Making Change: Can Ethnographic Research about Women Makers Change the Future of Computing?

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Two ethnographers from different parts of the same technology company set out to explore the role of women and girls in the worldwide maker movement. We wanted to know who is currently participating in the maker phenomenon, how they became makers, what motivates them to continue making, what kinds of things they make, and what their hopes are for the future. Most importantly, we investigated why women are underrepresented in the realm of tech making with the explicit goal of being change agents and triggers of transformation both within our company and in the broader technology landscape.

WHY DO WOMEN MAKERS MATTER?

In an effort to better understand who technology makers are, what motivates them to make, and how our company can facilitate their making experiences, we undertook a multi-phased research study to help Intel meet the makers, and we focused primarily on women. Our research revealed there is more than one path people take when becoming makers. Data shows that makers fall loosely into two categories: about half come from a technology background, mostly hardware or software engineering, and half do not. The non-techie half often come from an art, craft or design background and approach making with a very different perspective from their more engineering focused fellow makers. For them, technology is a means to an end as they pursue their passion for making; they are more interested in what technology enables, rather than in the technology itself. They are accidental technologists. Makers of both genders follow this non-technical path, but women are more likely than men to come to making this way. Accidental technologists matter to us because they are a large portion of the maker population and they are underserved by current products aimed at makers. Additionally, if making is an activity that excites non-technical people to engage with technology, and if that engagement leads to greater interest in science, technology, engineering and math (STEM) courses and careers, then making may be able to change the long standing gender imbalance in the tech industry.[1]

[1] Bureau of Labor Statistics and Harvard Business Publishing, via National Center for Women & Information Technology: http://www.ncwit.org/sites/default/files/resources/btn_02282014web.pdf

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This paper is in the emerging practices and methods section of EPIC not because of how we did our research, but why we did the research. What's new and different with this project is the intent. We want to do more than influence business groups at Intel to design products that make making easier for everyone, although we do want to do that. We want to make a difference in the way makers are perceived by our company – who is considered a maker, and what type of making is taken seriously. We also want to see if by understanding less technical makers, the accidental technologists, we can attract more women to making, and through making, attract them to technology. Then maybe, if our hunch is correct, a passion for tech making will lead to more interest and involvement for women in STEM-related courses and careers. What makes this project different for us is that our goal is to change the future of computing so that women play a greater role.

Men are the majority of members in most hacker and makerspaces. Studies indicate that men make up as many as 81% of all makers, a percentage that is similar to the gender breakdown of major tech companies.[2] We determined that by focusing our research on women and girls we could gain a deeper understanding of the portion of makers who come from a non-technical background – the part that was not being well-served by our company. If Intel wanted to expand the market for our products it would be crucial to address the needs and work styles of these less technical users. Of course many women and girls are deeply technical, and come to making with engineering backgrounds, computer science skills, and a love of science. Similarly, many men come to making from a non-technical, art, craft or design background. Our goal in concentrating on women was twofold: to learn how to appeal to the group of non-technical makers who represent a potential market for Intel, and to see how and if we could attract more girls and women to making, and possibly to STEM courses and careers.

We heard skepticism about our research from colleagues within Intel, and from industry associates, who wondered why we care if women are not better represented in the maker movement. One internal colleague said, "If women aren't makers, then they aren't our target market, why should we pay attention to them?" This colleague defined the users of Intel's maker products as the people already using or most likely to use the products. Kris Cohen has pointed out the problem of design researchers drawing on a narrow band of already identified users.(Cohen 2005: 7) When we don't look beyond the current users of a product we are ensuring the user will remain narrowly defined.

Similar concern was voiced at an industry conference where people asked of our research topic, "Why does this matter? What needs to be fixed?" If we are in the dawn of a new age of computing, as many people believe, and a majority of innovations and products will originate from individual makers rather than big industry players,(Hatch 2014: 5) then a vast pool of less technical talent is poised to be left behind. Many of the people in that untapped pool are women. As Fisher and Margolis say in *Unlocking the Clubhouse,* "If *boys invent things, and girls use the things boys invent,* a cyberspace culture will inevitably reflect the desires and sensibilities of males to the exclusion and often denigration of females."(Fisher and Margolis 2003: 12)

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[2] Make: and Intel Corporation, Maker Market Study, April 2012

Women will be purchasers and active users of the products that come from this revolution in hardware innovation, so their inclusion as research subjects – both as device users, and as potential device developers – is of paramount importance. By ignoring one gender we would, as Cohen says, proceed "on the basis of exclusions which are resident in concepts (our theories and methods) but manifest in designs (in the products we create). Sometimes those exclusions will hardly matter; sometimes they will matter a great deal."(Cohen 2005: 9)

If the make-up of makers continues to directly correspond with the current gender ratio of people in large and small tech companies, then the future of tech making will perpetuate longstanding status quo inequalities. Our objectives were to determine the actions needed to attract and retain women in this new and important sector of hardware innovation, and ultimately, to ensure that women will play a vital role in the future of computing.

WHO ARE THE MAKERS?

The number of makers worldwide is small, but growing. The Meet the Makers online quantitative survey, which was conducted by Harris Poll on behalf of Intel, shows that approximately twelve million adults in the U.S. are Tech Makers, about 5% of the population.[3] For the purposes of this study, we defined Tech Makers as people who make physical objects with electronic tools for their own purposes or with their own designs, as opposed to including every type of maker – weavers, knitters, woodworkers, welders – regardless of their use of technology. To be screened into our online survey, makers needed to have used one of these tools in the past year: microcontroller, laser cutter, computer development board, open source robotics, 3D manufacturing tools, or a 3D printer.

Running counter to the belief that most makers are trained techies, the survey found that 41% to 48% of women polled in the US, China and Mexico came to making from an art or crafts background, while 65% of men queried in the US and Mexico (about 50% in China) have engineering or physical sciences backgrounds.[4] US women are also more likely to identify strongly with terms related to art and creation such as: creator, designer, artist, crafter and inventor, while men were more likely to relate to terms such as: tinkerer, hobbyist, DIY-er and engineer.

[3] Harris Poll national survey of 2051 adults conducted in April, 2014

[4] The Meet the Makers survey was conducted online by Harris Poll on behalf of Intel in April, 2014. Survey data are unweighted and therefore representative only of the individuals surveyed.

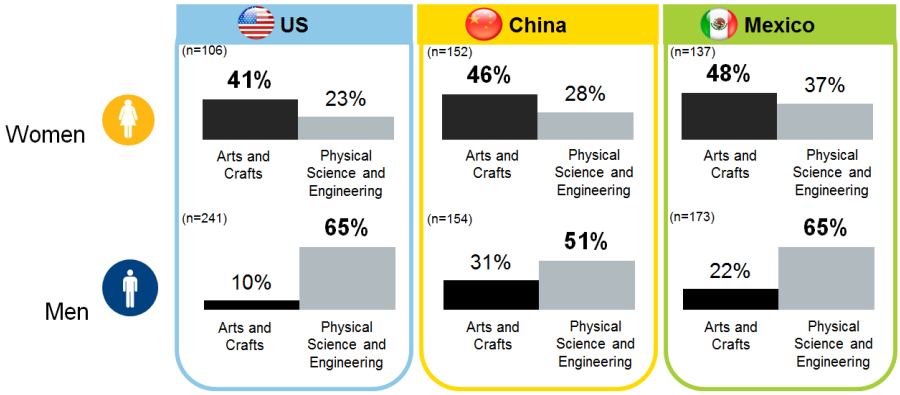

FIGURE ONE. "Which of the following best describes your path to becoming the creator/maker that you are today?" ***From the Meet the Makers survey conducted online by Harris Poll on behalf of Intel, April, 2014.***

The Maker community is comprised of a wide-range of people, many of whom do not come from an engineering or technology background. The path that people take as they become makers is important when thinking about how to design products for all makers. We know from the work of Fisher and Margolis that some boys appear to have a "Magnetic Attraction" to computers. "It is as if they fell in love at first sight, and from then on they knew that this would be something they would like to spend the rest of their lives doing." (Fisher and Margolis 2003: 16) From childhood many men are drawn to technology for the sake of it – they hack for the love of hacking, and tinker for the love of tinkering. The technology itself is a passionate interest. For many women and certainly some men too, technology is a means to an end. They did not have the same experience of falling in love with technology at an early age. According to Fisher and Margolis, "Computing and tinkering had not been (women's) main childhood activities or focus, but one interest among several."(Fisher and Margolis 2003: 17)

Makers with non-technical backgrounds think less about the tools they use, and more about the object they want to make. They create art, crafts, jewelry, or try to streamline a process in their everyday lives, and the use of technology comes about as a result of finding the best way to achieve their goals. Their passion for technology comes from their passion for making. They are accidental technologists – people who love what technology can do, and are eager to try every way to make a light blink or a motor turn, but who came to that love through trial and error, example and exposure, and are a little surprised to be working with technology at all.

WHY AREN'T WOMEN MAKING IN LARGER NUMBERS?

Our observational research in the US and China found makerspaces are dominated by men. Why aren't women going to makerspaces in larger numbers? The Meet the Makers survey shows the top challenges for women are the same as they are for men. Lack of money, mentorship, information, and access to tools and materials are the most common hurdles for all makers. For some women, their co-ed makerspace is a welcome relief from workplaces rife with sexism and "horribly inappropriate" behavior, as one software engineer explained. For her the co-ed makerspace she attends four or five times a week is a "no creep zone" where members are "vetted" and "you don't feel stupid for asking questions." But for other women, makerspaces and hackerspaces are not so welcoming. Women feel excluded, they find some makerspaces "creepy" or unsafe, and they face cultural prejudices against women using technology. In cities such as San Francisco, Seattle, Tucson and Portland, women have started their own makerspaces to avoid these issues. Liz Henry, one of the founders of Double Union, a feminist hackerspace in San Francisco, explains why women aren't going to maker or hackerspaces in larger numbers in her city.

> If we (women) aren't at hackerspaces, it isn't because we don't make things, don't code, or aren't technical enough. It's because men act like the space is theirs. Women face harassment ranging from assault to much milder, but more constant, come-ons and innuendos. Our geek cred is constantly challenged or belittled. You might be there coding, and you want to stop for a while and draw in your notebook and think, but if you're not staring at a black and green screen or, like, melding your brain with an Arduino every second, some dude is going to come up to you and act like you need his expert lessons in how to hack.[5]

In these spaces, many women find their work styles are undervalued or misunderstood – sketching and thinking are taken as signs that a woman needs help when she's just using a different work process. Art projects are not seen as being as serious as other, more technical, projects. There is a gendering of technology at play in these environments. Technology is culturally construed as masculine and art as feminine. Our culture, and many other cultures, places a higher value on the masculine. Technology trumps art, and an engineer trumps an artist. While both men and women can fall on either side of the equation—some men are artists, and some women are engineers—masculine categories of work are valued more highly than feminine categories of work. (McClard 2005) The result can be a feeling of not belonging, not being good enough, and not really being a maker. This is a big problem since making is often an community effort – even if a project grows out of one individual's personal interests, it often takes shape when that person can exchange knowledge, tools and expertise with a community of supportive fellow makers.

Studies show that female technology students lack the communities and mentors enjoyed by their male counterparts, making it harder for women to remain in the field. (Fisher and Margolis) Makerspaces are one way to provide this type of support for women. Makerspaces can connect them to other women in the field, and provide them with the community they lack in traditionally male-dominated spaces. The collaborative knowledge

[5] http://modelviewculture.com/pieces/the-rise-of-feminist-hackerspaces-and-how-to-make-your-own

building in makerspaces may be an even more important factor in motivating continued participation than the high-tech tools available to participants. (Barniskis 2014)

PROFILES OF WOMEN AND GIRLS WHO MAKE

We met a range of accidental technologists during the qualitative phase of our research. Becca Rose first majored in architecture, and then literature and the history of art, in a UK university while spending all her spare time making things. She had a loom in her house; she weaved, was an avid knitter, and started to work with puppets. Through the creation of paper shadow boxes her work became more interactive and she began working with circuits. She says it was, "A way of making a small world that people could kind of experience, and touch and feel…And I realized the only way that I could do it was I had to solder, and I had to make the circuits myself because it was quite bespoke." She created objects using craft materials and electronic circuitry, and became masterful at using paper puppetry to tell magical stories through light and shadow. Becca is currently teaching making in high schools in the Bay Area through Maker Corps, and is planning to go back to school for a degree combining illustration and circuitry.

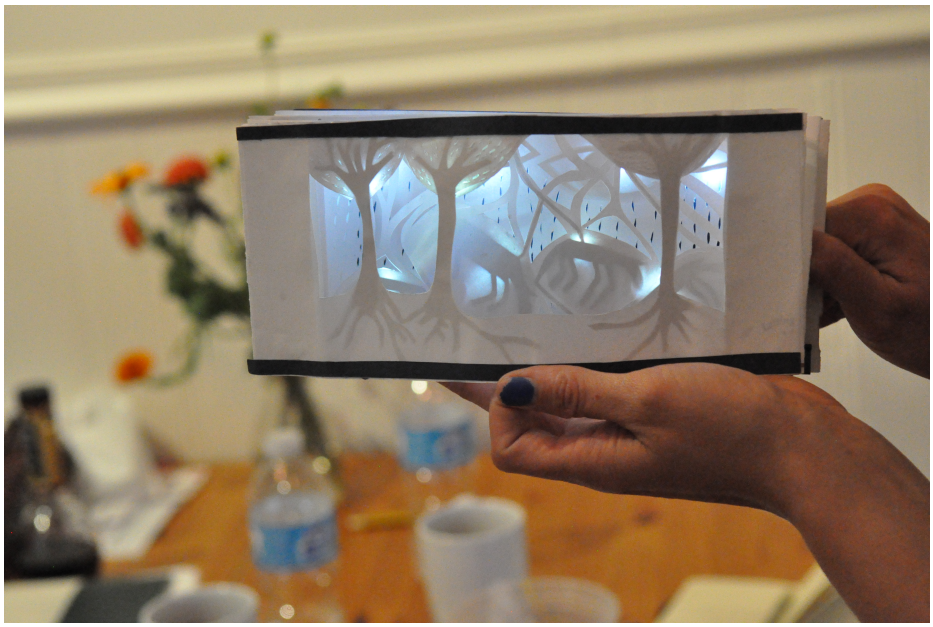

FIGURE TWO. ***A multi-layered, lighted forest by Becca Rose***
Photo credit: Anne McClard

Tenaya Hurst, an actor and dancer, performs one night a week in the San Francisco Follies. She has always sewed, knitted, done cross-stitch, and made projects out of soda can tabs, rubber bands, and anything else she could get her hands on. She says, "I've always been a maker, I just didn't call myself that." In 2013 she went to Maker Faire, discovered Arduino, the popular open-source electronics platform, and started creating jewelry and clothing with embedded electronics. She began teaching others how to use Arduino, and now teaches workshops for adults and camps for kids, geared toward making objects with electronics. Tenaya's own making is focused on self-expression and wearable technology. She says, "For me, being excited about electricity and electronics goes directly to 'I want to wear it,' because I am sort of a showy, actress-y person. I could make something that sits on my table or that I bring out to show a friend – a cool robot car – but if I wear it, it's already there to start the discussion."

FIGURE THREE. ***A necklace made of Atmel© microcontrollers by Tenaya Hurst. Photo credit: Susan Faulkner.***

Both Becca and Tenaya are makers without engineering or technology backgrounds whose love of creating beautiful, interactive objects led them to working with electronics. They represent a different entry point to technology use from the typical Intel developer.

We also spent time with kids enrolled in after-school programs and summer camps. In Oregon we visited a Computer Clubhouse, an after-school learning environment for kids to explore their own interests and learn about technology, and we met Carla who is entering

eighth grade. She was described by the clubhouse director as a "major maker." Carla and a few of her club mates made a little village using Makey Makey, an invention kit that turns everyday objects into conductive touchpads. She likes science and math, and told us she wants to be a veterinarian when she grows up. She and her friends like the social aspect of making, and Carla says, "When you're on the computer you work by yourself. When you make stuff you work with people." When we asked about the difference between making things in the Computer Clubhouse program or in science class in school, her energy level dropped. She said in school the girls do the writing and the boys do the experiment. "The boys grab stuff and do it, and the girls write the description." We heard a similar story from girls in a coed high school robotics club – girls tend to fill a communications role (which requires both a deep understanding of how everything works and the ability to communicate that to other people), and they rarely take the job of driving the robot.

How can we empower girls to "grab stuff" in a challenging school environment? How can we give them the confidence and drive to take charge of a coed science activity? Makerspace studies show that female participants become more engaged in learning new technology-based skills when they are incorporated into more traditional craft skills. (Barniskis 2014) Instead of changing the way teachers and boys act in middle and high school, can we bring more craft making into the classroom?

Like the makers we met who come from a more arts-oriented background, the girls we met in after-school programs are interested in projects to which they have a personal connection – a project of their own design. They come up with an idea for something they want to build, for instance a dancing trash can or an underwater sea creature, and technology is a means to that end. Mitchell Resnick says, "Children become most engaged with new technologies, and learn the most in playing with these technologies, when they work on projects growing out of their own personal interests." (Resnick 2006: 48)

We saw this first-hand at a middle school in San Jose, CA where we met some of the TechGyrls, the Silicon Valley branch of a highly successful nation-wide YWCA after-school empowerment program that provides girls with opportunities to increase their skills and confidence in the use of technology and engineering. There were about 15 middle-school aged girls in the group we met, and they had been given the freedom to come up with a concept for what they wanted to make. Almost all of the teams' ideas fell into two categories: unicorns or rainbows. One team made a stuffed unicorn with built-in intelligence. When two unicorn horns "hook up" they light up to show the unicorns are happy. Another team built a rainbow iPhone case that lights up.

When provided with an open-ended, girls-only experience that is less possible in the formal education system, these kids chose to make colorful, girly projects for the sheer fun of it. The TechGyrls demonstrated the personal connection discussed by Resnick. They were more motivated, and delved deeper into the technology, than they would have in a school classroom.

FIGURE FOUR. ***Happy Unicorns at MakerFaire made by a team of TechGyrls. Photo credit: Susan Faulkner.***

DESIGN CHALLENGE: MAKING FOR MIDDLE-SCHOOL AGED GIRLS

Designing products with unicorns and rainbows isn't the answer to reaching all girls and women (what works with some 12-year olds will repel others), but having a sense of what the current fads are within an age set might be useful for helping to engage them in activities like coding and making hardware that could otherwise seem boring. We decided the key was finding a way to make making easier, so we set out to provide a kit that would help kids make anything they wanted to make, including rainbows and unicorns.

A team of designers at Intel made a tinkering kit prototype expressly for middle-school aged kids. The kit is made up of tech components and lots of craft materials plus a white cardboard box and two Ping-Pong balls. The idea was for the kids to make an interactive creature of their own design. The concept started with Connect Anything, a tool developed by Intel Labs that allows makers of all skill levels to easily connect inputs to outputs and quickly build simple prototypes in real-time on Intel's Galileo development board. The first time the Intel team took Connect Anything to a girls' after-school program, some sensors got "cooked," there weren't enough connecting wires to go around, and an attempt to cut and multiply the existing wires backfired. But the main issue was that the girls found the

wiring of the electronics – the tangle of cords going in and out of a circuit board – to be confusing and intimidating. The next iteration of the concept is called the Tinkering Kit and it aims to simplify that part of the process. It is comprised of a simple connection shield that snaps onto the Galileo and allows sensors and actuators to be attached with standard connectors.

In the workshops we found that starting with the craft, and giving kids the freedom to come up with a concept for what they wanted to make, was the best way to engage them immediately. Every kid could jump in and participate in the craft activity. The creature became the focus, and when the technology was introduced it was a means to make the creature move and light-up. We also found that incorporating storytelling was a great way to further engage the kids. Each team created a story about their creature and its abilities. Several teams knew what they wanted to make, and worked toward a specific goal such as Gary the Snail from SpongeBob, a creature called Bella, named for one of its creators, and a one-eyed carnivorous monster.

We found it is important to leverage the playful aspect of tech making to captivate kids who might not be interested in technology otherwise. The exercise expanded the kids' concepts of what technology is – they could invent and create, not just *use*.

INSIGHTS AND CALL TO ACTION

Within Intel the research has influenced colleagues whose idea of a "maker" was an engineer with a love of circuits and resistors just like them. We have broadened the definition of what a maker is, and now include people who come from less technical backgrounds like art, design and music. A software solutions group that is designing maker kits for developers has expanded their definition of a "user" to include accidental technologists. We are increasing our efforts as a corporation to reach out to middle-school aged girls and excite their interest in making at a young age. The Labs' team continues to refine the Tinkering Kit, and is putting together a new kit aimed at kids for the Start Making program, part of the Maker Education Initiative (Intel is a sponsor along with Maker Media, Pixar and Cognizant.)

We know that programs and activities organized around making are a great way for children and adults to become excited about creating objects using technology, and that many of them become passionate about technology while working on projects they care about deeply. But does an interest in making influence interest in science, technology, engineering and math? Through this research we have identified big questions we want to pursue in a multi-year longitudinal study of a large group of kids. When non-technical people become passionate about making things with electronics does that lead to a broader interest in technology? Does a passion for making lead to an interest in STEM academic courses and careers? Can girls' passion for making be sustained past middle-school, the age at which many young women lose interest in science and technology-related courses? If the girls' interest in making remains, will that translate into interest in STEM? Is making a path toward bringing more girls and women into STEM? Can making change the gender ratio of the people creating technology? If the hands-on, open-ended, and personally meaningful attributes of making attract girls and women, and other underrepresented groups, to STEM-

related academic fields and careers, companies can move toward a more gender-balanced board room, leadership team, and overall employee roster. Maybe through making we can change the configuration of the makers, developers, hackers and users who will bring the next wave of computing to life.

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NOTES

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