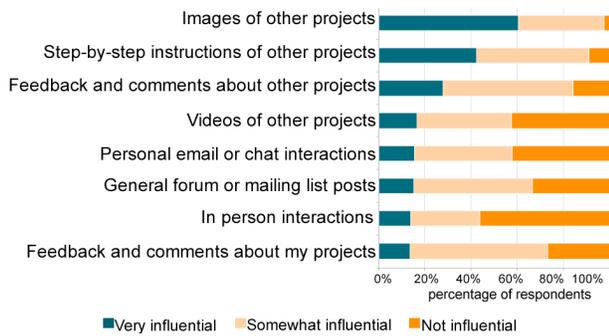
Figure 11. Aspects of DIY communities that participants find influential for their work.

Lastly, when asked which aspects of DIY communities are most influential for their work, the majority of respondents emphasize images of other projects (over 60%), followed by step-by-step instructions (over 40%). Surprisingly, feedback on projects is least found "very influential" by less than 20% of participants, despite the fact that it is one of the most frequent contributions. In-person interactions are the second least influential for DIY work, perhaps due to the fact that they are rare as well as the social (rather than purely work-oriented) focus of many in-person events- e.g., smaller knitting groups. Referring to one such gathering, a respondent explains:

"My in-person meetings are with friends that share my interests, not strangers. It provides a chance to socialize while sharing an interest."

Another respondent notes that meetings are used to transform online connections into personal relationships:

"When I get to meet an individual that I've talked to online in-person, it really helps me to put a face to the name!"

Thus, participants seek in-person contact to fulfill social as well as purely DIY-related goals.

LIMITATIONS
The six DIY communities selected for our study provide a representative cross-sample of the methods and materials employed by DIY practitioners: Instructables- a large site showcasing a projects in a step-by-step format; Adafruit- a small community of electronics enthusiasts; Ravelry- a large portal for knitters, crocheters and artists; Craftster- a community of "hip" and "crafty" practitioners; Etsy- an online marketplace for handmade work; and Dorkbot- artists who present ideas in-person. To gather unbiased probability sampling, we posted identical recruitment text on each community's discussion forums and our data somewhat reflects site statistics: fewer responses from smaller communities- Dorkbot and Adafruit, and a skew towards Ravelry (300,000 members) and Craftster (170,000 members). However, size does not explain the relatively small participation from Instructables, which, at 500,000 members, is larger than both Ravelry and Craftster. Perhaps our overwhelmingly female response

rate is due to a female majority in Ravelry and Craftster (71% and 68% respectively). We note that our methodology is not immune the common limitations of survey methods: self-selection bias, underreporting of egotistic values, categorizing participants' motivations into pre-defined lists, etc. While our data depicts the practices and values of DIY cultures at large, future work can pursue inter-community comparisons: for instance, do users belonging *exclusively* to Etsy express financial concerns above creativity and learning?

DISCUSSION
We now reflect on the broader processes and values that underlie DIY cultures, highlighting four themes that distinguish DIY communities from the other, more widely-studied communities. In doing so, we hope to entice HCI researchers to engage with DIY practitioners as an emerging group of builders, tinkerers, and 'experts' who create novel objects and interfaces that can be imported into HCI work. Furthermore, DIY communities represent early adopters of new cultural practices that reform and repurpose technologies, exemplifying a vibrant creative spirit often misunderstood and certainly understudied by HCI communities.

Low Barrier to Entry
With the majority of DIY projects costing less than $50, a low financial threshold enables people to work with a range of materials across different project domains. Just as most participants belong to several communities, many also work on more than one type of project, ranging from craft to cooking to electronics. We consider the overlap between communities and projects to be an exciting finding: accessibility of information and resources blurs domain distinctions, inviting knitters to tinker with electronics, roboticists to practice crocheting and mechanics to explore music. DIY communities lower the barrier to entry into different project domains by enabling what one respondent describes as "*exchange of ideas with so many different persons with different technical, artistic and professional backgrounds*". DIY communities thus invite individuals across all backgrounds and skill levels to contribute, resulting in: 1) rapid interdisciplinary skill building as people contribute and pollinate ideas across communities and 2) increased participation supported by informal ("anything goes") contributions such a comments, questions and answers.

Learning
The breadth of communities and projects that are often associated with a single person suggests widespread information exchange. DIY communities serve as instruments of learning through features such as discussion forums, the 'instructable' format, images and video. Our data reveals question asking and answering as the core process behind the propagation of methods and ideas. As one respondent pointed out, participants tend to "*learn more by teaching and sharing with others*". We contrast this mechanism with the more 'traditional'

dissipation of knowledge in academic fields: while research papers certainly do increase the fundamental state of the art, they often alienate a large portion of the general population by 'talking at' rather than 'talking with' the audience. Conversely, DIY communities entice learning by initiating a give and take dialogue between individuals across all backgrounds and skill levels. With 'learning new concepts and skills' as the second most-supported motivation for both engaging in DIY communities and working on projects, DIY is a culture that aspires to explore, experiment and understand.

Creativity
DIY communities and projects are driven by creativity. The vast majority of our respondents contribute to DIY communities not to gain employment, money, or online fame, but to express themselves and be inspired by new ideas. Moreover, creativity serves as a prerequisite for sharing, with nearly a quarter of the community refusing to share their work because it is self-perceived as uninteresting, not novel, or too simple. The types of projects showcased through DIY communities, ranging from robotic gardening tools to three-dimensional art quilts to ladybug cupcakes, embody the members' drive for the unique, the whimsical and the artistic, to enable what one participant described as *"full expression of your individual creativity".*

This *individual creativity* echoes Csikszentmihalyi's view of p-creativity, referring to individuals who are interesting, stimulating, and "experience the world in original ways" [9]. Personal creativity is, of course, different from historic genius- individuals such as Picasso or Einstein who impact our culture on a larger scale. DIY communities facilitate p-creativity by enabling millions of witty, curious, and enthusiastic contributors to share and draw from DIY knowledge. This knowledge affords inspiration and learning, which in turn lead to discoveries and innovations in personal DIY projects. According to Csikszentmihalyi, creative outcomes are validated by a "field of experts" who "recognize and validate the innovation". DIY communities provide this mechanism through open sharing and feedback. The "field of experts" in DIY communities consists of hobbyists and enthusiasts who critique and learn from others' work, giving rise to the ex*pert amateur*. With most respondents sharing some portion of their projects with DIY communities and more than half of participants contributing to a community at least a few times a week, sharing is the fundamental process that drives and validates DIY creativity.

Alternatively, Foucault discusses creativity as 'author function': the author produces a work but does not necessarily participate in its interpretation (e.g., the author's name "indicates the status of the discourse within a society and culture") [16]. By this view, DIY contributors become 'authors', and sharing takes on the form of 'story-telling' through a creative rhetoric. Again, we contrast this more natural approach of *telling* (for instance, showing a new gadget or sewing technique) with the more prevalent of top-down sharing mechanisms in CHI. With *storytelling* as a core process behind creative DIY sharing, we argue for importing similar practices into CHI (for instance, more emphasis on demos, etc.).

Open Sharing
Motivations for contributing to DIY communities highlight information exchange as a core value: receiving feedback on projects, educating others, and showcasing personal ideas and skills are the top factors. Sharing is accessible to individuals of nearly any background, since lack of equipment or skill is not a significant barrier. Participants are willing to share both their projects (especially through images, which are uploaded by more than 80% of respondents at least once a year), as well as raw knowledge by commenting answering questions. Sharing extends beyond DIY work and methods, as nearly 80% of participants seek to 'meet people with similar interests', or as on participant stated, "*to feel connected to like-minded people*". With nearly a third of all participants attending in-person meetings and almost a quarter presenting personal work at meetings at least once a year, in-person interactions serve as a "*chance to socialize while sharing an interest*". Community togetherness compliments the predominantly solitary practice of doing DIY work: 'working and spending time with my friends' is not a popular motivation for contributing to DIY projects, thus suggesting that DIY is a culture that strives to share together while working alone.

DESIGN IMPLICATIONS AND FUTURE WORK
The principles embodied by DIY communities- low barrier to entry, learning, open sharing and creativity- can benefit a variety of other corporate, academic and nonprofit collaborative environments. These values drive the exchange of ideas that lead to new discoveries and innovations. We now highlight three areas of design implications for DIY and similar systems that leverage personal knowledge exchange.

Integrating Physical and Digital Domains
A large body of literature in the social sciences explores material possessions as 'extensions of self': personal objects serve as points of reflection on one's identity as well as expressions of idealized future goals and desires [4,10,23]. Our participants, who create and repurpose personal objects, use online communities to broadcast self-constructed material things into the public sphere. In doing so, they symbolically project personal goals, values and practices into the digital domain. These contributions remain detached from the physical objects and states that produce them. Simultaneously, participants seek physical, in-person meetings, which provide social intersections ranging from putting "*a face to the name*" to receiving "*life advice and companionship*".

Our findings suggest a range of design opportunities for managing personal identities within and across physical and digital domains. Broadly speaking, new tools can

serve to ensure continuity across online communities to which our respondents contribute, as well as in the physical world where they create material objects and seek personal contact. For instance, new systems can inform users when they are interacting with the same individual across different websites, or showcase one's projects in single place even if they are initially shared in separate communities. Moreover, digital interactions can be exposed in physical spaces [*e.g.* 21] to reconcile online relationships with in-person experiences. Future work can import ongoing research of more sophisticated tools for identity management [*e.g.* 19] to explore the implications of linking virtual and physical domains: what are the social consequences of combining 'personas' across online and in-person communities? To what extent are users willing to share personal facts and objects across these domains, and how can identity management tools infer and address privacy concerns?

New Forms of Knowledge Transfer

Our results reveal commenting, question asking and answering as the most frequent contributions in online DIY communities. Since these communities function as instruments of learning and inspiration, we emphasize new media that enable richer experiences of knowledge transfer *beyond* text-based question and answering. Despite the fact that many communities already support expressive mediums, for instance images, step-by-step instructions and video, and participants find these to be most influential for their work, such contributions are considerably less frequent than text-based posts. Videos in particular highlight this discrepancy: despite being the least common (under 2% of respondents upload a video more than several times a year), they are deemed 'very influential' by almost 17% of respondents.

With lack of time as the main deterrent for sharing DIY work, there is a tradeoff between the time required to make a contribution and the extent to which it facilitates knowledge transfer. Videos, for instance, require a long time to edit, but can influence the viewer in at least three powerful ways: 1) by physically illustrating the steps required to create an artifact; 2) by showcasing a new idea in its functional form; and 3) by directly 'speaking' to and engaging with the audience. Future work can focus on media for expressive knowledge transfer. In the case of video, for example, new tools can offer fast and intuitive editing, non-linear traversal, descriptive overlays, tagging, and linkage to related projects. Images and tutorials can be made more powerful through voice annotation, interactive features, and graphical search, among others.

To compliment expressive idea exchange, future systems can explore light-weight mechanisms for gauging learning outcomes. While numerous contests and rating systems exist to indicate the popularity of online content, very few tools allow us to evaluate tacit knowledge transfer or learning experiences. Systems aiming to support scaffolding for knowledge exchange can allow users to quickly indicate how much they learned or search for content that other people have effectively learned from.

Supporting Iterative Studio Culture

Creativity- the core value embodied by DIY communities, simultaneously entices and deters participation: on one hand, our respondents want to share their projects to receive feedback and inspiration from the community; at the same time however, creativity is a filter for sharing work that is self-perceived as un-creative (not novel or uninteresting, etc). This 'creativity barrier' stems, in part, from current DIY sharing as a practice of showcasing functional and completed work. Broader participation can be encouraged by reframing DIY communities as instruments of iteration, critique and feedback on work in progress. With design studio culture as an emerging field in HCI [5,6,15], we emphasize the importance new mechanisms that elicit "*feedback early and often*"[6] in creative design processes.

DIY communities already do embody iterative feedback mechanisms through comments, forum posts and question/answer exchange. Many contribution formats are reminiscent of a studio culture, whereby users learn by 'observing' the 'actions' of others- tutorials, images, videos, etc. In the future, personal project sharing can draw from the successful contribution models of systems such as Flickr, Twitter, or Facebook, allowing for status updates, photostreams and similar 'live' formats. This approach can depict the current state of the work, enabling an iterative dialogue between the DIY'er, the DIY process, and the DIY community. Moreover, new tools can expose the role that smaller projects play in the ultimate creation of larger, high-profile work. For instance, a final robotics project may draw from one person's image of a circuit, another contributor's tutorial on motors, and a third individual's video of vacuum-forming. Future tools can focus on revealing the iterative processes between projects people to highlight that creativity is not confined to large-scale, complex work that tends to receive the majority of the "creative" credit.

CONCLUSION

We discuss DIY as a vibrant culture with a long history of learning, creating and sharing. Our study of six DIY communities suggests that these values are embedded in everyday practices and supported by the technologies that bring DIY communities into being. Drawing from numeric and qualitative data, we present opportunities for identity management across digital and physical domains, expressive knowledge transfer tools, and systems to support iterative studio practices. Above all, we argue for increased engagement between CHI practitioners and DIY expert amateurs, and hope that this work serves to import DIY culture into CHI and vice versa.

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