Manufacturing Expertise for the People:
The Open-Source Hardware Movement in Japan

MATT KREBS
KelCor, Inc., University of Kentucky

Manufacturing itself is changing as open-source sentiment grows with the "maker" movement, especially in FabLabs around the world. "Makers" are open-source hardware enthusiasts who want anyone to be able to make almost anything. This ethnographic research, conducted in 2013, centers on the "makers" in FabLabs in Japan. The research addresses cultural coherence among actors – human and machine – in these FabLabs, and changing notions of expertise enabled by open-source, DIY manufacturing practices. Are modern machines like 3D printers changing manufacturing? Will they change the world?

> "Scarcely a new invention comes along that someone does not proclaim it the salvation of a free society."
> Langdon Winner 1980:121-122

INTRODUCTION

Social researchers have been intrigued by open-source projects that have led to changes in industrial practice through disruptive software projects like Linux and Firefox. Perhaps some companies have been spooked by such projects as a threat to the bottom line or to the expertise that justifies some of the value of their products. Now, open-source sentiment is growing in hardware design and production domains as well, reshaping the expertise and practice of manufacturing. The term "maker" has begun to be used as shorthand for a do-it-yourself (DIY), open-source, global movement to "make" things and "hack" things that previously were the express domain of corporate design, engineering, and production teams. What does this "maker" movement look like at close range? The ethnographic research reviewed in this paper addresses a subset of the "maker" movement, focusing on the people who operate and occupy FabLabs in Japan. I conducted the research during the summer of 2013 with support from Intel Labs, visiting each of Japan's six operating FabLabs, interviewing proprietors and patrons, and observing the practice of "making".

Most people (especially in technology circles) now recognize that extra-corporate collaborators – ad hoc groups that create competing products - can deter well-planned product lines. However, the total impact of this percolating open-source sentiment is much more variegated and nuanced. Today, in the space between garage tinkerers and corporate engineering teams, there is a range of actors "making" things. There seems to be more at stake than a few product lines. "Makers" speak of a world where anyone can make "almost

anything" (Gershenfeld 2012, 2005) and where new tools like 3D printers presage a "new industrial revolution" (Anderson 2012). The ambitions of individual "makers", the venues of production, and the tools of choice may differ but their central purpose remains the same: put the power of manufacturing in the hands of the people and change the future.

The "makers" whom I observed in FabLabs in Japan help to provide some measured ethnographic perspective on the enthusiasm with which popular literature has begun to herald the "maker" movement. In this paper, after situating the Japanese "makers" among whom I studied within the broader context of FabLabs, of benighted economic Japan, and of the global "maker" movement, I will describe a few of the FabLabs in enough detail to give the reader a sense of their operation and attitude. I will highlight the way in which FabLabs are used to "employ" (in Latour's sense, 2005) ever-more accessible technical tools such as CAD software, 3D printers, microcontrollers, and laser-cutters - recruiting and assembling a host of agents. The proactive practice of the agents who employ these tools interacts with the existing cultures in which they operate. To tease out some understanding from the ethnographic data, I will address changing notions of manufacturing expertise and the Japanese sociocultural backdrop against which their work plays. Finally, I will comment on the way in which the lavish enthusiasm for the possibilities of "making", while perhaps overwrought, nevertheless has a discernible effect on the cohering of the agents that comprise the movement.

SITUATING "MAKERS" IN JAPAN

Making is certainly not new. People have always made things, of course. Chris Anderson, Neil Gershenfeld, and Cory Doctorow, who have helped to popularize the term, along with O'Reilly Media's "Make Magazine", neither invented the term nor the movement. Furthermore, FabLabs are not the only place where it coheres and performs. In my experience among "makers" there is certainly no singular nor essential culture (of expertise or otherwise) coalesced as a primary structuring force in "makers'" lives. "Making" in its present, technology-centric denotation refers to the broad practice of creating objects for fun or perhaps income. The creation usually involves new technical tools and the designs are often shared. A quick, general summary of the field will help to situate the "makers" among whom I studied in Japan.

"Making" can be applied as a descriptor to a host of creative practices. At any given "Maker Faire", of which there are now dozens around the world sanctioned formally by Maker Media, people of all ages will bring their resourceful creations to display and discuss. Some will be all plastic and duct tape. Some will be programmed by microcontrollers. Some will be just for fun and some will boggle the mind with their practical ingenuity. The allure of "making" is enhanced by the phenomenal range of creations that come from the minds of "makers", enabled by the increased availability of knowledge and tools.

There are many places where "making" happens. The general term: "makerspaces", often synonymous or at least co-located with "hackerspaces", describes the thousands of little workshops around the world where people tinker with things - either to fix, hack, or create them. In the U.S., San Francisco is a hub for "makerspaces", along with New York and Boston, following the vanguard of technology. Still, even my native Lexington,

Kentucky, is presently building public "makerspaces" in a school and a library. On the national stage, President Obama has instituted special support for education-a-la-"making" through the National Network for Manufacturing Innovation, funding new machine-centered curricula, such as that being programmed by Stanford's FabLearn Fellows program. Then, of course, there is the young but storied Tech Shop franchise from which inventions such as the Square credit card reader have emerged. This business-grade "makerspace" costs $125 per month but gets you access to top-tier equipment and hands-on help from experts.

"Making", then, is a global phenomenon that encompasses a wide range of people, places, and activities all animated by an interest in building and sharing things. Its future impact is an often-conjectured but open question.

Popular Literature on "Making"

While the precise etymology and static meaning of the term "maker", as it is used in this research, may never be more than an approximation, a few authors have certainly had an impact on its present signification.

Chris Anderson's 2012 book: *Makers: The New Industrial Revolution* has been a pivotal work of introduction to ideas about "making" for many people. Anderson suggests that "making" will redirect people to newly invented machines for local, collaborative, and DIY projects, fundamentally altering the preeminent mode of work in established manufacturing operations. The book gives many examples of impressively collaborative creations, such as his own DIY Drone project, and commercially successful projects like the Square credit card reader. Most notably, perhaps, is Anderson's unequivocal argument throughout the book that "making" is the beginning of "a new industrial revolution". At its core, Anderson's book is a tale of micro-batch entrepreneurs who can go from tinkering to sales very quickly, the business-class of the "maker" group.

Neil Gershenfeld, at MIT, seeded the burgeoning FabLab corner of the "maker" movement with his book about a lab he arranged on the MIT campus inside the Center for Bits and Atoms. *Fab, The Coming Revolution on Your Desktop - From Personal Computers to Personal Fabrication* (2005) is the introductory text for nearly all of the people I met as "makers" in Japan, who read its Japanese translation. Gershenfeld filled his lab in Boston with a set of machines by which students could make "almost anything" in one semester. The novel notion and belabored epiphany of the book is that with these new tools, "anyone can make almost anything" (17). With a creative idea, a lab with the right machines, and a mentor to help with software and hardware, Gershenfeld (and thousands more FabLab enthusiasts) hold forth that we will all be "making" things on our desktops and in garages, or in FabLabs soon. There are already more than 250 chartered FabLabs in the world. There is a ten-year-old International FabLab Conference and a FabLab Research Group. Gershenfeld's mantra is that fabrication (or "making", or design, or manufacturing) is on the cusp of being personal, social, and never again just commercial.

A final publication that has impacted the present meaning of "maker" is *Make* magazine, originally published by O'Reilly Media and then spun off as part of Maker Media. The magazine, however, is just an entrée to the website, the webshop, and the Maker Faire

events that Maker Media operate - a center of activity and publicity that continues to garner attention for the "maker" concept.

This sampling of publications gives a further sense of what is meant by the term "maker". Each publication has its own spin on the practice of "making" but I note that each is also, in its own way, imagining "maker" activity to be the precursor to a whole new human future. There remains, I think, ample space to examine as ethnographers the present shape of the movement, its rhetoric, and its future as it gains momentum around the world.

Critiquing the Rhetoric

Scholars in anthropology and especially in the interdisciplinary domain of science, technology, and society studies (STS) have not shied away from investigating the deep social implications of new social formations such as the "maker" community. M.J. Fischer has turned a great deal of research attention toward "emergent forms of life" (2009, 2003) enabled by technological change, of which "making" is certainly one.

Susan Currie Sivek (2011) has directly addressed *Make* magazine, suggesting based on her textual analysis of the magazine and observations of its Make Faires that it promotes a technological utopianism, offering "participation in technology as an opportunity for self-actualization" (189). Sivek questions the assumption therein that the power of technology is by definition positive and natural. She notes how the technical objects of "maker" affection reflect a narrow vision of what can be created. For example, "make" objects often require energy to function but "makers" seldom design down power requirements. Sivek calls for more critical research and writing to supplant the dominant utopian assumptions.

Brian Pfaffenberger, an anthropologist, has described the fallacy of "technological determinism" (1998), or the assumption that technology is a "powerful and autonomous agent that dictates the patterns of human social and cultural life" (Pfaffenberger 239). The claim that 3D printers will democratize manufacturing, for example, makes that assumption: that the object dictates the human patterns. In fact, maintains Pfaffenberger, "the outcome of a given innovation is still subject to substantial modification by social, political and cultural forces" (Pfaffenberger 240). The relevant point here is that with new machines like 3D printers or free CAD software like Autodesk, the rhetoric easily slips into this fallacy of determinism when in fact the human use of the machines remains subject to a great deal of pressure from existing social systems and redirection by external powers such as companies, research institutes and governments.

Dr. Gershenfeld, for example, is welcome to say that in FabLabs anyone can make "almost anything", but there may be many people who cannot, in fact, make anything, such as those inhibited by gender, income, race, and other intransigent social patterns. Examples of creative power in the hands of laypeople are impressive – no doubt. Still, the utopian rhetoric rings with the sense that all is as it should be – positive, natural, and accessible. Should we not expect to find, upon closer investigation, also stories of negative experiences in FabLabs or communities of "makers"? At the least, are there not stories of failed projects, frustrated "makers", or the transition from personal projects to private gain? Who is benefiting from the way in which we talk about "makers" today? And is this fate of

"making" determined by the new technology or is there a social story – with opportunities for derailment or redirection – still being written?

I certainly am not inclined to discredit the "maker" endeavor out-of-hand, faulting only its vaunted rhetoric – more often the contrary. However, there are reasons to ask whether the practices of "making" are what they purport to be.

Why "Makers" in Japan?

Against the global "maker" backdrop, this research focuses on "makers" in Japan where technological advances have been a central part of a once-ascendant global economy, still the third largest in the world. There are many people in Japan whose work is linked to machines, to design, and to manufacturing. Many of these people have worked for large companies such as Hitachi, Toshiba, and Sony, or carmakers such as Toyota, Nissan, and Honda. These have been the bastions of expertise in manufacturing, tightly linked to the universities, research institutes, and government resources that enable Japan's globally respected manufacturing sector. There are also many Japanese folks who fit the broad category "maker" that I have described above, working on personal projects as hobbyists. Sometimes, these are the same people. Many people employed to design and make things in a corporate environment by day continue to pursue personal fabrication projects during their free time. Other "makers" in Japan are unemployed or working in other industries.

FabLabs in Japan – In or around 2010, Dr. Gershenfeld's FabLab model came to Japan (or was brought to Japan, as I will explain in the next section). Now, there are ten FabLabs formally organized in Japan. The FabLab folks are an active group within the "maker" community in Japan. I chose to focus on FabLabs because "maker" activity in them is both anchored in a place and visible to a researcher's eye. A lot of "maker" activity, designed on personal computers and fabricated without the novel machines that interest me, such as 3D printers, is nearly impossible to catch by personal observation. A FabLab generally houses one or more 3D printers, a laser cutter, microcontrollers, CNC machines of various kinds, and other machines for fabrication. The purpose of the lab is to open these machines to the public, to make the software and hardware accessible through training programs, and to spread the knowledge and expertise of manufacturing, or "fabrication", to anyone.

Precarious Japan – Japan's laggard economy seems to have inclined many individuals to a despairing attitude about their prospects for a fulfilling life. This context turns out to be an important social backdrop for a study of "makers". The despair can seem to simmer through Japanese work and personal ambitions. That suggestion may seem rash or untenable – I certainly don't suggest it as definitive – but it is drawn from Anne Alison's (2013) analysis of modern Japan. Alison's key observation is that many in Japan have an existential sense of precarity in life. Alison wrote that this precarity arises from: "struggling with a long lasting recession, political instability, an aging and declining population, and, among the people, rising levels of homelessness, poverty, suicide, and existential despair" (124). This is particularly evident in the Japanese youth who can no longer expect lifetime employment after any manner of training and who are constantly pushed out of sight by the working

population around them. This is what I called, in my intro: benighted economic Japan. Alison draws her analysis through examples of lives disrupted and despairing, losing their connection to their nation, their fellow Japanese, and even themselves, but there is a particular passage that I think situates the role of the "maker" movement within the dire, precarious context that she describes.

> …in trying to survive a condition of precarity that is increasingly shared, one can see a glimmer in these attempts of something new: different alliances and attachments, new forms of togetherness, DIY ways of (social) living and revaluing life. One can sense, if one senses optimistically, an emergent potential in attempts to humanly and collectively survive precarity: a new form of commonwealth (commonly remaking the wealth of sociality)… (Allison 2013:18)

Japan's precarious context as described by Alison is, I think, part of what may give rise to a movement like the "maker" movement. It may be that the promise of a new way of life, "human and collective", as spun by the advocates of the "maker" way of life, is gaining traction for precisely the reasons and in precisely the context that Alison has described. The perceived failure of an old system is increasing clamor for a new system.

Thinking about larger social patterns in Japan such as precarity helps to contextualize the global "maker" rhetoric in a more particular time and place, distinct from the Western environments from which much of the rhetoric is published.

DESCRIBING "MAKERS" IN JAPAN

Considering the context described above, I now attend to a description of what I have observed in my work in Japan so far. I will profile Dr. Hiroya Tanaka who has inspired and helped organize all of the other FabLabs in Japan (Tanaka 2012). Then, I will describe just a few of the FabLabs. My purpose in this segment is to provide a description of these places, activities, and people. Further analysis will follow in the final segment.

Dr. Hiroya Tanaka

At the beginning of my research in Japan, everyone seemed to ask me if I had talked with Dr. Hiroya Tanaka. As soon as possible, I found that chance. I met him at the press conference in Yokohama announcing the opening of FabLab Kannai.

Dr. Tanaka had visited Neil Gershenfeld for a year at MIT in 2009 and then returned to Keio University to build his own laboratory that he calls the Social Fabrication Center. He trains students here much like Dr. Gershenfeld does at MIT, surrounded by machines, busily at work with hands-on projects. As the FabLab model is duplicated around the world - there are now more than 250 FabLabs - enthusiasts like Dr. Tanaka become central players in the coherence of the group. "Makers" in Japan have usually read a book by Dr. Tanaka called:

FabLife: The New Future of Making that Begins with Digital Fabrication[1] (2012)[2]. In that book, Dr. Tanaka describes the core values of the "maker" lifestyle in terms that seem to inspire and recruit many Japanese people to his vision.

Each of the FabLab directors with whom I spoke mentioned crossing paths with Dr. Tanaka, being motivated by him to start a FabLab, and getting startup advice directly from him. I learned from one of the FabLab directors that Dr. Tanaka holds a weekly Google Hangout video chat with all of the directors. Dr. Tanaka speaks often in Japan about FabLabs and is active in the international FabLab community, organizing and promoting the International FabLab Conference. He led Japan's hosting of that Conference in 2013.

When I had occasion to speak with Dr. Tanaka, he described himself as "open-source". That is: he expected everything he said and did to be public domain. He described his vision for the FabLab movement in dizzying detail. As exemplified by the name of his lab at Keio University: Social Fabrication Center, Dr. Tanaka feels strongly that the practice of "making" is best when it is social, especially as people in Japan become increasingly alienated from each other. He also made it clear that he did not want the labs to follow any formal model. Of course, the basic principles of sharing designs and expertise are essential but beyond that, Dr. Tanaka expressed his desire that each lab emerge on its own energies and with its own local personality. Dr. Tanaka's impact on "makers" in Japan, especially in the FabLab community, seems fundamental to the coherence of the enterprise.

Describing The FabLabs in Japan

In Japan, the FabLabs are in Tokyo (Shibuya), Yokohama, Kamakura, Osaka, Tsukuba, Sendai, Oita, Tottori, Hamamatsu, and Saga. I spent time observing "makers" at work in six of these labs. Oita, Tottori, Hamamatsu, and Saga each opened after I left. I attended workshops organized by "makers" and followed online conversations between "makers" on Facebook and other online spaces. I interviewed FabLab directors and patrons in most of those labs in an unstructured format (Bernard 2011).

In this section I will describe just three of the FabLabs in Japan, all started in 2013: Sendai, Kitakagaya (Osaka), and Kannai (Yokohama). Mentioning just a few notable features of each lab, my purpose is to give readers a sense of the distinctions in character between them. A chart at the end of this section gives overview detail on most of the labs, insofar as available to me so far.

Sendai - The FabLab in Sendai is located in an apartment on the fourth floor of a tall building just blocks from the train station in Sendai. Three staff members greet walk-ins from 1:30 pm to 9:00 pm five days a week. This is a lot of open time, compared with other labs. The lab has a wooden desk with electrical outlets in the middle of the room and computers on tables around the perimeter of the room. The fabrication machines are also built around the perimeter: a few 3D printers, a large laser cutter, and a CNC sewing

---

[1] Title translation by me because the book is only published in Japanese and Chinese.
[2] Notably, published by O'Reilly Media.

machine. The laser cutter stands out and was in use much of the time I was observing there. A large tube carries debris from the laser cutter out onto the balcony and city below.

The staff are employed officially by the Anno Design Lab (ADL). The company, a design firm, has a hefty grant from the City of Sendai to keep the FabLab operating. The staff reported that the City sees a high value in the FabLab as a place where citizens can work on projects to rebuild their city after the disasters in March, 2011. This business model – exclusive funding from government – is unique among Japan's FabLabs. The director informed me that he was working out a way to continue to fund the lab after the grant expired. He did not have a reliable plan when I last spoke to him but seemed confident that they would find a way to stay open. I saw no more than three patrons at-a-time in FabLab Sendai during the time that I was observing there, though the cost to use the machines was low and there was no entry fee.

One patron was a long-time dollhouse maker, a woman in her sixties. She was thrilled to have found a place that helped her learn to design dollhouse furniture on computers and print or cut them in the FabLab. She was a regular patron. Most of the other patrons I saw there were men who seemed to have a knack for the machines already. The staff was also working on projects, both for clients of ADL and for their own interests. When a patron needed help, the staff would trade off breaking from their work projects to help.

I did my first "making" at the Sendai lab. I needed a lot of help. I had found designs online for toys for my children. The staff at the lab helped me to convert those files to fit their machines and helped me send the files to be printed and cut. Thus, as a patron, I found that I did not need to have much knowledge at all to get an object made. Still, my appetite was whetted for learning the software and the machines better and for making more tailored objects. In fact, upon sending my downloaded design through the 3D printer, in something of an epiphany, I felt a surge of confidence and perhaps power. In my small step into "making" at FabLab Sendai, I understood better the feeling of owning the means of production and why so many people are motivated to own more as "makers".

Kitakagaya (in Osaka) – FabLab Kitakagaya is not open during the week, just on weekends. The FabLab occupies an emptied-out industrial machine shop in the shipyard on the Osaka port. The Osaka port has been second only in commerce to Tokyo's. Osaka is known for its rugged dialect and fast-paced environment. The FabLab reflects this. Everything inside the space is built from scratch. The first thing I was offered when I arrived was bug spray for the swarm of mosquitos hovering in the open-air lab at night. Second, I was offered a drink from the full bar built with wood cut on a CNC router. One room was built inside the lab, without a roof, to enclose the machines used to make projects: a 3D printer, a laser cutter, and a milling machine, among others. Outside the wall of that enclosure sits the large CNC router used to cut the wood pieces needed for projects. The impact of this wood-cutting machine is a most notable feature of this up-from-scratch lab.

As many as fifteen people cooperatively manage FabLab Kitakagaya, all with separate careers of their own including professor, artist (in Kyoto), and designer. The income is from $20 monthly memberships, held by about sixty members (as of 2013). Thus this lab functions more like a club for people who like to use the machines. They use those machines very socially, gathering over weekends to work in concert on a project. Though there are

women members, the majority are men. One weekend, they wanted to try to make a shoe. Each FabLab member would apply their own skills to different parts of the shoe and see what the team could create in a couple of days, lubricated well by drinks from the bar, of course. One patron told me that she goes to the lab for the people more than to make things. Another person called the lab "wild". Still, the tools are mostly the same as in other labs while the lab layout, the people, and the funding model are all quite different.

***Kannai (in Yokohama)* –** FabLab Kannai opened just as I was leaving in 2013. A young graduate student at Tokyo City University was active in organizing the lab and planning the preliminary events to build interest. The 9th International FabLab Conference was held nearby so that the official opening could be part of the conference: Dr. Tanaka's idea. There was not really a "lab", per se, when I was visiting. Rather, a few machines were stored on a shelf inside a shared office space for programmers and designers called Sakura Works. While the space was thus not exclusive to FabLab Kannai use, it meant that the lab had more event space than any other FabLab. Sakura Works is managed by the Yokohama Community Design Lab (YCDL). The folks who run YCDL are enthusiastic about the prospects for the FabLab. They are proponents of a tech- and citizen-oriented revitalization effort in Yokohama and publish a local paper to that end. In August, 2014, I read news that the FabLab had built shelves in a room within Sakura Works and was now holding open hours on weekdays and weekends. This certainly marks growth at FabLab Kannai. Hideyuki Furukawa, the graduate student who was central to the origin of the lab, early on built a small wooden cart on which he could fit all of the machines from his FabLab. He called it the FabLab *yatai*, or: FabLab cart. While the machines are still mostly borrowed and the funding is not entirely secure, FabLab Kannai has a lot of local support, including press, and is likely to grow quickly into one of the prominent FabLabs in Japan.

While all of the FabLabs in Japan hold events periodically, FabLab Kannai seems to excel at it. Perhaps this is because they have the space right at hand. As with every lab except Kamakura, FabLab Kannai is managed by men. At the events I attended, there were just a couple of women attending. One event showcased the 3D printer. Another showcased the new Lego Mindstorm kit. Another, the Arduino microcontroller. I did take the chance to talk with a young woman who was attending many of these events and helping to prepare for the Fab9 conference. She reported that she wished at times that there were more women around but that she never felt any derision or exclusion while volunteering.

	FabLabs Visited in 2013						New Since August 2013			
	FabLab Shibuya	FabLab Tsukuba / FPGA Cafe	FabLab Sendai / FLAT	FabLab Kannai (Yokohama)	FabLab Kamakura	FabLab Kitakagaya	Oita	Tottori	Saga	Hamamatsu
City	Shibuya	Tsukuba	Sendai	Yokohama	Kamakura	Osaka				
Date Established	2012	2011	2013	2013	2011	2013				
Location	in Tokyo	East of Tokyo	East of Tokyo	West of Tokyo	West of Tokyo	West of Tokyo				
Distance (from Tokyo)	0 km	80 km	370 km	35 km	55 km	505 km				
Parent/Host	co-lab		Anno Design Lab	YCDL						
Director	Hiroaki Umezawa	Susutawari (Noriyuki Aibe)	Keisuke Watanabe	Kazuo Kadota Tsuneo Masuda Kenichi Ohwada	Youka Watanabe	Kazutoshi Tsuda				
Salaried Employee?	Yes-partial	No	Yes-partial	No	Yes	No				
Open	Work Days - Varies	Sunday afternoons	Wednesday through Sunday	Most days	A few mornings each week, events	Weekends				
Food/Drink		Coffee shop				Home-made bar				
Building	An extension of co-lab's two-story design office	Second floor apartment in suburban Tokyo college town	Fourth floor apartment in downtown Sendai	Borrowed shelves inside Sakura Works' shared office space	Retrofitted portion of Dr. Hiroya Tanaka's 300-year-old home	Empty shipyard factory near Osaka Bay				
Notable Tools	Altogether, co-lab has the most tools but the FabLab uses a standard subset of those	Makes micro-controllers			CNC Sewing machines	ShopBot CNC Router				
Funding	Expensive user fees	Some fees, run by Susutawari as part of his prototyping business.	Funded by a grant from the City of Sendai for civic reconstruction after 2011 disaster	Borrowed equipment, volunteer run, some event and usage fees	Event fees, premium hand-crafted goods sales	Monthly membership from ~60 people at ~$20 each				
Description	Small room jammed with machines in the fashion district of Tokyo, hosts mostly prototypers from nearby design firms	Geeky, manga-character-decorated workshop with a focus on microcontrollers, run by Susutawari	One-room apartment in downtown Sendai, fully funded by Sendai City - most accessible of the FabLabs	Managed by volunteers, organizing events inside a shared office flat near a professional baseball stadium	Occupies a portion of Dr. Hiroya Tanaka's 300-year-old home. Compact on two floors, especially welcoming to seniors	Open-air space with a single room built around the machines. Young group paying membership dues				

Figure 1: FabLab Overview, produced by the author

UNDERSTANDING "MAKERS" IN JAPAN

The descriptions above may seem scant as a representation of the "maker" community in Japan, or even of its FabLabs. There is much more to learn and describe inside these FabLabs in future research and writing about, for example, the impact of existing structures such as gender and class and about the precarity of which Alison has written. I plan to spend most of 2015 in Japan, especially at FabLab Kannai, to extend this inquiry. Still, this project represents a closer look at "makers" in action in Japan than has been available so far from a scholar's ethnographic perspective. Thus, in this final section I aim to connect a few theoretical strands to this research that may be of interest to readers.

Expertise

First, as acknowledged in the title of this paper, there are important changes occurring in the "culture of expertise" by which global production is accomplished because of "making". Noted STS scholars such as Karin Knorr-Cetina (2009), Hugh Gusterson (1998), and Sharon Traweek (1988) have done ethnographic work inside labs and produced a body of evidence pointing to distinct cultures within these labs. These cultures seem to affect the output of the labs at a deep social level. More recently, scholars have been discussing cultures of expertise in a broader range of work (Boyer 2008) such as financial governance (Holmes & Marcus 2006, 2005) and craft cheesemaking (Paxson 2012). In addition, great ethnographic work has been done by many of my colleagues in the EPIC community inside large industrial companies (see Baba 2012, Jordan 2012, Moeran 2011, Cefkin 2009, etc.). From all of this work we are getting a look at what it means to be an expert in different domains, and what that special status imposes upon the output of each unique environment.

The FabLabs, however, are distinctly open-source and profess a rigid egalitarianism. This marks something of a departure from the corporate environments and standard models of expertise in science and manufacturing. I have observed in my work so far a unique culture of expertise forming in its own way among "makers" in FabLabs. In Japan, this "maker" expertise seems anchored in one's degree of openness, non-uniformness, and a geeky (*otaku*) sensibility manifest in personal and online styles, in addition to manufacturing skill. Dr. Tanaka would clearly be seen as an expert. His influence is undoubtable. At FabLab Kannai, however, Mr. Furukawa, perhaps seen by many patrons in 2013 as an expert, was in fact learning a lot himself about "making" as he organized events. In 2014, Mr. Furukawa is no longer managing FabLab Kannai and his status as an expert has probably waned. Reputations or positions of expertise within this community may rise and fall very quickly. Finally, this culture of expertise, aggressively open when compared to the experts who can access larger machines of production inside industrial companies, may be having its effect on the latter, although in the scope of this project I cannot quite get a handle on that influence.

Tools, Actor-Networks, and Cohesion

Another theoretical domain in which this research on "makers" in Japan seems relevant is the consideration of heterogenous actor networks and the question of cohesion in particular. In the actor network model (Latour 2005, Law 2009) the technical tools employed by human agents in FabLabs are not simply dumb objects but rather bear something of an agentive influence on the whole social operation. Robert Oppenheim's advice is to interrogate ad hoc group cohesion beyond the classic anthropological categories: "class, ethnicity and so on" (Oppenheim 2007:474), by way of technical "intermediaries" (Latour's word) that can "faithfully transmit the force of cohesive action" (474). As "intermediaries", newly accessible machines such as 3D printers may be central to the magnetism of "maker" activities. What I mean here is that the answer to why "makers" organize, as Oppenheim suggests by way of the actor network model, may require an inquiry into the objects themselves – 3D printers in this case – that are used as "intermediaries".

Even in my initial research there is strong evidence that the machines in FabLabs are central to the cohesion of the entire endeavor. The simple fact that each lab, very different in its business model, management structure, local community support, gender makeup, class categories represented by patrons, and dozens of other factors, still has the same three machines: the 3D printer, the laser cutter, and some manner of CNC mill, is one example of this evidence. In fact, among many brands available, the Cube 3D printer was observed in nearly every lab. There is a link between labs – a purpose in the acquisition and employment of these tools – that represents a pivotal position of influence born by technical intermediaries in the cohesion of FabLab and "maker" activities in Japan.

Imagination, Hope and Precarity

A final theoretical postulate that I wish to address in this review is the social force born by the human imagination in our modern world. Arjun Appadurai wrote that:

> The imagination is no longer a matter of individual genius, escapism from ordinary life, or just a dimension of aesthetics. It is a faculty that informs the daily lives of ordinary people in myriad ways: It allows people to consider migration, resist state violence, seek social redress, and design new forms of civic association and collaboration, often across national boundaries. This view of the role of the imagination as a popular, social, collective fact in the era of globalization recognises its split character. (2000:6)

Appadurai's posit seems to match what I have seen among "makers" in Japan – new civic associations and collaborations sparked by the imagination. Especially when prospects seem precarious, I suspect that the imaginative possibilities propounded by "maker" rhetoric are central to the emerging cohesion of the "maker" community in Japan.

Further insight into this operation is offered by a Japanese scholar, Hirokazu Miyazaki, who has done groundbreaking ethnographic work among financial derivatives traders at the top of the economy in Japan, and therefore the world. Miyazaki has traced the impact of new ideas about the world that infused a hope in the minds of these traders, and led to disruptions in the economy. Hope, for Miyazaki, "lies in the reorientation of knowledge" (2006:149) and is an important social factor because the "prevalent … ideas generate concrete effects" (151). It is these concrete effects that I think I have begun to trace among "makers" in Japan. The actions of FabLab proprietors to take risks, make sacrifices, and open a lab, as one example, evince a proactive practice in line with a reorientation of the knowledge they have about manufacturing. They seek to turn it not so much toward profit, as in the standard endgame, but to its recursion on itself in the public domain and the growth of a community that this knowledge helps to formulate (see Christopher Kelty on recursive publics, 2005). As another concrete example, the effect of Dr. Tanaka's own imagination has been central to the emergence of each FabLab in Japan. Dr. Tanaka writes, speaks, teaches, and talks over coffee about his imagined, or hoped-for, new future: social (not alienated), environmentally stable, and egalitarian. Each FabLab director with whom I spoke (nearly all of them) reported inspiration and continued guidance from Dr. Tanaka.

In precarious Japan, I saw evidence of people reorienting their knowledge for a new future, in Miyazaki's terms, in all of the "maker" practices and personal imaginings that I observed in FabLabs. Whether utopian, deterministic, or otherwise, this hope still seems to have a centrifugal effect, leading to a cohesion among heterogenous agents that has produced concrete effects, such as the reality of ten FabLabs in Japan in three years. Still, even though I asked often, no one reported anything concrete in the manner of a Linux- or even DIY Drone-equivalent open-source hardware project to speak of in Japan.

CONCLUSIONS

In FabLabs in Japan, at least, my observations lend evidence to the conclusion that some of the high-minded "maker" rhetoric differs from the practices of "makers" I observed ethnographically in Japan. "Makers" in Japan largely see their work as pre-corporate: the domain of hobbyists with shared values and interests, manufacturing for personal utility. There is not a lot of world-changing activity emerging from those labs, at least not in the scope by which Western audiences account for significance. Perhaps, then, companies should have little to fear off their bottom lines. However, from a longer term and social value position the "makers" I observed in Japan are in fact doing something of remarkable social moment. Organizing FabLabs and sharing their ideals – their "hope", in Miyazaki's terms – these agents are employing new tools to bring people together when other valences move them apart, as in Alison's portrait of precarity. This "maker" zeal, or hope, as a centrifugal principle, and its concrete social outcomes seem in any case to merit a continued watchful ethnographic eye.

Matt Krebs is a Ph.D. candidate in anthropology at the University of Kentucky where he also studied diplomacy (M.A., 2005). Matt writes about communication and collaboration for KelCor, Inc. He has been executive director of the Japan/America Society of Kentucky and consulted on economic development projects in rural Kentucky. mattkrebs@KelCor.com

NOTES

REFERENCES CITED

Anderson, Chris
2012   Makers: The New Industrial Revolution. New York, NY: Crown Publishing.

Appadurai, Arjun
2000   Grassroots Globalization and the Research Imagination. Public Culture 12(1):1-
          19.

Bernard, H. Russell
2011   Research Methods in Anthropology: Qualitative and Quantitative Approaches.
          Walnut Creek, CA: Alta Mira Press.

Boyer, Dominic
2008   Thinking through the Anthropology of Experts. Anthropology in Action 15(2):
          38–46.

Cefkin, Melissa
2009   Introduction: Business, Anthropology, and the Growth of Corporate
          Ethnography. *In* Ethnography and the Corporate Encounter: Reflections on
          Research in and of Corporations. Melissa Cefkin, ed. Pp. 1–40. New York:
          Berghan Books.

Cetina, Karin Knorr
2009   Epistemic Cultures: How the Sciences Make Knowledge. Cambridge, MA:
          Harvard University Press.

Fischer, Michael M.J.
1999   Emergent Forms of Life: Anthropologies of Late or Postmodernities. Annual
          Review of Anthropology 28(28): 455–478.
2003   Emergent Forms of Life and the Anthropological Voice. Durham: Duke
          University Press.

Gershenfeld, Neil
2005   Fab: The Coming Revolution on Your Desktop - From Personal Computers to
          Personal Fabrication. New York, NY, USA: Basic Books.

2012   How to Make Almost Anything: The Digital Fabrication Revolution. Foreign
          Affairs 91(6): 42–57.

Gusterson, Hugh
1998   Nuclear Rites: A Weapons Laboratory at the End of the Cold War. Berkeley, CA:
          University of California Press.

Holmes, Douglas R., and George E. Marcus
2005   Cultures of Expertise and the Management of Globalization: Toward the Re-
            Functioning of Ethnography. *In* Global Assemblages: Technology, Politics, and
            Ethics as Anthropological Problems. Aihwa Ong and Stephen J. Collier, eds. Pp.
            235–252. Malden, MA: Blackwell Publishing Ltd.
2006   Fast Capitalism: Para-Ethnography and the Rise of the Symbolic Analyst. *In*
            Frontiers of Capital: Ethnographic Reflections on the New Economy. Melissa S.
            Fisher and Greg Downey, eds. Durham, NC: Duke University Press.

Jordan, Ann T.
2012   Business Anthropology: Second Edition. Waveland Press.

Latour, Bruno
2005   Reassembling the Social: An Introduction to Actor-Network Theory. New York,
            NY: Oxford University Press.

Moeran, Brian
2011   Perspectives in Business Anthropology: Cultural Production, Creativity and
            Constraints. International Journal of Business Anthropology 2(1): 16–30.

Oppenheim, Robert
2007   Actor-Network Theory and Anthropology after Science, Technology, and
            Society. Anthropological Theory 7(4): 471–493.

Paxson, Heather
2012   The Life of Cheese: Crafting Food and Value in America. Berkeley, CA:
            University of California Press.

Pfaffenberger, Bryan
1998   Fetishised Objects and Humanised Nature: Towards an Anthropology of
            Technology. Man 23(2): 236–252.

Sivek, Susan Currie
2011   "We Need a Showing of All Hands" Technological Utopianism in MAKE
            Magazine. Journal of Communication Inquiry 35(3): 187–209.

Tanaka, Hiroya
2012   FabLife: Dejitaru Faburikeshon Kara Umareru Tsukurikata No Mirai. Tokyo:
            O'Reilly Japan.

Traweek, Sharon
1988   Beamtimes and Lifetimes: The World of High Energy Physicists. Cambridge, MA:
            Harvard University Press.

Winner, Langdon
1980   Do Artifacts Have Politics? Daedalus 109(1): 121–136.