MAKING GENDER: TECHNOLOGISTS AND CRAFTERS IN ONLINE MAKERSPACES

A Thesis
Presented to
The Academic Faculty

by

Beth Godfrey

In Partial Fulfillment
of the Requirements for the Degree
Master of Science in Digital Media in the
School of Literature, Media, and Communication

Georgia Institute of Technology
May 2015

MAKING GENDER: TECHNOLOGISTS AND CRAFTERS IN ONLINE MAKERSPACES

Approved by:

Dr. Christopher Le Dantec, Advisor
School of Literature, Media, and Communication
Georgia Institute of Technology

Dr. Janet Murray
School of Literature, Media, and Communication
Georgia Institute of Technology

Dr. Carl DiSalvo
School of Literature, Media, and Communication
Georgia Institute of Technology

Dr. Nassim Jafarinaimi
School of Literature, Media, and Communication
Georgia Institute of Technology

Date Approved: April 22, 2015

TABLE OF CONTENTS

		Page
LIST OF TABLES		vii
LIST OF FIGURES		viii
SUMMARY		ix
CHAPTER		
1	Introduction	1
	The Maker Movement	1
	Absenteeism of Women in Making	2
	Proposed Solutions	5
2	Online Makerspaces	8
	Makezine	9
	Hackaday	14
	Instructables	18
	Publishing Power and Gendered Authorship	27
	Final Site Comparison	34
3	Methods	39
	Site Overview	40
	Building a Demographic Database	43
	Survey	47
	Interviews	49
4	Participation in Online Makerspaces	52
	Gender Identity	52
	Gendered Categorization	55

Locative Making 56
Education 58
Occupation 59
Compensation and Income 61
5 Practices, Skills, and Confidence 65
Practices, Skills, and Confidence in Technology 65
Practices, Skills, and Confidence in Crafting 68
6 Interviews 72
Helen- Founding a Makerspace 72
Sarah- Non-technical Making 75
Rachel- Being a Woman in Tech 77
Anne- Learning through Making 83
Julie- Building a Maker Community 84
7 Discussion and Recommendations 88
Values, Ideals and Beliefs 88
Reasons for Participating 93
Recommendations 98
APPENDIX A: Survey 103
REFERENCES 113

LIST OF TABLES

	Page
Table 1: Gender Breakdown of Online Makerspaces	9
Table 2: Representation of Gender and Practices	54
Table 3: Levels of Engagement	55
Table 4: Educational Achievement	59
Table 5: Income Variation	63

LIST OF FIGURES

	Page
Figure 1: Makezine 2005	10
Figure 2: Makezine 2015	13
Figure 3: Hackaday 2005	16
Figure 4: Hackaday 2015	17
Figure 4: Instructables 2006	22
Figure 4: Instructables 2015	25

SUMMARY

The Maker Movement is a rapidly moving development towards non-traditional education through hands-on creation of technological artifacts, indicating tremendous potential for attracting previously marginalized groups underrepresented in science and technology fields. The movement is compellingly situated as the intersection of an expansive array of interdisciplinary efforts and thus equipped to be leveraged by women and girls who are more likely to originate from artistic and creative backgrounds. Women who make are severely underrepresented in all documented embodiments of the maker movement, including maker media, events, and tangible collaborative spaces. This study explores the possibilities of removing barriers to entry into making for women by converging upon the narrow focus of online makerspaces, engaging with the denizens of the space, and scrutinizing the manner in which they participate in the broader maker community. The timeliness of this probe into women's personal engagement with science and technology making is indicated by the convergence of discussion surrounding the underrepresentation of women in STEM and approaches to increasing accessibility through making as a natural point of entry.

.

CHAPTER 1

INTRODUCTION

The Maker Movement

Maker culture is a technology-inspired branch of the do-it-yourself (DIY) movement, which promotes learning through doing in a social environment (Dougherty, 2012). Makers are do-it-yourselfers, hobbyists, and inventors who are motivated to engage in the maker community by a variety of reasons, whether it be simply for fun or as a launch pad for spawning product ideas and serious entrepreneurial pursuits (Intel, 2014). Makers of all ages and background use a broad array of tools and methodologies from engineering-oriented pursuits like electronics, robotics, and 3D printing to more traditional craft-oriented activities like jewelry making, textile production, and woodworking. They are artists, hackers, scientists, crafters, students, cooks, engineers, designers, and more, leveraging household or accessible materials to craft the world around them.

People identifying themselves as makers comprise an increasingly international population (Intel, 2014). The movement is poised on the brink of a remarkable shift in perceptions of agency in conceiving and constructing the world around us, melding humanistic and engineering frames of reference to lend innovators the capability to improve lives through fabricating affordable technological devices (Intel, 2014). Making itself takes an inter-disciplinary human-centered computing approach of focusing on the process rather than the product, collaboration rather than isolated efforts, and an integrative rather than a specialized approach.

What began as a branded tech-inspired DIY movement headed by the team behind MAKE Magazine, which launched in 2005, has since broadened to include a wider variety of crafting and hand making practices. For this reason, the un-capitalized terms "maker movement" and "maker community" are here used interchangeably to indicate the broader community of makers. The movement is being hailed as the beginning of a new industrial revolution, the era of personal fabrication (Gershenfield, 2005), as integral electronic components and tools like microcontrollers, 3D printers, and laser cutters become less expensive and more accessible. Democratization of technology has spurred involvement in the tech-fueled movement with powerful implications for augmenting non-traditional educational systems and bolstering lifelong learning, cultivating a growth mindset argued to be the new psychology of success (Design-Make-Play, 2012). Making fosters learning through personally meaningful projects and collaborative, multidisciplinary, and playful approaches and hands-on experience with technology (Intel, 2014). It fosters innovation by promoting self-efficacy, experimentation, and persistence in science learning (Design-Make-Play, 2012).

Absenteeism of Women in Making

Although the maker movement is gaining momentum, there are numerous challenges that prevent certain segments of the population from fully participating, specifically girls and women. Expense, lack of information, and lack of access to tools and materials are barriers to entry for both women and men, establishing and perpetuating a knowledge gap between more connected communities with a higher socioeconomic status and those with a lower status (Techenor, Donohue, & Olien, 1970), but women also face an additional set of constraints. Lack of mentorship is the second-ranked challenge preventing women from entering the maker movement, with one in three women citing it as an impediment (Intel, 2014). One in six women have been excluded

from making solely on the basis of being a woman, and a similar number live in a culture where making is considered inappropriate for women (Intel, 2014). One in 14 say they do not feel safe going to maker activities like Maker Faires and workshops hosted by local maker and hacker spaces, both of which are integral to the maker community (Intel, 2014). A 2012 study conducted by Maker market demonstrated that the maker community was 82% male (Maker Market, 2012), a percentage that is similar to the breakdown of gender representation in major tech companies (Bureau of Labor Statistics, 2014). It appears that gendered participation in maker events is somewhat more representative but still highly skewed male, a 2013 study of Maker Faire attendees showing the attendance rates of men at over twice that of women (MAKE, 2013).

If women constitute half of the world's population, where are all the women makers? Susan Faulkner of Intel argues that women *are* making, but are being undercounted in the worldwide Maker Movement because the work they do is less likely to be taken seriously (Faulkner, 2014). Women are more likely to identify with terms external to the Maker Movement like creator, designer, artist, crafter, and inventor while men relate more to terms such as tinkererer, hobbyist, DIYer, and engineer (Intel, 2014). Makers from less technical backgrounds have found that their work styles are undervalued or misunderstood—taking a pause to sketch or think out a concept is taken as an indicator than a woman needs assistance (Faulkner, 2014). Granting that the Maker Movement is promoting a renewed interest in manual crafts and DIY culture (Intel, 2014), it seems to be discounting the original practitioners of such traditionally feminine practices like sewing, decorative wearables, and household hacks.

Another reason women may be consistently undercounted is their lack of presence at physical maker and hacker spaces, which are open community labs functioning as centers for peer learning and knowledge sharing in the form of workshops, presentations, and lectures. Women and men similarly cite lack of money, information, and access to resources as reasons for not attending makerspaces, but women additionally struggle to find the time. As one maker said to Faulkner (2014), "To be a maker, you don't need an engineering degree. You need childcare." As women are entering the workforce at higher rate than ever, this serves to substantiate the concept of the "second shift," in which women experience the double burden of unpaid childcare and home labor in addition to paid work in the formal sector (Hoschild, 1989). Faulkner (2014) found that while coed makerspaces are a welcome relief from workplaces rife with sexism for some women, others find the macho atmosphere promoted by the use of welding equipment and power tools to be uninviting. Female makers find their geek cred constantly challenged or belittled alongside harassment ranging from assault to much milder, but consistent come-ons (Henry, 2014). Male makers are increasingly aware of the need to be welcoming and helpful towards their female counterparts, but often this heightened level of attention can make women feel uncomfortable. Arising from this friction is a host of feminist hackerspaces based on the assumption that shared values, explicit and implicit, enable group members to flourish and empower themselves (Toupin, 2014).

Contrary to early assumptions by tech companies regarding on whom their marketing efforts should be focused, women are the new lead adopters of technological products and services. Women in the Western world are 17% more likely to use the internet than their male counterparts (Bell, 2012). Bell (2012) also notes that they are also

more likely to spend time on their mobile phones talking, using location-based services, and sending text messages. Young women are the largest and fastest-growing user base of Skype, a video-calling messaging system, as well as every social networking site that focuses on social communication, which has often been the realm of women (Bell, 2012). The one exception to this is LinkedIn, which is a business-oriented networking site used by a greater percentage of male internet users than female (Business Insider, 2015). Women are also the vast majority of all internet enabled devices, from e–book readers to healthcare devices. Faulkner posits that the dearth of female makers means that women entrepreneurs could be left behind in the creation of the Internet of Things, in which a majority of innovations and products will originate from individual creators rather than industry players (Faulkner, 2014).

Women will be purchasers and active users of the products that come from this revolution in hardware innovation, so their inclusion as potential developers and innovators is of paramount importance (Faulkner & McClard, 2014). By excluding women from the transformational Maker Movement, one would be proceeding "on the basis of exclusions which are resident in our concepts but manifest in designs" (Cohen, 2005). If the make-up of makers continues to directly correspond with the unbalanced gender ratio palpable in the tech industry, the future of technology and product design will perpetuate longstanding status quo inequalities (Faulkner and McClard, 2014). Thus half of the modern world's inhabitants will have no part in the design, engineering, or fabrication of products set to define their interactions with the digital environments surrounding them.

Proposed Solutions

If absenteeism of women in making is a defined problem, how do we move forward in bringing more female makers into the fold? While Faulkner (2014)

suggests making a concerted effort to broaden the definition of what is and is not making, including women practitioners who may not directly identify as makers, there still exists a disregard in the maker community for products that fall somewhat outside the realm of technology. Faulkner and McCloud additionally suggest altering the definition of what a "user" of any particular technology is to include accidental technologists, or those who came to technology through their passion for making and are a little surprised to be working with technology at all (Faulkner and McClard, 2014). Intel's MakeHers report suggests a host of recommendations for engaging women and girls in making, including building more inclusive maker environments in schools, designing maker spaces that enable open-ended investigations of meaningful projects, encouraging parents to engage in making with their children, and developing initiatives which give girls more access to makers their own age and female mentors (Intel, 2014). While these are valuable methods for including women who are already makers into the broader making community and engaging young girls in a non-traditional, hands-on STEM education, they do not offer any solutions for women who have discovered making later in life. Young women who lacked exposure to making through the course of their postsecondary educations or who are already embedded in non-technical fields have no direct path to engaging in the maker movement. A salient barrier for entering into making is additionally highly dependent on location. Makerspaces and tech-friendly economies tend to be concentrated around a handful of urban areas, namely East Coast cities near Silicon Valley or large urban areas in the Midwest and Northeast. Accessibility for rural inhabitants, families with a lower socioeconomic status, and attendants of educational systems less invested in

promoting a STEM curriculum are also limiting factors for representative participation in the Maker Movement.

A solution, proposed here, is to expand our definition of what is included as a maker- or hackerspace and who the users or participants of that system are. In this study, makerspaces are broadened to include online maker communities like Instructables, Makezine, and Hackaday and makers to anyone who engages and authors project documentation-style content on these sites. With the increasing accessibility of internet-connected devices, online makerspaces such as these are argued to be an extension of the broader maker community but encompass the affordances of openness and anonymity of a virtual presence. In the following study, three of these online makerspaces are examined and assessed for their gendered production, consumption, and inclusion, and further inquiry is made into the Instructables community, its affordances, and the gendered participation of its makers.

CHAPTER 2

ONLINE MAKERSPACES

Makerspaces, also known as hackerspaces, hackspaces, and fablabs, are collaborative learning environments where people come together to share materials and create, born out of a mindset of community partnership, collaboration, and creation (Library as Incubator Project, 2012). They facilitate participatory learning through doing, springing up in schools, libraries, community spaces, and even basements to increase public accessibility to expensive equipment like 3D printers, laser cutters, and computerized machine tools. In addition to the approximate 2,000 tangible makerspaces scattered around the world (Tierney, 2015), the maker community also exists in a virtual format on a number of online makerspaces, including Makezine, Hackaday, and Instructables.

There exists a disparity in gender representation within the sites similar to that of tangible makerspaces (Intel, 2014), with women noticeably absent from both (see Table 1). Approximately one in seven makers on both Makezine and Hackaday are women, while one in three makers on Instructables are women While disproportionate representation in the first two tech-focused spaces isn't entirely surprising, given the dearth of women ascribing to the narrowly defined practices of the tech-based movement (Intel, 2014), the higher percentage of women in the Instructables community indicates that the site may differ in significant ways. Following is a site examination of Makezine, Hackaday, and Instructables, in both their current and nascent forms, in an effort to explore what purposes these sites serve for the maker community and why they might be more or less successful in attracting female makers.

Table 1: Breakdown of online makerspace participants by gender

Online Makerspace	Male	Female
Makezine	**85%**	**15%**
Hackaday	**87%**	**13%**
Instructables	**68%**	**32%**

Makezine

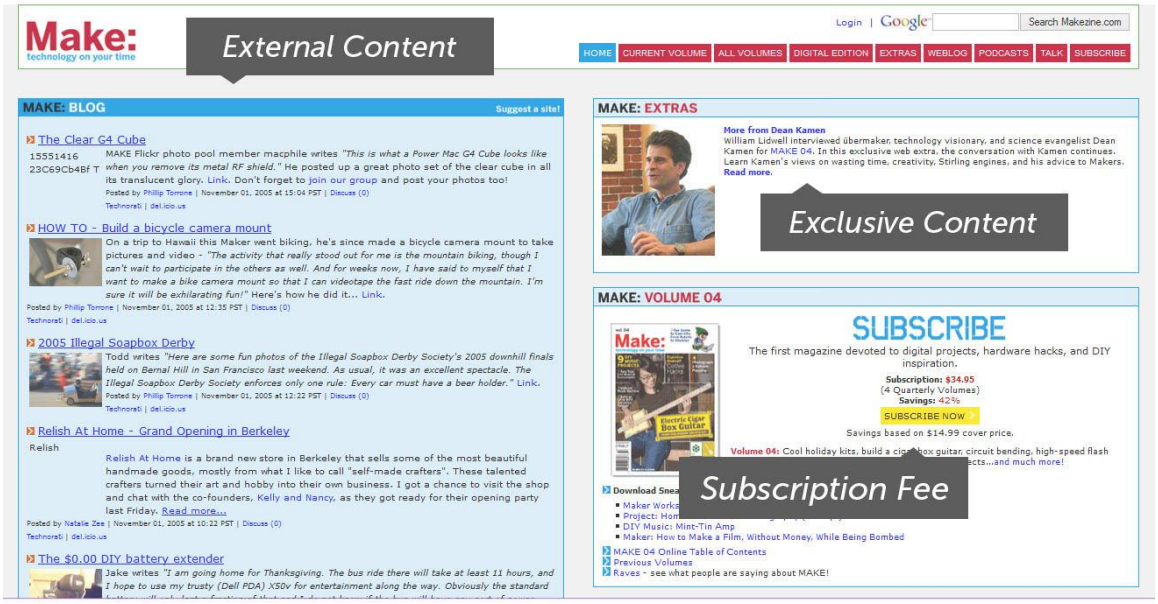
Beginning as an offshoot denizen of the print media world, Makezine serves as the online portal for the bimonthly MAKE Magazine published by Maker Media, a self-described global platform for connecting makers with one another through media, events, and ecommerce (Maker Media, 2015). A result of these roots in magazine journalism is a unique set of thematic elements on the site focusing on passive content *consumption*, event *participation*, and material *acquisition*. Maker Media is essentially a money-making entity and thus appears to be founded on journalistic goals emphasizing readership in a niche community. An inherent problem in producing maker content within a journalistic framework is a lack of representation by women in positions of power. While there are increasingly greater numbers of women in journalism, much of the field is still considered a boy's club, with women struggling for professional acceptance (Harcup, 2004). As evidence to this continuing trend, only three of the nine members of Maker Media's executive board are women (Maker Media, 2015). Make magazine is considered a "central organ of the maker movement" (The Economist, 2011), having released thirty-eight issues over the course of ten years as well as founding a series of Maker Faires, and thus has a prominent voice in maker community. Explored

here is how the journalistic emphasis and lack of female representation in positions of power have influenced the online portal.

Makezine 2005

The original Makezine site emphasized passive *consumption* of content (primarily articles), not yet including material *acquisition* from an online store or engagement in event *participation* activities related to the Maker Faire, which had yet to be established. The site instead served mainly as a repository or digital archive for the tangible print magazine, though it did offer a variety of other genres of content, including a blog, forum, and an "extras" section for content that didn't make it to print. The landing page features a layout similar to that of a magazine page, with two columns featuring blocks of content grouped by similarity in tone or function. The left-hand column features a selection of the most recent entries on the Makezine blog, which includes entries ranging from reviews of local DIY supply stores to calls for participation in a special Halloween event held in the online virtual world of Second Life, which had only been released two years previously. The left-hand column also features tutorials created by Make magazine readers or and community members, though the tutorial is hosted on external sites and simply linked to via Makezine. The right-hand column of the landing pages features a shorter selection of content, including an "extra" interview that didn't make it into the print copy, an advertisement for subscription services, and a plug for the Make magazine newsletter.

Figure 1: Makezine in 20015



As a whole, the website acts as an archive for passive *consumption* of past print editions and extraneous content rather than a platform for members to create and distribute content of their own. Instead, visitors to the site were confined to reading articles written and published by Makezine authors, who Buechley (2014) has shown to be most male. When evident, member-created tutorials were hosted on external personal websites rather than built on-site, meaning that makers likely needed to have their own personal site on which to publish tutorials before being featured on Makezine. With women earning only 17% of computer science degrees (National Science Foundation, 2010), it is less likely that they were building their own websites, meaning they simply didn't have the platform on which to publish until a fleshed-out documentation platform emerged.

Makezine 2015

An interesting transformation took place in the decade between Makezine's inception and today, perhaps reflecting on the popularity of Instructables and a transition

towards a niche yet unoccupied: large-scale maker event *participation*. The landing page continues to be formatted as an interior magazine page, with a hodge podge of news, videos, events, and projects, each graphically represented. The most notable emergence forms of content display are events and projects, each indicative of a move away from a digital archive towards a standalone online community.

Events are a major staple of Make magazine, the creator of the Maker Faire. The first Maker Faire was held in April of 2006 in San Mateo, California, and consisted of six workshop pavilions and a five-acre midway of exhibiting makers, demonstrations, and competitions. The Maker Faire has grown into a massive series of events, including three flagship event in San Mateo, Detroit, and New York City, and numerous Mini Maker Faires hosted by local community organizers. In 2013, a Mini Maker Faire was even held on the Georgia Tech campus, drawing students, families, and children to present and explore a wide array of projects.

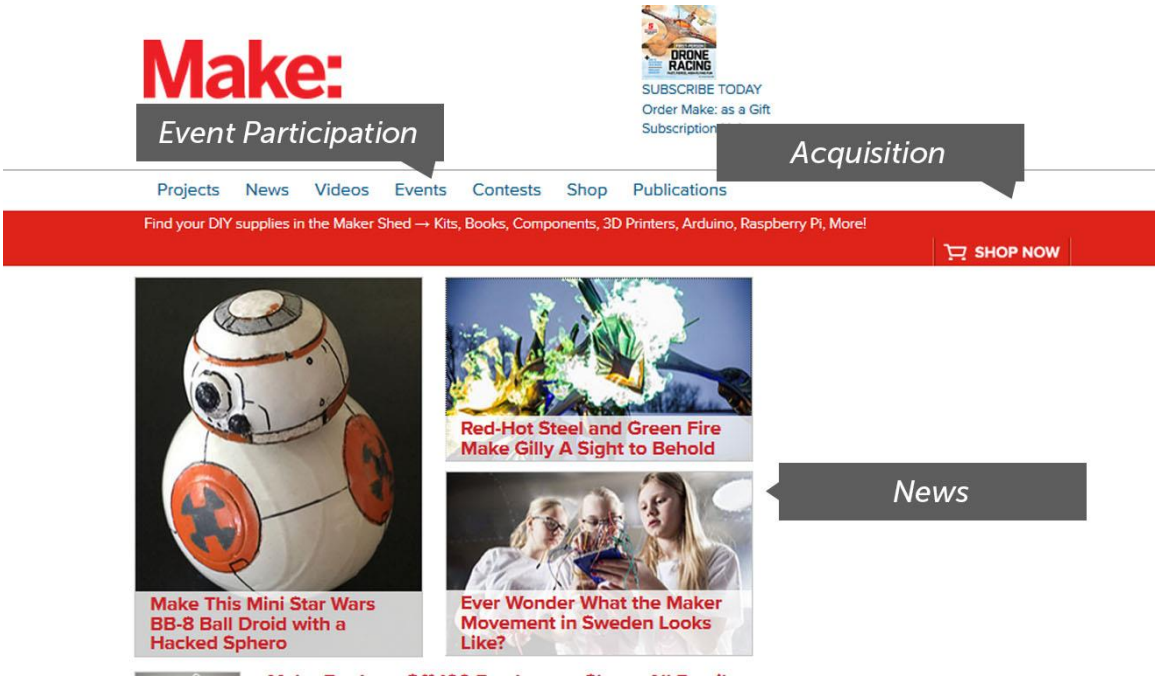
The one overarching theme of these events is a lack of women; male Maker Faire attendees outnumber female attendees two to one, as reported by MAKE itself (2013). One cause of this may be an event focus on large-scale feats of engineering and robotics, as indicated by the Maker Faire's representative icon in the form of bright red robot standing assertively against a stark white background. Maker Faires are typically held in wide, open spaces that can support presentation of physically larger engineering projects that may be more often built by men with engineering or construction backgrounds. Women, who comprise only 11% of current practicing engineers (Fouad, 2014), are more likely to present projects that may be physically smaller or have less of an engineering focus. In this way, projects created by male makers are given greater attention as crowds

are immediately drawn to visually impressive or physically commanding artifacts upon entering the Faire.

Makezine 2015 has moved slightly away from the passive *consumption* of its earlier iteration, featuring reproducible projects in a greater proportion. These projects now include a combination of complete tutorials built conforming to a standardized format and blog-like entries that introduce a member-made project along with a links to the tutorial on the member's personal site. Unlike Instructables, Makezine does not allow for member-created tutorials to be featured in their entirety on the website mandating all published content to be created and approved by the (largely male) Makezine team.

As an additional point of interest, Makezine in July of 2009 included a spot on their home page encouraging members to join the MAKE community on Instructablesand post their step-by-step documentation of projects. While there doesn't seem to be an official Make

Figure 1**: Makezine in 2015**



magazine group on Instructables, there are no restrictions on posting a project to both Instructables and Makezine. There was a veritable overlap during the early years of both sites, in which many projects posted to Makezine were de facto links to tutorials created on Instructables, possibly used as a workaround for makers who did not have personal websites or blogs. However, despite this maker-oriented documentation platform that circumvents the need for web programming, it seems that women are in no greater abundance at this point than in 2006.

In addition to the marginal de-emphasis on passive *consumption* and introduction to event *participation*, Makezine now promotes *acquisition* of physical tools and materials from its online shop. Featured artifacts for purchase fit snugly into the traditional definition of tech-based making, including microprocessors, robotics components, and hardware prototyping tools. These items range from five dollar breadboards to six hundred dollar drones, illustrating that making is not a cheap hobby. This expense is cited by female makers as a major barrier to participation in the maker movement (Intel, 2014).

Hackaday

Hackaday serves as a contrast to Makezine while catering to an altogether different audience. Featuring a new "hack" each day, the site features content written or selected by a mostly male team, and portrays itself as a rather underground and unmonitored community through its lack of comment monitoring and an emphasis on somewhat less expensive and unpolished projects. The site is a curious mixture of its two counterparts, including the themes of *production* and *iteration* found on Instructables (to be discussed later) with the *consumption* and *acquisition* aspects emphasized by

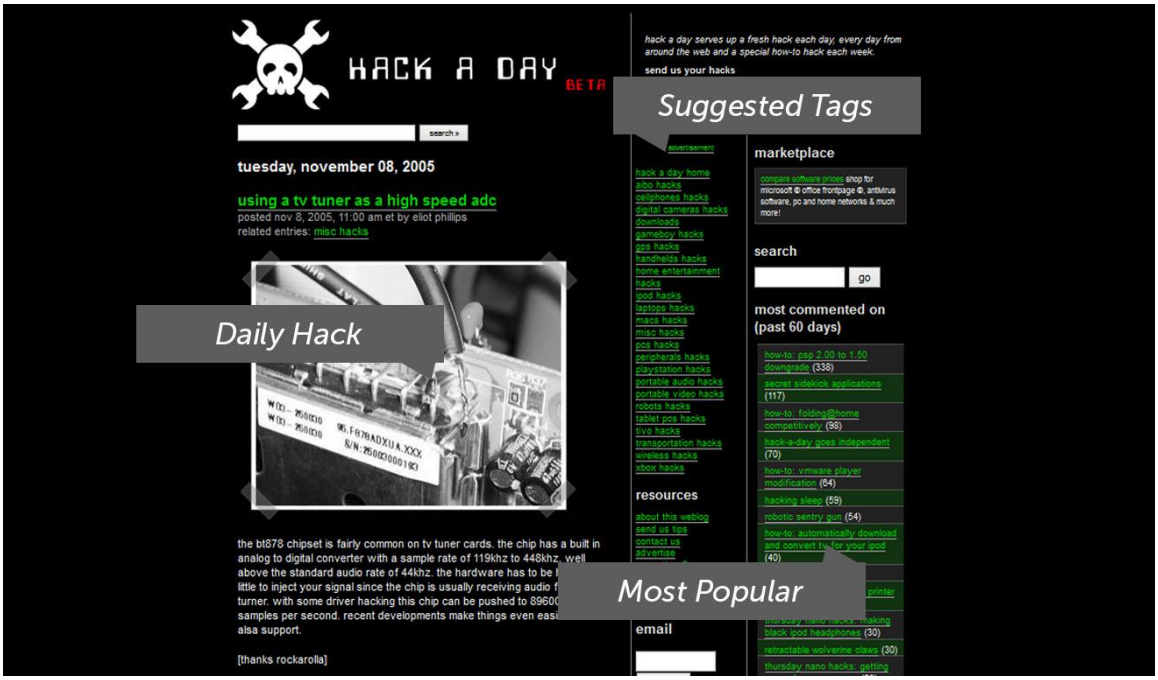
Makezine. Surrounding this is a framework within which the term “hacker” is not only accepted but embraced, discarding the negative connotations affixed to hackers engaged in computer crime in favor of a repurposed definition emphasizing quick thinking and experimentation. Only one in seven articles or projects posted on Hackaday are authored by woman, which is perhaps an artifact of this emphasis on the term. Hackers are generally young, white men who identify with technology over people (Sollfrank, 2002), creating an exclusive environment potentially hostile to outsiders that seems to bleed over into user interaction within the Hackaday community.

Hackaday 2005

Hackaday in 2005, a year after its first publishing date but still described as in the beta stage of development, was at this point less sophisticated than Makezine in terms of both design and functionality. On overabundance of text in stark white and lime green against a black background (along with a logo comprised of a skull-and-“crossbones” aka wrenches) lend it the look and feel of an underground community. Featured hacks tend to be repairs or modifications of existing technology to increase functionality or aesthetic appearance. This initial iteration follow Makezine’s emphasis on *consumption*, as users are only able to read articles selected and published by the Hackaday staff. Paired with this is an affordance allowed by a comment section housed beneath each published article: robust discussions regarding future *iteration*, where members discuss possible problems, solutions, and alterations. While this discussion can include constructive feedback, its unfettered nature promoted by anonymity of its users often allows for highly critical and negative remarks. Women, who experience a lack of confidence in their skills

when compared to their male counterparts, (Orenstein, 1994) may be less likely to submit their projects to a site that allows this sort of negative criticism.

Figure 3: Hackaday in 2005



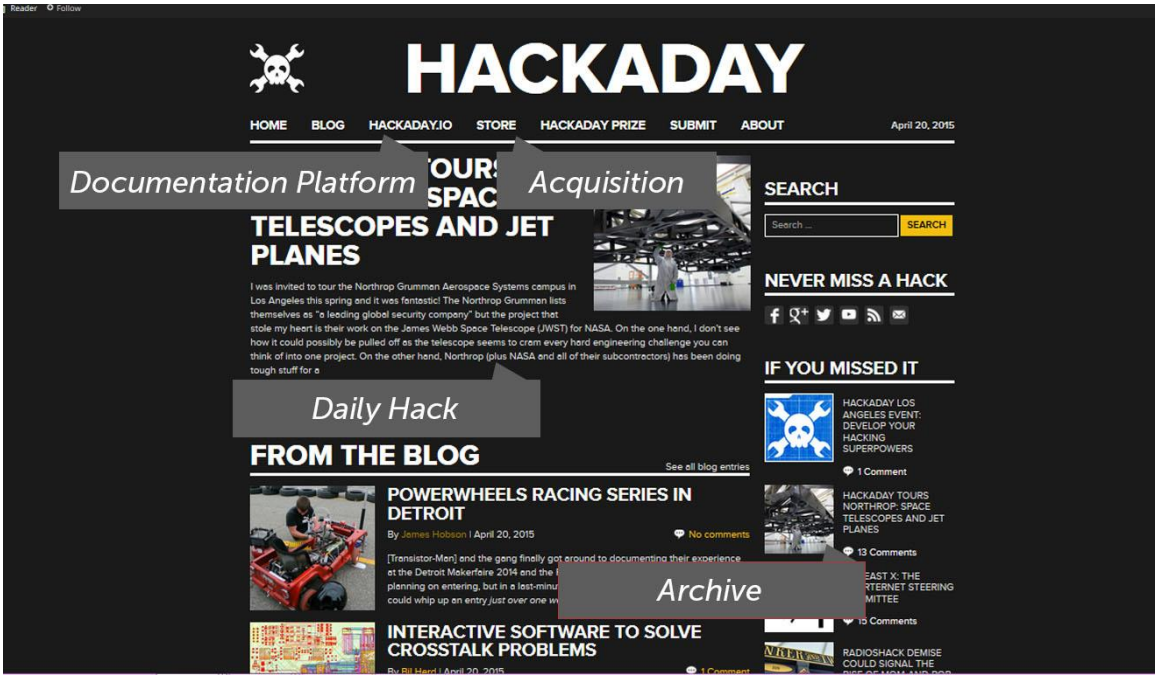
Hackaday 2015

For the current iteration of Hackaday, a visual makeover softens the black background to a grey and nixes the lime green for a soft white, though preserves the skull-and-crossbones logo. With a doubtless increase in traffic since 2005, the "hack a day" now includes a slideshow of the day's selected hacks. Similar to Makezine, the home page is laid out in the style of a magazine page, with boxes of content sorted into similar categories found also in the menu above, and thus continues to emphasize *consumption* over *production*.

Also mirroring Makezine, Hackaday has created an online marketplace for tools

and materials using in tech-oriented making. Items for sale are almost exclusively those needed for building electronics, including microcontrollers, sensors, and circuit board. Also like those listed in Makezine's online shop, these components do not come cheap, nor are they geared towards practices more commonly used by women. Women are represented in even lower proportions in electrical engineering, earning only 11% of bachelor's degrees in the discipline (Yoder, 2011). The inclusion of this ecommerce section (*acquisition*) and news content (*consumption*) is augmented by the introduction of a *production*-oriented documentation platform on Hackaday's hosting site, hackaday.io. Hackaday.io is itself a further breakdown in the hybridization of Makezine and Instructables, serving as a platform for members to document their projects step by step. Unlike on Instructables, however, the projects are not formatted in a way that encourages replication. Projects are immediately viewable as a series of photos from a gallery, then as a set of "project logs" in the form of dated, blog-like entries. The posts are often

Figure 4: Hackaday in 2015



lengthy and meandering in comparison to the succinct, precise language common to projects posted to Instructables, focusing on the narrative aspects of the *ideation* and *production* process unique to the individual author. A visitor can subscribe to the project, receiving updates as logs are posted. The combination of these aspects, along with the generally drawn-out timespan from project initiation to completion, discourages other members from *iterating* on the project and providing experiential feedback and critique.

This format is perhaps influenced by the continuance of passive consumption enforced by the genres of content on display throughout the rest of the Hackaday site: news, blogs, and features. Though a platform is in place that might one day highlight intercommunication and cooperative efforts that are commonplace to Instructables, Hackaday.io users are not leveraging the affordances of the medium in a manner that promotes a rapid *ideation*, *production*, and *iteration* process. As a collection of project blogs, it suffices, but the culminating effect is not one of a wholly interactive community. This lack of interconnectivity between members on both Hackaday and Hackaday.io may be serving to discourage women, who are more likely to prefer collaborating with others (Intel, 2014), from publishing or participating fully.

Instructables

Foundation and Development

The final of the three makerspaces and the focus of this study is Instructables, a website specializing in user-created DIY content that is uploaded, commented on, and rated by members within the online community. Instructables differs from its counterparts in a myriad number of ways, most prominently its inclusion of practices not traditionally ascribed to tech-oriented making. This culture of inclusivity perhaps

originates in its unique inception, created by disillusioned academics focused on community first and technological practices second.

Three of four of the original Instructables founders met as graduates students in academia, a domain increasingly populated with ideals concerning open source software, technology, and knowledge. As a developmental model, open source promotes universal access and redistribution as a collaborative effort, recognizing that improvements spring from iteration. Eric Wilhelm, the primary founder of Instructables, was nearing the end of his stint as a PhD student and encountering grim tales of applications for professorships rejected and an overabundance of jobless PhDs when he, along with a few colleagues, branched off from academia in an effort to make a "direct impact on the world" (Wilhelm, 2010). Thus Squid Labs, and later its spinoff Instructables, came to be, presenting as an electronics consulting business and deeply immersed in the discourse surrounding research-based design and production. Now with 7 spin-off companies, producing products running the gamut from lighting products for bicycles to wearables that measure refractive error for low-cost eye care, the use of Squid Labs as a name and parent company has been retired and is referred to by its founders as a successful experiment. Its most prominent success story has been Instructables, the most visited site for step-by-step instructions for technology, living, workshop, play, food, and outside projects.

Instructables grew out of necessity and a more personal story of three founders encountering trials and challenges in the expensive, then-nascent sport of kitesurfing and their efforts to document construction of hand-sewn kites and plywood boards. Documentation artifacts were posted on the individual members' personal blogs and

accumulated on a joint blog called Zeroprestige, which has since moved to a group on Instructables. After receiving emails from kitesurfing community members near and far looking for tips, information, and meet-up spots, the three formed Monkey Kites, a de-facto home base for the emerging sport and its practitioners. This connectivity with the practicing community and the handmade nature of a construction activity not affiliated with technology formed a design influence for the later Instructables site, wherein the founders foster positive community engagement and interdisciplinary collaboration through rewarding helpful feedback and iteration on another maker's project.

With Monkey Kites as a previous proof of concept for a web-based documentation system and the resources from Squid Labs to build a more robust version, a prototype of what is now Instructables was built as an in-house documentation system, released at the O'Reilly Foo Camp conference, then made accessible to the general public. Within a few months, the site grew from consisting mostly of the founders and their personal friends to mainly newcomers. Lacking enough revenue from Squid Labs to hire another full-time employee, the crew turned to fundraising methods, including seeking investments by venture capitalists. This differs from the Make Media model of requesting payment in return for delivered content, as the Instructables first created the community then requested funds to make it better. Since then, Instructables has turned from owing money to investors to meeting even and finally making a profit, producing tangible books featuring collections of projects from the site and even inspiring an Instructables Restaurant, in which you can make or sell anything you would wish as long as it originates from a project on Instructables. This includes the food you make in the Instructables Restaurant kitchen, the lamp fixtures that hang overhead, and even the

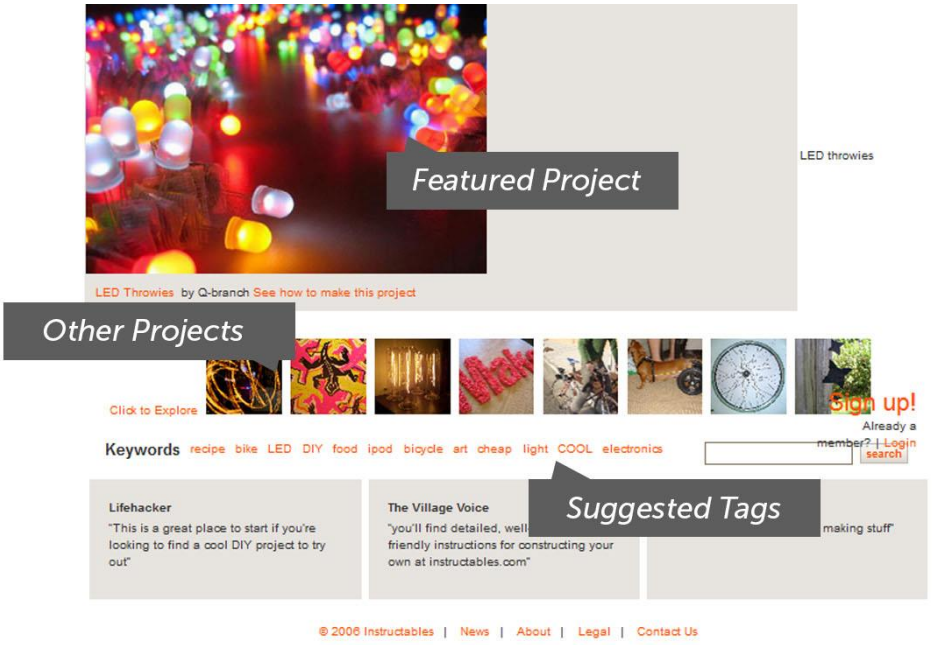
chairs surrounding the long, communal table. The Restaurant has also come serve as a space for DIY workshops, art installations, and community gatherings.

This foundational background emphasizing community before profit and originating from an appreciation of non-technological practices influences the website's presentation from its inception to its current form. Rather than the passive consumption encouraged by Makezine and Hackaday, Instructables has a *production*-driven approach, placing the power of authorship in the makers' own hands. Closely related to this theme of production are those of *ideation* and *iteration*, both facets of an overall process of making that encompasses both technological and non-tech forms. The singular focus on the productive activities associated with making has allowed for a robust community to develop around a shared interest without being pulled away from interpersonal interaction opportunities by news content, items for sale, or other potentially controversial content.

Instructables 2006

The landing page of Instructables in 2006 is not that unlike its current form, featuring *production* in the form of photographs of eight recently posted projects above the fold and option to scroll through additional projects below. Users are encouraged to explore the projects rather than searching directly for a desired project, exposing the community to the wide variety of projects published. Rather than defining these projects as technology-based, this format allows makers of all backgrounds or gender to openly approach the content without possessing a specific purpose. Below the fold sits a line of suggested keywords adjacent to a search bar, the keywords indicating qualities of posted projects, like "cheap" and "easy," or objects being made or augmented, like "bike" and

Figure 5: Instructables in 2006



"recipe." This emphasis on the qualities of the project over the specific type of artifact produced again allows for approachability, allowing a maker with little experience in soldering, for example, to encounter a potentially useful project that uses soldering as an easy-to-learn step towards a larger purpose.

Selecting an intriguing photograph or title directs you to the individual project page, which lays out the tutorial steps, each represented by its own picture. Left of the photos lies the option to view all steps on one page, otherwise the user advances through steps after completing each one by default. This seems to be formatted to allow a maker to follow along with the steps, using his or her own tools and materials. This additionally allows for reproducers of the project to pause in between steps and easily find it later, a potentially useful function for female makers who may face additional time restrictions when at home preventing long periods of time devoted to a single project. Women are more likely to engage in multi-tasking while completing household activities and break

their tasks up into smaller segments (Schneider, 2011), which means they may be more likely to either engage in projects that require less time or those that can be completed intermittently.

Below each set of steps is a space for user comments, which offer up questions regarding clarification, concerns about validity of a step taken by the project's author, suggestions of modifications, and feedback about their own personal *iteration* on the project. As opposed to Hackaday, these discussions are friendly and constructive, instilling a sense of collaboration and interconnectivity to the community even in its early form. While women do not seem to be visibly participating in large numbers at this early stage, this interconnectivity sets the tone for the community throughout its development. A side-effect of this *iteration* found in the project discussions is the emergence of idea *ideation*, as makers run their potential project ideas past one another to gauge interest and gather feedback. *Ideation* and *iteration* are two sides of the same coin, involving blending practices and materials together to create something innovative or building on a past idea to make it better. These terms are separated out because they possess different requirements for publishing on the current form of Instructables. *Iteration* is completed by visiting the project page a maker replicating, clicking "I Made It!," then giving feedback to the original authors as to what was altered or improved upon. *Ideation*, however, results in a fully fleshed-out tutorial unique to the individual maker, detailing the process taken and steps for replication. Makers are rewarded with achievements for producing individual content and thus take the opportunity whenever possible to create a unique tutorial.

Primary impressions gained from a cursory examination of the archived and not fully functional site emphasizes the projects, around which all discussion is oriented. Users are continually prompted to engage with the site and give back to the community, the authoring of projects framed as "contributions." Browsing projects is described as "exploring," lending a sense of motion and activity with a connotation of fun rather than the tedium of searching through a library of objects. "Groups" and "forums" encourage users to interact with one another and not solely the site's content, facilitating discussion of more general concepts surrounding different making practices, techniques, and ideas for projects and hacks. Establishing this place for community-building discussion and feedback indicates that the Instructables team is invested in promoting a positive community of makers. This affordance for direct interpersonal interaction, an aspect valued by female makers (Intel, 2014), may be one reason Instructables boasts twice as many women as both Makezine and Hackaday.

Instructables in 2015

The three themes of the fledging Instructables persist, though with a greater emphasis on high-resolution photography and graphics of projects steps. The theme of *production* is inherent in the format of the landing page, with its emphasis on suggested categories and completed projects, and creation of visual content only surrounding the process of making such artifacts. In fact, the only content available for consumption or comment are projects authored by site members. The main page features an ever-changing display of pictures, encompassing the entirety of the above-the-fold real estate and making abundantly clear the *production* emphasis at first visit. Each picture features either a project by an artist in residence at Instructables or an example of a project

submitted to a current contest, along with the appropriate search term that leads to a listing of similar projects as for a source of inspiration.

Below the fold is displayed a sampling some of the more intriguing or timely published projects, not arranged into any specific order or category. This sampling is a development of the suggested tags from the 2006 iteration, again exposing makers first to a wide array of robust project documentation instead of funneling them directly into tech- or non-tech categories. In this way, the men and women of Instructables have a say in what content is important to the community through what content they choose to produce. This equal treatment to all "feature-worthy" projects no doubt plays a factor into greater participation by women and crafters both. Rather than defining the makerspace as a tech-oriented community, crafting and electronics projects are featured side by side on the home page.

The top menu still encourages visitors to "explore," but groups and forums and been consolidated into "community," "contribute" has become "create," and a space for "contests" has been created. *Ideation* is found in projects utilizing a variety of materials and means to create something new to the community, formed in these comment and forum discussions. While a portion of the projects are similar to tutorials in nature, focusing on *how* to build an artifact (ie. *How to Solder*), a greater number of projects present ideas or concepts (ie. *Psychodelic Milk*). Discussion about ideation before production is found on the forums, where makers ask whether or not a project would be of interest or even possible to carry out.

A similarly productive activity of *iteration* is found in the user comments at the bottom of each individual project page, with suggestions regarding potential

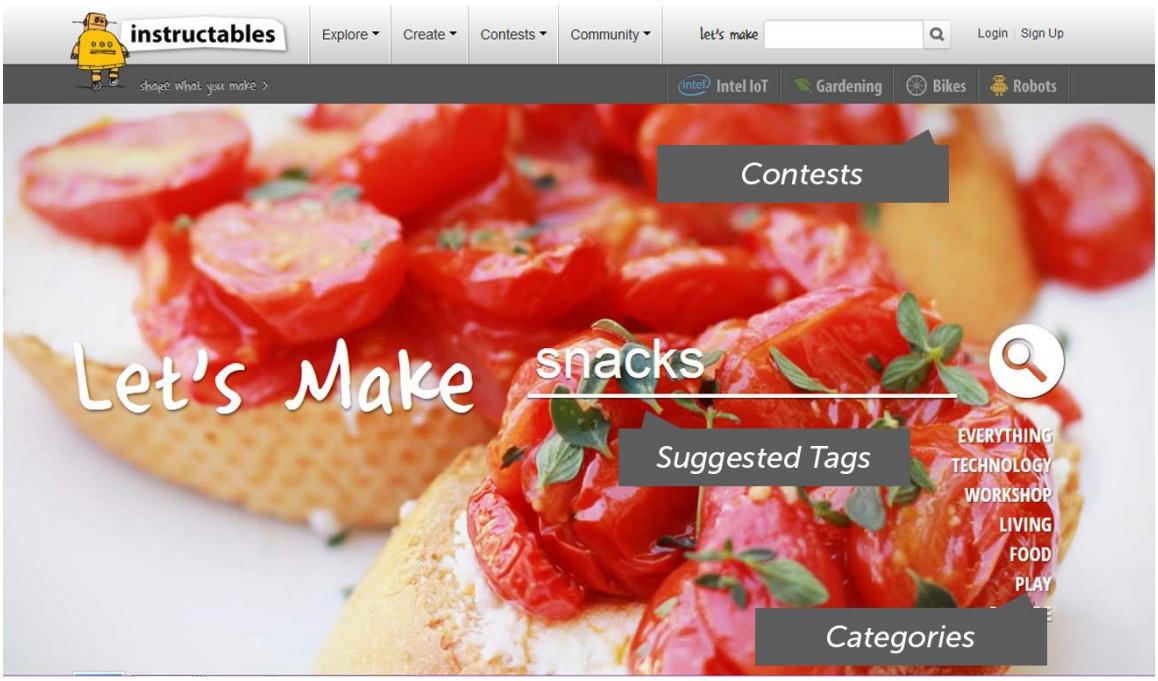
modifications that might allow for a more efficient process, alternative resources or materials that might be used, and other artifacts that might be made utilizing the steps from the project. Users are also encouraged to iterate on a project by a button proclaiming "I Made it!" at the top of each project page, the selection of which pulls you down to the comment section and prompts you to share feedback on your experience along with a mandatory photo of the completed artifact.

The transition from "contribute" to "create" indicates a few things, namely the growth of Instructables from a website just starting to find its feet to a mature community. With a populous base of authors, the site can now support a number of community members who create a profile but never do anything more than explore and comment on other makers' projects. It also embraces female makers who are more likely than their male counterparts to identify with terms like creator, crafter, artist, and designer (Intel, 2014). By simply using the word "create" instead of "make," makers outside of the traditional tech-oriented definition may be encouraged to submit their projects. The option to author a public project becomes an option rather than a request to support the community. Additionally, the shift in terminology reflects a salient value in maker culture, the act of making as fulfilling in and of itself rather than a task necessitated by participation, as well as a term associated with the sense of identity felt strongly by both male and female makers (Intel, 2014).

Lastly, the introduction of a space for "contests" is likely a design choice allowed for by the exponential growth in number of community members over the past decade, allowing for multiple contests to be held and judged simultaneously with an abundance of submissions. This also has an effect of producing a corpus of projects similar in theme or

use for potential use in later tangible publication, like *Practical Duct Tape Projects*, *Healing Spices*, and *Projects to Get You off the Grid*, all of which are current titles released by Instructables. These contests come in two forms: practice oriented and purpose oriented. While practice-oriented projects calling for 3D printed or programmed objects may exclude women who tend to be accidental technologists, seeing technology as a means rather than an end (Intel, 2014), purpose oriented projects are more inclusive. Contests like "Bicycle" or "Backyard" encourage both men and women of various backgrounds to use their particular skill sets to solve a problem or simply create something fun.

Figure 6: Instructable in 2015



Publishing Power and Gendered Authorship

Much of what content becomes published or featured is chosen by those in positions of power, even within these online makerspaces. Articles on Makezine are

chosen by publishers and editors within the ranks of the Maker Media Staff, presumably with direction set by the management team. Projects and content featured on Hackaday are written and selected by an editorial team of twenty. Projects selected as "feature-worthy" on Instructables are hand-selected by a team of thirty. In all of these cases, women occupy no more than one-third of these positions with the power to choose what does and does not get featured on the sites. If women are lacking in representation on these editorial teams, how does that affect gendered participation in the general site-wide community?

An obstacle for women pursuing careers in STEM fields is often this lack of female mentors; there are few enough women in upper management in sundry other fields, but this effect is magnified in technology-based companies. Women are entering STEM fields in droves, but are leaving voluntarily in greater proportions than their male counterparts, in part because there are too few women in powerful positions to model behavior after, develop mentor-to-peer relationships with, and serve as an example of the possibility of advancing upwards in the company hierarchy. Lack of mentorship is ranked as the second highest challenge to entering into making, with one in three women citing it as a barrier (Intel, 2014).

If women are visible in positions of power within an organization, it stands to reason that other women are more likely to consider applying to or engaging in activities conducted by that organization. A prevalence of conspicuous women serves as an indicator that the organization is an open, accessible space to potential female members seeking a point of entry. If we posit this as true, what does it mean for these online maker communities that serve as a voice and platform for the expanding maker movement? By

nature of their virtual derivation, communities that exist wholly or in part on the internet should be accessible to those of any gender, age, race, or religious affiliation (as long as they can afford access to a computer). Why, then, are women so underrepresented in positions of power and authorship on these sites? Here, a site-by-site examination of the gendered representation on these editorial boards in concert with gender participation rates within their respective communities seeks to explore this connection. Particular attention is paid to Instructables, which both serves as the chosen site of further inquiry and provides richer detail in the backgrounds of its team members.

Makezine

In a study of Make magazine over a course of two years, 2011-2013, and 512 articles, authors who were men were represented at a rate of 85%, meaning only 15% of the articles were authored by women (Buechley, 2014). In a 2013 survey conducted by Make seeking to glean information about its own audience, results confirmed that readership demographics approximated those of the authors, with 80% of respondents identifying themselves as male and 20% as women. In addition to this, the median age of responders was 44 and over 97% had a college degree. In fact, approximately 80% had completed some level of graduate coursework. To set this audience even further away from the average, the average income of responders was $106,000, which is more than 82% of income gained by the average American household and more than 96% of individuals. This means that authors, readers, and featured persons of Make are more male, highly educated, and wealthy than the rest of the country.

In addition to this rich data provided by both an independent researcher and Make itself (an artifact of the income generated by Maker Media), an examination of the

management team of Make is unsurprising. Of nine upper-level members of the executive team, only three were women. These women occupy the position of vice president of Maker Media, vice president of marketing, and senior sales manager. Their job descriptions that match those found in advertising, marketing, and sales, all domains that boast much higher percentages of women employees than those found in STEM.

With approximately similar percentages of men and women represented as both authors and audience, this serves to emphasize a correlation between the demographic makeup of those in positions of power/authorship and that of potential applicants/readers. It seems that women have less interest in consuming articles that almost always feature and are authored by men.

Hackaday

While no in-depth studies have been conducted on Hackaday, a less visible and more niche community, examination shows similar demographics trends in authorship and audience to that of Make. The community is managed by a small staff of twenty, five of which are women. Like Make, the Hackaday staff members skew more white, male, and well-educated than the general population; most of the contributors possess bachelor degrees or above in fields like electrical, computer, and mechanical engineering, as indicated by brief staff biographies. Of interest, however, is the somewhat different routes the women tread to becoming Hackaday staff. Only one of the five received a degree in electrical engineering; the other came from backgrounds in biomedicine, art, costume design, and telecommunications. This serves to accentuate the differential experiences women have when entering traditionally male dominated disciplines like engineering. At least a handful are entering sideways, through peripheral

disciplines like art and design, rather than thorough conventional methods that often entail an education that necessitates hands-on experience with electronics.

Augmenting this slight decline in representation of women in positions of power at Make (down from 30% to 20%) is the steep drop in actual authorship of content. In a survey of 500 blog posts (the site's primary content) over a period of three months in 2015, only 32 of those posts were made by women. This means that only 13% of the articles used to represent and inform the Hackaday community were crafted by women, which perhaps explains to some extent why the audience skews so strongly male. Power by representation and editorial choice escapes women, even this niche, hacker community of aesthetes. This trend is likely to continue in self-perpetuating cycle of suggested content from a male dominated community, production of blog posts written by male contributors, and featured hacks created by male makers. A potential home for women disenfranchised by an impenetrable Makezine community (and perhaps one requiring less expense), Hackaday instead serves as an inaccessible point of entry denied to female hackers and makers.

Instructables

In contrast to the considerable underrepresentation of women in positions of power within the online makerspaces of Makezine and Hackaday, Instructables shows some signs of improvement. Though the original team of founders conform to the majority demographics of Makezine reader and Hackaday authors (educated white males), the Instructables team has grown to encompass thirty employees, eleven of whom are women (Instructables, 2014**)**. This is only a moderate increase from Hackaday's team of 25% women and on par with Make's executive board. So why does Instructables boast

so many more female community members if representation of women with editorial power is equal to that of its male-dominated counterparts?

The answer here lies in the quality and prevalence of interaction between those in power and community members. It is not enough to include women in visible positions of decision-making; they must also leverage this power to increase representation on a smaller scale, expanding visibility in everyday interactions between community members and the site's content. Evidence that this is not being enacted on either Makezine or Hackaday is demonstrated by the bulk of content continuing to be produced by male authors. Though 30% of the Make executive board members are women, only 15% of the site's authors are women. Situated similarly is Hackaday, contributors to which are 25% women who produced only 13% of the content. Counter to both Makezine and Hackaday, Instructables shows no decline in executive team representation versus actual community participation; in fact, there might even be an increase in the percentage of projects posted by women (over one-third of projects surveyed) in contrast to the number of female staff members (one-third of the Instructables team).

In addition to other structural and social factors inherent in the Instructables community, this continuance in representation rates is due at least in part to the team members' own personal engagement with the community. Team members not only participate in activities related to the management of the site; they also participate in the *production* activities integral to the site's performance. They post tutorials on cooking, fabricating, soldering, cleaning, constructing, and making just like any other member of the site. This not only indicates their interest in making as a practice, but also their investment in the community as a whole. Team members often come from the

community itself, rising from independent authors to Instructables officials with their photo and bio featured on the "about us" page, situated alongside the Instructables story of how it began and a promotional video. Aside from this page featured the staff, each team member is not signified in any way special on his or her own personal profile. Each individual must choose to disclose their position at Instructables within their "about" section.

Staff Identity and Background

So who identifies as belonging to the Instructables staff, since their special status is not automatically marked on their personal profiles? Though women tend to identify to identify with the terms creator, crafter, artist, and designer over the word maker (Intel, 2014), it appears that both men and women are equally likely to make their position within the maker community visible on their profiles. Approximately half of both men and women either spell out their specific role or note that they work for Instructables, while one-quarter include content in their "about me" but do not explicitly mention their work for the site. The remaining one-quarter of each have no content in their "about me" section. It seems that there is no disparity here in between men and women both being proud to be a part of the decision-making part of the community and willing to take credit for their work.

The team members themselves have a rather uniform makeup in that they are largely Caucasian and between the ages of 24 and 35, though this is a subjective assumption based on presentation of personal profile photos. As reported on short biographies listed on the staff profile page, they also tend to be well-educated, holding

degrees in a variety of disciples from UC Berkeley, MIT, and other colleges specifically in California but also throughout the United States.

A divergence materializes in the academic backgrounds of the male and female team members, however. The men tend to come from roles you might expect of conventional makers: mechanical engineering, manufacturing, industrial design, computer science, and architecture. While the women also come from disciplines like computer science and architecture, they also come from an array of creative disciplines like art, costume design, and fashion design. While this demonstrates the tendency of women to enter tech through nonconventional means, it is also indicative of Instructables' inclusion of crafting practices as a part of the online makerspace, something Makezine has yet to do with any level of success and Hackaday has not addressed. Studies have shown that girls and women makers are more likely than male makers to come to making through multiple pathways including engineering and computer science, but also art and design (Intel, 2014). By embracing making in a variety of contexts, Instructables has become the sole online makerspace inclusive to both men and women.

Final Site Comparison

Instructables, Makezine, and Hackaday began similar in nature, but have branched off over the course of the past decade to fulfill differing purposes.

Instructables, invariably the most popular and prolific community, continues to be project-oriented. Users are a rewarded for authoring and interaction activities including number of tutorials created, comments made, followers subscribed, projects favorited, and overall views. This rich variety of interaction has encouraged makers to participate in

ideation, *production*, and *iteration* activities, all while tied to and held responsible by a larger community of collaborators and peers. This strong sense of community is explored further throughout the process of the following research, and will be discussed at length later in this paper.

In contrast with Makezine and Hackaday, the singular focus on project *production* has allowed for more precise and comprehensive discussion surrounding various aspects of any individual component, procedure, and design choice. Participants are made accountable by often detailed personal profiles describing interests, location, and gender. The combination of these facets of Instructables' overall structure and design make it the obvious choice for further research into gendered interaction in online makerspaces. The large body of work produced by a diverse populace engenders greater facility in recognizing trends in how women and men are engaging differently in practices of making, crafting, and do-it-yourself (DIY).

In contrast, Makezine would be a poor choice of domain for an ethnographic study into virtual communities, as members are given scant opportunity to feature their own, user-created content. Rather than being *production* oriented, Makezine is modeled around the *consumption* of publisher-generated visual and textual content. While users who have posted at least one project on Instructables are immediately conferred the title of "author," the power of authoring here lies instead with publishers of Makezine. Users may still submit content in the form of story idea submission forms, but the ultimate choice of what is displayed does not lie in their hands. *Acquisition* through the "Maker Shed" store serves as a resource for purchasing tools and materials, though emphasizing the money-making intent embedded in Maker Media. Event *participation* is a prevalent

component of Make, though event details and materials are hosted on their own, externally-hosted sites.

Interaction is limited by nature of the of the magazine-format presentation; users are confined to absorption of pre-selected content rather than given the opportunity to contribute to the general discourse. Delivery of news articles, editorials, narrative accounts, and profiles in a set tone of journalist-to-reader establishes higher standards of production value; photographs are high resolution, descriptions are rich, and videos have animated introductions in alignment with the Make brand. Makezine, Make Magazine, and the Maker Faires are visibly connected to their parent company of Maker Media, from which the approaches to the maker movement as in need of a news source were doubtlessly drawn.

While a valuable part of the maker community, providing a more legitimized and cohesive voice, this is again in contrast to the emergent nature of making as a both a practice and a source of identity, which is evident in the overwhelming focus on user-created content of Instructables. If makers go to Instructables to engage with specific projects or concepts in line with their own interests or expertise, they visit Makezine to gain a better sense of the broader trends in technologies, tools, and community. In an additional divide, Instructables' reach extends across the globe, transcending accessibility limitations, while Makezine largely features content marketed towards and American audience and a required payment of subscription fees to access the full extent of content hinted at by its online presence.

Finally, Hackaday provides an interesting divergence from both Instructables and Makezine, reclaiming a term that has gained a negative connotation with the general

public, “hacking.” The term hacking entered computer culture at MIT in the 1960s, almost half a century before the Instructables founders began their studies in the MIT Media Lab (Harvey, 1985). Popular opinion held that there were two types of students: *tools* and *hackers*. *Tools* were the student who could be found working in the library when not regularly attending class, while *hackers* were those who neglected class in favor of recreational activities. An important distinction lies between a *hacker* and a *slacker* in that hackers must pursue a hobby with dedication and flair. Combined with a dedication to the craft, hackers also often ascribe to a particular aesthetic visible still on Hackaday (ie. dipping stock white headphones in black plastic to match a black mp3 player).

By nature of the term, Hackaday has thus differentiated itself from mainstream making, drawing an audience that skews much younger and much more male. In contrast to Instructables and Makezine, which both exhibited numbers of men and women at approximately the same percentages as the general internet population, males are overrepresented on Hackaday. This, in combination with a lower education level and the vast majority of Hackaday users accessing the site from a school, paint the picture of a community populated by adolescent males accessing the portal in their free time during the school day, though this is not meant to serve as representative of the community as a whole.

As posts are made by a staff of well-educated, though still overwhelmingly male, authors, Hackaday seems to serve somewhat of a different audience. This points toward functioning as a point of entry into maker culture for youth as well as newcomers turned off by the more populous and mainstream Instructables and Makezine. The Hackaday community requires less interaction by its members, allowing them to spend a brief

amount of time on the site and still have the sense of seeing all there is to see. Thematic elements feature a mixture of *production* through documentation on hackaday.io, *consumption* of feature articles, and *acquisition* through the Hackaday General Store. The relatively slow growth in audience over the past decade accentuates an orientation towards a niche service for a community disparate from its mainstream counterparts. In the context of gender studies in maker communities, it would be a beneficial future case study, but at this juncture is not representative enough for this study's general focus of women in online makerspaces.

Given the more inclusive nature of Instructables and a greater representation of women within the community and its editorial board, along with a host of richer interaction details and individualized profiles, Instructables was selected as a site of further inquiry in this study. Driven by user-created content, the site affords a broad community of makers with robust profiles detailing their demographic information, authored projects, and participation achievements, accessible through an on-site messaging system. The inclusion of both traditionally feminine craft activities alongside technology practices is situated to serve as an ideal case study of the interplay between male and female makers, technologists and crafters, engineers and artists.

CHAPTER 3

METHODS

For this study, a mixture of quantitative and qualitative methods were used to first provide a comparison between three online makerspaces (Makezine, Hackaday, and Instructables) and then gather both broad, demographic data on the users of Instructables and individualized experiences with the maker community. First, a qualitative approach in the form of textual analysis was used to provide a description of the three sites, examining the power structures of authorship, types of interaction afforded by the platforms, and the general look and feel of these online communities. This was carried out by comparing the sites, past and present, and the forms of interpersonal interaction and content creation they allowed or encouraged. Situated as the first step in a longer process, this analysis was done to gain a familiarity with the sites, inform appropriate facets for further inquiry, and formulate a rich description of the online communities as they relate to and differ from each other in form and function.

Secondly, a quantitative approach was used to gather information into a database regarding who was posting what, with particular attention paid to gendered interaction. For Hackaday, this meant examining a corpus of posts published over the course of several months to gather a sense of who was publishing in what percentages. For Makezine, data regarding gendered content creation was pulled from Leah Buechley's research on authorship and demographic representation on Make Magazine, presented at the 2014 Eyeo Festival in New York, N.Y. For Instructables, this process meant developing a database of featured projects along with their respective author's gender.

Instructables was then chosen as a site of further inquiry due to a larger community of female makers and greater agency given to the individual users.

Thirdly, surveys were sent out to the authors of these projects on Instructables in an effort to gather more detailed information on the makers' demographics, demonstrated skills, confidence in a variety of technology and craft practices, values and ideals, and reasons for using Instructables. Explored in further detail below, this survey included a mixture of close-ended questions, brief open-ended questions, and five-point Likert rating scales. The survey was formatted to take only ten minutes for completion, seeking to garner as many responses as possible. This was done in two stages, sending identical surveys to makers in both the Technology and Living categories of the site to offer not only a comparison of demographics, skills, values, and usage reasons between men and women, but also technologists and crafters.

Finally, a few makers previously surveyed were contacted with requests for a further interview, which sought to delve deeper into the information presented in the survey as well as explore topics difficult to convey in such a brief format. These semi-structured interviews were conducted via a variety of instantaneous text chat services, deferring to the preference of the interviewee. Time lengths of interviews ranged from forty-five minutes to an hour and a half, depending on the schedule and gregariousness of the participant.

Site Overview

Data on the type of visitors and the broader quality of interaction was culled using Alexa (www.alexa.com). Audience demographics, traffic rankings, and browsing location were selected as points of interest to gather an initial perspective of

who was using these sites, to what degree they were being used, and where they were being accessed from (home, school, or work), which might lend a very generalized hint at what occupations the users held (stay-at-home parent/self-employed, student, or industry worker). Bounce rate, page views, and time spent on site were included to gain a basic understanding of the depth of engagement that held users' attention. Were they visiting once a day just to see what is new on the front page, or are they exploring projects and possibly interacting directly with other users?

Concurrently with preliminary data gathering regarding each of the three sites' user, a textual analysis was conducted on each site's information architecture, presentation of content, and general look and feel, noting structures which might facilitate greater participation by female makers as noted by Intel (2014). Since each community differed greatly from the other, this was done to provide a rich description of the three after interacting with each at length. While a site's structure may not define its community, it certainly defines the sort of interactions available to its community members. It also sets the tone for which interactions are promoted within the community and which are viewed as unacceptable or not conforming to the community's values.

Textual analysis included identifying overarching themes of each site to better depict what purpose each community served to the broader maker movement, the focus of which was on the types of interactions afforded to individual makers. A sampling of examples of these interaction types include project *production*, material *acquisition*, and passive content *consumption*. An additional portion of this textual analysis included exploring structures of publishing power and gendered authorship, examining who held the power to choose what content was featured on the site and reflecting on how that

might influence gender participation by the broader community. This data was pulled from listings of staff, team members, and executive board members publicly available on each site.

This evaluation was conducted by comparing snapshots of each site one year after their inception and their current from in 2015. The snapshots of Instructables (2006), Makezine (2005), and Hackaday (2005) were gathered through the Wayback Machine, a digital archive of the World Wide Web and other information on the internet created by the Internet archive, a non-profit organization based out of San Francisco, California. The one-year gap between each site's creation and the time period from which the snapshot was pulled was determined after examining the sites in their nascent phase and in increments on one month after creation. This standardized time for each site allowed for the site to become somewhat more established within the maker community and work out the preliminary kinks in interface design and implementation.

These snapshots were then compared against their current iteration to unearth how these sites might have expanded or reoriented themselves as the maker movement developed a greater presence through connectivity afforded by the internet. At both stages, early and current time periods, the three sites were compared with each other as well. For the current iterations, power structures were evaluated, examining who had the agency to author content and make decisions about its presentation. This data was pulled from public listings of each site's staff members in addition to brief biographies, each of which were featured under their respective site's "about" section. For the early snapshots, this information was not made available on any of the sites and could not be located. This is to be expected of inaugural forms of community platforms, which are often in flux as

the creators engage and disengage with the project and are less willing to reveal their personal presence until satisfied with the end product.

Building a Demographic Database

Following the site overview on the qualitative characteristics of the three makerspaces, a database of individual user demographics was built to include 500 Makezine articles, 500 Hackaday posts, and 400 Instructables projects. The first set of this data regarding Makezine was culled from previous research conducted by Leah Buechley on authorship and demographic representation of Make magazine's readers and authors. The second set, incorporating 500 posts on Hackaday, was pulled from the Hackaday website itself over a course of 4 months. This included only project title and author's name, correlated to the author's gender as listed on the staff biography page, as further information is not publicly available. A final, more detailed data set of project tutorials on Instructables was built to include not only project title and author gender, but also a wider variety of details included in the authors' personal profiles. These 400 projects were pulled equally from the Technology and Living categories to include both technologists and crafters. The 400 authors of these projects were additionally contacted with a request to complete a survey, which is later explored further in depth.

Makezine

Demographic data regarding Makezine's audience and content creators was pulled from Leah Buechley's study on authorship and demographic representation on Make Magazine, which she presented at the 2014 Eyeo Festival in New York, N.Y. Buechley's research examined gender, age, and income of the magazine's authors and readers, encompassing 500 articles over the course of 9 years. This study offered a more

robust depiction of the Makezine community, which is otherwise proliferated by articles authored by a range of content creators whose demographic data is unavailable to the public.

Hackaday

Data from Hackaday, which hosts a more anonymous and somewhat antagonistic community (to be discussed later), was limited in that comments were often posted anonymously, with no publicly available profile. Commenters were given the option to include a link of their choice to de-anonymize their post, but most chose not to, and those who did often linked to an external site that did not include any of the demographic detail sought by this study. Comments were few in number for most postings, usually ten or fewer, and commenters' choice of display name was not enough to gain a clear understanding of their gender identification. With these aspects in mind, information gathering regarding demographics and specifically gender was limited to who made the daily posts and was a part of the Hackaday staff. A survey of the most recent 500 postings was conducted and correlated to the staff members' brief biographies, as listed on the site.

Instructables

After Instructables was affirmed as an appropriate choice through a prevalence of rich community interaction, a large body of content, and a larger proportion of female makers, qualitative data gleaned from a survey of the three sites, a more in-depth inquiry was begun. Over a course of four months, a database of over 400 projects and their authors *featured* in the Technology and Living categories was built, including approximately 200 projects for each category.

These categories were chosen out of the six categories available for a number of reasons. Technology and Living were the most prolific categories, featuring a higher rate of project postings than the other categories of Play, Workshop, Food, and Outside. They both included a greater number of subcategories as well: 39 and 32, respectively, in comparison to 31, 24, 23, and 13. In addition to this, the Technology category was selected as a desired focus in the context of the current push for women in science, technology, engineering, and math (STEM) fields. In contrast, the Living selection was selected as an effect of its inclusivity, encompassing subcategories of practices commonly held to be more feminine activities.

Member data was collected by building a database of projects included under the *Technology* and *Living* categories over the course of 4 months, then documenting self-reported demographic data of the projects' authors. This data included gender, location, number of projects posted, achievements, and linked website. For this study, projects were culled from the *featured* sorting of each category, the thought process being that most users would browse through the content as immediately presented to them before choosing to sort the category differently. Additionally, projects are designated as a *featured* tutorials regularly enough that it is unlikely a user will encounter the same project on the first page, even if visiting the page daily.

Featured projects are those that are selected by the Instructables staff as worthy of the designation as a result of possessing qualities that make it valuable to the community. According the featuring guidelines posted by a staff member on the Instructables forum, criteria the team looks for include documentation and reproducibility. This means that the title and introduction should be descriptive (including the motivation for creating the

project), project steps should be clear and easy to follow, a list of tools and materials should be included, photos should be original and in-focus, and the tutorial should include all the information necessary to duplicate the project. Time invested in creating *featured* projects typically means that the maker who authored them is invested in the community, willing to engage with other members, and is not a newcomer to the site. For these reasons, it is through the *featured* projects that author data was gathered.

Featured projects and their associated author's demographic data, as posted on their user profile, was gathered in sets of at least 25 during any one session, to ensure a representativeness of the day's selections. Data catalogued included project title, user name, gender, location, number of projects, number of achievements, and type of website linked to from their profile. Project title and user name were collected as a way to reference the subsequent information, ensure no duplicate profile information was included, and to later contact the users for a survey. Gender and location were included to differentiate between who were posting and from where, to discover trends in gendered and locative participation. Number of projects and achievements were used to determine the depth of participation with the community. Achievements are virtual medals given out by Instructables for engaging with the community by posting projects, gaining audience views of those projects, and commenting on others' projects. While community members often have a profile yet never post any projects, instead engaging through viewing and commenting on others' projects, it is difficult to gain a good sense of who these users are. There is no accessible database of user profiles, since essentially the only content on Instructables is the projects themselves. Finally, links to websites, a feature

embedded in the profile building system, provided an example of how these users are presenting their work or engaging in other online communities.

Survey

After gathering demographic data on each of the site's user and authors, surveys were sent out to each of the authors associated with projects in the built Instructables database (see appendix). This amounted to approximately 400 surveys sent out, the response rate to which was 140 participants, or 35%. While it is difficult to determine what an appropriate response rate is for any particular survey, a rate of 35% for an unsolicited invitation lies at or above the average (Sheehan, 2006). This high response rate was unanticipated and perhaps a result of the initial invitation being made through Instructables own messaging system, lending a sort of legitimacy to the request. It is also a reflection on the investment makers have in the broader maker community and interest in their own community as a site of research. Respondents also had a completion rate of 63%, with 86% of participants using a computer, 9% using a smartphone, and 5% using a tablet to complete the survey.

The survey was formatted to take the participant no longer than ten minutes to complete from start to finish, assuming an average rate of five close-ended questions per minute. This meant formatting many of the questions as close-ended, providing a set array of answers to choose from, rate, or rank. At the conclusion of the survey, participants were given the opportunity to opt in to a further interview and input their email address. 81% of these respondents agreed to further contact and included their email, indicating a majority interest in participating in research about their community.

The first portion of the survey consisted of close-ended questions on demographic data including age, race, gender, education, and income, for which participants were given a pre-selected array of possible answers. For both race and gender, participants were additionally given the opportunity to include an answer beyond the options provided, in an effort to not exclude makers based on race or gender identity. Intermixed with these close-ended questions were open-ended ones inquiring about the participant's location, occupation and Instructables username (to correlate with information gathered in the project database).

The second portion of the survey consisted of close-ended questions, namely in the form of five-point Likert rating scales, seeking to gather information related to experience with different maker tools and processes, participant values, and reasons for participating in the Instructables community. First the participants were asked to select practices they have used in creating project tutorials for Instructables from a provided list of common practices, pulled directly from project tutorials posted on the site, including sewing, soldering, jewelry making, and 3D printing. An effort was made to include equal numbers of practices from both the technology and crafting domains in order to properly represent both. Participants were then asked to rate their confidence with each practice individually, using a five-point Likert scale. The purpose in separating out questions of skill into confidence levels and actual use was to identify not only who was making what, but also what they might have experience in but choose not to make. An additional purpose was to explore the concept of a gendered confidence gap, cited by Orenstein (1994) as a primary cause for the prevalence of men in advanced programming disciplines while women are confined to data entry-oriented tasks.

The third portion of the survey sought to explore values ascribed to by makers and consisted of a series of five-point Likert scales asking participants to state how much they agreed to a series of statements like "using sustainable practices is important to me," "I enjoy collaborating with others," and "I prefer to make things rather than buy them." These statements were formulated through an examination of current literature on makers, observation of discussions on Instructables, and informed speculation on possible values not covered in either of these. The questions were formatted as "I" statements in an effort to incite reflection on individualized experiences rather than a general reporting of observable phenomena in the maker community.

Lastly, participants were asked to rank their reasons for participating in the Instructables community from least important to most important. A list of answer options included learning skills, sharing skills, making social connections, having fun, and relieving stress. This question sought to explore the dichotomy of work and pleasure evident in the skill-based labor that goes into production of artifacts featured in these tutorials, whether they be aesthetic or purely functional, serious or playful, robotic or human-oriented. At the conclusion of the survey, participants were given the option to opt in to further interview and asked for their email address.

Interviews

The final step in the process was interviewing female makers to gather detailed personal accounts of their experiences with Instructables and the maker community as a whole. Through deliberation, a choice to interview only female makers was made as an effort to document a marginalized and underrepresented community that is otherwise

difficult to locate and research. Previous efforts have been made to document the maker experience, an otherwise overwhelmingly male population.

These makers were recruited as a result of their willingness to participate in a further interview, as documented by their acceptance at the end of the completed survey. Potential interviewees were selected to be as representative of the larger whole as possible, including both crafters and technologists, community builders and students, and residents of several different regions within the U.S. In one case, the maker interviewed had little experience with Instructables itself, but was recruited through a previous contact who was connected within the maker community and included to offer a perspective from a maker who chooses not to engage in online makerspaces.

Questions asked in the semi-structured interview sought to expound on answers provided by their survey completion but also to delve further into their motivations for participating in the maker community and their experience interacting with other makers. These personal narratives often included when and why each maker began participating in the community, challenges or obstacles they face while making and their interactions with other makers.

These interviews were conducted via a variety of instantaneous text messaging, mostly through Google Hangouts or Skype chat, though in one instance through an internet relay chat (IRC) at the participant's request. This particular medium was chosen for several reasons. Most participants lived in time zones other than that of the interviewer, a result of researching online communities, and it was difficult to coordinate schedules. A text-based chat allowed for a ready-made transcript after formatting. The format also allowed for asynchronous communication, which allowed one participant to

leave to catch a bus without breaking off communication entirely. Drawbacks to this medium, however, were that physical cues could not contribute to what the participant was saying, nor emphasis made on certain concepts as would occur in natural verbal communication. Typing also is more time consuming for some participants, breaking the natural flow of conversation. The best format found for these interviews was Google Hangouts, which notifies the researcher and participant when the other has seen their response and is responding to it. The IRC was unwieldy in that by the time a follow-up question was formulated and asked, the participant may have moved on to another topic., causing a great deal of interruption. There was also no feedback when someone was typing a response.

CHAPTER 4

PARTICIPATION IN ONLINE MAKERSPACES

Crucial to understanding an online community is understanding who participates. In the particular case of Instructables, this further means investigating who is publishing project documentation and processes, where they are posting from, and for what purposes they are using Instructables. This is conducted in the framework of a gender study, with specific focus on how men and women are participating differently within the community. While a portion of this information can be gathered directly from user profiles on the site, some necessitates communicating directly with the participants through the means of a survey, and a smaller fraction needs to be speculated about through conjecture. In this study, makers were identified by gender, level of engagement, location, education level, occupation, income, skills, and a system of beliefs and values.

Gender Identity

Instructables conforms to the standard of most systems with individual profiles by requesting, but not requiring, that users list their gender. While the usefulness and appropriateness of requesting the user to list their gender can be debated, in this case it is helpful for understand how women and men engage differently with the community. Following the recent trend of providing alternative gender choices, there is the option to list one's gender as male, female, bloke, miss, guy, gal, robot, and "none of your business." While at first this reads as an attempt to portray LGBTQIA sensitivity, these gender options (aside from robot and "none of your businesses) conform to a binary view of gender identity. This comes across a missed opportunity for Instructables, which seems

to have included a variety of options to portray the playful nature of the community rather than providing an avenue for makers who do not conform to the gender binary system to self-identify. Although the range of choices are fairly synonymous with "man" or "woman," the addition of two non-gendered identifiers allow collectives or groups posting to Instructables under one profile to not be faced with a choice between two genders which may not represent the overall makeup of the group.

For the purposes of this study, male, bloke, and guy are incorporated under the umbrella term "man", as are the terms female, miss, and gal combined into "woman," although the author recognizes a wider spectrum of gender identities. Users identifying as robots, "none of your business," or unlisted have not been included in the following discussions of gender.

Gender Participation Rates

Reflecting the current trend in underrepresentation of women in technology careers, the number of women publishing projects within the *Technology* category was vastly below that of the *Living* category. Men were overrepresented in *Technology*, posting 85% of projects tied to users who declared their gender. Out of the 170 users who had featured technology projects, only 25 of these were women. In contrast, the percentage of men and women participating in the *Living* category was nearly equivalent; 52% of projects were posted by men and 48% by women. This means that participation by women dropped by over 33% when the context was altered to include subcategories encompassed by the broader umbrella defined by Instructables as *Technology*. In addition to this, were was a small 5% increase in users unwilling to reveal

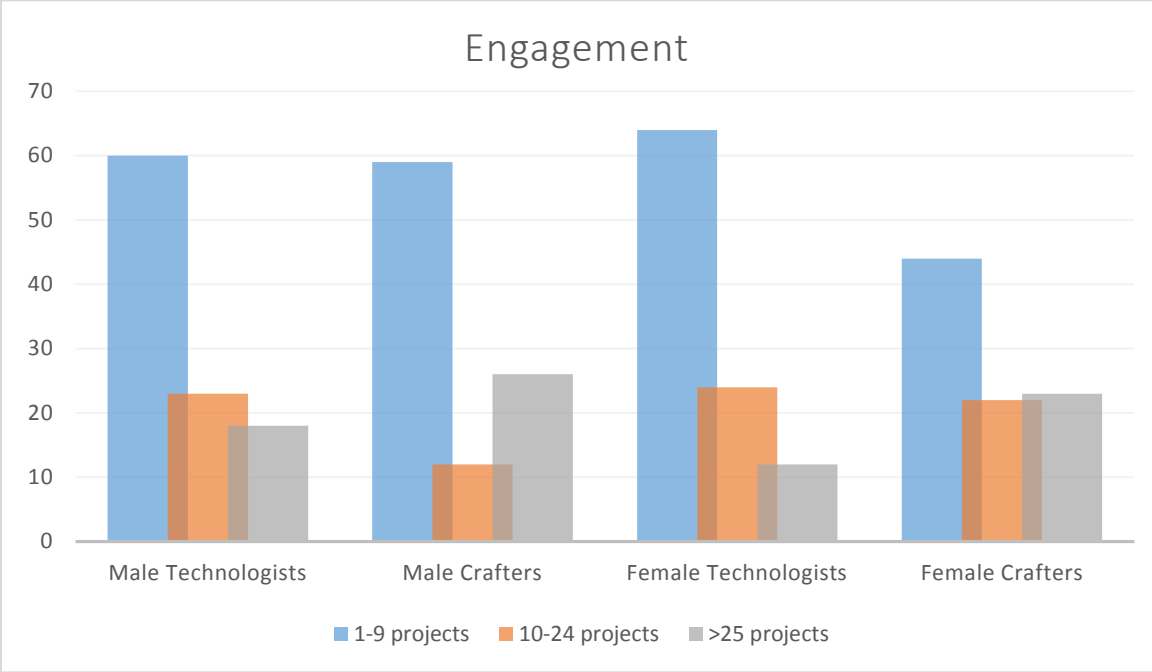
Table : Gender breakdown of makers in the Technology and Living categories of Instructables

Gender	Technology	Living
Male	85%	52%
Female	15%	85%

their gender identification when posting to the *Technology* category. Notwithstanding this 5% increase in unidentified gendered users in the Technology category, this steep drop in participation is concerning for a community part of a movement that seeks to promote open-access tools and knowledge to makers of any ilk. In an appraisal of depth of engagement, here defined by the number of projects posted by any individual user, interactions again differed between the *Technology* and *Living* categories. Users were split into three groups based on number of projects authored: top producers (25 or more), intermediate producers (10-24), and low producers (1-9).

In the *Technology* category, 64% of women were low producers, 24% were intermediate producers, and 12% were top producers in comparison to male *technologists* who were 60% low, 23% intermediate, and 18% top. While these changes may seem less significant, it is worth nothing that 12% represents one woman out of the 25 who posted a technology Instructables, meaning that only one female *technologist* has posted 25 or more projects. With the large majority of both men and women producing fewer than ten projects per user, this may provide evidence for the costliness and time consuming nature of producing technology projects.

Table 2: Percentage distributions of engagement levels within categories



The *Living* category displays a less even progression from many low producers to a few top producers, with 44% low, 22% intermediate, and 23% top female *crafters* and 59% low, 13% intermediate, and 26% top male *crafters*. While the majority of male *crafters* continue to produce fewer than ten projects each, the number drops to below 50% for women, who seem to hold more staying power in the *Living* category; for women climbing from low producers to top producers, the percentage only drops in half. The number of top producers in the *Living* category is more than twice those in the *Technology* category, again indicating that the time requirements and costliness of living projects may be less than that of technology.

Gendered Categorization

An issue arises in how an author can categorize his or her projects when submitting it for publishing. What exactly constitutes technology versus living? Makers

rarely create projects that readily conform to only one of the 170 subcategories available under the six broader umbrella categories. While a handful of subcategories fall easily under *Living* (like parenting, relationships, and travel), others are less easy to define. While *Living* subcategories seem indicate broader themes or purposes (i.e. pets, green, and life hacks), *Technology* subcategories indicate specific components or processes (i.e. soldering, Arduino, LEDS). Under which category might you find a vest for therapy dogs that allow them to communicate with their owner via a series of pulls and sensors? Or a homemade solar power generator that promotes a green lifestyle? It might be here, then, that the men and women diverge, as women are more likely to focus on the *purpose* to which an artifact would be used and men the *process* of making it. Female makers are thus more likely to become accidental *technologists*, as technology becomes a means rather than an end (Intel, 2014).

Locative Making

An affordance of an online makerspace in comparison to its physical counterparts is the diversity of content originating from makers across the globe. Though Instructables was initially launched in California, it has spread to include makers from all fifty states as well as a host of countries abroad, primarily India, Germany, and the United Kingdom. Of the two categories of projects studied, foreign makers represented 37% of the technology projects and 29% of the living projects.

Consequently, makers who identified as American contributed 63% of the technology and 71% of the living projects. These makers were mostly concentrated in clusters around larger cities that fostered a tech-friendly environment; though individual makers were also scattered across the states, they most commonly were within a one-hour

drive of a mid-large size city. A significant 26% of all craft and technology projects were published by makers living in Los Angeles, San Francisco, and nearby urban areas in California, likely a consequence of the proximity to Silicon Valley and a number of first-rate universities as well as the Instructables headquarters. An additional 11% of projects originated from Texas, and 7% were posted from New York.

The consolidation of makers in the immediate vicinity of a large city reflects more than just an increased population; the whole of Florida, the third most populous state in the U.S., was only represented by 3 makers in contrast with the 27 found in San Francisco, California, alone. The cities with the greatest number of makers posting to Instructables were those that have a thriving technology industry in parallel with a do-it-yourself spirit. These cities were also likely to encompass a number of distinguished universities that promoted engineering and design disciplines and therefore a bounty of young students and professionals looking to both expand and promote their skill sets.

In addition to the technology focus of these cities, they are also more likely to have a robust community of interconnected makers who engage physical makerspaces, which exist in greater numbers in these concentrated tech hubs. There are at least 16 makerspaces in San Francisco/Oakland/San Jose, California, 4 spaces in Houson/Austin, Texas, and 3 spaces in New York City, New York. Not meant to be comprehensive, this listing only includes spaces that have posted their existence on the Makerspace Directory and Maker Map, but serves as an example for the accessibility of collaborative spaces in these areas.

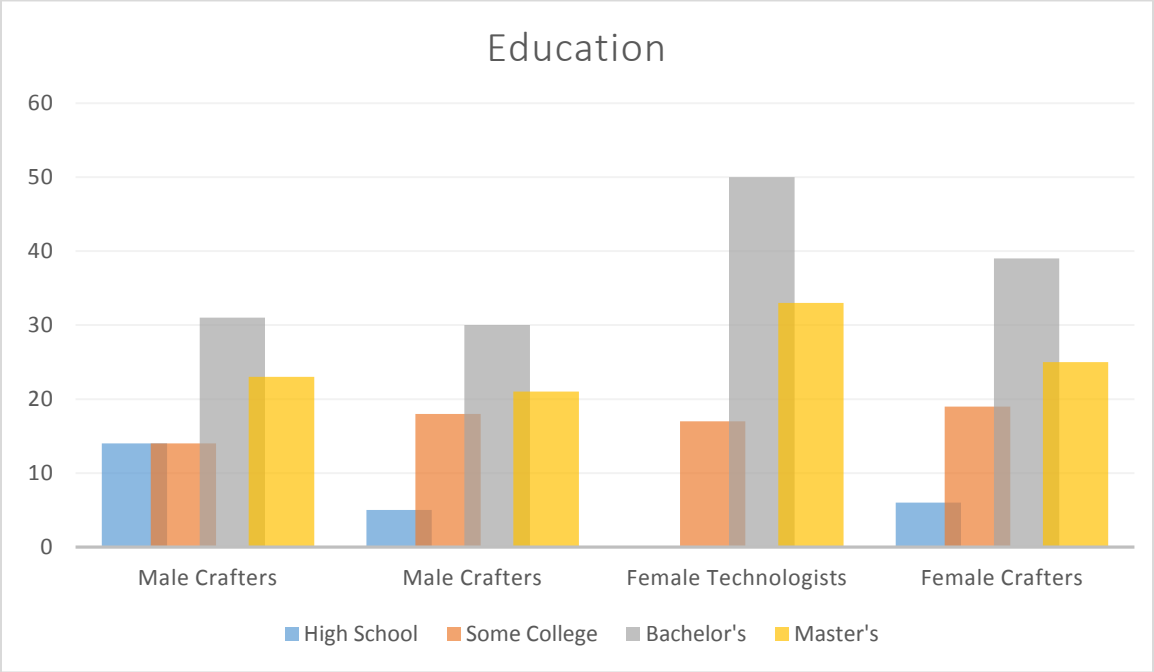
These locations are also more likely to play host to official Maker Faires and Mini Maker Faires, a series of large-scale events created by *Make* magazine to celebrate arts,

crafts, engineering, science projects, and the DIY mindset. The first-ever Maker Faire was held in San Francisco in 2006, and one has been held there every year since as well as expanding to San Diego, Riverside, and Santa Rosa, California, as Mini Maker Faires in subsequent years. The second location to ever host a Maker Faire was Austin, Texas, expanding as into Mini Maker Faires in Houston in 2012 and New Braunfels in 2014. Starting in 2013, New York began hosting one of the three Flagship Faires, held also in Detroit, Michigan, and the original location of San Francisco, California. The New York Maker Faire is also known as the World Maker Faire.

Education

Education levels among *technologists* and *crafters* exhibited similar trends in growth and participation, though differed in average level of education received. Both categories showed similar patterns as makers advanced from high school through college, with a small number earning high school diplomas or an equivalent, a significant number more having earned some college credit but no degree, and only a handful earning associate's degrees. The trend then capped at over 30% of makers earning bachelor's degrees, declining slightly to around 25% earning master's degrees, then dropping to only a couple earning doctoral degrees. In addition to this, approximately 4% reported some trade or technical training. None of the makers reported receiving high school credit but no degree. Female makers had a higher level of education on average than their male counterparts, which mirrors current national trends (US Census Bureau). Additionally, makers in both groups earned advanced (master's and doctoral) degrees at a much higher rate than the national average.

Table 3: Percentage distributions of achieved education levels within categories



Technologists tended to be somewhat more educated than *crafters*, earning 7% more master's degrees and 6% more bachelor's degrees. They also tended to report trade or technical training twice as often as *crafters*. There were also twice as many *technologists* than *crafters* who received only a high school diploma and no college credit. Subsequently, *crafters* earning 3% more associate's degrees or received some college credit but no degree. This overall higher level of education reported by *technologists* indicates that the skills required to post projects to this category necessitated academic experience in a related field; for as many who earned only a high school degree, there were three times as many who had bachelor's degree or higher. This results in a category populated with projects posted largely by the highly educated, potentially creating a community exclusive to those without the financial resources or time to attend an academic institution.

In addition to education level attainment, a study shows that educational backgrounds of female makers vary more widely than those of male makers. While the most common degrees for both women and men were engineering and computer and information science, women are more equally spread between the STEM fields and the Humanities. 35% of women held STEM degrees, 38% held degrees in the Humanities, and 21% held both (Intel, 2014). Despite this strong showing in STEM, women do not always identify strongly with their science and technology backgrounds, instead describing themselves as becoming makers via arts (45%).

Occupation

Technologists and *crafters* hold a variety of occupations, the most common of which are (in order of decreased percentage) students, designers, retirees/unemployed/self-employed, engineers, educators, artists, and writers. While students, designers, and artists were equally common in both groups, the categories diverged in a number of other aspects. *Technologists* who held engineering positions were three times more common than *crafters* who held similar positions. These engineers had backgrounds in a variety of engineering disciplines, including electrical, mechanical, and civil engineering. *Crafters* were twice as likely to identify themselves as educators of some sort and three times more likely to be writers. Most writers additionally listed themselves as bloggers and their practices posting documentation to Instructables as an extension of their blogs. Thus, while the *Technology* category features just as many makers with expressive occupations (like designers and artists), it has a heavier population of engineering-focused *technologists,* a discipline that traditionally is

populated by men. Likewise, *crafters* are just as likely to hold expressive occupations as teaching positions, which is conventionally considered a nurturing, feminine undertaking.

Twelve percent of all respondents identified as students, emphasizing the portrayal of the Instructables community as place for learning. Many of these students utilize the project-creation platform for documentation of class projects; a few, like one of the interviewees, are required to do so as an extension of a grading stipulation. In this manner, Instructables offers a prime place for beginning *technologists* and creators to encounter and practice a wide variety of methods, tools, and concepts. It also serves as a source of information and inspiration for students, allowing them monitor what their peers might be creating and building upon that foundation.

Compensation and Income

It is commonly acknowledged that men and women are compensated differently for their efforts. Women may have to take on more responsibility and work longer hours in an effort to be considered for salary raises and promotions in comparison to their male counterparts. A poignant example of this stems directly from a female maker and educator contacted during the course of this study. Her efforts and attention surrounded building and supporting tangible makerspaces, establishing a sense of community and engaging programming. She is experienced in and passionate about the community-building aspect of makerspaces and spent a significant portion of her time producing literature on community building until it came to her attention that her male counterparts were being compensated for their efforts while she was not. They were provided financial compensation for their technology-focused work while her community-building efforts

were not similarly rewarded. This not only provides a prime example of differential compensation by gender, but also a devaluation of her less technological work.

Additionally, women may often be expected to engage in nurturing activities that are considered to be more feminine, like organizing company events and resolving disagreements, without being compensated for their efforts. If women choose to not engage in these sorts of activities, then are held in disregard for their refusal to do so, while men are not penalized for neglecting to volunteer their time but lauded when they do. As a result of the interplay of these factors in addition to the pay gap between men and women of similar positions, women may have different motivations for participating in a community that does not directly offer tangible compensation.

As an interviewee noted through relating her experience running a technology-oriented podcast, women are more hesitant to offer their time for a variety of reasons. Primarily, women may be more wary about unsolicited invitations requesting their time or attention, as evidenced by a lower survey response rate from women included in this study. More often the targets of untoward advances and potential scammers, women perhaps will be more distrustful of communication from a stranger. To overcome this hesitation, any reward for engaging with the request must offer something compelling or tangible. Throughout the survey process, women requested more information about the study and potential compensation before completing the survey, despite its short length, while men only engaged in further contact to affirm their participation and express an interest in the research results.

Additionally, occupations and activities that women may be drawn to are devalued at a greater rate than those represented by men. A prime example of this is the

field of computer science, which was originally dominated by women in the early stages of development (Light, 1999). The operation of early computers that utilized a punch-card system was relegated to women, viewed as a secretarial and administrative activity and thus of lesser importance. As men began to enter into the picture, computer science was elevated to not only a worthwhile pursuit, but crucial to technological development. Women were sidelined and not acknowledged for their contributions to the field.

A poignant example stems directly from a respondent included in this study. An accomplished educator and maker, she found herself receiving differential compensation for her labor, which emphasized the importance of community building within tangible makerspaces. In comparison to her male counterparts, whose efforts focused on the more technologically productive aspects of making, she was being paid drastically less and eventually left the position.

Income

Contrary to the gender pay gap evident in industry, women who participated in Instructables earned slightly more than their fellow makers who were men. While it is difficult to gauge the validity of the comparison among *technologists*, due to a combination of a lower response rate and the preponderance of men within the category, women met or exceeded the salary ranges of men. 50% of female *technologists* earned less than $50,000, while almost 70% of male *technologists* earned within the same range. 41% of male *technologists* and 50% of female *technologists* earned less than $25,000 a year, indicating that many of the authors within the category were students obtaining and practicing skills related to their desired occupation. 33% of male technologists earned

Table 4: Percentage distributions of annual income within categories

between $50,000 and $100,000, indicating makers established within their careers. Only 12% of male technologists, and no female technologists, earned over $100,000, a representation of only half the top earners in the *Living* category.

Both female and male *crafters* earned over $100,000 at a rate of 21%. An additional 31% of women and 19% of men earned between $50,000 and $100,000, indicating that women who posted within this category occupied a greater number of positions of power. Conversely, 19% of female *crafters* and 30% of male *crafters* earned between $25,000 and $50,000. A comparable percentage of female and male *crafters* earned below $25,000 at 29%, a significantly lower rate than *technologists*. Affirmed by the comparison of occupations between the categories, there appears to be more students exploring and authoring within *Technology*, while the *Living* category appears to be more diverse but skew a bit more family-oriented and thus slightly older.

CHAPTER 5

PRACTICES, SKILLS, AND CONFIDENCE

Makers across both the *Technology* and *Living* categories exhibited an array of skills showcased in their project documentation. Inherent in the comparison of these skills is the context in which this information was requested; makers reported both the *methods* they used in projects they have published on Instructables as well as the *confidence* they displayed in a variety of skills. Notable in this reporting of skills and confidence is a sharp divide between skills used by makers in each of these categories, indicating niche communities formed on the basis of utilized practices rather than shared interests. This may have an effect on the rates of participation by female makers, who report technology as a means rather than an end. Forming categories based on skills rather than purpose has resulted in a separation of knowledge sets not conducive to interdisciplinary collaboration.

Practices, Skills, and Confidence in Technology

Technologists more commonly hold a narrower scope, authoring projects that highlight the *components* and *tools* used to assemble (mostly) electronic artifacts like "How to Solder," Making Custom Lenses," and "Intro to Stepper Motors." These tutorials then serve as building block for the rest of the community to discover best practices and cobble together multiple methods to create an artifact of their own design. When these projects do result in a final, designed artifact, the documentation emphasizes

the technology used throughout the process of creation, like "Arduino Powered Pet Feeder," "3D Printed Raspberry Ice Pie," and "Chameleon LED Skirt." A combination of title choice and category placement imbues technology with greater importance than the alternative categories of *Pets*, *Pie*, or *Fashion*, respectively. The separation of *technologists* and non-*technologists* create a divide between makers designing similar artifacts. An avid follower of featured projects in the *Pets* category will likely not encounter the automatic pet feeder, as the project is filed under the *Technology* category and the *Robots* subcategory. While a tagging process allows authors to add additional tags, like "pet" in this case, relevant tagged projects are only accessible through a site-wide search for the select term.

This schism may culminate in a subsequent separation of male and female makers, if men tend to publish *technology* projects that focus on *components* and *tools* and women tend to be *design* and *purpose* oriented. As an example, female makers in the *Fashion* subcategory may suffer as a result, without exposure to the additional possibilities of incorporating LEDS and other technologies into wearables. Likewise, male makers in the *Technology* category may not take advantage of a wider use of materials and purposes for use in their projects, confining themselves to fabrication techniques typical to the category.

Skills

Makers who published in the *Technology* category most commonly utilized tools and methods commonplace in electronic production, including electronics (98%), soldering (89%), and programming/coding (73%). Somewhat less common were fabrication techniques like woodworking/construction (67%), metalworking (60%), and

3D modeling/printing (49%). *Technologists* very rarely demonstrated skills commonly regarded to be more feminine, like knitting/crocheting (2%) jewelry making (9%), sewing (16%). When these projects arose, there were more often placed within a non-technology category.

As very few respondents within the technology category were women, it is difficult to draw conclusions regarding gender disparity in the display of skillsets. However, it is significant that so few of the projects featured techniques from more traditionally feminine crafts like sewing, knitting, jewelry making, and paper craft. The lack of an inclusion of these "soft" materials has created a community that espouses a very particular aesthetic that does not always allow room for crossover artifacts that combine technology-oriented and craft methods.

Confidence

On a scale of 1-5 (little confidence to great confidence) *technologists* described themselves most confident in practices like soldering (4.5), electronics (4.1), and cooking (3.5). While confidence in soldering and electronics mirrors the percentage of skill usage, there exists a disparity between cooking confidence and cooking projects authored. While *technologists* described themselves as very confident in the kitchen, they refrained from posting projects exploiting this skill. They described themselves as least confident in craft practices like knitting (1.6), leatherworking (1.7), and pottery (1.9). Although this mirrors their published experience with these methods, it is interesting to note that *technologists* rate themselves as less confident with 3D printing/modeling (2.8) and laser cutting (2.7), despite having cited their usage at 33% and 50%, respectively.

An interesting pattern emerges in comparing the confidence rates of male and female *technologists*. Female *technologists* rated themselves as *more* confident in every category except 3D modeling and the workshop practices of leatherworking, woodworking, and metalworking. These rates reflect on a couple of possibilities. Primarily, the workshop practices have skewed male for a period of time longer than that in which electronics has existed. The men are likely to have encountered leatherworking, metalworking, and woodworking early in their lives through the teaching of male family members or shop classes. These are a handful of entry points available to young men for affirming their masculinity through physical making activities and are generally not suggested to young women. The men and women may also have differential access to 3D printers, which are expensive and most often situated in workplaces and educational spaces that again skew highly male. The high rate at which women display confidence, however, is contrary to current assessments of male versus female confidence, in which men tend to overestimate their skill while women underestimate. A possible reason for this might be the exclusive nature of the *Technology* category; those women who *do* publish projects are more likely to have extensive experience with these methods, overwhelming doubt that may cause a woman to think twice before inserting herself into a masculine space. Women who have somewhat less experience are less likely to intrude, fearing negative feedback or criticism from their more visible male counterparts.

Practices, Skills, and Confidence in Crafting

In contrast to the *technologist* focus on components and tools, makers in the *Living* category practice what is here called *purposeful making*, or making something with a definitive function that solves a specific problem. These are the projects that focus

on the ultimate use of the artifact rather than procedural making; examples are “Fish Tank Coffee Table,” “Pinhole Camera,” and “Air Plant Necklace,” all of which include processes and components like laser cutting, woodworking, 3D printing, and LED strips. These are all common to the *Technology* category, but have been relegated to the *Living* category because of the importance of form and function placed over process. These projects are also more likely to include personal narratives driving the maker to engage with the project, like needing to manufacture a costume for an upcoming party..

Evident here again is the divide between the two categories’ makers. Many of these *Living* projects could ostensibly be placed within the *Technology* category if given a more tech-centric title and further expression of the technical components and processes. Likewise, *Technology* projects can often be considered under the realm of *Living* if branding were to emphasize a specific purpose. As an example, “3D Printed Air Plant Necklace” is placed in *Living* under the subcategory of *Jewelry* and tagged “air plant,” “tillandsia,” “necklace,” “plant,” “jewelry,” “pendant,” wearables,” and *finally* “3D printing.” If it were to be placed within the *Technology* category, a rebranding might be undergone to format the project as “3D Modeling and Printing Small Objects” with the final artifact as inconsequential to the process. This indicates a tendency for female makers, who are in greater prevalence within this category, to create out of *necessity* as well as *self-expression.* As Rachel said in her interview, “I build the things I feel the *need* to build. Sometimes it’s something useful, sometimes it’s just silly and fun.”

Skills

Crafers, here indicating makers in the *Living* category, displayed a greater distribution of skills, though the most frequently cited were woodworking/construction

(60%), sewing (50%), and jewelry making (49%). Artistic skills like drawing/painting (43%) were noted just as frequently as both traditionally masculine methods like metalworking (40%) and feminine methods like paper craft (37%). This is presumably due to the more even representation of men and women within the category, but also is likely a direct result of the definition of categories laid out by Instructables. The *Living* category incorporates a wide variety of purpose-driven subcategories that are defined by their use case rather than specific materials or tools. The least cited methods were laser cutting (9%), programming/coding (14%), and 3D modeling/printing (16%), though cited proficiency with these methods were well above the most infrequently used skill in *Technology*, knitting/crocheting (2%).

The disparity in demonstrated tech-based skills among female and male *crafters* was much steeper than that of *technologists*. 47% of male *crafters* had published experience with soldering, while only 11% of female *crafters* did. Likewise, 21% of male *crafters* had publicly indicated some familiarity with programming/coding in comparison to only 5% of female *crafters*. Over half of male *crafters* have used electronics in at least one of their projects (51%), while only 14% of female *crafters*. This does not illustrate that women possess fewer of these skills directly conducive to technological making, but it does indicate that female *crafters* are not documenting projects that demonstrate these skills on Instructables.

Confidence

In contrast to the female *technologists*, those in the *Living* category expressed slight less confidence in their skills in comparison to their male counterparts. While they expressed more confidence in traditionally feminine activities like sewing (3.6), jewelry

making (3.7), paper craft (3.9), cooking (4.1), and knitting/crocheting (2.9), very few rated themselves as "very confident" (5) in any particular skill. Male makers within this category rated themselves as more confident than their female counterparts with tech skills like 3D modeling/printing, soldering, programming, and electronics as well as traditionally masculine workshop activities like leatherworking, metalworking, and woodworking.

Crafters also exhibited less confidence in their skills overall in comparison to the *technologists*, with even the highest confidence ratings falling into the neutral-somewhat confident range. These makers were much more likely to rate themselves as having no or little confidence than their technological counterparts, who would rarely rate themselves as having "no confidence," even if they had no experience with the method. This is indicative of a couple of factors. The *Technology* category is dominated by men, who are more likely to attribute their failures to an external factor in comparison to women, who will often attribute any failure to an inherent negative trait within themselves. This encourages men to persist in making activities despite numerous failed attempts at something without any impairment to their confidence. A secondary contributor to this effect is the self-confidence galvanized by hands-on experience with electronics, which may lend a sense of agency over an increasingly digital world.

CHAPTER 6

INTERVIEWS

Following a survey intended to gather data regarding demographic information, skills, confidence, values, and reasons for participating in the Instructables community, several makers were again contacted to request a further interview. These women are presented as representative of the community as a whole, encompassing a range of ages, locations, occupations, and motivations for making. Textual analysis was used to interpret the transcripts of these interviews, which were conducted via various forms of instantaneous text chat. These personal narratives are established within the context of previous findings from the broad range survey and are intended to provide individual accounts of these broader experiences reported by the Instructables community.

Helen

The first interviewee, Helen, originates from a mid-sized city in the Midwest, falls within the 25-34 age range, holds a bachelor's degree, and works in the health care industry. Her intehelenrest in making developed through watching a favorite television show, becoming inspired by the clever hacks devised by one of the characters, and branching out to discover similar practices. She, along with her male partner, operates a tangible makerspace out of her basement, where friends and community members come together to collaborate, create, and share both knowledge and tools.

Unlike many female makers, she utilizes mostly tech-oriented practices like soldering, programming, and electronics. In this way, she conforms to the traditional definition of making as tech-centric, though her focus remains in interpersonal connections. Discovering that there were no tangible makerspaces in her area, she sought

to first make a case to the Institute of Electrical and Electronics Engineers (IEEE) chapter for a space to be built, and when nothing resulted took the initiative to establish a makerspace in her own basement. Her push for a physical collaborative space aligns with other female makers' preference to interact, connect, and collaborate with others. In addition to focusing on collaborative making, members of the makerspace have formed a regular presence of 15-20 makers who gather together as a community not only to create, but to share dinner and connect.

Helen reports that her makerspace falls roughly along the lines of Makezine in terms of gender representation, with 20% female, 75% male, and 5% transgendered or agendered. Despite this disparity, she actively seeks to remain inclusive and encourage women to participate. During previous efforts to invite more women makers onto a podcast she once hosted, she cited frustrations with getting women to agree to appear on the show. She notes that while over 90% of men contacted regarding an interview agreed to appear, only 30% of women did the same. Reasons she says were offered by the women were a lack of time or interest in the podcast. The presentation of time as a valuable resource to female makers aligns with Faulkner's findings on participation in tangible makerspaces, indicating that women are more selective with who or what they devote time to.

A strong focus on the collaborative and interconnectivity aspects of the physical makerspace remains through Helen's use of Instructables as a documentation platform, which she states that she uses primarily to support her makerspace. While the space was still in its early stages of growth, a member suggested taking Instructables up on the offer of a sponsorship, which brought much-needed tools to the space in return for creating and

publishing project tutorials. Helen reports that as the makerspace grew, more of its member began contributing to Instructables under a single profile to maintain the sponsorship and promote the space. This parallels female makers' use of technology as a means rather than an end (Intel, 2014), as Helen makes use of Instructables not for the dubious joy of documentation, but to support a community in which she is invested.

Helen mentions that she also submits projects from the makerspace, partially because of a personal connection with one of the editors but mostly to direct traffic to the makerspace's YouTube page. Helen prefers Instructables, which she describes as much nicer than some of the other communities that highlight DIY work, though Instructables directs fewer visitors towards the collection of videos. This is an artifact of site structure, as Instructables users explore projects in the context of one space rather than clicking through to an externally hosted tutorial. Though Helen continues to post to Hackaday to bring in viewers for the videos, she says she tries to stay away from the comment section, which can be highly negative and derogatory towards the project authors. This personal experience parallels a culture of misogyny allowed by the affordance of online anonymity, establishing an open but unregulated stream of occasionally highly negative criticism witness during the early site overview. In addition to this, Helen makes mention of Hackaday being a site overwhelmingly populated by men, which was confirmed by the analysis that served as a precursor to this study.

Through information gathered by the survey conducted among Instructables contributors, Helen displays a mix of attributes typically associated with both makers and crafters. Similar to other female makers, she exhibits a gap in confidence between her demonstrated ability with programming and her reported confidence. She also aligns with

her fellow female makers in regards to values, rating using sustainable practices, living simply, and promoting social change as very important. She also places value on being connected with the maker community and using Instructables to establish social connections, which is evidenced by her efforts to found and support a tangible makerspace in her own basement. She will almost always attempt to repair something before buying a replacement and will make something before buying it, but only if the process of making would cost the same amount or less than that of purchasing, displaying an awareness of cost indicated by other female makers (Intel, 2014), although she does not cite this as a barrier.

Sarah

Sarah is a young Caucasian woman in a mid-sized city in the Midwest. After earning her bachelor's in English, she headed a private music school owned by a relative, but was frustrated by demanding parents and dull administrative work. She now works at a hydroponics farm, from which she derives satisfaction in knowing that people will enjoy the food she is growing, a pleasure she did not find in in administrative work. This parallels findings that female makers particularly motivated by the social service aspects of making, wanting to help or give to others (Intel, 2014).

Like Helen and other female makers, she values collaborating through interaction with others and participates in a local makerspace, through which she posts project tutorials to Instructables in support of the makerspace. She posts tutorials mostly related to her cooking skills, creating projects that feature recipes, and her experience with small-scale farming, describing these tutorials as "housewife type activities." This relegation of her valued skills to "housewife type activities" indicates and acknowledgement of the

overall disregard for traditionally feminine activities and crafts. Sarah states that she often needs encouragement to document her project process, as she does not acknowledge her process as particularly special in and of itself. This again is indicative of a confidence gap and devaluation of personal skills which may be preventing women like Sarah from participating more fully in the maker movement.

Sarah admits that socializing and engaging with the maker community is not her strong suit, though by this she means the broader community external to her own makerspace. Like other female makers, she takes particular pleasure in collaboration with others and seeing those she cares about enjoy what she has made, specifically the food she cooks for her fellow makerspace members. She considers engaging in online communities to be a sterile activity, viewing it as labor to engage with a virtual community in comparison to face-to-face interaction with people she has a developed relationship with. This may provide insight into why women remain underrepresented on online makerspaces like Instructables; perhaps they do not consider virtual communication to be real interpersonal interaction. If this is so, then tangible makerspaces that allow for this physical interaction should provide an entry to participating, if these spaces were modified to be more inclusive if differential methods of making.

Similar to these non-traditional practices often used by women and misunderstood in physical makerspaces, Sarah prefers to make on the fly rather than following a stringent step-by-step process. She reports that from an early age, she was building, tinkering with, and fixing things that needed to be fixed and thus rejects the glorification of the making process. She says that once she is familiar with components, she is able to

assemble and rearrange things at while, similar to the make-it-up-as-you-go approach to cooking.

Sarah also reports time as being a valuable resource to her, noting that she once regularly wrote a personal blog but has lost both interest and motivation to update due to the time-intensive nature of writing. In a similar vein, she does not relish composing lengthy Instructables tutorials, preferring to direct readers to an external blog space where she expounds on what she would have done differently with the projects.

Sarah exhibits characteristics commonly attributed to *crafters*, placing importance on interpersonal connections and relationships. She prefers to work in direct and peripheral collaboration with others, engaging with fellow makers on individual projects as well as simply creating in the same physical space. She values making a difference, transitioning from an invisible occupation to one in which she can see the positive impact of her work. She will always make something by hand if it required no more time or resources than buying its equivalent, especially if the handmade product is has greater intrinsic value.

Rachel

Rachel is a young Caucasian in the 25-34 age range with a recently earned master's degree in engineering, operating out of a large city on the west coast. As part of her graduate work, she developed extensive experience in designing and building electronic hardware. Now a freelance engineer and statistical consultant, she utilizes skills directly associated with making practices, including mathematics, programming, and hardware prototyping.

Previous to working as a consultant, she was employed at a technology-based pop-up store supported by the Maker Education Initiative, an off-shoot program chaired by the CEO of Maker Media developed in response to the presidential "Educate to Innovate" campaign to promote science and math achievement among American students. As a part of this work, Rachel repurposed components from discarded electronic devices into new artifacts in the front window of the store, piquing the interest of passersby to start a conversation about electronic waste and the importance of a STEAM education. Rachel holds an abiding interest exploring renewable energy technology through non-traditional science education settings such as this; she has also served as a facilitator for an eco-boat competition that teaches high school students to build and race solar-powered boats, emphasizing conservation of natural resources in addition to practical skills in engineering and problem solving.

After completing her work in the pop-up store, she was placed in a makerspace for a number of months, through which she conducted projects, discussions, group activities, and a summer maker camp. As a part of her work within the hacker space, she began documenting projects on her personal blog, but quickly realized she was not getting the site traffic she wanted to promote her business. She transitioned to posting on both her personal blog and Instructables shortly thereafter and has found that particular community to be entirely welcoming to her projects, which often feature converting waste materials into new products better for the environment (upcycling). Her focus on reuse mirrors makers of both genders valuing sustainability and repurposing as practices important to them.

Rachel has also attempted to post her projects elsewhere, namely Reddit, but

abandoned the effort after receiving highly negative reactions from the site's denizens. She attributes this to the anonymity and lack of accountability ubiquitous to Reddit, which is styled as an entertainment, social networking, and news site consisting of content submitted by users, as well as the site's dominating male culture. Although she has had a more positive experience with Instructables, which has a "be nice" comment policy and an overall supportive community, she continues to receive criticism from men. While Rachel reports that she is not outwardly perturbed by criticism, this may not be representative of female makers as a whole. She notes that women, in contrast, will be exceedingly polite and apologetic when asking a question and rarely criticize her design process. She goes on to posit that men may be more likely to critique women partly due to life-long encouragement to display masculine attributes (like dominance, confidence, and aggression) but also because women who invade "masculine activities" like building cars are viewed as more threatening than those who engage in more traditionally feminine activities like crafts. She points out a handful of older women she knows personally who have demonstrated skills in house renovation and construction but describe what they are doing as a "makeover." This indicates again a trend of devaluing the work women do as less difficult, important, or worthy of notice. This differential view of the processes and practice women engage in is evident in the misunderstandings some male makers have about female maker's design processes, their tendency to pause to think or sketch being taken as an indicator of a need for help.

Rachel is surrounded by a majority male cohort of coworkers as part of her occupation, and the hacker space she is a part of consists of approximately 100 members, 90 of whom are men, displaying a similar gender representation to Makezine and

Hackaday. Having previously attended an all-girls school, she didn't originally consider her career choice to be out of the ordinary, saying "I never thought it was weird to be a woman in tech until it was pointed out to me." A result of this singular upbringing has allowed her to escape the confidence gap visible when men and women enter technically demanding activities. Being a part of the Instructables community has increased her exposure in somewhat more proportional representation of female makers, which she accredits to the overall supportive nature of the community as well as the inclusion of categories for crafts and food, which may draw more women.

Though Rachel mostly publishes tutorials that utilize soldering, programming, and electronics knowledge, she also expresses confidence in craft practices like sewing and jewelry making, acting as a crossover between the *technologist* and *crafter* categories. Like Helen and other female makers, she values using sustainable practices, living as simply as possible, promoting social change, and being connected to a larger community of makers, emphasizing the social service aspects and collaborative activities that draw women to making. Like the previous interviewees and female makers as a whole, she enjoys collaborating with others and values homemade artifacts over buying something, but only if costs the same or less than the purchased artifact, indicating an awareness of the expense associated with technological making. Unlike the previous respondents, however, her making activities directly reflect on her occupation as an engineer, which means she uses Instructables mainly for learning, sharing, or demonstrating skills. Rachel was the only interviewee who came from a background directly linked to traditionally defined technological making, aligning with the overall trend of most (but not all) female makers coming to making from a variety of non-

technical disciplines. In addition her use of the platform to promote her business, she also views her making activities as a form of self-expression similar to playing music, creating artifacts that range from purely utilitarian to more light-hearted and artistic. She places importance on the role of self-expression through making, like female *technologists* and crafters surveyed in this study. She views her participation in the Instructables community as a fulfilling intersection between having fun and expressing herself all while developing a skill set related to her career.

Anna

Anna is a 25-34 year old, Caucasian graphic designer and full-time graduate student studying design and technology in a large city in the Northeast. Now in her second year of study, she participates in the Instructables community largely to fulfill requirements associated with class assignments. Though she has not published anything on the site unrelated to her coursework, she plans to contribute more when she has more free time. She interacts with the community in other ways to fill in the gaps, judging several on-site contests and giving feedback to project authors. She herself won second place in and Instructables contest and described it as intensely validating for a school project. In contrast with female makers in the U.S., she highly values this sense of accomplishment above the most often-cited reason for participating: social service aspects of helping or giving back to others (Intel, 2014).

Though her publishing on Instructables is limited in scope due to her current focus on design and technology, she, like other female makers, demonstrates an interest in more traditional craft and artistic practices like sewing, drawing, and paper craft as well as technology. She enjoys combining low tech practices with high tech, analog and

digital, transforming technology use into a more tactile experience through use of differing media approaches. Her design process typically entails exploring a conceptual space, then proceeding from there to determining the best method of production would be and which medium would provide the best support. This supports the statement that female makers view technology as a means rather than an end, designing with an end product in mind before limiting oneself to a particular set of practices. In selecting the appropriate category under which to place her projects in Instructables, she tends to publish things under the umbrella of technology, assuming a level of proficiency with electronics, programming, and fabrication that would require prior instruction before beginning a project.

Emphasizing the importance of collaboration and interpersonal interaction valued by female makers, Anna appreciates the Instructables community for the sense of camaraderie it promotes amongst its members, which she views as crucial for the broader maker community to foster the trust and support promoted by a movement that focuses on collaborative creation and rejects intellectual property rights. She also uses Instructables as a resource for her graduate work in design and technology, building on work done by others to create more sophisticated works without having to start from scratch and teaching herself the basics through trial and error. In this way she uses Instructables primarily as a learning resource, which was cited by both men and women as their reason for participating in the Instructables community. Though she has not participated in any other form of project representation in an online makerspace, she notes that the feedback she has received from Instructables community members has been generally positive. This is a result of Instructables' focus on community and inclusion

evident in its "be nice" policies as well as its enfolding of crafting practices alongside traditional tech practices.

As an extension of her academic work, she has met with a handful of makers and *crafters* active on Etsy, a peer-to-peer e-commerce site focusing on handmade or vintage items, through which she gleaned a broad spectrum of practical feedback concerning monetization of crafting practices, difficulties in working from home, and challenges to productivity. These participants skewed disproportionately female, reflecting on the crafting focus of Etsy, and subsequently encouraged to Anna to attend local meetups hosted by Etsy sellers focusing on female empowerment. These makers seem to have overcome the expense barrier to entry in making by selling the products of their efforts to not only pay for their making practices, but turn a profit.

Anna contrasts her experience speaking to the group of Etsy sellers, who were remarkably open and positive throughout the process, with her attendance at a Maker Faire, noting that there seems to be a paradoxical undercurrent of shameless self-promotion beneath the veneer of community publicly espoused by the Faire. By nature of the sidewalk exhibition style fair, makers largely attend as a means to showcase their work in search of recognition rather than develop connections with other makers. Exacerbating this effect is the social draw of the more "impressive" projects that feature robotics and other advanced demonstrations of technology, which are predominantly created by men. In contrast, attendees are less likely to stop by booths that feature traditional craft practices, which seem more approachable (and therefore mundane) as an artifact of being both affordable and accessible through association with traditionally feminine homemaking activities. Most people have encountered practices like sewing at

some point in their lives, though they may not have an advanced degree of proficiency, while it is less likely that one has experience with electronics. Anna also conjectures that expense might limit accessibility to making practices like robotics, electronics, and fabrication, as a great deal of expensive equipment is required to even being to foray into the realm of technological artifact production (indicated by female and male makers as a primary barrier to entry). She emphasizes that it is the cost, not a learning curve associated with either craft or making practices, which prevents easy entrance into making.

Like previous interviewees and female makers as a whole, Anna expresses an interest in more artistic and craft-centric processes of making in addition to the traditional methods of soldering, programming, and laser cutting. Though she displays the greatest confidence in soldering, laser cutting, and cooking, she does not publish content related to her cooking skills on Instructables, perhaps a further indicator of the devaluation of traditionally feminine making practices as well as a lack of relevance to her current studies. She values promoting social, economic, or political change as well as self-expression through her making activities, aligning with female makers' emphasis on the importance of social service activities through making.

Julie

Julie, a Caucasian woman with an academic background in sociology, currently works with a company that strives to connect nonprofits, foundations, and activists with software and technology solutions to maximize their effectiveness and impact on the world. Her background and current work serve to emphasize the different pathways women take to making as well as their social service-oriented reasons for

making. Julie differs from the other interviewees in that she has never used Instructables by choice, instead electing to make a difference in the real world by establishing and supporting collaborative community spaces. Her strong emphasis on community aligns with the overall trend of female makers emphasis on collaboration and interactions with others through making. Her first public foray into collective making was an entrance into the hackerspace scene in the Northwest in the last 2000s, through which she encountered a community of chiefly advantaged white men. She subsequently branched off with a few like-minded peers to found a makerspace that had a greater focus on education and outreach, intended to serve as an onboard ramp that few to the more specialized hackerspaces. During this period of time, she also began engaging with an association for leaders of collaborative spaces that focuses on sharing resources, best practices, and ideas, including basic zoning and insurance knowledge to keep these physical spaces intact and self-sufficient. Following the trend of facilitating resource creation for collaborative spaces, she also cofounded an organization to aid maker and hacker spaces in engaging with disaster and humanitarian response. This additional emphasis on social service aspects, as well as Julie's efforts to bring discussion on these aspects to new community, emphasizes a larger trend of social service through design and making, which is the primary reason women make (Intel, 2014). Though her paid work has transitioned from that affiliated directly with makerspaces to a continuation of her interest in humanitarian response, she remains in contact with the broader maker community, engaging with local hacker and makerspaces and giving talks at hacker conferences.

In addition to her work with humanitarian response and collaborative spaces, she also is an affiliate, fellow, and professor of the practice at several prestigious academic

institutions, through which she teaches a class on digital communities to an evenly gendered mix of students. Despite this more proportional representation among the students, her overall experience with the maker community has included far fewer women as a whole. While this is unsurprising given the statistic on participation by women, this nonetheless confirms the pervasiveness of the problem.

Through directed efforts at strengthening diversity, the hacker space she co-founded drew a less uniform crowd compared to other, mostly white and male makerspaces, though she noted that other spaces were doing even better at drawing women. Successful practices included hosting women-focused classes often enough to gain visibility but not so often to incite self-segregation by gender; embracing traditionally feminine crafts, which was uncommon among makerspaces but was met with success; and establishing a set of rules that demanded a respectful and courteous space in which to exchange a free flow of ideas. This inclusion of traditionally feminine crafts runs parallel to Instructable's effort to include a variety of tech- and craft-based practices, both of which resulted in a greater (though not yet equal) participation by women. In addition to this, efforts to combine technology with crafting in the form of several wearable tech events were met with a resounding success, inviting more equal gender ratios with a distinctly unique tone of interaction in contrast to typical meetings.

Julie has made an evident impact in the realm of physical makerspaces, making the space "happen" rather than producing projects as a member of the space. At the conclusion of the interview, she expressed an importance in noting that she always felt like she had agency in speaking up when women were not being represented appropriately, that fellow makers were genuinely interested in helping effect change in

the gender dynamic but didn't always know how to do that. Instances of malice related to gender in her experience were incredibly rare, and negative interactions more often were related to inaccurate perceptions perpetuated through socialization process and various forms of mass media. Julie's largely positive experience differs from previous interviewees, who cited online criticism and aggression displayed by male makers and contributors. This may, however, be an artifact of Julie's experience existing exclusively in tangible maker spaces rather than on open virtual communities where critical users may not be held to any level of accountability.

CHAPTER 7

DISCUSSION AND RECCOMENDATIONS

Values, Ideals and Beliefs

Makers of any gender and choice of thematic content ascribe to their own personal set of ideals and values, the aggregation of which are unique to the individual. There are some markedly visible trends between genders, however, as well as between the two categories examined here in both the importance placed on various aspects of social life as well as purpose for using Instructables. Values identified here range from political to economic in nature, from personal preferences to worldviews, from and social enactment to purchasing predilections.

Sustainability, Reuse, and Repurposing

Both *technologists* and *crafters* described using sustainable practices as important to them, though *crafters* tended to place somewhat of a greater emphasis on practicing sustainability. Values ingrained in the movement towards sustainability include rejecting consumerism to some degree, repurposing materials rather than disposing of them, and being selective about practices used in one's work to diminish the amount of waste product produced. The act of making in and of itself is a rejection of consumerism, as makers elect to create what they need or want as a substitute to purchasing it. This also encompasses placing a greater value on homemade products, both for their aesthetic and quality. As interview respondent Sarah stated, "I like (what I make). I make them by hand. They take literally the same amount of time and they (are) better, so why not?" A

movement towards sustainability in making is evidenced by a trend in the repurposing of old artifacts into new ones, indicated by the creation of *reuse* as a subcategory in both *Technology* and *Living*. The maker industry is picking up on this as well, promoted by people like respondent Rachel, who was hired to disassemble electronic waste and make new things in a store-front window to bring awareness to the movement. This sense of agency in bringing about change through awareness is supported by makers of both categories agreeing with the statement "I strive to promote social, political, or economic change."

Crafters rated using sustainable practices as very important (4.7), while *technologists* rated it as somewhat less important (4.3). While female makers in both categories rated sustainability as equally important (4.5), male *crafters* rated it as much more important than their *technologist* counterparts (4.9 versus 4.1). Both sets of makers agreed with the statement "I try to live as simply and consume as few products as possible," though women agreed at a somewhat higher rate than the men. Both sets will also attempt to repair something before buying a replacement, though female *technologists* will do this at a slightly lower rate than the others (4.2 versus 4.7).

Collaborative Making

Collaborative making, or working with other makers in the process of ideation or production, is a value espoused by the physical maker and hacker spaces as well as Instructables, which by way of site structure encourages discussion surrounding specific projects as well as iteration upon an idea by makers other than the original author. It additionally is important to female makers specifically, who are more likely than their male counterparts to value interacting and connecting with others. Makers in both the

Living and *Technology* categories enjoy collaborative activities, though *technologists* tend to prefer collaborating with others (4.3) at a much higher rate than working on their own (3.6). In contrast, *crafters* tend to prefer working on their own (4.3) over engaging in collaboration (4.1). In addition to this, female *technologists* exhibit a lower likelihood of working on their own (3.5) than their female *crafter* counterparts (4.4).

With a vastly higher percentage of female *crafters*, these findings contradict those stating that female makers are 7% more likely to work with others than male makers (Intel, 2014). A possible explanation for this is the virtual nature of this community in concert with a hesitation to engage with unknown others. A greater hesitancy towards develop relationships, however brief, with strangers met online may lead women participating in online maker communities to collaborate less frequently than they would in person. The greater inclination for female *technologists* to engage in collaboration may result from their acceptance of withdrawn social boundaries as a necessity of presenting oneself in the space to learn and share skills.

Makers of both groups equally valued being connected with a larger community of makers (4.5), exemplified by their choice to participate in the online community. The sense of community was emphasized by individual reactions to this study. Instructables users were noticeably responsive to the researcher's presence and were equal parts emphatically interested and cautiously curious. Respondents reacted positively to a research interest in their community and willingly offered a wide array of personal information at unanticipated high response rates. Personal messages from community members indicated an enthusiasm for the process, requesting information regarding when the results were to be released and expressing well wishes for the investigation. A scant

few of the members contacted reacted somewhat negatively to the infringement on what they viewed as a somewhat private community space, implicating that the investigator was an outsider and therefore not welcome to intrude. Both sets of reactions accentuate the strong sense of community felt by the makers of Instructables, underscoring the site's aim to be a positive space for makers to create, share, and interact.

Self-Expression

Expression of self is integral to the maker community and specifically to female makers, who are more likely to identify with creative and expressive terms like artist, crafter, and designer. This is illustrated by makers of all backgrounds, genders, and categories placing self-expression among the consistently most highest-rated values (4.5) included in this study. Making is considered a creative act above everything else, placing a community-wide emphasis on unique designs and novel solutions, and creativity is considered integral to the maker experience. Creating personal artifacts thus becomes an extension of self-expression, as individual makers draw from a corpus of personal knowledge in addition to the resources provided by the overall community to produce artifacts that either offer a personalized solution to a problem or demonstrate a maker's particular skill gained through his or her own experience.

While the importance of self-expression may glaringly obvious from a participant's perspective within the community itself, this self-reporting is worth noting as an aspect that serves to set the Instructables community apart from the enactment of other, more utilitarian uses. Assuredly, there are manifold other people out there that practice similar activities to Instructables members but nonetheless do not identify themselves as "makers" because they do not consider their creations as an expression of

self. Rather the Instructables community likely self-describes itself as expressive due to the nature of those makers who are publishing content to the site. One who utilizes Instructables to search for solutions to a problem or learn a specific skill may be a user of the site but not necessarily a community member until he or she has authored content to contribute to the larger compilation of projects. Creating such content necessitates at least some form of self-expression, whether it be evident in the writing of the Instructable project, the choice of methods used, or the use case of the final artifact produced.

Here also is evidence pointing towards how male and female makers differ in perspective. Perhaps unsurprisingly, female makers rated self-expression as more important (4.5) than did male makers (4.0) across both categories examined. This is characteristically the case from early childhood onward, as boys and then men are encouraged to be physically expressive and girls/women to be physically undemonstrative but emotionally expressive, which appears to carry over somewhat into maker culture. While male makers appear to be more welcoming to the concept of self-expression through creative activities, male *technologists* are somewhat less expressive than their counterparts in *Living*. This could be attributed to the different materials and processes used within the two categories if it weren't for the steady rate at which female makers valued self-expression, regardless of category. If expression is limited by the hard, robotic aesthetics of identical components necessary to making a tech project, then female *technologists* have found a way to transform these to fit their needs in both function and form.

Reasons for Participating

While makers of the Instructables community seem to ascribe to a similar set of values and ideals, each encounters and uses Instructables for a different purpose. While some speculation about occupation can serve to indicate possible use cases, direct feedback from participants assists in shedding a light on why these makers continue to engage with the online community. Augmenting this is an examination of the websites each maker has chosen to include in their personal Instructables profile.

Skills, Connectivity, and Personal Fulfilment

Technologists, *crafters*, men, and women reported that learning skills was the primary reason they choose to participate in the Instructables community when asked to rank a set of reasons from 1-5, with 5 being the most important. At an important rating of 4.3, it seems that both men and women use the site largely for the same reason. The next most prevalent reason makers used Instructables is similar to the first; sharing skills came in a close second at 4.2. Thus makers view Instructables as a form of non-traditional education for encountering and practicing new skills related to their making practices, a peer-to-peer education system enacted from the comfort of the home. At 4.0, the third most cited reason most makers choose to engage with the community is simply to have fun, creating unique artifacts disparate from their occupations. This brands making as not only an educational practice but a hobby. Makers make because the act of making is essentially enjoyable in and of itself.

Both sets of makers reported that learning skills was the primary reason they choose to participate in the Instructables community when asked to rank a set of reasons from 1-5, with 5 being the most important. At an important rating of 4.3, it seems that both men and women use the site largely for the same reason. The next most prevalent

reason makers used Instructables is similar to the first; sharing skills came in a close second at 4.2. Thus makers view Instructables as a form of non-traditional education for encountering and practicing new skills related to their making practices, a peer-to-peer education system enacted from the comfort of the home. At 4.0, the third most cited reason most makers choose to engage with the community is simply to have fun, creating unique artifacts disparate from their occupations. This brands making as not only an educational practice but a hobby. Makers make because the act of making is essentially enjoyable in and of itself.

The reasons men and women engage in the community differ significantly as well. Male *technologists* cite making social connections as a much less important reason (2.5) for using Instructables than their counterparts in *Living* as well as female makers in both categories. This, in combination with the individual physical process, presents technology making as a solitary activity of focused assembling in contrast to the more open process attributed to crafting found in the *Living* category, which allows for makers to engage in other activities simultaneously (like knitters carrying a conversation in a knitting circle). An even starker contrast lies in the effect of stress on female *technologists*, who rate stress relief as a *much* less salient reason for making (1.8) in comparison to both the male *technologists* (3.0) and makers of both genders in the *Living* category (3.3). A good portion of the stress attributed to technology making for women may be in large part due to the masculine culture of tech production, which can be a caustic environment for women, who may be seen as intruders or outsiders. As one of the interviewees noted when quoting a friend of hers who works as a programmer in the tech

industry, “It’s like 1000 paper cuts every day, a lot of little things adding up to make it very difficult to be a woman in tech.”

External Representation

Authors on Instructables rarely limit their online presence to the virtual maker community embedded in the site. Given the option of including a link to an external website on their personal Instructables profile, most members choose to link to a secondary representative space. These sources feature a vast array of virtual sites, but most commonly include portfolio websites, social media platforms, company websites, instructional videos, personal blogs, other project-hosting sites, and websites for physical maker and hacker spaces.

While makers who chose *not* to link to an external site represented approximately 40% of the makers included in this study, male makers neglected to include a link at a higher rate (43%) than female makers, and *crafters* did *not* link at higher rates (51%) than *technologists* (32%). This seems to suggest that *technologists* have a greater interconnected online presence and believe that their work on Instructables is relevant to their personal and professional representation on other sites. The most commonly linked-to type of site was a portfolio or personal website that often featured projects in a professional manner alongside contact information and a resume or curriculum vitae. Portfolios often featured work doubly published on Instructables, creating a linked pathway between the specific projects hosted on each site. Female *technologists* were over twice as likely (36%) to link to an external portfolio as both male *technologists* (15%) and male and female *crafters* (14%). They were *half* as likely to link to a social media platform (8%) compared to male *technologists* (17%) and *crafters* (13%). This

suggests that female *technologists* view their participation on Instructables as an extension of their professional representation and a means through which to prove their technical skills.

The next most commonly linked-to site was that of a maker's employer or company, a personal business, or an Etsy shop. Company sites often included blogs to which the maker contributed. Personal businesses or start-ups often used Instructables as a platform on which to advertise their products. For example, a producer of a very specific type of strong adhesive published projects that utilized the adhesive to demonstrate its reliability. Etsy shops were also commonly linked to, especially by *crafters* who often published project tutorials on the goods they sold through their shop. While *technologists* of both genders and female *crafters* included these links at equivalent rates (approximately 11%), male *crafters* very rarely linked to an external company or shop (2%). This indicates a divide between what the men view of as a hobby versus their profession, which may not run parallel in the case of the *Living* category.

Makers of both genders and categories were equally invested in producing educational content in the form of additional project tutorials or instructional videos (8%), which were usually hosted via a blog-style format on a personal website or YouTube, respectively. These tutorials or instructions often served as extensions of a project hosted on Instructables, including a richer description and narrative of the process and what they might have done differently given the chance as well as videos which were directly embedded into the Instructables documentation. The one differentiating factor in this aspect was the form of the presentation; fewer women chose to present their content in the form of a video (4%). This may be due to the greater scrutiny women are placed

under on YouTube, through which most of the videos were hosted, regarding their physical appearance and presentation. As the video hosting platform includes no "be nice" comment policy like Instructables and faces a greater problem with anonymity, this encourages highly negative remarks with few repercussions for the comment authors.

Lastly, a handful of makers linked to personal blogs unrelated to their making activities (3%) or physical maker/hacker spaces (1%). A number of physical makerspaces have a presence on Instructables, through which they post projects originally created by individual or collaborative members of the space. The spaces represent themselves with a logo as their profile photo on Instructables alongside a link to their virtual presence, which consistently features a description of the space's activities, short biographies of the members or founders, and details on how to become involved. Some of these physical makerspaces may be supported directly by Instructables itself, which sponsored the purchase of various tools for a makerspace founded by one of the interviewees in this study. While both female and makers listed links to personal blogs in equal proportions, it is worth noting that links to physical makerspaces were only listed by male *technologists*. This may be an artifact of the greater percentage of men involved in physical makerspaces, which mirrors the disproportionate representation found in the Instructables community as reported by interviewees involved in such spaces, but is also skewed but the collaborative presence of makerspaces on the site. As most makerspaces are likely to include members of at least two genders, collaborative spaces appear to utilize the "robot" gender option on Instructables or simply decline to list a gender as a way to navigate the lack of a group profile option.

Recommendations

This study was intended as an initial probe into gendered interaction and participation in online makerspaces, a facet of the broader maker community which has until now been left relatively undisturbed. While the representation of female makers is marginally more representative in the Instructables community in comparison to physical makerspaces and events, the balance remains unevenly weighted towards male makers. While female crafters are more prevalent on the specific site of inquiry, female technologists remain a minority, exacerbating the divide between those who practice technological making (men) and those who do not (women) and erecting barriers of entrance to STEM fields. Resulting from this investigation is a series of recommendations to alleviate some of the effects resulting from gendered barriers and offer a design direction for current and future makerspaces, both tangible and online.

Purposeful Making

Documentation provided by female makers in this investigation overwhelmingly pointed towards a tendency for purposeful making. They are highly motivated by aspects of social service and interpersonal connections, preferring to make things that are personally meaningful or helpful to others around them. They are contextually focused, narrowing in on a specific need or want they wish to fulfill through making, whether it be cooking a good meal for the maker friends, manufacturing a costume for a friend's Halloween party, or retaining funding provided to their basement makerspace. They use a variety of different methods and tools to accomplish their goals and are more likely to be accidental technologists than men, utilizing technology only if is the best possible method

available. They tend to conceptualize their work in an unconstrained design space, identifying the problem first then working through possible solutions.

Traditional hierarchical structures in virtual maker spaces tend to highlight a documentation process of physical assemblage, which neglects to feature the mental design process female makers enact through sketching, thinking, and searching for inspiration. This results in more visually appealing documentation originating from male makers who work with intricate electronics parts in contrast with the occasionally simple-seeming process of craft assemblage. A recommendation for encouraging a more equitable representation of the invisible design work conducted by women would be to embed a content framework encouraging documentation of the design process in addition to the physical labor.

An alternative to this would be introduce virtual workshops or contests, a feature already in place on Instructables, to initiate a call to action for makers in the community to solve a particular problem. For example, a challenge might encourage makers to go out into their own communities to discover a problem faced by people in their own backyard, work with those community members to develop a solution, then document their process and end product. This might mean engaging with people with disabilities who have limited physical mobility due to structural barriers in their home and designing a ramp or lift to assist them through entryways, or it could be fabricating a wearable device that protects or alerts people who commute on foot when they are approaching areas with poor lighting or visibility late at night. This emphasis on service and human-centered design would facilitate greater interdisciplinary collaboration and encourage makers to leverage sundry methods in innovative or unexpected ways.

Technology Intertwined

The primary issue resulting the stark gender divide on Instructables is the somewhat arbitrary naming of project categories, to which makers are required to ascribe their process documentation. This has culminated in a form of self-sorting, as women keep their distance from the highly male-dominated *Technology* section to immerse themselves in a category populated by more familiar materials and artifacts. This segregation is exacerbated by extended exclusion, as technology projects skew one-dimensional (all electronics all the time) and crafters' documentation includes fewer instances of technological intrusion. Thus a space in which makers from all backgrounds could intermingle and learn from each other becomes a set of niche communities in itself, paring down the diverse array of methods a maker might otherwise encounter.

A recommendation for this is a move towards more open, collaborative making, exposing men and women from different background to both crafting and technology practices outside the confines of defined categories like "Technology" and "Living." A way to leverage female makers' purposeful making into a reorganization of an online maker community would be through a creation of a new type of classification system not found in current online makerspaces. Rather than pigeonholing a project by which tools are used, as the *Technology* category does, a feasible alternative would be to conduct categorization through the use case of any particular product. In this way, projects like a DIY Child's Thermometer and a set of Home Remedies could be included under an umbrella category driven by Health. The objective of this is to feature technology projects and non-technology project side by side, exposing makers of both to a wider

array of possible solutions to problems they seek to solve. Even engaging peripherally with alternative solutions may make an unfamiliar process seem less intimidating.

Inclusive Tangible Spaces

One thing that every interviewed maker cited as a discomfort was participating in traditionally male maker spaces. Though the maker community as a whole seems to be striving towards inclusivity and egalitarian participation, navigating these potentially uncomfortable interactions is a source of fear for both men and women. All but one of the interviewed makers additionally participated in (or founded) a physical maker space at one point and made note that overtly masculine spaces were, however unintentionally, unfriendly towards women and occasionally demeaning. While the motivated few persevere, many female makers are disillusioned by the physical communities and feel unwelcome. These spaces offer tools, resources, and knowledge that female makers are missing out on, forcing them to individually bear the significant expense of technological making.

Suggestions to ease this sense of unwelcome are less clear and would require some time before gaining real visibility. Inequalities in social structures may often be easy to identify but difficult to repair and require a concerted effort by all parties involved. Makers must revamp their maker- and hackerspaces to become more welcoming and accessible to those from different backgrounds and demonstrate an appreciation for the distinct methods used by female makers. Newly established spaces should foster collaboration and peer learning above any particular skill, with makers promoting a sense of agency in creating the world around them and working together to learn the skills necessary to do so. Rather than splintering into male hackerspaces and

feminist hackerspaces, the Maker Movement should turn inwards and underscore the importance of cultivating a community at the center of a global push towards stimulating a lifelong desire to learn, establishing a sense of self-efficacy, and empowering women and girls on a personal level. Encouraging women to make and identify as makers will lead them to better opportunities and livelihoods while triggering broadened participation in computer science and engineering by women.

Broadened Definition of Making

Lastly, an argument can be made for broadening what we consider to be making beyond the term's initial boundaries of technology-inspired DIY into the wider realm of crafting, tinkering, hacking, building, and designing practices. Though the movement sprung from technology roots, the community has since expanded include peripheral maker who had not previously identified as such, spurred along by increasingly inclusive online makerspaces like Instructables. Making and the age of personal fabrication is set to change the very way we consume and produce artifacts, and we cannot risk excluding marginalized groups because their skill sets do not fit neatly inside the technology bubble. While this study has examined the disproportionate representation of gender in the maker community, it is argued that this divide would diminish or disappear entirely if the types of making women engage in were acknowledged and given credence,

SURVEY

1 Consent Form

*

PURPOSE
The purpose of this research is to examine how people engage with and interact within online making and crafting spaces. We are interested in how participation in the Instructables community is influenced by or affects participants' occupation, confidence with technology, and social experiences. You are being asked to take part in a short survey that help us understand your personal experience with making and crafting. The primary goal of this research is to develop guidelines for creating and maintaining inclusive participatory spaces. A secondary goal is to augment existing academic literature on gender and making.

PROCEDURES
As a a volunteer participant, you will be asked to complete a short survey about your participation in the Instructables community and experience with making and/or crafting. Completion of the survey will take approximately 30 minutes. Upon completion of the survey, you will be asked if you are willing to be contacted for a further interview. You may opt out of participating in this study at any time.

RISKS/DISCOMFORTS
The risks involved are no greater than the risks involved in regular computer usage. Though this survey will take approximately 30 minutes, be aware that extended periods os computer usage may result in minor eye strain.

BENEFITS
You should not expect to benefit directly from this research. However, your participation in the survey may provide you with a better understanding of the different motivations people may have for creating new things and sharing the making process with others.

○ I accept ○ I don't accept

2 Username *

Instructables username

3 Age *

○ under 18
○ 18 - 24
○ 25 - 34
○ 35 - 44
○ 45 - 54
○ 55 - 64

- ○ 65 - 74
- ○ 75 or older

4 Race *

- ○ American Indian or Alaskan Native
- ○ Asian or Pacific Islander
- ○ Black/African American
- ○ Hispanic/Latino
- ○ White/Caucasion
- ○ Other

5 Gender *

- ○ Male
- ○ Female
- ○ Other

6 Education *

Highest degree or level of school completed
(If currently enrolled, highest degree received)

- ○ None - 8th grade
- ○ Some high school; no diploma
- ○ High school diploma or equivalent (GED)
- ○ Some college credit; no degree
- ○ Trade or technical training
- ○ Associate Degree
- ○ Bachelor's Degree
- ○ Master's Degree
- ○ Professional Degree
- ○ Doctorate Degree

7 Income *

Annual household income

- ○ < $25,000
- ○ $25,000 to $49,000
- ○ $50,000 to $99,000
- ○ > $100,000

8 Occupation *

9 Location

a. City *

b. State/Province

c. Country *

10 Practices *

Which practices do you use for projects on Instructables?

☐ Sewing ☐ Drawing, Painting, or Sculpting ☐ Papercraft ☐ Jewelry Making

☐ 3D Modeling and/or Printing ☐ Soldering ☐ Programming/Coding ☐ Knitting/Crocheting

☐ Leatherworking ☐ Metalworking ☐ Woodworking/Construction ☐ Pottery ☐ Electronics

☐ Pottery ☐ Laser Cutting ☐ Cooking ☐ Other

11 Confidence

Please rate your confidence with using the following practices

Sewing *

1 2 3 4 5

Not confident Very confident

Drawing, Painting, or Sculpting *

Any or all of the above

1 2 3 4 5

Not confident Very confident

Papercraft *

Including origami, stationary making, and scrapbooking

1 2 3 4 5

Not confident Very confident

Jewelry Making *

1 2 3 4 5

Not confident Very confident

3D Modeling and/or Printing *

1 2 3 4 5

Not confident Very confident

Soldering *

1 2 3 4 5

Not confident Very confident

Programming/Coding *

1 2 3 4 5

Not confident Very confident

Knitting/Crocheting *

1 2 3 4 5

Not confident Very confident

Leatherworking *

1 2 3 4 5

Not confident Very confident

Woodworking/Construction *

1 2 3 4 5

Not confident Very confident

Metalworking *

1 2 3 4 5

Not confident Very confident

Electronics *

1 2 3 4 5

Not confident Very confident

Pottery *

1 2 3 4 5

Not confident Very confident

Cooking *

1 2 3 4 5

Not confident Very confident

Laser Cutting *

1 2 3 4 5

Not confident Very confident

a. Other

27 Identity

Please rate your agreement with the following statements

Using sustainable practices is important to me *

1 2 3 4 5

Strongly Disagree Neutral Strongly Agree

I strive to promote social, economic, political, or environmental change *

1 2 3 4 5

Strongly Disagree Neutral Strongly Agree

I try to live as simply and consume as few products as possible *

1 2 3 4 5

Strongly Disagree Neutral Strongly Agree

Self-expression is important to me *

1 2 3 4 5

Strongly Disagree Neutral Strongly Agree

I will attempt to repair something before buying a replacement *

1 2 3 4 5

Never Sometimes Always

I enjoy collaborating and making things with others *

1	2	3	4	5
Strongly Disagree		Neutral		Strongly Agree

I prefer to make things on my own *

1	2	3	4	5
Strongly Disagree		Neutral		Strongly Agree

I value being connected with a larger community of makers *

1	2	3	4	5
Strongly Disagree		Neutral		Strongly Agree

I make things to create or replace things that I *need* *

1	2	3	4	5
Never		Sometimes		Always

I make things for *pleasure* or *fun* *

1	2	3	4	5
Never		Sometimes		Always

I make things to improve or demonstrate skills related to my occupation *

1	2	3	4	5
Never		Sometimes		Always

I prefer to *buy* things rather than *make* them *

1	2	3	4	5
Never		Sometimes		Always

I prefer to *make* things, even if it costs more to *make* it than *buy* it *

1	2	3	4	5
Never		Sometimes		Always

I prefer to *make* things, but only if it costs the same or less than to *buy* it *

1	2	3	4	5
Never		Sometimes		Always

42 Rank by importance your reasons for using Instructables(1 - least important; 5 - most important)

a. Sharing skills

b. Learning skills

c. Making social connections

d. Having fun

e. Relieving stress

43 Contact

a. Are you willing to be contacted for a further interview? *

○ Yes ○ No

b. If yes, please provide an email address

Submit

REFERENCES

Alexa: Actionable Analytics for the Web. (n.d.). Retrieved March 1, 2015, from http://www.alexa.com/

Bell, G. (2012). What does our technology future look like? *Commonwealth Broadcasting Association Conference*. Lecture conducted from Brisbane.

Business Insider (2015). The demographics that make LinkedIn's audience so valuable to businesses. Retrieved April 14, 2015 from <http://www.businessinsider.com/linkedin-as-a-marketing-and-brand-platform-2014-9>

Buechley, L. (Speaker) (2014, June 1). Thinking About Making. *Eyeo Festival*. Lecture conducted from Walker Art Center, Minneapolis. < https://vimeo.com/110616469>

Cohen, K. (2008). Who We Talk About When We Talk About Users. *Ethnographic Praxis in Industry Conference Proceedings, 2001*(1), 9-30. Retrieved April 13, 2015, from http://onlinelibrary.wiley.com/doi/10.1111/j.1559-8918.2005.tb00005.x/pdf

Design-Make-Play: Growing the Next Generation of Science Innovators. (2010) Report of conference held at New York Hall of Science. http://nysci.org/wp-content/uploads/DMP-Report-2012.pdf

Dougherty, D. (2012). The Maker Movement. *Innovations: Technology, Governance, Globalization, 7*(3), 11-14. <http://www.mitpressjournals.org/doi/pdf/10.1162/INOV_a_00135>

Faulkner, S. (2014). Women Who Make: Undercounted as Makers and Underwhelmed by Makerspaces. *Computer, 47*(12), 30-31.

Faulkner, S., & McClard, A. (2014). Making Change: Can ethnographic research about women makers change the future of computing? *Ethnographic Praxis in Industry Conference Proceedings, 2014*(1), 187-198. Retrieved March 6, 2015, from Wiley Online.

Fouad, N. (Speaker) (2014, August 1). Leaning in, but getting Pushed Back (and Out). *2014 Annual Convention*. Lecture conducted from American Phsycological Association, Washington D.C..

Harvey, B. (1985) What is a Hacker? https://www.cs.berkeley.edu/~bh/hacker.html

Hochschild, A., & Machung, A. (2012). *The second shift: Working families and the revolution at home*. New York, N.Y.: Penguin Books.

Intel. (2014) Engaging Girls and Women in Technology through Making, Creating, and Inventing.http://www.intel.com/content/dam/www/public/us/en/documents/reports/makers-report-girls-women-exec-summary.pdf

MAKE, Maker Market Study and Media Report. (2013) <http://cdn.makezine.com/make/sale/Maker-Market-Study.pdf

MAKE 2013, Maker Faire Bay Area Attendance Study (2013) http://cdn.makezine.com/make/sales/MFBA%202013%20Survey%20.pdf

Makezine. (n.d.). Retrieved March, 2015, from http://makezine.com/

Hackaday. (n.d.). Retrieved March, 2015, from http://hackaday.com/

Henry, L. (2014). The Rise of Feminist Hackerspaces and How to Make Your Own. *Model View Culture,* (2). Retrieved from https://modelviewculture.com/pieces/the-rise-of-feminist-hackerspaces-and-how-to-make-your-own

Internet Archive: Wayback Machine. (n.d.). Retrieved February 27, 2015, from http://archive.org/web/web.php

Instructables, How to Start a Business. Retrieved March, 2015, from http://www.instructables.com/id/How-to-Start-a-Business-1/

Light, J. (1999). When Computers Were Women. *Technology and Culture, 40*(3), 455-483. Retrieved from Project Muse.

Orenstein, P. (1994). *Schoolgirls: Young women, self-esteem, and the confidence gap*. New York, New York: Doubleday.

Reiche, C. (2002). Not Every Hacker is a Woman. In *Technics of cyberfeminism:*. Bremen, Germany: Thealit Frauen. Kultur. Labor.

Techenor, P., Donohue, D., & Olien, C. (1970). Mass Media and Differential Growth in Knowledge. *Public Opinion Quarterly, 34*(2), 159-170.

Toupin, S. (2014). Feminist Hackerspaces as Safer Spaces? .*dpi*, (27). Retrieved from http://dpi.studioxx.org/en/feminist-hackerspaces-safer-spaces

Wilhelm, E. (2010). How to Starts a Business. Retrieved April 1, 2015, from http://www.instructables.com/id/How-to-Start-a-Business-1/

Women in Technology Education Foundation. (n.d.). Retrieved March, 2015, from http://www.womenintechnology.org/witef/resources