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# Making Experts: An Ethnographic Study of "Makers" in FabLabs in Japan

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MAKING EXPERTS:
AN ETHNOGRAPHIC STUDY OF "MAKERS" IN FABLABS IN JAPAN

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DISSERTATION

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A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy in the
College of Arts and Sciences
at the University of Kentucky

By

Vaughn Matthew Krebs

Lexington, Kentucky

Director: Dr. Lisa Cliggett, Professor of Anthropology

Lexington, Kentucky

2019

ABSTRACT OF DISSERTATION

MAKING EXPERTS:
AN ETHNOGRAPHIC STUDY OF "MAKERS" IN FABLABS IN JAPAN

"Makers" around the world cohere in a digital and physical network of technology hobbyists. "Makers" are open-source hardware enthusiasts who use machines like 3D printers and laser cutters - manufacturing tools that have only recently become accessible to laypeople - to make things. "Makers" share a vision for a world where everyone would be able to make almost anything, supplanting top-down economic systems and channels of production. This ethnographic research examines a subset of the "maker" community: "makers" in "FabLabs" in Japan. These "FabLabs" are small workshops that house the machines that "makers" need and make them open to the public.

Drawing on 18 months of ethnographic fieldwork in Japan, this dissertation argues that the network of people, spaces, and machines remains coherent not because of common cultural forces like capitalist ambition, religion, geographic proximity, or even nationality. Rather, the coherence is more precisely understood - in the frame of science and technology studies - by examining the cohesive force of newly invented rituals and "active" ideas that engender hope and spur action toward a shared vision. Furthermore, the FabLab community in Japan exemplifies a novel culture of expertise wherein laypeople call on experts as-needed to accomplish their personal ambitions, flipping the usual understanding of expertise as a guarded product of insular cultural systems. I examine this unique culture of expertise and outline types of expertise developing from this dynamic, disparate, and impressively coherent FabLab network in Japan.

Drawing on my ethnographic observations, I argue that laypeople, still bounded by political-economic forces in Japan, nevertheless are exercising a degree of agency that was previously the domain only of experts in manufacturing. This action by laypeople is what activates sufficient cohesive activity to sustain the community in the absence of more traditional social cohesive forces.

KEYWORDS: Ethnography, Japan, Makers, Science and Technology Studies

Vaughn Matthew Krebs

11/30/2019

MAKING EXPERTS:
AN ETHNOGRAPHIC STUDY OF "MAKERS" IN FABLABS IN JAPAN


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11/30/2019

DEDICATION

This dissertation is dedicated to my wife, Corinda, and to our children. May the sacrifices they made for this research and writing lead to their own increased joy and knowledge, recurring in perpetuity.

# ACKNOWLEDGEMENTS

TABLE OF CONTENTS

LIST OF FIGURES

Chapter 1 - Introduction

Situating This Dissertation

Modern technology, especially in the last two decades, from ubiquitous mobile devices, to computers with stunning processing power, to the software and hardware (machines) that give even laypeople access to that power, has made possible many human ambitions that were not possible before. Still, peering out across the technosocial landscape today with an anthropologist's structural lens, some of the public enthusiasm for how technology will reshape our future and our power structures seems overwrought. In fact, inasmuch as these techno-centric discourses bear influence on public policy and practice, it may be downright dangerous to leave technology's full scope of influence unexamined, else the tool come to determine that policy and practice (Pfaffenberger 1998).

Popular media and even policy discourses give technology strong odds for such conquests as reversing social ills, extending human life, and reducing poverty. President Obama established a National Network for Manufacturing Innovation, saying in a State of the Union address that shared machining workshops such as those I examine in this research have: "the potential to revolutionize the way we make almost everything" (Remarks by the President 2013). Education funding has tilted decisively toward science, technology, engineering, and math (STEM). Yet anthropologists studying technology consistently suggest that great care be taken to observe technology's social operation in practice - to juxtapose soberly the rhetoric and the reality (Hess 2015, Chandler 2010, Yamaguchi 2010, Sein & Harindranath 2004) and not lose sight of "real people doing real things" (Ortner 1984:144). Anthropological study of the actual social practices - the existing structures and the networks of agents that act within them (Ortner 2006, Bourdieu 1989) - evolving around these technological tools, can fortify a circumspect relationship to these inventions in ways that matter greatly for our shared future. If technology is a path to comity, health, and global sustainability, what shape does its material reality - its present practice - take? Are "experts", such as the engineers and manufacturers that produce our modern sociotechnical pathways, always going to

maintain their dominance? If humanity will invent its way out of a possible trajectory of self-destruction, who is creating (or claiming to create) that future now and can we see and interpret anthropologically the things they are doing?

For anthropologists of technology and scholars in the overlapping interdisciplinary field of science, technology, and society studies (STS) whose raison d'être is the link between social and technical worlds, such questions are paramount. This research is situated in that literature, which I will introduce more fully in each chapter as related to the research therein.

For the purpose of situating this dissertation, in this introduction I focus on one macro-question derived from the literature. That is: "How are emerging technologies used to shape an emergent sociotechnical community among "makers" in FabLabs in Japan?" I consider this something like testing the null hypothesis, which would be that the hegemonic social systems would remain unaltered: a new sociotechnical community such as I observed would not emerge. In presenting the ethnographic details of the FabLab network in Japan - which I will describe presently as a sociotechnical emergent culture - I will show how experts are using the technical tools of fabrication (manufacturing) to give laypeople a heightened degree of agency. I will show that the FabLab network components cohere not through business, nor religious, nor normalized social pressures but rather through invented rituals and rhetoric that inspires hope and action. Also, that the culture of expertise within the community recurs authority to the laypeople who themselves become the acting experts in a sense. The laypeople exercise their heightened agency to further grow the community, within their social context.

Thereby, in answering the question of "how" this sociotechnical community emerges, I argue in the context of anthropological discourse that "makers" in Japan are using technologies to shape an emergent community that empowers laypeople. Laypeople and 'experts' together enlist other actants (people, gathering spaces, machines) to create new social pathways. This is neither determining nor democratizing futures, as some models would predict. This is enabling laypeople to express a heightened agency - heightened by access to machines - which they use to shape the emergent community themselves.

This emerging community of heightened agency for laypeople marks an important social moment for anthropological consideration. This community, in its detail, which I will elucidate, shows how technologies - in practice - can be used by laypeople to shape an alternative to the hegemonic patterns and practices.

Scholarly Context for "Maker" Technologies

Michael M.J. Fischer, writing at MIT from where technological invention flows to the world, has called for nearly two decades on anthropologists to examine these "emergent forms of life" (2016, 2009, 1999). Fischer's mnemonic recognizes the vast interconnected and interacting social conditions of the modern technical world, emphasizing research on "new… civic political contests… in the arenas of new technoscientific infrastructures in which market, law, code, and norms compete for hegemonic control over the rules of play (2005:55)". Anthropologists of technology propound ethnographic cases of emerging social networks facilitated by modern technologies. As examples: Boyer (2015) on restructuring power dynamics in electric power networks. Helmreich (2009) on heretofore unknown microbes. Kelty (2008) on open-source software collectives. Hess (2005) on citizen-led cancer research advocacy. These and other scholars are interested in how modern tools create, enable, deform, reform, and in a concert of human/technology interactions, spawn new, emerging networks. I am especially interested in how emerging networks create opportunities to redefine and redistribute the high degree of agency that accrues to experts within these systems.

To say that technology either determines or democratizes our society leaves little room for exploration or argument. What is more interesting - and what gives rise to the ethnographic project reported in this dissertation and studies such as above - is to examine how emerging technologies foment coherent communities that contend with existing practices.

Fischer adjured the discipline in 1999 to notice how:

... systemic contradictions and pressures for reversal of centralizing control, as well as toward increased democratic participation by diverse agents … lead toward a new 'reflexive modernization' that emerges out of the contradictions of industrial society in a manner parallel to the way capitalism emerged out of the contradictions of feudal society (459).

In other words, dissatisfaction with the status quo leads disparate energies to coalesce around new models and social forms, and anthropologists should watch this happen. Coleman's (2012) work on the hacking group: Anonymous, and Cool's (2012) work on early hacking collectives are especially good benchmark studies depicting technology-led, -enabled, or -driven movements and networks emerging to contest "centralizing control", energized by "increased democratic participation by diverse agents (ibid)".

Scholars of expertise, within the research domain of science and technology studies, have shown how expertise is socially constructed and operates inside walled intellectual and social citadels (Martin 1998) of science and industrial production. What happens, however, if the walls come down? What if the disparate social actors are able to use the tools of manufacturing to exercise a higher degree of agency, relative to traditional manufacturing experts? Create their own paths?

In the political economy of this sociotechnical system, it may be ironic that these smaller, cheaper tools were developed after generations of corporations and their laborers. All of today's technology follows that which humans developed in the past, with all of its weight of social disharmony. Even today's "makers" rely on the same global economic, capitalistic system to produce their relative prosperity, which gives them space to develop their hobbies. But what if the tools can be used to reorient the system? There is a lot of insight to be gained from observing ethnographically what these emerging technologies are doing in practice.

To produce new insight in anthropology and STS scholarship, this dissertation project sought to engage a technology-based social community that is animated by rhetoric, geographically dispersed, and thriving both online and offline. And, of course, a community rich with potential insight but not examined heavily in the literature thus far. I seek to provide further evidence and analysis from exploration of a modern milieu where new structures are budding that contest existing structures.

Following Christopher Kelty's theoretic construct: I sought out a "recursive public" to study. Kelty describes this particular kind of emergent society as:

> ...a public that is vitally concerned with the material and practical maintenance and modification of the technical, legal, practical, and conceptual means of its own existence as a public; it is a collective independent of other forms of constituted power and is capable of speaking to existing forms of power through the production of actually existing alternatives (Kelty 2008).

The "maker" community I chose to study in this dissertation matches Kelty's definition of a recursive public, and also serves as an excellent population to examine as an emergent "form of life" in all of its techno-social implications. Within the global "maker" movement, I chose to focus on the FabLab community in Japan, part of a global network of more than 1,600 FabLabs (FabLab-Connect 2019). The FabLab community, within the "maker" community, does indeed purport to produce an alternative to manufacturing practice as presently constituted. I will explain FabLabs further just below. Focusing on FabLabs in Japan allowed me to observe an active and cohesive group of people in this emerging global movement spawned by "fabrication" (manufacturing) technologies newly accessible to the lay public.

The "maker" social phenomenon is both stratospheric in its rhetoric and vision for itself (Anderson 2012, Tanaka 2012, Gershenfeld 2005) and also extant in form and practice sufficiently to be studied ethnographically. "Makers" are people - especially laypeople and hobbyists - who use manufacturing technology in novel ways. 3D printers. Laser cutters. CNC (computer numerically controlled) mills, routers, paper cutters, and sewing machines, as examples. Many of these machines have only become accessible (in price and complexity) to laypeople in the last ten years or so. "Makers" share knowledge and designs prodigiously on the Web, show off their inventions at sprawling fairs, and publish actively about the "by-the-people" manufactured future they are building. Millions of people around the world may justly refer to themselves as "makers" - anyone, especially laypeople, but including professionals, who "make" things through tinkering with materials, microcontrollers, machines, and more.

What is a FabLab?

As explained above, this research focuses on a subset of people within this "maker" community who organize a particular kind of "makerspace" called a FabLab. A FabLab is a permanent workshop where fabrication machines are made available for public use. "FabLab" is short for digital fabrication lab, or a lab where digital designs are fabricated into material objects. The first FabLab, known as such, was a workshop at MIT where Dr. Neil Gershenfeld had collected a variety of machines that can be used for making things. Lots of things. Anything. Students used the machines to make creations of imagination and sometimes practicality. With Gershenfeld's leadership and through the hopes and energies of thousands of enthusiasts, these machine workshops - FabLabs - have spread around the world. To register officially as a FabLab one simply accedes to the principles in the FabLab Charter (2012), promulgated by Gershenfeld's Fab Foundation. The core tenets of this Charter include: enabling invention, providing a community resource for the public, sharing knowledge and inventions, and limiting commercial initiatives in favor of other uses. There are more than 1,600 FabLabs around the world today.

In this dissertation, I will use the word FabLab almost 1,000 times in various examples, descriptions, stories, and reflections. I do not wish to take a lot of time here to elaborate on FabLabs further. However, a few perspectives from informants may help to set the stage, showing what they think is the purpose of FabLabs, beyond just what is in Gershenfeld's Charter.

Mr. Sakata (male, 30s), who has led multiple FabLabs, told me that the core purpose of a FabLab was to: "make people who make things (interview, 2013)." In other words, he thinks of FabLabs as a training ground for people who might not otherwise have access to the machines or training on how to design for and use the machines. Ms. Hayakawa (female, 20s) had a similar idea:

> We can have machines and "make" things in our own homes but I think it is really good that FabLabs create a place where we can be together and learn from each other... FabLabs are a place to make things but they are also a place for community (interview, 2013).

The FabLabs are also thought of as grassroots communities, intentionally built from a town or regional context. Hiroya Tanaka, perhaps the eminent "expert" of Japan's

FabLabs, told me: "I have always told people: 'Every FabLab should be different (interview, 2013).'" He also said he encourages founders to keep local traits and traditions intact. He does not want the machine workshops to try to mimic the other international FabLabs with which they interact. Uehara (male, 30s), a "maker" leader in Kyushu, a region far from Tokyo, likewise told me: "We really are not focused on commerce at all. Our goal is to promote local, traditional skills… that we can then exchange with other [regions] (interview, 2015)."

I also thought it was notable that numerous people spoke of FabLabs as a place where failure was not only all right, but encouraged. At FabLab Yonago, the leader held a workshop for children to make wooden whistles and trains from kits. He told them with panache and conviction: "Okay, kids: listen up. Life is long. Please be sure to fail over and over again (fieldnotes, 2015)." Ms. Nakayama (female, 20s), is a bit shy in disposition and dedicated to "making." She told me: "I really got interested in joining FabLab Kannai because they told me that failing was okay (interview, 2015)." And Mr. Iwasaki (male, late 30s) - a leader of FabLab Oita - had a new realization of why FabLabs were so powerful when he observed people in other Asian FabLabs (Bhopal, India, and the Philippines): "They were all really working together, learning as they went. If they failed they would say: 'well, there is always tomorrow.' This way of working without fear of failure was a major culture shock for me... It was refreshing (interview, 2015)."

In addition to these few perspectives from people in FabLabs, I will use many more stories from inside and around Japan's FabLabs to examine and test these ideals as this dissertation unfolds. I will refer sometimes to "FabLab ideals" or "the gospel of Fab." There are dozens of iterations of these ideals but for the purpose of this dissertation (I explore each of these more carefully in Chapter 4), here are three core "FabLab ideals" that I saw at work in Japan:

- A new future is possible with your efforts.
- The "maker" movement is by the people.
- Everyone should open their work to others by sharing it publicly.

Why Japan?

While the questions that I sought to answer will primarily address anthropological and STS concerns such as emerging cultures, technologies in practice, and expertise, as I have outlined thus far, I also propound my research and findings as part of the anthropological consideration of Japan itself. However, my data presentation in succeeding chapters does not take Japan itself as an object of inquiry but I do present a great deal of ethnographic data that was recorded in modern Japan in a technology-centric community. Therefore, I now offer a summary backdrop of how this project matters to the study of Japan. I will comment periodically on Japan throughout the book but this segment accounts for my most direct consideration of Japan itself in this report.

Japan is the national backdrop of this dissertation. Examinations of Japan's people and practices have set forth archetypal characteristics such as: reverence for ancient tradition, social homogeny and order, high intellectual and artistic acumen, and other generalized national character traits. However, these aggregate cognitions hardly help to bring much insight to an extended ethnographic inquiry of Japan. With an effort to not generalize, I hope my in-field observations will nevertheless contribute nuance and detail to discourse on Japan, at least in the context of the "maker" community as it operates in Japan.

Japan has captivated imaginations around the world through exports such as sushi, anime, just-in-time manufacturing, karaoke, cars, and other artifacts of cultural transfer. On the geopolitical stage, Japan's Prime Minister Abe was the first foreign leader to court a personal relationship with Donald Trump. At home in Japan, Abe has held together the longest-standing government since the 1960s. As Japan prepares to host the 2020 Summer Olympics, the nation is grappling with momentous social change and historical reckoning. One example is its reckoning with past crimes of war and a related, advancing dialogue about removing its constitutional "peace clause", which limits its military to defensive maneuvers. Economically, Japan has struggled since the 1990's, when preceding decades of fierce global growth slowed to a crawl, though its global brands continue to bring home critical cash for national programs.

Japan is still the world's third largest economy, only recently surpassed by China: its neighbor with more than ten times its population. Japan is indeed a country of renown, of global political and commercial importance, of unique cultural practices, and of perennial fascination for outsiders.

Anthropological scholars of Japan have drawn attention to its domestic changes and challenges. Perhaps the most famous anthropological report on Japan in America is Ruth Benedict's description of Japan written hermeneutically in 1946 and impacting that generation's views on Japan's national culture. Ronald Dore's prolific writings presented detailed and first-hand accounts from village life (1994) to market capitalism (2000, 1973), though his work did not enter the American conscience quite so much as Benedict's. Embree's Suye Mura (1939) is another widely read account of a traditional Japanese village before urbanization and modernization shifted cultural practices West-ward. These and many more studies gave thoughtful ethnographic interpretation to Japan as it was emerging in our public consciousness.

While that consciousness is of course ever-partial and limited, there has been a long line of research conducted by Japanese and non-Japanese scholars that presents a rich canon of observation in Japan. While the native voices of Japanese anthropologists, about Japan, are more widely read than in the past (Kubo 2010, Kudo 2007, Nakane 1974, Ohnuki-Tierney 1995, Shibamoto 1987, Tamanoi 1990), and research by Western anthropologists certainly continues, the 1980s and 1990s were especially active. There has not been an Annual Review piece related to the field of the anthropology of Japan since William Kelly's in 1991, for example.

Modern studies have elucidated the nation's 21st century challenges and institutions. William Kelly on baseball as a cultural force (2006, 1998). Jennifer Robertson on the women-only theatre revue: Takarazuka (1998, 1991). Robertson's edited volume on Japan anthropology - with compelling essays asserting Japan's relevance to the discipline (2008). Joy Hendry on layered, formalized traditions and practices, which she relates to the fastidious wrapping of gifts (1995). Ian Condry on the Hip-hop music scene in Japan (2006). Ted Bestor on the now-closed Tsukiji Fish Market in Tokyo (2004, 2001). Marro Inoue on materializing patterns of resistance and identity among Okinawans, against Japanese and US impositions of power (2013, 2004). Anne

Allison on hostess clubs in Tokyo (1994) and the precarity of discarded classes of citizens, alienated from broader society by rigid social expectations (2013). Hirokazu Miyazaki, tracing the function of 'hope' in social relations (2006) and exploring how financial derivatives traders adjust to dramatic social changes regarding their practice of capitalism (2013).

Naturally, this list could go on and on. The sample above should give at least a cursory notion of topics under study. In this project, I will revisit Anne Allison's and Hirokazu Miyazaki's work, which I will explain better in context (see below, and chapter 4). As noted above, I take Japan as a backdrop for this study but not a subject.

I do wish to explain that I think Anne Allison's depiction of Japan in her 2013 book: *Precarious Japan*, sets a stage where my research can resonate. Allison describes the Japanese' wrestle to find meaning in life (individual and collective) as modernity and economic stagnation produce more and more alienated citizens - a 'precariat' class. My project in particular has located an emergent social community in the FabLabs that proactively organizes to bring people together in response to this economic and social 'precarity'. She writes:

> ...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).

The malaise of which she speaks is not general, in my experience, but is discernible and can certainly be located in some of the interviews and observations I made. The people in FabLabs were very often seeking a new and adventurous way to meet other people and share in something they enjoyed and believed made a difference. I will show throughout this report how this 'new commonwealth' (perhaps a more context-specific way is to say with M.J. Fischer: an emergent culture) is cohering in "precarious" Japan. I will also explain how Miyazaki's operationalized use of 'hope' helps us to comprehend the actions of "makers" in Japan who are not pulled into the FabLab orbit by predictable valences such as employment, familial ties, or religious obligations. Their participation seems to follow from their earnest anticipation of meaningful connections. Not all of

them, nor even a majority, are in the 'precariat', as in Allison's device. However, they do seem to seek new ways of connecting in their native Japan, hoping to overcome the social distance ramifications of highly structured social pathways.

Two statements made by Tanaka to me directly, further show how intentionally he is seeking, as a denizen of the movement, to bring people together. Throughout this report, I will describe how the rhetoric that Hiroya Tanaka and others use to define and promote the FabLab and "maker" movements indeed shapes the social practices in the community toward these ends. Tanaka circumscribes the whole effort as a way to unify people through "social fabrication."

> In a FabLab, certainly, you are making a 'thing:' a real product. But you see: everyone is focused on the product, the final outcome or output. When in reality, that is not the real idea of the FabLabs. Community and the making process itself - it's invisible. So, you know, that is why I have invented this notion of social fabrication. In Japan when you are working in a FabLab, whereas Neil Gershenfeld speaks of 'personal fabrication', I always thought that was the wrong approach. I don't know. I just thought: that is wrong. He was going from 'personal computer' to 'personal fabrication,' but I am thinking about the rise of social networks online, like Facebook. And I think there should be more creativity with the actual social way in which we make things… When you work on fabricating a thing, you can see what others are working on - ask them about it. This is when you are actually activating a place where people work together. As a professor, I saw my students not looking so happy on their computers all day, you know. That is when I first had this realization of [why social fabrication matters] (interview, 2013).

"Social fabrication" is an idea, an antidote to social distance and precarity, that Tanaka spoke about nearly every time I heard him speak publicly. Speaking to me more about the challenge of creating FabLabs and explaining their importance to other people in Japan, Tanaka said:

> This is difficult to explain but the FabLabs are not really 'industry' nor are they really 'life' but more of a social fabric. In Japan, it is very clear the distinction between industry and hobby. When I say: 'social fabric', people ask me: 'what is that?' … Anyway, that is why I think we need more people like anthropologists or sociologists to describe the possibilities of what can - to them - be invisible (interview, 2013).

Dr. Tanaka has found a powerful rhetoric for drawing people out of their predictable social pathways into a social activity that he, trailed by acolytes, seems to fervently believe can transform modern Japan and its future, by "making" things together

in FabLabs. Thus, if there is insight about Japan to draw from this dissertation, it is in the details of how a "new commonwealth," as in Allison's precarious Japan, is emerging that brings people together in ways that may not have been otherwise available.

Why This Dissertation?

Stated succinctly, this research project and dissertation examines the emerging, observable culture of a technosocial community of "maker" enthusiasts in Japan, primarily in FabLabs, whose vision is to change the world by teaching laypeople to use manufacturing technology. It is my aim to contribute new knowledge to the anthropological exploration of emerging technoscientific "forms of life" by focusing on this emerging community of techno-hobbyists with a structure-shifting vision: "makers" in FabLabs, against the national cultural backdrop of Japan.

To focus the analysis of my ethnographic data from Japan in this dissertation, I will relate the findings and observations in each chapter to the distilled question that I presented on page 7: "How are emerging technologies used to shape an emergent sociotechnical community among "makers" in FabLabs in Japan?"

As I present data from each chapter, I will make the argument, also introduced on page 7, that "makers" in Japan are using technologies like 3D printers to shape an emergent community that empowers laypeople. 'Experts' and empowered laypeople enlist other actants, such as people, gathering spaces, and machines, to create new social pathways. Laypeople express a heightened agency as a result of access to these technologies, and use this to advance the alternative, coherent, emergent culture distinct from the sociotechnical status quo and held together by newly invented rituals and by actions prompted by hope in aspirations and ideals.

A FabLab Afternoon in Kannai, Yokohama, Japan

The evidence and structure of that argument will unfold one segment and chapter at a time. I will summarize the findings that underlie the argument in this introduction. However, in order to set the stage for all of the ethnographic data that will follow, it seems necessary to introduce a typical afternoon at FabLab Kannai, in Yokohama. This

scene at FabLab Kannai, one of my primary fieldsites, is an aggregate of fieldnotes and interviews. I include elements from different days of observation and participation.

Early April, 2016

As I walk towards FabLab Kannai, it is lunchtime on a Saturday. Through the dense city of Yokohama, there is a little cloud cover visible above the buildings. I arrive at the entrance. I know it because I have been here dozens of times now, so I take the stairs up to the door, turn the corner, and enter a 2,500 square foot co-working space run by a non-profit called Yokohama Community Design Lab (YCDL). Back in the corner, a half dozen machines, none bigger than an office desk, are being used by "makers" - people who want to manufacture things of their own design. Each of the people using the machines is a "member" of FabLab Kannai. They have paid $100 for three-months of access to these machines, not including materials such as plastic for the 3D printer. Those are purchased as-needed on site, or you can bring your own.

The open floor space at YCDL is full of tables, and around 50 people working on their laptops or DIY projects. Most of these people are not here for the machines. They are not part of FabLab Kannai. They are freelancers or volunteer journalists (YCDL publishes a local public-interest paper). The FabLab is in use by only around 10 of the people here today. And, if I had come yesterday, the machines would have been dormant. FabLab Kannai is only open for public use on Saturday and Sunday during the afternoon.

As I walk towards the FabLab Kannai corner, I can see a few of my friends. Mr. Morita (male, 50s) is showing his LED-lit acrylic art boxes to Mr. Kohno (male, 30s). The boxes are laser cut with art designs: cats, Christmas trees, robots, and more. Morita laser cuts into sheets of acrylic about 5 millimeters thick, sometimes using fluorescent colored sheets. He pieces the cut pieces together into boxes, placing an LED light inside to make the art visible.

I can also see Mr. Koizumi (male, 40s) standing beside the Makerbot II 3D printer, watching it to make sure it produces his robot's head piece correctly. The printer lays down layer by plastic layer, creating a mount onto which a servo (programmable joint) will be attached, along with LED lights. The mount will be the head of a robot called "Fabbot." The servo movement will mimic the neck, turning the mount as its head. Two

LED lights will act as Fabbot's eyes, turning on and off as programmed. At the nearby table, Dr. Kunda (female, 30s) is reviewing her written instructions for Fabbot. She has done most of the technical design work for Fabbot's insides. She and Koizumi are working together to make this robot, which can fit inside a Starbucks cup, an educational tool for young people interested in robotics. They plan to showcase Fabbot at Japan's largest "MakerFaire" in Tokyo in August. They told me previously that they don't plan to mass produce them, but will make some kits and do small classes. The bigger idea is to share the designs so anyone can make a Fabbot inside a FabLab with the machines on-hand, learning as they go.

I sit down next to Ms. Nakayama (female, 20s). She and I share an interest in the TV drama "Once Upon a Time." She has a glass Coca-Cola bottle in her hand, to which she is fastening an LED bulb. Her parents, she once told me, have no clue what she really does every Saturday and Sunday, or up in her room half the time. She has finished school and has a part-time job, but she enjoys a lot of time obsessing over what she can "make."

"That looks cool," I say. "When did you start this project?"

"A few months ago, actually," she replies. "I just haven't brought it here yet."

I notice that above the LED bulb is a small solar array. "Oh, I see. Permanent light."

"Yep. I made a website and I'm hoping to sell these."

We visit for a few minutes about how she came up with the idea and where she got the components. Then, I open my laptop to make some notes about what I have seen so far, already, at FabLab Kannai today.

I first came to Kannai in July 2014. I was at the kickoff event for FabLab Kannai that summer - a large press event where Mr. Ohnishi, a young graduate student, spoke in front of the cameras about the FabLab he was opening. Hiroya Tanaka also spoke. He guided Ohnishi and made key connections for him, such as to YCDL, to get the FabLab started. FabLab Kannai has changed a lot since then. I have met a few dozen of its patrons as I have come on Saturdays during the past year.

I sit back and let my mind consider this group of people at FabLab Kannai. Some of the members are not even working on a project. They are talking about projects and enjoying being among friends. My mind wanders to the other FabLabs around Japan. I have seen thirteen of them all across the country, each one a little different. A few are set

up as companies, or operate as one activity inside a larger company. Others are not legal entities, just places for "makers" to gather. Some charge a membership fee. Some charge only for materials. Some are open during normal business hours. Some are only open to the public five or six hours, all week. All of the FabLabs, however, cost very little to start-up or operate. Once the machines are purchased, usually for less than $5,000, and a venue secured, they just require someone to volunteer to make sure no one breaks them. A FabLab can pop up anywhere that machines and a venue can be secured, if someone cares enough to lead the effort.

As I look out the window, thinking about the people who are here and there, making stuff that would have been impossible for a layperson to imagine, design, or produce ten years ago, I realize that it is cherry blossom season. The windows all along the wall at YCDL are wide open and a breeze has blown the light pink, fallen petals inside our workspace. So beautiful. So ephemeral. Always reminding me to enjoy the beauty around me while it lingers.

I look over to where Mr. Susutawari (male 40s) is teaching a small class of members about microcontrollers - his speciality. With a nod, I excuse myself from Nakayama's table and her Coke bottles. I move over to the table by Susutawari to learn about these palm-sized, inexpensive computers that are as powerful as industrial computers were when I went to college, almost 20 years ago. By dinnertime, I learn more about microcontrollers, catch up with Koizumi and Kunda, meet a few new patrons, and type up a bunch of observation notes. Time to head back to the train station, and home.

Summarizing the Research Project

The research that comprises this dissertation was undertaken in FabLabs and makerspaces in Japan during a total 19 months living in Japan, with the longest term from April 2015 to August 2016. I visited most of Japan's FabLabs but focused my regular visits on two labs: FabLab Kamakura and FabLab Kannai, two cities just south of Tokyo. Professor Hiroya Tanaka at Keio University, who is a central figure in the FabLab movement in Japan, was my research host during the project.

FabLab Japan Maps

      The current nineteen FabLabs in Japan are situated all across the country, as pictured below. An aggregated description of some of their characteristics follows.

*Figure 1.  Nineteen FabLabs Across Japan. From Fablabjapan.org.*

*Figure 2. FabLabs in Western Japan, from West to East: Saga, Dazaifu, Oita, Yamaguchi, Hiroshima-Akita. Kitakagaya. From fablabjapan.org.*
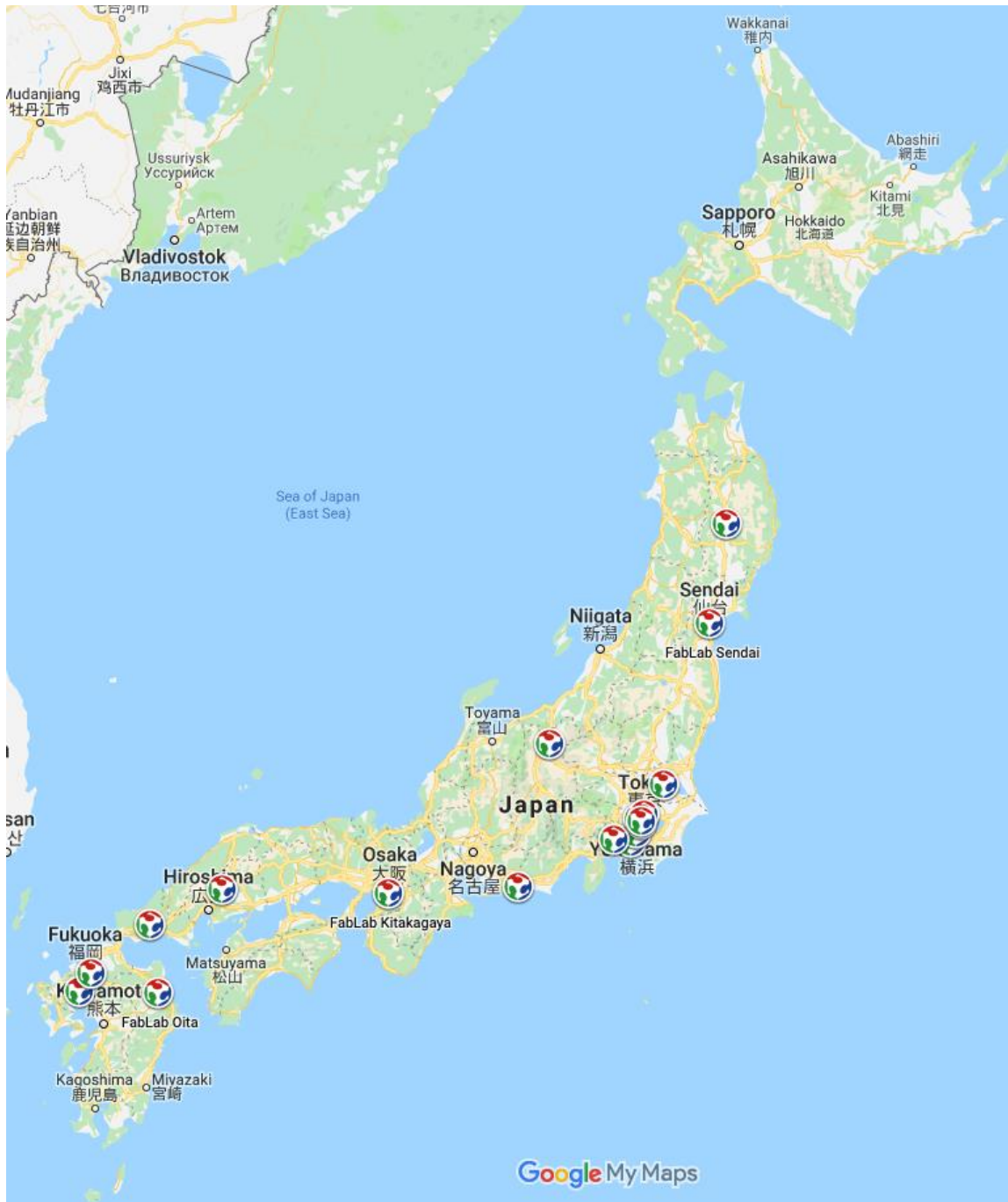
*Figure 3. FabLabs in Central Japan, Outside of Tokyo: Hamamatsu, Nagano, Tsukuba. From fablabjapan.org.*
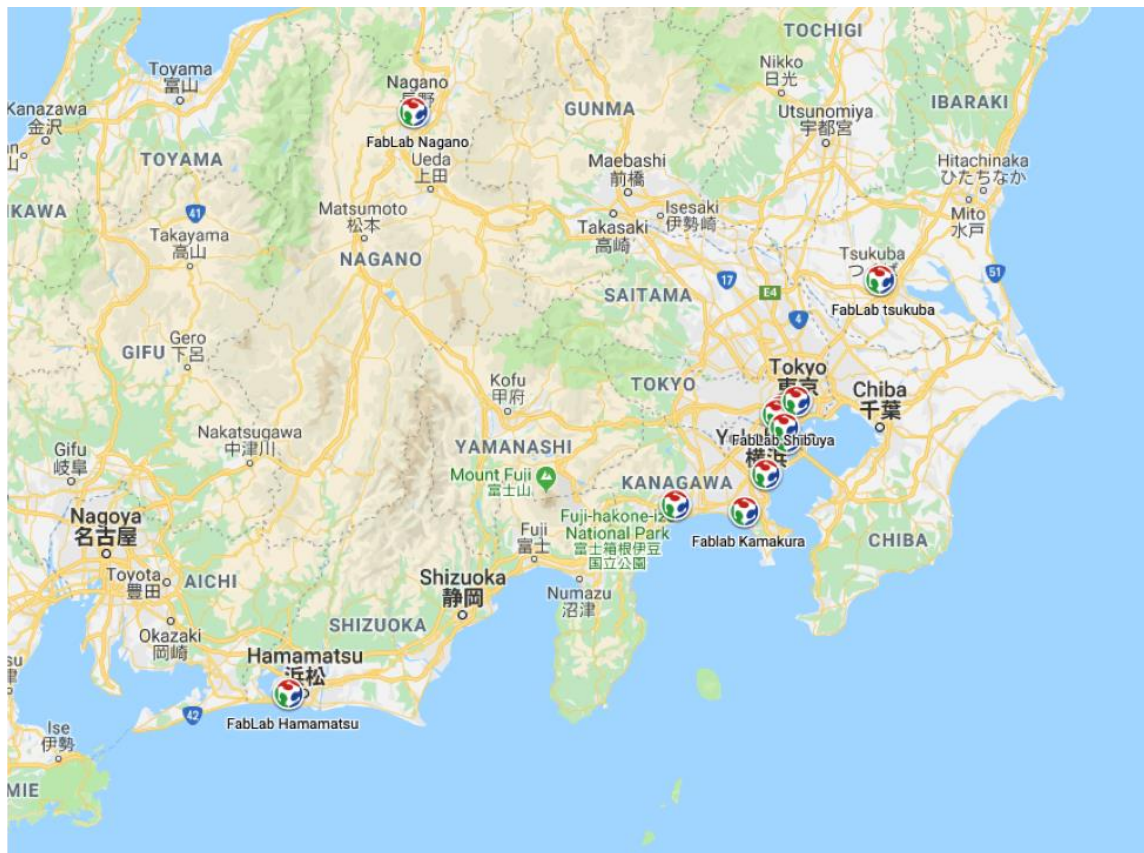
*Figure 4. FabLabs in and Near Tokyo: Hiratsuka, Kamakura, Kannai, Ota, Shinagawa, Setagaya, Shibuya, Nishikicho. From fablabjapan.org.*
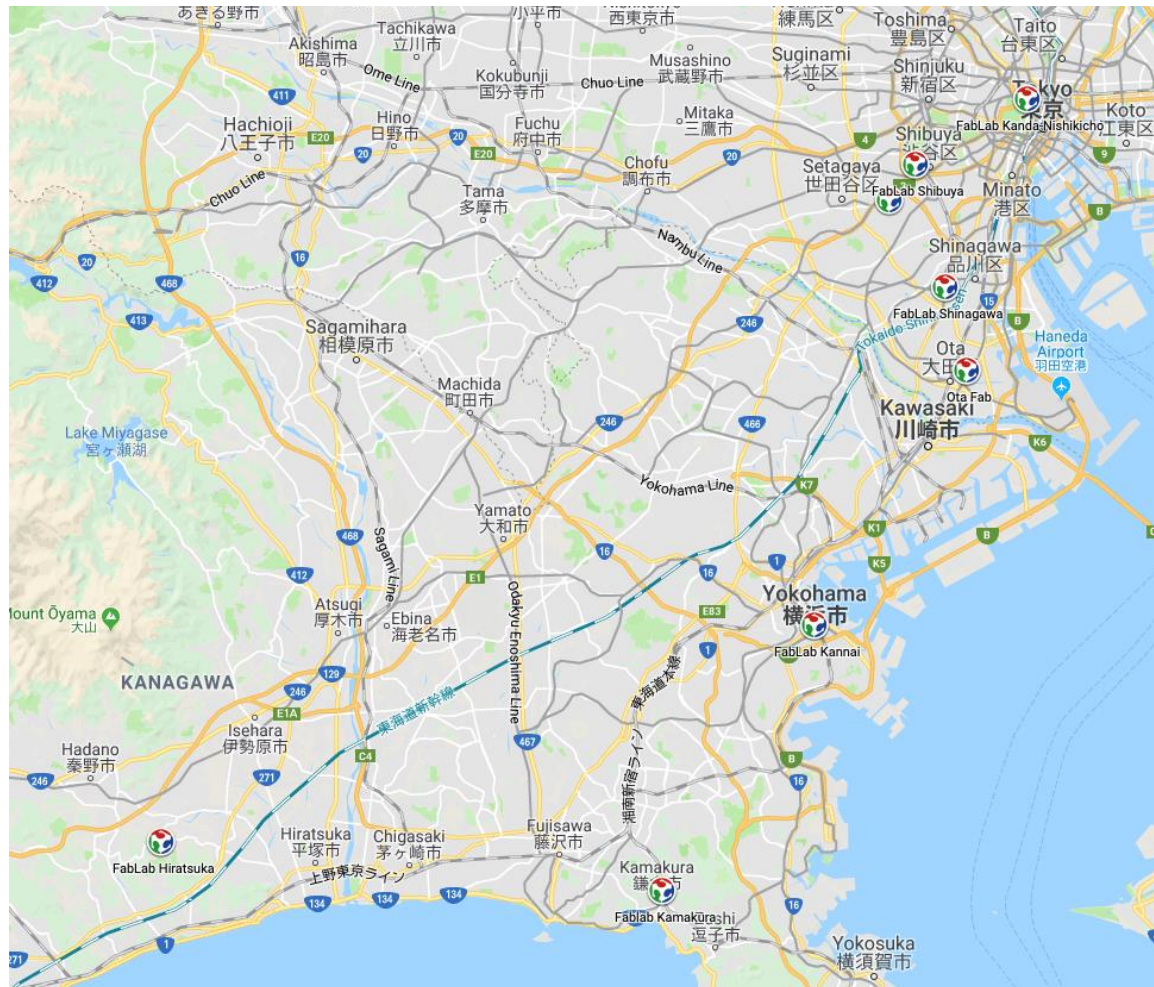
*Figure 5. FabLabs in Eastern Japan: Sendai, Shiwa. From fablabjapan.org.*
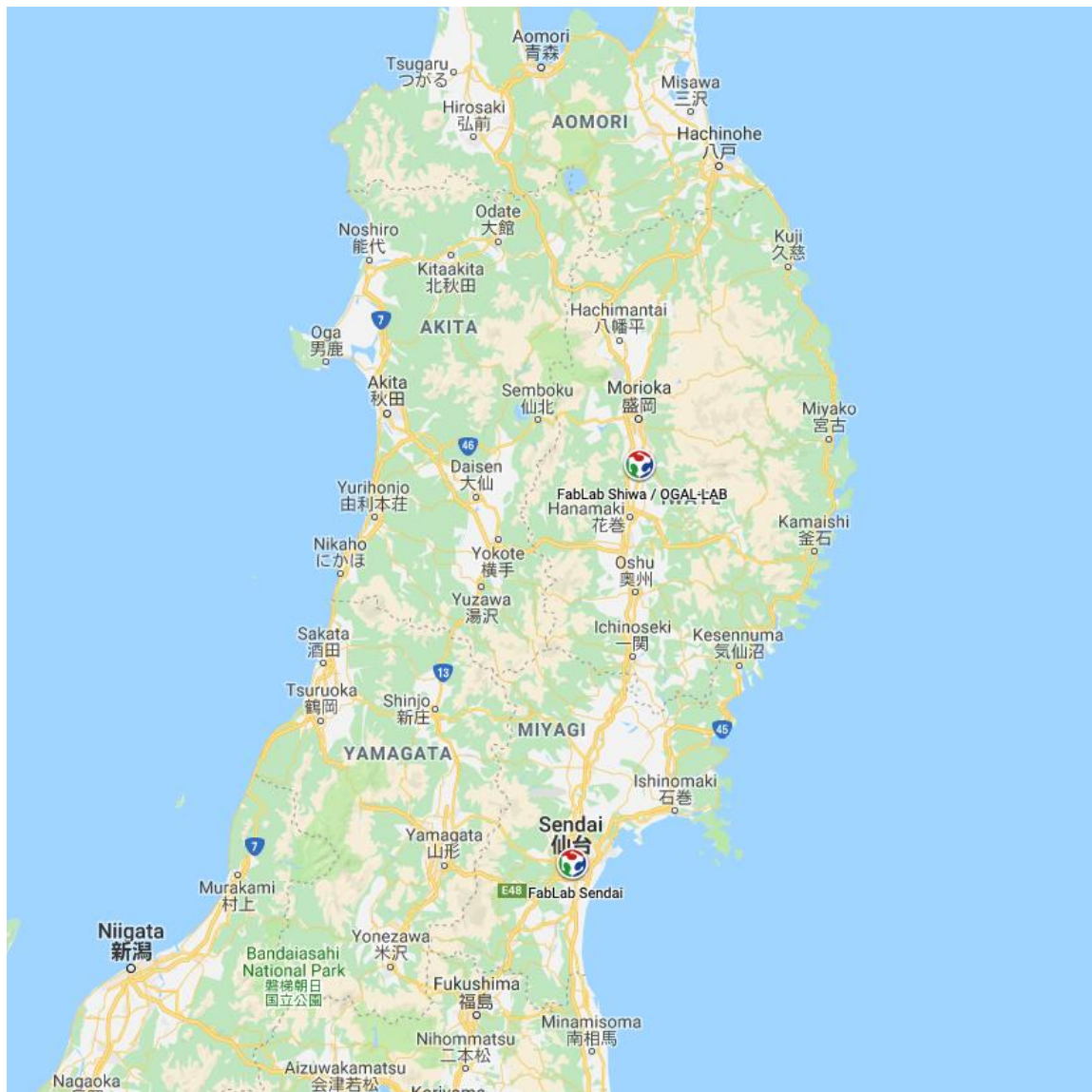
FabLab Japan Details

This chart summarizes a few details about the FabLabs started since 2011, as far as I know them. Below, I will explain additional points of interest.

*Figure 6. Overview Sketch of Japan's FabLabs as known by the author, 2019.*

| | Visited | Open/Closed | Income | Staff | Open Hours |
|---|---|---|---|---|---|
| FabLab Dazaifu (Fukuoka) | Yes | Open | Materials fee only | Parent company | Business hours |
| FabLab Hamamatsu (Shizuoka) | Yes | Open | Materials fee only | Volunteer director | By invitation |
| FabLab Kamakura | Yes | Open | Grants. Business Services. | Paid director | Mon. / Wed. |
| FabLab Kannai | Yes | Open | Memberships | Volunteer directors | 24/7 |
| FabLab Kurayoshi | Yes | Closed | Government | Paid director | Closed |
| FabLab Oita | Yes | Open | Government | Parent company | Business hours |
| FabLab Osaka/Kitagaya | Yes | Open | Memberships | Volunteer directors | Weekends |
| FabLab Saga | Yes | Open | Materials fee only | Parent company | Business hours |
| FabLab Sendai/FLAT | Yes | Open | Government | Parent company | Business hours |
| FabLab Shibuya | Yes | Closed temporarily | Participation Fees | Parent company | Closed temporarily |
| FabLab Tottori | Yes | Closed | Materials fee only | Parent company | Closed |
| FabLab Tsukuba/FPGA | Yes | Closed temporarily | Materials fee only | Parent company | Closed temporarily |
| Super FabLab at Keio/Kannai | Yes | Open | University | Parent company | By invitation |
| FabLab Hiratsuka | No | Open | University | Parent company | Business hours |
| FabLab Hiroshima-Akita | No | Open | Materials fee only | Volunteer director | By invitation |
| FabLab Kanda-Nishikicho | No | Open | Unknown | Unknown | Unknown |
| FabLab Nagano | No | Open | Unknown | Unknown | Unknown |
| FabLab Ota | No | Open | Unknown | Unknown | Unknown |
| FabLab Setagaya at IID | No | Open | Unknown | Unknown | Unknown |
| FabLab Shiwa / OGAL-LAB | No | Open | Unknown | Unknown | Unknown |
| FabLab Yamaguchi | No | Closed temporarily | Unknown | Unknown | Closed temporarily |

I have personally visited 13 of the FabLabs in Japan. Two of those FabLabs are now closed and two more are closed temporarily. Of the 8 remaining FabLabs that I have never visited, 5 have opened since I left the field in summer 2016. I know very little about them.

The FabLabs mostly get their primary income from parent companies that operate the FabLab for the public but have other business activities in the background. These tend to generate FabLab income only by asking patrons to cover the cost of their materials (the fees therefore can hardly be considered income). There are 9 FabLabs, out of the 15 for which I have data, that are operated by a parent company. Municipal government funding once covered the cost of FabLab Kurayoshi, paying a city employee to manage it, but Kurayoshi is now closed. Government funding also pays a company (AnnoLab) to manage FabLab Sendai.

There are 4 FabLabs that are basically all volunteer operations. Hamamatsu is operated by a young man who purchased the machines himself and opens his workspace to the public. Hiroshima-Akita is also run by one person who shares their machines. Kannai is operated by three volunteer leaders, with membership fees covering the cost of renting the space that houses the machines. Osaka/Kitakagaya is another membership community run by a group of volunteer leaders.

Only Kamakura is run as its own company, built around the FabLab and paying its own director salary.

A final detail that helps to show how "open" the FabLabs really are to the public, is that only one FabLab is open to the public or members 24/7. That is: Kannai. A few are open just by invitation and Kamakura is only open Monday mornings and Wednesday evenings for a few hours. Osaka/Kitakagaya is open only on weekends. The rest are open during normal business hours. Then, as I noted previously, four of those FabLabs for which I have data are either closed temporarily or permanently.

Speaking specifically of the FabLabs that I visited, they each have a unique personality, reflecting their geographic setting, local culture, director personalities, patron personalities, and a host of other factors. I will share much more insight and observation about the FabLabs from my observations as I present my data hereafter.

Summarizing the Research Findings

How, then, are emerging technologies used to shape an emergent sociotechnical community among "makers" in FabLabs in Japan? In order to argue that the technologies are used by "experts" to grant laypeople access to their power and thereby a heightened agency, I lay groundwork in each of the data presentation chapters, summarized in the following findings.

Finding 1. The components of the community: people, gathering spaces, and machine, emerge in spite of participation being highly elective (Chapter 3).

Finding 2. The cohesive social practices in this emerging network, beyond capitalist practices that drive most manufacturing networks, are rituals and ideas. (Chapter 4).

Finding 3. The technologies enable a culture of expertise that recognizes technical skill and organizing skill but also grant the laypeople a high degree of agency (expert power). (Chapter 5).

The FabLab network is an "emergent culture" (Fischer 2009) that coheres as an "actually existing alternative" (Kelty 2005) to the dominant regime of capital-driven manufacturing because laypeople inherit a heightened agency in a culture of expertise that recurs authority to them and then their practices shape the sociotechnical community. I outline each chapter below in a few words and then outline each chapter a bit more thoroughly in the subsequent sections.

Overview of Chapters

Chapter 2 presents a description of the methods I used and a general report on my research and fieldsites. This will lay groundwork for understanding the context where the research was undertaken and my chosen approach to fieldwork. Chapter 3 confronts the fundamental question of how the dispersed, multifarious, self-labeled "open" network of "maker" hobbyists coheres as a FabLab community, focusing on the components of the network. Chapter 4 continues the inquiry into the coherence of the network by focusing on the practices that help to cohere the FabLab network. Chapter 5 presents data on the STS question of how the culture of expertise operates in the FabLab network in Japan. Chapter 6 synthesizes the data and findings to describe more explicitly how the research contributes to anthropological and STS theory.

Description of Chapters

Chapter 1: Introduction

Chapter 2: Methods and Research Report

Before I embark in chapters 3, 4, and 5 on full data presentation, I present my fieldwork methods and a report on the research I did in Japan. I will describe the ethnographic methods I used and the scope of actual use in the field for each. Then, I will explain how each method unfolded and what kind of data each method helped me to produce. Next, I will undertake a description of the primary fieldsites to give the reader a sense of place to anchor the subsequent chapters that present data from those places. Finally, I note certain limits of the project.

Chapter 3: Coherence of an Emerging Network - The Components

I begin to present data thematically in Chapter 3 to justify my first finding, that the components of the community: people, gathering spaces, and machine intermediaries, emerge in concert in spite of participation being highly elective. I think about this network as an assembled array of components as Latour and STS scholars might, less with distinction between human and machine "actors" and more attentive to the flows of power, action, and meaning that construct their coherent social reality (Latour 2005, Latour & Woolgar 1986).

Of course, it is easy enough to say this coherent network - the FabLab network in Japan - is a new "form of life" that reshapes existing social practice. However, the story of that network and how it coheres as a social entity must be told to justify the statement. The evidence provided by this fieldwork and dissertation is really in the details of how this new "form of life" coheres in a novel shape, of its own design, rhetorically independent from the existing social practices. Also, how that design is impinged upon, redirected, and in important ways, not-so-novel-nor-independent in the face of orthogonal practices, norms, and "forms of life."

Only after thorough presentation and analysis of fieldwork evidence can I attend to how the reshaping of existing practice occurs. Therefore a first purpose of this chapter is to paint a picture of the warp and weft of the FabLab network in Japan. What are its

components? Each section in the chapter highlights a component that functions coherently in this new "form of life". In each section, I present ethnographic data from my fieldwork to show how the components operate within the whole.

As I reviewed my data, I often remarked how participation in the FabLab community was highly elective. No one, so far in my experience, is "born in" the FabLab network. Very few are brought there by a family member or enlisted by historic tradition. In fact, most participants told stories of setting aside their common priorities to pursue their FabLab work, of forging new paths. Only very few derive income directly from a FabLab - participation is not compelled by a normalizing business or economic motivation. The impact of capital is in fact an important component of the network but I have postponed my more thorough treatment of capital to Chapter 4. There is no common religious element pressing individuals to become Fabbers, though there is fervor that echoes religiosity. Government action has so far mostly been a post-genesis contribution, and generally limited to a financial one. And there is no obvious common geography anchoring the network. Yet while there were no FabLabs in Japan six years ago - nineteen exist today (according to the official count at fablabs.io on July 27, 2019).

In other words: because participation in this community is so highly elective, the centripetal social forces drawing this network into its coherent present shape apart from the existing social practice of manufacturing are of paramount interest to my theoretical question about technology reshaping social practice. Those centripetal forces merit investigation and description with an eye to how each operates. Many elements of cohesion make up the whole and each provides a unique perspective on how agency and structure interact in the modern, technological, emerging FabLab context. These are the components of the coherent network that I interrogate:

*People:* The people who produce and populate FabLabs are the first component that I will describe and situate as a cohering element. Tanaka and Youka each with their own story. The FabLab leaders. And, the patrons.

*Gathering Spaces:* A FabLab is a place - a workshop - where the public can use 3D printers, laser cutters, CAD software, and other technologies to make their own things. Face-to-face. In close quarters. These physical gathering spaces host - and shape - much of the social interaction that coheres the FabLab network in Japan.

*Machine Intermediaries:* The tools themselves are a critical element of coherence. The operation of the 3D printer, the laser cutter, and more, strongly influence the distinctive nature of this network.

Chapter 4: Coherence of an Emerging Network - The Practices

I continue my inquiry into network coherence in Chapter 4, finding that the cohesive social practices in this emerging network, beyond capitalist practices that drive most manufacturing networks, are rituals and ideas. In Chapter 3, I will describe the network components in detail - a groundwork for understanding its shape and operation as an actor network. In Chapter 4, I will begin to explain the argument I make in this dissertation as to why this occurs and why it is significant, continuing the argument in Chapter 5.

Social practices contend with existing regimes (Ortner 2006, Bourdieu 1989). This FabLab network undoubtedly exists within a particular political economy (Roseberry 1997, Wolf 1990) and the actors are articulating (Roseberry 1988) new practices and "forms of life" within that structure.

The components I described above, holding together in spite of being highly elective, can be shown to hold together because of certain social practices. These practices seem to function as a centripetal energy drawing the network: people, spaces, machines, and more, into shape. And they do this against the backdrop of the capitalism-centered regime of manufacturing practice worldwide. It is also true within the FabLab network in Japan that capital (money and labor in this treatment) is another component held together by these practices, though I will not dwell on its role as a component in this chapter.

This is not to suggest that the demands of capital are absent in this FabLab network. However, in this chapter, I wish to address the function of capital a bit differently. I will show that the social practices are cohesive in spite of what is manifestly an absence of capital in the network, relative to standard manufacturing networks (corporations and their markets). In other words, capital is certainly a component of the FabLab network, as it is with most modern sociotechnical systems, but the more compelling finding from my research is that compared to how manufacturing practices operate writ-large today, the

centrality of capital is much diminished in Japan's FabLab network. Agents use technology, and other means, to organize a new "form of life" adjacent to but separate from the dominant business- and government-anchored pole of manufacturing practice. Thus, in the FabLab network in Japan, I could home in on two social practices that act as cohesive agents, even contending with the capital-centered manufacturing regime: ritual and ideas that lead to action.

*Ritual:* Recognized as a cohering practice across domains of anthropological inquiry, ritual no less functions as a cohering element of the FabLab network in Japan. I will proffer a bespoke definition of ritual in this research context and show how a particular ritual in FabLab Kamakura functions as a cohering practice.

*Active Ideas: Rhetoric and Hope:* The agents cooperating in this network share a fundamental idea: that through their cooperation a new future is possible. This future-imagining, as an organizing principle, animates much of the network's advance against the status quo, functioning much like nationalism was shown to function by Benedict Anderson (1983). Rhetoric engenders hope (the operational notion of which I will tie to Hirokazu Miyazaki's work (2006)) that leads agents to act in concrete ways, bringing the network components into a more coherent shape as it emerges.

Chapter 5: Making Experts

In Chapter 5, I address the culture of expertise that I observed and queried as I interviewed FabLab "makers" in Japan. Some studies of expertise, a prominent pursuit in STS research, focus on the "citadels" (Martin 1998, Downey & Dumit 1997, Traweek 1988) where scientific knowledge is "made". The culture within the "labs" where knowledge is produced - that culture of expertise - is effectively shown in such research to socially construct the knowledge produced (Knorr-Cetina 2009, Gusterson 1998, Latour & Woolgar 1987). Other recent studies have explored even further the assailable position of expertise in modern sociotechnical systems - the way it is contested from outside. One example is Howe & Boyer's depiction of wind power and its experts, blown about by many other agents of power: "ethical projects, … political claims" (2015:15). Boyer has elsewhere written that cultures of expertise: "routinely encroach upon one another, challenging jurisdictions, borrowing ideas and re-functioning them for new

purposes and audiences (2008:43)." Coleman described young hackers studying up on copyright law and assailing legal experts (2012). Kelty described technical "polymaths" who learn enough about many fields of expertise to become supra-experts (2008). These recent studies put the assailable nature of expertise on display.

The research population in this study, however, this FabLab "maker" community in Japan, seems to foster an even more layperson-centric role for expertise. The FabLabs, of course, are no citadel claiming authority over a certain domain of knowledge, nor is the community preserving a sanctified control over a singular expertise. Furthermore, the operation of expertise in FabLabs seems even more porous and multivalent than scholars like Howe & Boyer, Coleman, and Kelty have been describing. The FabLab community that I observed seems in some ways to flip the role of expertise on its head. Not assailing it, per se, but rather using it, co-opting it, accessing expertise as needed for individual projects.

What I observed in FabLabs was a much more agent-centric path through the galaxy of sub-varieties of expert knowledge within manufacturing. Each "maker's" individual project drove them to seek out experts whose knowledge or skill could help them reach their goal. Fundamentally, the community is designed to create an exchange of expertise capable of guiding lay and trained "makers" through their personal "making" projects. Asking "makers" to describe a singular expertise within their community was generally fruitless. Each person sought out experts as-needed. Hence, I will use the term: "as-needed experts", to locate the function of special knowledge and skill in the FabLab community in Japan. This is a central principle in how the community functions: you find and use the experts you need.

The sought-after skills were mostly technical expertise, of course: knowledge about how laser cutters work on acrylic or the best servos for robot arms, for example. In addition to narrating what I saw of that technical expertise at work: sought-after skills to accomplish a particular task, I will also describe another category of expertise that emerged as I asked people to name "experts" in their community.

That other category is: "organizing experts". Organizing activities such as bringing the "makers" together for meetings, establishing a lab, setting up an exchange Web site, and planning a hackathon, for example, were widely recognized as special contributions. Many people considered the work of organizing venues and exchanges as a kind of expertise.

Chapter 5 presents more stage-setting literature in the anthropological and STS study of expertise along with evidence gathered in fieldwork about the way expertise works within a community proactively designed to bring multiple domains of trained knowledge to bear on a wide range of hobby and personal projects. I will describe technical, organizing, and as-needed expertise in the chapter. However, beyond their function, these forms of expertise are guideposts in the chapter that allow me to explore how expertise is negotiated and how the fundamental principles of "open-source" and "sharing" that undergird the culture of expertise can miss their mark.

Chapter 6: Synthesis

After presenting data in Chapters 3, 4, and 5, I synthesize the findings explored in each chapter to bring the dissertation back to its roots in anthropological and STS theory. I will highlight the cross-cutting insights that emerge in conversation with anthropological theory from the preceding chapters of data presentation about my research.

Chapter 2 - Making a "Maker" Research Project

Chapter Overview

The purpose of this research project, as I have introduced, was to gather and analyze data about "makers" in FabLabs in Japan and how they use technologies to shape their emergent sociotechnical community.

I designed a primarily ethnographic research project as this was well suited to the nuanced and first-person answers I sought to my research question. I conducted the field research in three phases: Summer 2013 for six weeks to reconnoiter the fieldsite, Nov 2014 and Feb 2015 for a total of five weeks to keep up contact with my research partners and the "makers" I had met, and then the dissertation year, from April 2015 until August 2016. I learned right away in Summer 2013 that Hiroya Tanaka was a centerpiece of the "maker" community in Japan. It also seemed clear that to comprehend the full nature of the network and its expanding dimensions I would need to visit each FabLab, comprehending each on its own terms. The following three segments outline the work done in each phase, then I will note some limits to the research.

Summer 2013 - Fieldsite Recon

The first phase of my research was designed as a way to determine if there was indeed a fieldsite and research population in Japan that would fit my research objectives. That first visit transitioned quickly from field site reconnaissance to gathering real data: visiting FabLabs and interviewing "makers". The People and Practices Research Lab at Intel Corporation had taken an interest in the "maker" community in Japan and agreed to provide a grant for me to do a summer research project there in 2013. This served a dual purpose as my pilot dissertation project. I was introduced through Intel contacts to Dr. Yanagi (male, mid-30s), a scholar of geek culture in the Department of Sociology and Media Studies at Tokyo City University (TCU). Yanagi had also taken an interest in the "maker" community in Japan. We spoke previously over Skype calls and email and therefore scheduled a meeting at TCU in Yokohama shortly after my arrival in July 2013.

Yanagi wanted to introduce me to one of his graduate students, Mr. Ohnishi (whom I mentioned in the introductory chapter as the young man who started the Kannai Lab). I

arrived early at the Yokohoma train station and waited in the nearby square. It was a quiet area, so when I noticed a young man sitting alone, glancing at me periodically, I said hello. Mr. Ohnishi was nervous about speaking English, and relieved that I could get by with Japanese. It was nice to get to know him a bit on his own terms before his professor arrived. Yanagi arrived presently and introduced me to a burger joint just off campus. During our quick lunch, it was clear that we shared an enthusiasm for "making" and anthropology. The three of us moved to Yanagi's office at TCU, also a gathering place for his students, and continued to talk about the "maker" community. Yanagi introduced me to a few other students and to another TCU professor, Seita Koike (male, 50s).

Before this first research trip to Japan in 2013, I had read about the FabLab movement. I knew it was a sub-community of "makers" whose enthusiasts opened mini-workshops to the public with laser cutters, 3D printers, and other machines for anyone at all to use. I knew about Hiroya Tanaka, the primary Japanese scholar then writing about and establishing FabLabs in Japan. In 2013, there were just a few FabLabs in Japan: Kamakura, Tsukuba, Shibuya, Kitakagaya (Osaka), and Sendai. I had not previously considered FabLabs as a compelling focus for this dissertation, nor did I have a personal connection to any of them. Yanagi and Ohnishi, however, had a front row seat for observing the growth of the FabLab movement.

After sitting in Yanagi's office, talking with he and Ohnishi for just that one afternoon, the Shibuya-centered project began to shift. I had planned to spend my summer research time in the Tokyo region: Shibuya, where tech and "making" were highly concentrated. However, that afternoon Ohnishi offered to show me FabLab Kannai, under construction in Yokohama, and everything changed.

Ohnishi explained to me more about his interactions with Hiroya Tanaka, working directly to establish FabLab Kannai, located nearby. Yanagi himself was familiar with Tanaka's budding network but Ohnishi knew Tanaka and the five existing labs personally.

The way they explained it, with characteristic Japanese modesty, Ohnishi had shown an interest in starting a FabLab and so Tanaka connected him with his friends at the Yokohama Community Design Lab (YCDL) who were also interested in building something. Ideas led to action and the FabLab was well underway to its public opening in August 2013.

A few days later, Ohnishi took me to FabLab Kannai for the first time. He mused that the FabLab was in its "beta" phase. I will take time to describe the scene in more detail in Chapter 3 but it is important to note that at this time, FabLab Kannai was just a few small machines set along the wall in a large open room where dozens of digital freelancers worked. The space was known as Sakura Works, within YCDL. The few machines available for use were borrowed or donated second-hand.

I realized on this visit just how much deference Tanaka had given to Ohnishi. He was responsible for the machines, for planning the events that drew interest to the FabLab, and for managing its audience. Ohnishi was not just studying this FabLab for his graduate research, or participating in it: he was founding it. In succeeding visits, I continued to see that Tanaka and others were leaving much of the creativity and execution to Ohnishi. And he was clearly enjoying the experience, dedicating much of his time to it.

This was the sixth FabLab established in Japan, less than two years since Tanaka established the first in his own apartment in Kamakura. This time, in Kannai, young Ohnishi was the founder, using his time in graduate school to align the machines and supporters, and plan kickoff events.

Ohnishi's description to me of what he was doing was animated but also self-deprecating. It was just a few machines, he said. He hoped his first few events would not totally flop. On the evening just before the pre-opening event that he was calling "FabLab Kannai 0.5," we watched a milling machine at work. A computer-numerically-controlled (CNC) milling machine uses a small drill bit to carve a block of plastic into a programmed shape. Ohnishi had designed the shape in 3D software. This particular design was a jello mold so he could make jello for his guests. As we watched, we heard it grind ominously and then watched the drill bit drag across the mold. As the machine ground off-point, the carving was ruined. Ohnishi puzzled with a nearby friend for a few

minutes. This friend was an early FabLab recruit, a professional product designer, who had helped create the 3D design for the mold. I tried to act interested and involved but had not the least idea how the machine worked, let alone its malfunction - least of all the Japanese words they were using to discuss it together.

Yet there I was, in Japan, more than a decade since I had last lived there. Less than a week since arriving and I am watching a young man - ten years my junior - about to launch a community venture and wrestle with a jello mold carving.

It was right around this time that I realized I had found my dissertation project. There was so much ethnographic data just in Kannai, and even more to examine across this FabLab network. After seeing FabLab Kannai in its pre-open stage, I realized that there was an "emerging" community in the FabLabs, co-constituted with human actors and novel technological tools, and I had an opportunity to watch it take root.

New recruits. Big ideas. Unbelievable machines. Regular people connected across continents, pursuing a vision of "making" - of manufacturing for the people. And blunders. Frustrations. Failures. Watching Ohnishi, inside the genesis of a FabLab, I would be able to see customary practices congeal in real-time. I could answer my fundamental research question about how the machines and people generate new social practices in manufacturing. I never really returned to Shibuya, except for a couple of interviews. I decided to focus on FabLabs for the Intel-funded project and for the dissertation.

Okakara introduced me to Tanaka shortly thereafter. Yanagi and I interviewed him together at a cafe in Kamakura. Then, with permission, I used Yanagi's and Ohnishi's names to email-introduce myself to the other FabLab directors and I soon scheduled interviews with a few of them. Tanaka told me about other labs that were in development. During these intial six weeks, I visited nearly all of the FabLabs in Japan at that time: Kannai, Kamakura, Sendai, Tsukuba, Kitakagaya (Osaka) and Shibuya (Tokyo), and interviewed some of the directors. I also visited related labs in Gifu and Tokyo. My research focus shifted from the tech hub of Shibuya to finding my way into the early days of FabLab expansion in Japan.

Fall 2014 and Winter 2015 - Preparing for the Full Research Year

I reported back to Intel Corporation in Oregon and also at the Ethnographic Praxis in Industry Conference. My front-row seat to the burgeoning "maker" network, in FabLabs, seemed to intrigue businesses, offering insight about the creative manufacturing energy outside of their proprietary design teams. My underlying goal, however, was to add new knowledge to the anthropological body of research on emerging cultures. My 2013 fieldsite preview had opened the door to a full dissertation project.

In November 2014, after completing qualifying exams, I went back to Japan to keep the project moving. More than a year had passed. Over email, I explained to my contacts that I was indeed doing the project but still arranging particulars like funding. Some were scholars themselves. Everyone seemed to understand that it took time to prepare the full research project. I set up a few interviews before I arrived. Once I arrived, I reconnected with my contacts and caught up on the major changes underway in the network.

On this trip, I interviewed more FabLab directors and visited FabLabs far outside of Tokyo using a Japan Rail Pass. This unlimited, discounted train pass, only available for tourists for up to three weeks, allowed me to traverse the country to make these visits at a fraction of the cost compared to paying for travel once I became a resident of Japan.

I discovered a motley roster of FabLab leaders around Japan, whom I will describe throughout this dissertation, as their insights bear on the research questions I sought to answer. I went all the way to the western Kyushu islands and then headed back east, past Tokyo again, all the way to Sendai. I have fond memories of typing notes and gazing out the windows of bullet trains over deep green mountains, centuries-old rice fields, and the bright lights of pachinko parlors and cheap hotels.

The visits were brief - just a few hours or a day in each town. Each one filled in blanks about the people and places that were banded together in the FabLab network. I saw both enthusiasm and exhaustion. I heard about Tanaka at each site and his role in inspiring - sometimes directly facilitating - the formation of each FabLab. I was not able to observe for long on my visits, but the visual and personal connections helped me to contextualize the dissertation year fieldwork that I was then preparing.

Naturally, I reached back out to Ohnishi and visited FabLab Kannai. A curious response came back: he was no longer involved. After his auspicious beginning, in the 15 months since my first trip, Ohnishi had dropped out of his graduate program and left the leadership of FabLab Kannai. It was now run by three men who were seasoned engineers each working professionally or semi-retired. I previously met each of them in 2013 while hanging around the FabLab but had little idea what role they played then. Now, they co-led FabLab Kannai and told me, essentially: "Ohnishi was a great kid. Not sure what he is doing now." Ohnishi himself was happy to hear from me but said he had decided after all that he needed to take full-time work, and had done so. I visited with Ohnishi a couple more times and learned more about his decision to get out, which I describe in Chapter 4, but at this early phase it was a jolt to my expectations.

By the time the November 2014 trip was over, I had collected significant data and the project was well underway. I could not wait to be back for the full project.

Still waiting to hear good news about grants for which I had applied (and having received a couple of rejections already), I scheduled one more short trip for late February 2015. I planned to bring my wife and four young children to live with me in Japan during the extended fieldwork segment. There was a great amount of groundwork to make this possible: looking for housing with an agent, obtaining passports, confirming the legal process and visa details, even checking out schools. My family wanted to leave as soon as possible for the field, naturally.

On this February 2015 trip, I focused my research time on staying connected with my contacts like Tanaka and the FabLabs in Kannai and Kamakura. While I was in Japan, I learned that I was granted research support from the Japan Society for the Promotion of Science, administered in the US by the Social Science Research Council. My wife and I bought plane tickets in early March, sold our home in Lexington, KY, and moved to Fujisawa, Japan, just a few weeks later in late March.

Wrapping up this second phase in itself felt like a triumph and transition for both me and my family. After three and a half years of graduate work, the fieldwork phase was ready to begin. I was finally ready to undertake a full dissertation research project.

I eagerly anticipated this phase of research for many years. During my undergraduate study, when ethnographic research and anthropology became a compelling

epistemology to me, I imagined doing a long stretch of engaged fieldwork such as this. I spent seven years working in the non-profit sector before deciding to pursue a Ph.D. in anthropology. Always, I was drawn to the human stories and the bigger picture of lived experience. Then, throughout the few years back on campus, honing my theoretical approach and my research questions about technology, humanity, and Japan, I was intent on creating this extended fieldwork project. I gained experience creating projects and networks, and writing, as a professional. Yet I craved the time that an ethnographer can take to pursue deeper threads of inquiry, to observe over time, as experiences unfold, instead of on the urgent clock of a company budget.

My recent visits to Japan also dusted off my atrophied Japanese language skill. I first studied Japanese at the Missionary Training Center for the Church of Jesus Christ of Latter-Day Saints. A 10-week intensive study there was the beginning of two years of missionary service that would follow: my longest stretch of time living in Japan, from 1999-2001. These years shaped my fundamental personal impressions of Japan. I spent those years visiting families around Hiroshima and western Japan to talk about matters of faith. We invited people to join the Church and also helped the members in their lives. I also taught free English classes. I met thousands of Japanese people and felt my own personality shift as I came to appreciate the depth of their concern for humanity and the natural and spiritual worlds we inhabit. I learned much more from those years than just how to communicate in the Japanese language.

My first experience living in Japan, however, was from 1981-1982 when I lived in Yokohama as a toddler. My dad worked in the City as an attorney at a Japanese firm. I have almost no memories of this time living in Japan. My language skill developed, as I wrote above, during my mission-service years when I used Japanese for daily life and work. I also took a minor in Japanese in college. In succeeding visits to Japan and through my professional work, I expanded my comprehension in business and government environments. This dissertation fieldwork required me to study again. After the initial weeks of dusting off my atrophied skills, I returned to a level of comfort with the language and society that allowed me to fully engage with my research population.

As noted above, my comprehension of Japan as a whole is rooted in my time as a missionary, coupled with personal and university study of the nation's history, language,

and current events. My position as a scholar was also mediated somewhat by my previous professional background. On one hand, because I had been the executive of a small non-profit company, I could quickly connect with the leadership experiences of the FabLab proprietors. They were natural friends and compatriots in a sense. I could sympathize with their challenges developing a small social organization. On the other hand, my lack of knowledge in the underlying technology of their labs meant that my comprehension of the technical components of the community was always beginner-level. Not to mention my limited understanding of the Japanese technical language that described concepts already opaque to me.

The FabLab community proactively seeks recruits, however, and nearly everyone was quick to give their attention when I asked it. Many of them were scholars or at least arm-chair philosophers in their own right so they took me as a peer and showed genuine interest in the progress of my project. Some people wanted to practice speaking English with me because I was a native English speaker. I studied among teachers, professors, graduate-trained engineers, and civic leaders - often a self-aware group of cultural agitators. It was my privilege to learn among them.

2015-2016 - The Dissertation Year

The early interviews and visits to FabLabs that I completed during the first two phases gave me a sense of the physical and social geography of the FabLab network as far as it had emerged up until February 2015. I observed enough to distill my research questions and select FabLab Kannai and FabLab Kamakura as my primary field sites.

After the move, and settling in to life in Japan, I entered the dissertation year with a strong sense that the research now needed long days of participant observation inside FabLabs. I had made a lot of contacts and seen many of the FabLabs, but in order to see more "real people doing real things" (Ortner 2006), I began spending my weeks visiting the FabLabs and other sites where "makers" were gathering.

I selected a home for my family where I could take an easy train ride to FabLab Kannai or FabLab Kamakura. The route to Kannai was a little more direct, and I anticipated spending most of my time there. Mr. Ohnishi's absence had changed my

relationship to FabLab Kannai somewhat but as a research concern, this made it all the more interesting as a site where the FabLab community was materializing in real time.

In earlier trips, I had spoken briefly with Ms. Youka Watanabe who led FabLab Kamakura. I knew that I would be welcome at the open-to-the-public weekly events at FabLab Kamakura but with more connections to FabLab Kannai, I expected to be there most often. I will explain more about the differences between the two labs in Chapter 4 but wish to note here that I shifted early on to spending more time in Kamakura. This was an early and important additional change-up. Once I was in the country, and visiting consistently, Youka took more of an interest in my project and the utility of my English skills, leading to this shift in focus. Youka opened opportunities for me to meet people outside of the central FabLab community with whom she was collaborating, and she drew me in to some of her projects outside the walls of FabLab Kamakura itself.
I conducted semi-structured interviews throughout the project. Many of these were earlier, especially when getting to know the FabLab directors. The interviews helped me to hear opinions on key themes such as sharing, openness, what it means to be an expert, and how the FabLabs differ. Also, in interviews, I often received more introductions to other corners of the network. My interviewees often wanted to encourage my interest in learning about and - they seemed to hope - supporting the network. Some interviews were helpful in getting past rhetoric and hearing what people thought, more candidly, about the network. Most people were still enthusiastic but face to face, with some degree of rapport, I noticed that they were less inclined to varnish their commentary.
I recorded 22 interviews under signed consent. 8 were FabLab directors. 14 were patrons or other ancillary participants. 4 were women. 18 were men.

Over time, participant observation and interviews led to deeper familiarity and comfort with the patrons. During the second half of the project, I held fewer interviews but more meaningful conversations where I could ask questions casually. I became a regular at FabLab Kannai and FabLab Kamakura, more consistent than all but the most dedicated patrons. The observations I recorded and the conversations I held as I went to the FabLabs and other events and venues - the participant observation activities - generated the rich, thick, nuanced, and sometimes very disorganized data that I consider the critical data in this ethnographic analysis.

I recorded 142 different field note entries, each covering different visits and events around Japan's FabLab network. At my primary field site: FabLab Kamakura, 40 notes were recorded, representing around 175 hours of observation (estimated). In Kamakura, I attended the morning Fab event 21 times and the evening Fab event 13 times. The other visits to Kamakura were for special events. During this time of observation and discovery I became an expected face at regular Fab events. At my secondary site: FabLab Kannai, I recorded 24 notes from different visits, or around 125 hours of observation. Of these, 10 were Saturday visits when the FabLab was open to the public and patrons would come and go - not so formal as in Kamakura. The rest were events organized to draw in crowds: member recruitment, skills training, reports from other FabLabs, and even a wedding.

Beyond these regular visits to Kamakura and Kannai, I ranged across the Tokyo area often, within a couple hours of where I lived. However, during all three phases of the research, I listed from western to eastern Japan to eventually visit 15 FabLabs. That was all but a couple of the Labs that were operational while I lived there. In order from western to eastern Japan, I visited Saga, Oita, Dazaifu, Kitakagaya, Kurayoshi, Yonago, Tottori, Hamamatsu, Kamakura, Kannai, Super Kannai (Tanaka's graduate student lab), Shibuya, Kamakura, Tsukuba, and Sendai. I met the director at each of these and maintained my connection to each at events where they gathered and over email and Facebook. I spent around 75 hours visiting the FabLabs beyond my primary and secondary sites.

My experiences in these sites are given more detailed treatment in the data presentation chapters. I spent a lot of time, as the above sketch shows, in FabLab Kannai and Kamakura, especially during the first ten months or so of Phase 3, the extended fieldwork segment. This was always part of my plan, earning a trust and familiarity with my research population such that I could nearly blend in. The effort was rewarded with research insight and with treasured relationships.

I wish to make special mention, however, of how my attention was spread around the network during the project. Especially during my last six months in the field, I turned significant attention to events and activities not based in FabLabs but where "makers" and FabLab patrons tended to gather. I visited 21 different sites for events related to the

FabLab movement, spending more than 100 hours at such events. Throughout the project, I also patronized a bevy of coffee shops for interviews and catch-ups. I will describe some of these special events as my data reporting unfolds.

The variety of activities that took place outside of FabLabs speak to the nomadic nature of the FabLab network. Some sessions were at universities. Some were in government offices, like the Japanese equivalent of our USAID: called JICA. Some were "makerspaces" not designated as FabLabs - commercial ventures seeding hardware startups. Some were inside corporate offices and others in art museums. Another, the biggest annual MakerFaire (O'Reilly Media's worldwide sensation, a show-off venue for "makers"), was in one of Tokyo's biggest convention centers.

More to the point of how I traced the FabLab network outside of the walls of FabLabs themselves, is how my research focus changed after around nine months in the field. During the last quarter of 2015, my participation in the network, and the observations generated therefrom, shifted somewhat as I took opportunities to be directly involved with projects related to the FabLabs. Youka and Tanaka invited me to be a participant in some of their projects and I quickly accepted, knowing I would see more of the inner-workings of the community, beyond open-to-the-public FabLab sessions.

Tanaka seemed to be constantly speaking at meetings, conferences, and exhibits. Youka kept a close pace with her engagements. And other FabLab leaders are likewise involved. The most involved I got was with the FabLearn Conference, organized by Youka with Tanaka's full support, in partnership with Stanford University, which established the FabLearn conference model in California. That event, held in December 2015, was aimed at educators who wanted to incorporate hands-on technology in their curriculum. At another Fab-related event in March 2016, I presented my research at the International Conference on Digital Fabrication, organized by Tanaka for engineers from Japan, India and Australia. Also outside of FabLab visits, I attended industry and government meetings where Tanaka was a keynote speaker. I went to art exhibits where some of the patrons' creations were on display. I attended the MA thesis defense of one of Tanaka's students.

This later period of fieldwork during which I was invited to participate more in community activities helped me to see different sides of the individuals and the activities connected to but not held inside the FabLabs. Different vantage points of participation.

The Future of Industry, Mobility, and Making (A Mini-Conference Tale)

One mini-conference, "The Future of Industry, Mobility, and Making (FIMM)," in which I participated is a good example of the mixture of interests at play and the ad hoc nature of the FabLab network. The two-day event was held at Tanaka's "Super FabLab" in Kannai (a short walk from FabLab Kannai), which was built for his graduate students. I present this anecdote in this section because it strikes me as representative of the people and values operating in the FabLab network, which frankly are quite hard to circumscribe with even a litany of anecdotes. I find it unlikely that a gathering such as FIMM would have coalesced outside of this unique FabLab milieu.

On a Friday night in the early summer of 2015, a few dozen of us gather on the second floor of a nondescript building in Kannai, Yokohama. The sky outside has darkened and downstairs the Yokohama city nightlife is starting up its revelry in restaurants, bars and clubs. Our gathering is also befitted with drinks and snacks but we have our own style of revelry. We come from industry, academia, retirement, and other commitments to socialize and yammer about "future mobility". Dr. Tanaka and Mr. Adachi (male, 50s), two central actors in Japan's FabLab community, entice us with the question: how will we move people in the future, beyond cars? Tonight is the opening reception for FIMM, a mini-conference meant to bring designers and activators together to explore innovations for mobility in Yokohama.

The venue is Sakura Works, the meeting space operated by the non-profit Yokohama Community Design Lab. I have attended dozens of events here, from comically staged wrestling matches to youth orchestra performances, from academic study groups to a wedding. We are on about 5,000 square feet of floor space, an open kitchen is in one corner of the room and chairs and tables are pulled off their racks near the wall as needed. The floor and walls and unfinished ceiling are all painted black. Brightly colored hand-painted art accents the black walls. Accent lights are hung, stuck, or standing haphazardly around the room. Tonight the chairs are in rows facing a screen

and projector, suggesting a classroom function. I just moved back to Japan two months ago and I only know about five people in the room - lots of new friends to meet tonight.

Mr. Sawano (male, 60s) presents his ideas to the crowd. He is unable to walk and has limited movement in his arms and hands. He is elated to show us his specialty motorized scooter, which he tricked out with specialty features of his own making. We can see the bliss on his face as he is introduced and ceremoniously drives the scooter up the center aisle to the audience oohs and aahs. He tells the story of how he designed and made each modification to the standard scooter. We also catch some slides from Jin, a Chinese young man who grew up in Italy where his father manufactured auto parts. Jin and his team have designed a chassis and engine system that he calls the open source vehicle: OSV. Sharing the designs freely, he tells us that anyone can build a car. He offers technical advice through an eponymous company called OSV.

This event is the opening of FIMM, the third in a series of events designed to bring industry, government, academic, and FabLab activators together. Mr. Adachi and his colleagues at FabLab Oita are the ringleaders, with Dr. Tanaka and Mr. Sugimoto from YCDL as influence and logistics supporters. A simple Facebook event page handled the bulk of the FIMM advertising. 243 people were invited and on Friday, there were more than 80 attending. I notice that only around 10 are women. A couple of local-beat news articles will probably be written about the gathering, touting big ideas such as: the sharing economy, the power of DIY making, and industry-university-public partnerships. This Friday night soiree is just the warm-up, however. Tomorrow, we get to actually make something.

On Saturday at 11am, around 20 of us gather again on the second floor of another building, this time about ten blocks away, across the street from the professional baseball stadium of the Yokohama BayStars. I see just one woman today, and notice that she is gone before the afternoon is over. This second day of FIMM is hosted by Dr. Tanaka at his "Super FabLab". The Super FabLab is a fabrication research workspace for graduate students of Dr. Tanaka and Dr. Kakehi, another Keio professor who teaches interactive media. Unlike Japan's other FabLabs, the Super FabLab is not chartered with Gershenfeld's global FabLab organization. It is not open to the public for hobby projects but welcomes visitors who come and go during the day. Students and visiting researchers

are often at work through the night. The lab was created in early 2014 because space was getting tight at the Keio SFC campus. It maintains a thrown-together feeling over a wide 4,000 or so square feet. The floor is plywood with cables running up through intermittent holes. Every fabrication machine imaginable is on hand, resting on tables or on the floor around the room, without much apparent order.

As you enter the room, Dr. Kakehi's students gravitate to the left hand side and Dr. Tanaka's to the right hand side, where most of the machines sit. The only walls in the wide space are office cubicle dividers but they are sparse. The floor space is used up by at least twenty tables of no particular style or size and chairs are grab-and-go: abounding but never matching. The entrance is signified by a short hallway created by lining cubicle dividers on both sides of the doorway. Artifacts of past "making" projects decorate the eight feet of hallway, as well as an assortment of flyers for events and research reports, plus a flyer displaying the all-important Wifi SSID and password - free and high speed for any visitor. Just past the hallway on the right side is the seven-foot 3D printer built in-house by Tanaka and students, a conversation piece for many guests. Mr. Otsuka (male, 50s), Tanaka's assistant, gets a divider-enclosed office, as do just a couple other people. A few group meeting spaces are marked by dividers on three sides with a circle of chairs inside. The grad students find table space wherever they can move aside a project. Electric plugs on extension cords are always somewhere nearby, emerging from the floors, the middle of tables, under couches, or behind machines.

A couch is situated off to the left side of the entrance, where a large table with chairs around it and behind it face a 60 inch TV on a rolling cart. This feels like the most obvious location for a group meeting and this is where our FIMM group gathers. The audience is dressed according to no particular code. There are t-shirts and jeans, slacks and button-up shirts, and everything in between, even a *samue*: the loose-fitted work outfit associated with zen monks. Notably, no one is wearing an office suit like they were last night.

Mr. Adachi, a consummate emcee, gets us started with an overview of the topic and the day's activities. He tells us we are going to design something today, whether with pen drawings, CAD drawings, Legos, or any other medium. He gives us a sense that our ideas will be taken seriously by telling us that he has an appointment with the Mayor of

Yokohama where he will share our ideas. We hear from Dr. Tanaka for a minute about the program and about the importance of citizens thinking about and solving mobility challenges in the city. Then, we are randomly split into groups of five or six each to discuss and design a solution or idea for improving mobility in the future. And off we go.

My group included a 3D designer and visiting researcher: Mr. Qi, the wheelchair innovator: Mr. Sawano, Mr. Tarumi from FabLab Oita, and Mr. Kitanaka, a high school engineering teacher. We started out by listing challenges and obstacles for mobility in Yokohama. Favoring our wheelchair-bound compatriot, we chose the topic: Accessibility 2.0. We decide to pursue a solution not for mass mobility but for accommodating physically limited citizens.

A lot of ideas come out in the brainstorming session:

- Drivable pods that attach and detach to a lead vehicle so you can tag on with a lead driver and not worry about driving yourself once attached.
- Stair-climbing motorized carts.
- An extra car on the regular trains and subways for storing motorized vehicles.

Mr. Sawano has all the first-hand knowledge and actively shares insights with our team about what he has imagined using during his excursions. His vehicle ideas, however - and he is the first to admit this - bear only a thin connection to what is possible. His enthusiastic imagination doesn't refer much to what exists or what is possible, and he fits right in at FIMM.

As we share ideas like improv artists, thinking nothing of their feasibility, I find myself both relieved that I don't have to be embarrassed by my own silly ideas but also pretty certain that the mayor is not going to fund mag-lev motorized scooters or legislate wide-scale retro-fit accessibility-driven construction projects. We are, simultaneously, kids playing with Legos, designers, professors, officials, and professionals brainstorming and prototyping the future. After we talk about ideas for an hour, we break for lunch.

Lunch is out on the town. My group walks to nearby Chinatown and enters the first restaurant we see. Along the way, our group watches thoughtfully as Sawano deals with obstacles, asking him for details about how he manages his scooter around town. He always waits for elevators - no stairs for him - so our group waits, too. The restaurant

chooses to seat our group next to the front entrance and seats Sawano at the table end nearest the door for easy entry and exit. He uses canes to walk after standing up from the wheelchair. He is proud to show us the chopstick-holder he had made on a 3D printer to fit his hands precisely. At lunch, we discuss how watching him navigate the many small curbs, un-level or narrow walkways, and tight spaces in the restaurant gave us a better understanding of how the city lacks accommodation for physical limitations, as a general rule. We make plans to incorporate fixes into what we are designing that afternoon.

My own design skills lacking, I do not have a lot of input into the eventual output object of our group but I try to keep up as the group works. Sawano is a strong voice and the group quickly begins to work on his idea for a scooter that can traverse stairs. Lego Technica becomes the base - a motorized Lego system popular in schools that allows you to attach wheels and axles to a motor, to build and control your own vehicle. Qi uses his skills to quickly draft a car and human figure in 3D so we can envision how the thing might really move in real life. In the end, the 3D model does not contribute much to the Lego-built design but we show it to the other teams anyhow as another artifact of our work.

Not long after lunch and this "making" session begins, I notice that the whole room seems to drift away from its project focus. A couple people are working on the Legos and Qi is fixed on his 3D design. I am half-involved in listening/watching, periodically offering comment to seem engaged, but mostly making notes on my laptop. Then, Mr. Tarumi unboxes a helicopter drone that he has brought and begins getting it set up. Out of sync with the task at hand? Maybe. But no one seems to mind. In fact, whereas I mostly observe my Japanese friends to be patient and deferential to others when a fun toy or delicious food emerges, people seem unabashed about leaving their task and asking for a turn. The drone quickly catches attention from people in every working group.

Laughing as it levitates, turns, bumps bookshelves or machines, and often falls back to the ground, the men play like boys. As I watch, I enjoy the assurance that they are at this event for many reasons, but perhaps mainly because they want to be here. Mr. Adachi provides us a measure of order during the afternoon hours, blowing a whistle every half hour and telling us how much time we have left. Eventually, with a mad rush right before the time for presentation comes, our Lego project is in some form worthy of

presenting to other groups. In turn, each group presents their ideas and their creations. The other two groups have gone in totally different directions and also seem to have played their way through the "making" time. None of the ideas are in range of something I can imagine in the real world. Dr. Tanaka's group has essentially built a dozen or so vehicles with Legos that represent road-driving conveyances that have an underserved purpose for city dwellers but do not exist yet because only cars and buses and trucks have generalized markets.

After we wrap up the reports on this Saturday afternoon, we hear a presentation from a woman in her eighties, sweet and poised, who has funded the $3 million cost to design a motorized scooter that suits her personal design ideals. Now, she is selling the carts commercially. She is unemotional as she acknowledges that her sales are not on pace to recoup her investment. She seems content enough to have the scooter that she had at one time only imagined for herself. As she concludes her remarks, Adachi steps aside with her and a few others to ask additional questions. Nothing more is said about FIMM. Without a coda, the event simply ends. Some of us stand around and talk as the Super FabLab returns to its latent state of buzzing activity.

In all of its ambitious, creative, loosely organized, professional, playful, and social dimensions, the style of this FIMM event is representative of what I often saw around the FabLabs. There are rules but they are only guideposts. People are there to think and learn as professionals but also to play. We really did not make anything novel or anything that could be implemented in the real world but we got to know each other better. We talked about ideas that will not impress the Mayor but that helped us to understand problems better.

I hope that the ethnographic approach I took in this FabLab community will capture its nuance and the nascent nature of its emerging culture. That is the fundamental reason I think ethnographic methods were suited to my research questions in this particular community.

Limits of This Research

This research is solely my work and is not intended to speak for the research population. All interpretations of data are mine as are any conclusions drawn.

While the FabLab in Japan certainly has a distinct personality relative to the FabLab networks in other national contexts, such as the United States, I set out to examine only the Japanese FabLab network. I do not endeavor to write a comparison to other FabLabs in other countries, as I think the descriptive and analytical work of this dissertation would not be sufficiently improved by such a comparison.

Furthermore, whereas it may seem incumbent on a scholar to produce concrete "findings" based on hypothesis, or perhaps end with action or policy prescriptions, that is not the approach of this research or dissertation report. While my data and analysis are designed to contribute to the production of knowledge in the academic social sciences, I designed this report to be heavy with description. I think that the "emerging" network in Japan's FabLabs has much to contribute to academic knowledge from its stories of daily practices. I have extrapolated these descriptive details to theoretical models in some cases but allowed ethnographic description without theoretical context in other cases. The "findings" that I present may be considered points of analysis deriving from the aggregate of ethnographic data, in the context of anthropological theory and public interest.

I have, myself, translated the interviews that I held in Japanese. I have endeavored to publish direct quotes as accurately as possible. Any possible misrepresentations are unintentional. At times, when informants have spoken to me in English, I have sometimes made their English more clear when quoting them, to preserve the intent of their message.

Lastly, throughout this dissertation the present verb tense is used when I know that something was true throughout the duration of my research. Sometimes, if that thing has changed since I left, I may not know it. It cannot be assumed that something I say "is true", remains true to the present.

Chapter 3 - Coherence of an Emerging Network - The Components

Intro Remarks

As explained in the introduction, I studied an emerging social community enabled by modern technology. A fundamental aim of the project was to observe a social world that did not exist until recently, and therefore perhaps has dimensions that can provide unique anthropological insight on an emergent culture. Enabled by layperson-accessible manufacturing tools like CAD software, 3D printers, and laser cutters, the "maker" community in FabLabs in Japan has taken shape since around 2010. That is when Hiroya Tanaka was at MIT studying with Neil Gershenfeld, the father of the global FabLab movement.

Today, nineteen FabLabs dot Japan, dedicated to openness, sharing, and layperson engagement in manufacturing. Yet the group is coherent enough that thousands of people engage with tools and with other people in the network.

This chapter presents data from the field to address this fundamental question: How does the community cohere if it is establishing itself outside the business, government, religious, and other common domains of human social activity?

Involvement in this community is eminently elective. Human actors nearly always elect to participate in FabLabs against a degree of opposition or ambivalence from their personal networks. Their boss at work, their parents, their friends from school: the FabLab people I spoke to in general were not motivated by these socially proximate people but rather told me of pushing against the grain to join the FabLab community. That makes this community fundamentally different from a workplace or a society that recruits through salary, citizenship, religion, or other arcs of compelling social obligation. Fabbers are of course still bounded in those regimes but their activity in the FabLab is generally hard to describe with terms of social pressure or coercion. After setting the stage, I will introduce the network components and network practices that, in my observation, serve to cohere the emerging FabLab network in Japan.

Theoretical Framing

      A bit of theoretical framing will help to explain how I came to interpret the elements of cohesion within the network. Then I will present findings divided into two categories: network components and network practices.

      In science, technology, and society studies (STS), the social construction of technology framework helps me to organize these disparate data-points (Pinch & Bijker 1987). This framework comprehends technology as anchored in a social milieu, its current state being an outcome of contests and negotiations. Approaching "maker" technology and the network as socially constructed is important to this project, allowing that there is not a singular nor essential description of the phenomenon or fact but rather it is - even now - still shaping into its present, describable form.

      Actor network theory (ANT), one oft-cited analytical toolkit that aligns with the goals of the social construction of technology framework, seems particularly well-suited for ordering and presenting this chapter (Latour 2005). Actor network theory is often employed as a tool for opening "blackboxes" and revisiting the social construction process that came before facts. However, inasmuch as I interpret the FabLab network as emerging, or pre-black box, I use ANT concepts and assertions in this chapter to describe the moving parts as I have observed them in the field, rather than to peel back any static concept that is widely accepted or adopted as a formalized blackbox. The FabLab network in Japan is only eight years old today, counting back to 2011 when FabLab Kamakura and FabLab Tsukuba were established, and there are currently nineteen chartered FabLabs in Japan. Worldwide, there are more than 1,600 FabLabs, though the scope of this research does not encompass the global FabLab network. New FabLabs emerge each year and the community's members come and go, as do projects and priorities. The network is so dynamic and transitional that I found myself feeling pressure to record its present form before that existence evolved.

Network Components

      The central question of this chapter, deriving from ANT, remains: what actors and actants are present in the network and how do they operate in concert to produce the FabLab movement in Japan? The segments of analysis that I explore below each

represent a category of actor/actant that functions in the enterprise of FabLab network coherence. I refer to those categories as network components. Those components are: people, gathering spaces, and machines, and I will attempt to describe how each functions as a cohering element in the FabLab network in Japan. Other components such as ideas and capital could be considered components but are not included in this chapter. I will consider certain additional factors as practices in Chapter 4.

People

First, of course, is the people. Individual human actors play a steering role in network coherence. Across the world, people who identify as "makers" pursue their shared vision. In Japan, and in FabLabs, a subset of these global "makers" are actively pursuing the vision outlined by Gershenfeld and the FabLab charter. Their ideas, their plans, their invitations, their efforts, and their communications - all of their activities - are the choreographers of the community.

I can only describe a handful of these actors by name or in sufficient detail to depict their function in the network. I won't even call them prototypical. However, the Fabbers described below are carefully selected for either their unique influence or their qualities representative of some general "Fabber" qualities.

Ms. Youka Watanabe

Youka Watanabe worked at a design firm in Tokyo in her twenties in the late 2000s. She describes that time in her life as very busy but exciting, though she was starting to feel strained. She had grown up near the US Army base at Camp Zama, about an hour southwest of Tokyo. She studied design in college and worked for her professor's design company, on a stable path but not feeling precisely settled in that trajectory. One day she was in a car accident that left her recovering for weeks, and reconsidering her life. She learned about Tanaka and the FabLab movement and decided to get involved. Her life has become entwined with the FabLab movement since that time.

Youka contacted Hiroya Tanaka while he was in Boston at MIT in 2010 and asked if she could help him. He did, in fact, need help. Tanaka wanted to start a FabLab and needed someone in-country to choose the space. Tanaka expressed that he wanted to find

a place in Kamakura, a temple-, shrine-, craft-, and tourist-filled town on the beach far south of Tokyo. Also, many ancient Japanese craft traditions have been well preserved in and around Kamakura. Tanaka wanted to anchor this first FabLab in that historic tradition of "making." Youka found a building and got the green light from Tanaka. I will describe this "gathering space" in much more detail in a subsequent segment. The community at FabLab Kamakura has been led by Youka since this time.

*Figure 7. FabLab Kamakura. Reprinted with permission from FabLab Kamakura 2019.*

I did not see FabLab Kamakura until 2013 when it was already two years old. The building has three separate residences within it. The building owner lived in two of the residences. In 2011, Dr. Tanaka rented and lived in the third residence, the front of the building, which he then opened to the public most of the week as a FabLab. So, perhaps it is more accurate to say the FabLab lived in his house. In either case, Youka directed operations but Dr. Tanaka was frequently present. By the time I saw it in 2013, however, Dr. Tanaka lived in the back third of the building and Youka ran the FabLab on her own. In the dozens of visits I made during this research, I only saw Dr. Tanaka drop by once. That could be a function of when I was there or perhaps because his globe-trotting, news-making, student-coaching schedule kept him elsewhere. I speak of the absence of Tanaka to assert further that Youka is, indeed, the boss at Kamakura.

FabLab Kamakura is a corporation and Youka is its president. Not all FabLabs are established as legal entities. Youka established the Japanese legal equivalent of LLC status for FabLab Kamakura in 2012 and in 2015 shifted to a different status as a non-profit educational entity. Youka's salary always came from the company, from the beginning when she won a grant to get it started. However, she told me: "I was not paid that much. Not enough for living in Kamakura. I lived with my parents 90 minutes away by train for the first few years (interview, 2015)."

It is important to explain this business side of FabLab Kamakura, which says a lot about Youka and her role in the network. Very few people know much about the income and expense details that she manages. This is of course true of most businesses. FabLab Kamakura's patrons know they can use the machines on Monday morning and Wednesday evening. Some people make arrangements to use them at other times, paying for the privilege. Youka keeps the business of the FabLab to herself for the most part. She finds many ways to bring in revenue. She consults with major Japanese companies on how to set up their own FabLabs internally (not Gershenfeld-approved, but the same concept) and get employees to use them. She does a skills training program. She rents out the FabLab to other organizations for their training projects. She organizes conferences. She allows freelancers like Senko to rent desk space. There is no definitive business model yet. In 2019, Youka told me that she was finally starting to consider charging a

membership fee. She was not sure what she would do after October 2019 when a current grant expires but said: "we always find something."

In 2013 while in Japan exploring the FabLabs as a potential research subject, I attended the opening press event for FabLab Kannai. I mentioned this event in my introductory chapter. I first met Youka there, very briefly. At that time, Youka's FabLab Kamakura, around 30 minutes away from Kannai, had been running for two years already. At this press event, she was one of just a few speakers in front of half a dozen news cameras and an audience of more than a hundred people. I had heard about and read about FabLab Kamakura. I had hoped to meet Youka and made my way over to say hello. It was a brief meeting and Youka was polite but not effusive. She did not invite me to her lab nor ask much about my project.

At the press event, however, Youka did announce a day-long event later that month where she would give a tour of her lab and other spaces in Kamakura where innovation was thriving. That tour became my first visit to FabLab Kamakura in July 2013. I was one of nearly twenty guests on this tour, led by Youka. I did not meet all of the guests but I met a few professors of design and engineering and also young professionals who were intrigued by Youka's FabLab. About half of the participants were women. Youka kept our attention with descriptions of the machines, of her vision for the lab, and stories I would come to hear often in the ensuing years. One was about her friend: Kuluska, who designed a simple laser-cut leather shoe and now his design has been used around Africa in settings where shoes were otherwise much more labor and cost intensive. Youka, however, showed us more than her FabLab in Kamakura. The FabLab tour took less than an hour. We spent the rest of the day walking through Kamakura, touring other innovation hubs such as a shared office for software startup companies. Youka told us that Kamakura - the 13th century capital of Japan - was becoming a Bay Area-style "Kama-con Valley".

Helping to deliver the point, we ended the day near the beach. Kamakura has gorgeous beaches, visited by Tokyo-ites since before Kamakura was Japan's capital in the 13th century. Our group seemed easily caught up in Youka's raise-all-boats vision. She ended the day by engaging us in an idea session about how we can shape the future. The sticky-note-heavy, animated dialogue took place at a beachfront collaboration

workspace designed for seminars that bring Tokyo day-job acolytes out of their cubicle coma and into the world of creativity and collaboration. By the end of the day, Youka had this group of forward-thinking professionals and professors brimming with big ideas and excitement.

Youka possesses a dignified style and design sensibility. FabLab Kamakura is a thoughtfully renovated 300-year-old wooden structure. Her eye for design is evident around the FabLab. She keeps a handful of patrons' projects on display, judiciously chosen for their aesthetics but also for their reusability as show-pieces for when outsiders visit. Youka draws together a motley mix of old and young, men and women, hobbyists and professionals, from across the region south of Tokyo and visitors from around the world.

Youka's playful and inclusive leadership style makes everyone feel welcome. She is not afraid to ask people to do things for her or for the Lab, however. A number of people have small "roles" they fill, which Youka has tasked them with. Mr. Hayama, an older man with gray hair and a jovial smile, comes every Monday morning with a bucket full of rags for the morning cleaning ritual. Yamamoto, a recently retired male engineer, is helping develop curricula for high school students to learn the Fab basics. Kondo (female, 20s) and Kanda (male, 30s) are direct reports who are paid for some of their time at the lab. Horiguchi (male, 50s) volunteers as a FabMaster. Everyone there is made to feel like they make a special contribution. They do, in fact, and it is designated by Youka. What Youka says, mostly goes. For example, Youka is set on everyone learning English. She insists that the end-of-session reports be done in English. Some reports become very short. Some slip quickly back to Japanese. But overall, people stretch their skills and attempt to report in English.

One evening while a group of patrons ate dinner together inside the lab, around the community table, I noted that Youka was bent on making the FabLab more clean. Following the very common practice, she asked us each to introduce ourselves. Names, bios, and favorite projects were shared by each person around the table. I had heard Youka introduce herself many times before. She usually just stated her name: no statement of her role because everyone knows her. This time, however, she added this description: "I clean up after people, because no one cleans up." I smiled. So did she. So

did the others. But during the evening she commented to various people on the trash situation in the FabLab, how they needed a more decisive place to put the trash. She would be working on that. Then, she strongly expressed the opinion that one of the biggest problems in life is looking for the right tool to do a job. Things need to be quickly accessible and then they need to go back to their place. The lecture was performative, very subtle as it was so direct, and yet joking but not funny. The group listened and responded earnestly, playing along and agreeing, asking questions. Message sent. Message received. With virtually no disruption to the overall tone of welcome and enthusiasm for "making."

Youka does not do the work in the FabLab alone, of course. The seven-year-old FabLab relies mostly on volunteer time. People step in to help with projects and initiatives. Sometimes, Youka makes a trade. Senko (male, late 20s) is a freelance designer and rents the loft at FabLab Kamakura for a place to focus. In exchange, he leads the evening Fab event each Wednesday night. Even the two employees: Kondo and Kanda, only get paid periodically when a project fee comes in to the FabLab. They are volunteering a lot of their time. In exchange, they are allowed to use the space and machines for developing their own businesses based on skills and networks they are building through their FabLab efforts.

Kondo, for example, runs the Monday morning AsaFab (9a-12p every Monday), the feature event for outsiders to utilize the space. Youka is sometimes in attendance, sometimes not. She trusts Kondo to handle AsaFab alone and this says a lot about how Youka chooses and deputizes her helpers. Kondo is in her early twenties and is warm and affable with guests. She leads the cleaning ritual, the introductions, the opening instructions, and the wrap-up phase. She knows the machines well and is a go-to for advice on technical questions from lay-visitors. Kondo has a tone-setting effect on the regulars and newcomers and is a well-selected right-hand to Youka. For her side business, Kondo has developed a brand and line of artfully designed, hand- and machine-crafted small products. Her main craft is a broach, laser cut in wood, dyed, and then pieced back together in a circle, creating a curved line contrast between colors - something like a yin/yang insignia. Youka nurtures a number of people like Kondo and is able to keep the FabLab running as a business with their efforts.

Youka frequently arrives with guests. Sometimes a few business-people from Tokyo. Sometimes, city officials whom she asks for support. Sometimes, it was an international visitor who took interest in the FabLab and traveled to see it. One time during AsaFab, it was a camera crew from national broadcaster NHK doing a story about FabLab Kamakura.  Much of her energy during my fieldwork period was dedicated to perpetuating enthusiasm for the lab and finding new ways to keep it running. She met with potential consulting clients, starting up her training program for beginning "makers", and creating new global relationships in FabLab-based education. She generated publicity for FabLabs in general and for FabLab Kamakura's services in particular. New revenue must have certainly been always on her mind but she never brought it up in conversation around any but her closest associates.

FabLab Kamakura is an anchor lab that other FabLabs and makerspaces in Japan tend to admire. Youka's personality and drive to grow the network across Japan have helped many other people, spaces, and machines in the network to cohere and continue working together.

Dr. Hiroya Tanaka

Youka Watanabe, as I wrote, was drawn into the FabLab community in Japan by Hiroya Tanaka. Professor Tanaka is considered by most people I spoke with to be *the* key figure in Japan's FabLab movement. To a person, every FabLab director whom I asked: "how did you get started?", answered with a story that included Hiroya Tanaka's inspiration or in most cases, direct support and mentorship. In this next segment on the people of FabLabs in Japan, I will examine Tanaka's role as a human agent of coherence.

Tanaka is a professor at Keio University in the department of Environmental and Information Studies. In 2010, Tanaka took a year off of his campus duties and went to MIT to study in Neil Gershenfeld's lab as a visiting professor, to see first-hand how he trains students to make "almost anything." Even during that year, Tanaka began setting up FabLabs in Japan. Upon connecting with Youka, he enlisted her in finding a space for a FabLab somewhere near where he teaches in Fujisawa. They settled on Kamakura, as noted above.

When Tanaka returned to Japan from MIT, he guided the establishment of the next wave of FabLabs. As I explained in Youka's profile, he knew that he wanted to have an apartment with a FabLab inside of it in Kamakura and with her help settled on the old sake warehouse that became FabLab Kamakura. He lived there at the FabLab in the beginning. It was a sign to others that he was living every ounce of the doctrine he professed. Tanaka's character and interests are reflected all throughout the FabLabs. He is an engineer trained at the highest level (Ph.D. Engineering, Tokyo University, 2003) but also a social researcher (M.A. Human Environmental Studies, Kyoto University, 2000). Whenever I was around him, he was at the center of many moving projects and was always, it seemed, broadcasting his ideals of "social fabrication," by which he means a return to healthy society through digital sharing and "making."

Tanaka's name appears dozens of times in this dissertation. I don't wish to overstate his influence to the exclusion of the many other important cohering factors that represent the full range of FabLab activity in Japan. It is not my argument that the movement in Japan would not have happened without Tanaka, but some anecdotes and observations will help to situate him as an energy center for the community. Tanaka influences the community by writing, speaking, teaching, mentoring, and introducing people.

**Writing** Tanaka published a book in Japanese in 2012: *FabLife: The New Future of Making that Begins with Digital Fabrication* (title translation by me because the book is only published in Japanese and Chinese). In it, Tanaka lays out his vision of what is happening in the "maker" community globally and the movement's possibilities for reshaping our society. It is heady stuff, and the book has been read by thousands of people across Japan. Many people who meet Tanaka are already familiar with his book. The book carries his philosophy and the core values of the "maker" lifestyle that is - for many outsiders - their first brush with the "maker" movement. It has led many people to seek out FabLabs, maker-faires, and manufacturing skills.

Ms. Kuniko Inaba (female, 30s) is one such person. In early 2016, after considerable effort and support from Tanaka and others in the network, Ms. Inaba opened a FabLab in Yamaguchi city, far down the western half of Japan past Hiroshima. Yamaguchi city is known as a resort and natural hot spa destination. Yamaguchi is also home to one of Japan's famous art and technology museums: Yamaguchi Center for Arts

and Media (YCAM). A Maker Faire (Mini) by O'Reilly Media was held there in 2013 and 2015. Ms. Inaba works at YCAM. Still, she chose to locate the FabLab away from the Museum inside a covered street market with small shops in the heart of town, since the Museum required admission and the FabLab needed to be accessible to the public. In February of 2016, I met Ms. Inaba when she spoke at an event in Tokyo. She spoke of the influence that Dr. Tanaka had on her work in Yamaguchi. She joked that she carried his book around while reading it and would show it to people as she went about building the support community in Yamaguchi.

The director of FabLab Dazaifu (in Fukuoka), Ms. Nakazomi (female, 20s) relayed a story to me about a woman who came to her FabLab after reading Tanaka's book. The woman said it was the first time she has been excited about life in a while. Now she was excited to learn to use the FabLab machines and be part of this movement.

*FabLife* was on display on the bookshelves at many of the Fablabs. At one point, Tanaka and I spoke about translating it to English. The book is an extension of Tanaka. Within the FabLab network in Japan, one could assume that everyone knew Tanaka and that they knew his ideas, often because they had read and believed the message of his book.

**Speaking**  Another path of influence for Tanaka is his public speaking. Tanaka speaks to audiences of professionals, government leaders, and academics often. He is quoted in the press when stories are written about the new era of tech and social change. Tanaka actively organizes large events to bring broad attention to the movement.

In late summer 2013, I attended a special press event organized by Tanaka and the Yokohama Community Design Lab to announce the opening of FabLab Kannai and the kickoff for Fab9: The 9th International FabLab Conference. More than a dozen press agencies were in attendance. The young founder of FabLab Kannai, Mr. Ohnishi, and the founder of FabLab Kamakura, Youka Watanabe, also spoke in front of the large audience and the press. I later heard their messages at other conferences as well.

Messages such as:

- Machines are cheaper and more accessible to lay designers than ever before.
- We can shake up the slow process of innovation with an inclusive effort to teach manufacturing skills to everyone.
- People want to share what they create. FabLabs allow people to come together to pursue this vision.
- The social distance between people can be shortened when they work together on these machines to design and create.

I saw Tanaka give this speech, often using essentially the same slide deck, at other venues. I saw him talking about his work and vision to a group of global development professionals at the national headquarters of JICA in Tokyo, which I have previously explained is the equivalent of USAID in America. I saw Tanaka give the talk to a national meeting of technology-for-change researchers around Japan, funded largely by Japan's Ministry of Education. And I saw the speech given at a conference Tanaka organized with other technology schools in the Asia Pacific. Dr. Tanaka's public organizing and speaking perpetuates the momentum of his message.

**Teaching**  Then, of course, it should be remembered that Tanaka's primary career is as a full-time professor at Keio University's Shonan-Fujisawa Campus, an engineering focused campus ninety minutes southwest of Tokyo. Here, Dr. Tanaka has a captive audience of students. In Japanese universities it is common for a professor to have a group of students in a study community named for that professor. Team Tanaka, for example. Students select which professor-team they want to join as they apply and matriculate. Very popular professors get more students and dedicated meeting spaces or "labs". The Hiroya Tanaka Lab is widely known now across the Keio system. He has an actual lab with machines at the campus in Fujisawa, which he shares with a fashion design professor. In the same building, upstairs, is a smaller space with additional machines just for his students, mostly for collaborating and working on computers. He also has a lab for more advanced projects and outside researchers in the heart of Yokohama, which he calls: Super FabLab. Tanaka also shares this space with another professor and his students.

Students do most of their schoolwork in these labs. I always entered the undergraduate lab quietly because there tend to be students sleeping. In fact, in the corner is a makeshift bunk-room: a bunkbed and floor space with blankets strewn around, walled-in by cubicle dividers. Tanaka requires his Team Tanaka students to complete one project every week. I once overheard him exulting that he doesn't ever teach, just assigns and reviews projects. This comment seemed tongue-in-cheek, but the students do indeed work around the clock on projects, which leads to the need to have makeshift sleeping quarters. Whatever teaching methods Tanaka employs, his skills and ideas do appear to be transmitting to the minds of his students, who are active around the network.

Ms. Nakazomi, now the lead at FabLab Dazaifu in far western Japan (Fukuoka) whom I mentioned above, was one of Tanaka's first students. Besides helping her learn the skills and doctrines of the "maker" community, he recommended her to the business owner who opened FabLab Dazaifu behind his shop. Ms. Nakazomi joined "Team Tanaka" shortly after Tanaka joined the faculty at Keio SFC. She told me that she and her classmates "watched him become famous (fieldnotes, 2015)." She learned to favor work with electronics during her time at Keio and designed children's books with felt pages, decorated with all kinds of playful shapes (like Christmas trees) and buttons to snap on and off. She also incorporated LED lights and sounds that turn on and off as kids touch this, or twist that. She spent her whole life in the Tokyo area but when graduation and the job hunt came, Dr. Tanaka recommended her to Mr. Yanase, who runs a mid-sized business selling electronic toy kits across Japan: EK Japan. Yanase has built a FabLab adjacent to his design and operations hub. He hired Ms. Nakazomi to run FabLab Dazaifu but she also works on other projects for EK Japan. Tanaka's dozens of former students, such as Ms. Nakazomi, work around Japan now, often continuing to directly promote his FabLab vision through their work.

**Mentoring**  Related to teaching but outside of the classroom, Tanaka mentors dozens of people. Especially notable are the FabLab directors. I learned from one director that for a long time, Tanaka would host a live group video chat with the FabLab directors to talk about challenges and successes. As I have written earlier, he did help each of them in different ways as they began. For Ohnishi, the graduate student founder of FabLab Kannai whom I introduced in previous chapters, Tanaka was essential to his meeting the

right people and getting the FabLab established. For other directors, he was their teacher at Keio: Nakazomi, Sakata, and Iwanishi. I don't know all the FabLab director stories - some were established after I left the field - but Tanaka maintained a mentoring relationship with every FabLab that I visited. When I spoke with Tanaka, he often talked about the things he was trying to do with the FabLabs. They were his favorite project: the extension of his vision to bring society together through manufacturing.

**Connecting People and Projects** A final function of Tanaka's influence happens in the background of his writing, speaking, teaching, and mentoring. Tanaka frequently introduces people to each other and connects people for projects. He seems to relish his role at the intersection of "maker" activities. Dr. Tanaka spins up partnerships, projects, and resources to get things done at a remarkable rate. Every time I encountered him, he seemed to be talking about the big ideas of "making" and helping people to figure out how they could do more. I watched him help many people find their place in the community, though everyone knew that most of the legwork would be their responsibility.

I experienced Tanaka's quick decision, big outcome, kind of approach myself. As I explained in Chapter 2: Research Methods, when I first came to Japan with funding to do pilot research among "makers" in Japan, I initially did not meet Dr. Tanaka. I met Dr. Yanagi through a colleague's introduction. Dr. Yanagi was interested in but not directly studying the "maker" community. He introduced me to Ohnishi and both of them agreed that Dr. Tanaka was the right guy to meet if I wanted to work among the FabLab folk in Japan. I met Dr. Tanaka briefly at a press event. Then, I arranged an interview with him and we had a nice talk. Dr. Yanagi also attended and asked questions, sharing a video of the exchange with his own students. Sometime toward the end of that first eight-week stay, it occurred to me that I should shoot the moon and ask Dr. Tanaka if he would host me as a visiting researcher when I returned for the full dissertation. The trick was: where could I find him again and get his attention?

Ohnishi and I went to Yokohama on the day before I was to depart. The 9th International FabLab Conference was to be held there beginning just a few days after I left. Tanaka was with his students setting up an ad hoc lab, using old machines that had been replaced by new machines back on campus. There were people and boxes, bicycle

parts and mannequins, and 3D printers everywhere. I knew this would be my opportunity to ask Dr. Tanaka about hosting me. We had only spoken a few times, including the interview. Ohnishi and I caught him as he walked across the room and Tanaka joked a bit about the busy room. Then I asked him: "I have decided to make this FabLab community my dissertation topic and will be back in Japan soon for a year of fieldwork. Would you host me at Keio as a visiting researcher?"

He smiled for a second, thinking it through, and replied: "of course (fieldnotes, 2013)." Even as we arranged the paperwork in the ensuing months, I had a tinge of uncertainty about whether this arrangement would materialize. Dr. Tanaka was even then at the pivot of a vibrant network of capacities. Still, with just a little extra effort, he could ask Keio to extend visiting researcher status to me and give me a brilliant home base from which to do my dissertation research. I asked. He made it happen. And then the dissertation unfolded along that path of people and projects. Snap. Done. Dr. Tanaka facilitates many projects such as my own dissertation in the background of his primary activities.

FabLab Leaders

In the segment above, I wrote briefly about Tanaka's mentoring of FabLab leaders. While he is certainly a resource for these people, they themselves are the activators and drivers of their FabLabs. They are the people who keep the labs active week-to-week, each in their own way. The FabLabs, of course, are the anchor spaces for the network - which I will speak more about in the next chapter segment - but they don't exist unless someone brings them together. The greatest amount of human energy expended to bring a lab into reality is by the founder-directors.

For example, Mr. Sakata (male, 30s) operated the FabLab Shibuya. The lab has evolved and moved venues since I left the field, from what I am told, but Sakata was a leader in building that lab as well as a couple other "makerspaces". He studied with Tanaka and in my interview with him, could recite Tanaka's talking points with his own infectious enthusiasm.

Dr. Taguchi (male, 30s) was one of three friends who organized (and built) FabLab Kitakagaya in the powerful port city of Osaka. Taguchi is an environmental studies

professor and with his friends, who are artists, they decided to open the FabLab. Their lab is more like a hip club, complete with a bar they created out of panel wood on the CNC lathe. The members meet each weekend, pick a project, and work on it together.

Mr. Takemoto's (male 20s) lab is in Hamamatsu, Japan, a few hours by train west of Tokyo. Takemoto's lab: "Take-Space", is unique because it is not built in commercial, campus, or civic space. Take-Space is housed in his farmer-parents' unused, very large farm shed. Takemoto had been collecting "maker" machines for a while for his own interests. His friends often came to work on projects with him. Eventually he decided to open his shed to the public and charter an official FabLab.

As I have written earlier, there are nineteen labs today across Japan. The people who founded and keep these labs open are important actors whose function both coheres and also choreographs the activities within the FabLab network.

Patrons

Another key category of people who are part of the fabric of FabLabs in Japan are the thousands of patrons spending time each year in Japan's FabLabs. Many are one- or two-time only visitors. Some get hooked and become regulars.

**Visitors** Thousands of people go through Japan's FabLabs each year. Still, one of the characteristics of the FabLab network is its tractable nature compared to other social forms. A FabLab can form quickly. People may be drawn to it right away but the flip side is that many people who come turn out to leave just as quickly. Visitor numbers can wane and FabLabs can close.

At FabLab Kamakura's AsaFab, there were usually two to ten visitors - or, non-regulars. Sometimes I would see a visitor a second time but often only once. For these visitors, the FabLab is a site to see but not a place to be. In Kannai, because the FabLab is part of a large, open, co-working floor, there is no way to even be sure who is there because of the FabLab and who is working on a non-FabLab project. Visitors to Yokohama Community Design Lab may be intrigued by the machines and get a quick-tour. Then there is FabLab Dazaifu, situated in a room behind the EK Japan storefront, many store-goers or guests of the owner will drop in to ogle the machines and the 21$_{st}$ century vibe of computers and machine parts but they are at EK Japan to buy toy building

kits, so they don't stay long. Then, there are the students from a nearby campus who will stop in to work on assignments and socialize but may not actually use the machines.

Visitors bring their wonder with them. The vast well of curiosity about what is possible with modern machines: "what is next after the era of the personal computer?", draws the crowds that are essential to keep the day-to-day enthusiasm of the network leaders ablaze. Visitors ask questions and they marvel, a sentiment that fuels the hope that regular patrons and proprietors have in their vision. They do not always return. They may not develop a long-term relationship with a FabLab or any of its machines but they have glimpsed the vision. For FabLab regulars, this counts for a lot. Researchers may not be able to count "awareness" but the growing interest from visitors, and even media, feeds a pulsating energy to the network and reassures its actors that their cause is compelling.

**Regulars**  The persistent personality of each FabLab is shaped largely by its regular members, though the directors and Tanaka each have their impact. Each FabLab has a different access procedure and a group of regulars. FabLab Kannai has monthly memberships paid at ~$100 for three months at a time. Kitakagaya also charges a modest membership fee. Kamakura has two open-to-the-public weekly lab sessions: Morning Fab (Mondays) and Evening Fab (Wednesdays), but no paid memberships. Whether paying a fee or attending regular, scheduled events, the "regulars" are those people who have been to their FabLab more than a handful of times. Many of them begin to take an official role in the activities. Sometimes, they have a project that they work on every time they visit. Or, they may bring things they made elsewhere to show to their friends. The regulars get to know each other and look forward to seeing each other.

Mr. Muto (male, 60s) and Mr. Hayama (male, 60s) attend FabLab Kamakura nearly every time I go for AsaFab. They come every week to spend a few hours on their hobbies with friends. They are not paid. Neither of them. They are both retired men who live near FabLab Kamakura.

Mr. Muto's interest lies chiefly in gears and wind-up robots. He built a "doll" about one foot tall on wheels that rolls across the table when wound up. Its motion is triggered by weight being placed on a tray that the "doll" carries. The mechanism sits on a shelf at the Lab and is brought out nearly every Monday and Wednesday when Mr. Muto shows

it to  new visitors. The gears are visible in the body of the "doll" and the hand-made machine is really quite interesting to watch as it rolls along the table very quickly. It nearly falls off the table each time it is wound and released. Muto suppresses his kid-like enthusiasm only enough to not seem too proud of the attention it garners. He is working on other projects now. He showed me the instructions he found for a cog-wheel machine that moves a samurai shooting an arrow. It may be impossible, he told me, because he wants to make all the parts instead of buying the pre-made kit. Still, he will study it out and probably work on the project until he really cannot go any further. Muto loves English. He sometimes asked me to sit by him. He told the group at one particular Monday morning AsaFab session that his plan for the day was to discuss jokes with me – some of which he invented in English himself. After the session that day, Mr Muto reported to the group that he had succeeded in making me laugh with his English jokes, which is undeniably true. Mr. Muto is a staple of the lab, a regular visitor to whom the younger staff show due respect. He spends much of his retirement building cog-wheel machines and showing them to his friends at the open Lab sessions near his home in Kamakura.

Mr. Hayama is another regular visitor to the open sessions and is also retired. His stark white hair extends about six inches out from only the back third of his head. The rest is bald. Hayama is the only patron taking rigorous notes besides me. He doesn't miss a patron's name during introductions, writing it all down along with his own notes about what each person is working on. He is not shy to engage people – especially new people – about their projects or to share with them his own ideas. I have never seen Mr. Hayama actually working on a computer or machine-based Fab project. He sometimes brings kits or pieces of material to help describe his various ideas, and often drawings. He designs new energy production mechanisms, new machines, and other problem-solving ways to improve our human condition. Each week, he describes his latest idea to us. One week, a spherical combination of cross-cut cylinders, the purpose of which I could not understand. He may not have bothered to explain it, actually. I almost never understand his vision. The drawings mostly serve to help me comprehend the detail with which he has thought these things through, not often the actual purpose or feasibility of the projects, which I gather are usually quite un-makeable. When he speaks, the group listens

politely. Mr. Hayama contributes to our sense as a group that everyone has ideas and that our time together with the machines in the FabLab is open to everyone and anyone who wants to pursue their ideas.

Such people bring FabLab Kamakura to life. Regular patrons form a community in every FabLab in Japan, although these communities can fail to develop the permanence that FabLab Kamakura's weekly programs enjoy.

Analysis

The above stories are just snapshots. They give a glimpse into the way that people such as Youka, Dr. Tanaka, other FabLab leaders, and patrons are situated in the FabLab network. Each influences other people who now continue to work and play in the FabLab community.

Gathering Spaces

Another component that I observed working as a cohering element is the actual gathering spaces themselves: the FabLabs and other venues where people meet each other. These shape the community and bring its disparate actors together.

The FabLab network in Japan is not traceable as a coherent entity within a defined geographic perimeter. There is no village with a residential community of group members to visit. In corporeal existence, the FabLabs themselves function as the outposts, or physical gathering spaces, that anchor and shape the community. As brick and mortar commons, these FabLabs are a central component of the actor network. Scholars have pointed to the importance of physical spaces in shaping communities that coexist online and offline. Jennifer Cool, writing about Cyborganic, an early Silicon Valley social group with a before-its-time online social chat community, has said:

> … the interdependence or mutuality of Cyborganic's online and onground (face-to-face) aspects has been a key finding of my study…Although the tremendous growth of real-time, global, information networks untether social being from many of the spatial and temporal constraints to which it had been tied, it does not dematerialize these facets of human existence (2012:13).

Relative to the digital existence and interaction component of the network, in this research project I have in fact spent much more time attending to the physical,

corporeally embodied component of the FabLab network. The frequent face to face interactions that take place in FabLabs are an essential element of its coherence and the spaces themselves shape what can and cannot be done, and what can and cannot be imagined therein. I open this actor network presentation chapter by describing the FabLabs and other venues that anchor "maker" action in Japan, adding some preliminary analysis to my descriptions.

Gathering at FabLab Kamakura

Many of the people and machines that I speak about in this dissertation found their gathering space at FabLab Kamakura. This lab was one of two primary field sites in my research - the other being Kannai, which I will address in the next segment. I visited Kamakura one-to-three times each week for much of Fall 2015 and Winter/Spring 2016.

When I first visited FabLab Kamakura in 2013, I was a little intimidated. FabLab Kamakura is a very thoughtful, wise building – nearly three hundred years old. Youka, the director, is admired by the other FabLab directors for running a successful operation (though she assured me that it never feels that way to her). The first few times I met Youka, I did not receive an effusive invitation to visit the FabLab, as I had with many other labs. I only got to see the space during the visit I described previously, when she gave a tour of the FabLab and the tech scene in Kamakura to a group of curious professionals. At that early stage of this research, I did not expect to focus my research on FabLab Kamakura. I am glad that this changed. As noted in Chapter 2, when I arrived in 2015, committed to more than a year of fieldwork, Youka invited me in degrees to become more involved, and Kamakura became my primary fieldsite.

**A Day at FabLab Kamakura**  The following description is an aggregate of experiences, combining notes from my first visit with a few common elements of succeeding visits.

It is a crisp Monday morning in late spring, 2015, I am making my first visit of the extended fieldwork session to FabLab Kamakura. As I sit on the train watching the scene of green trees and homes pass by, I wonder what everyone at AsaFab will think of me as I become part of their regular routine. AsaFab is a weekly three-hour event where anyone

from anywhere can come to use the machines at FabLab Kamakura. It is my plan to attend at least a couple dozen times, and to become part of their community.

Kamakura Station bustles with tourists from all over the world, here to explore this city, once the capital of Japan nearly a thousand years ago. I walk slowly through the half-kilometer of specialty shops for name stamps, chopsticks, anime merchandise, bridal gowns, and many more goods for global tourists. I smell fresh coffee and pastries like a perfume welcoming me to town as FabLab Kamakura comes into view. As I approach the front of the lab, I greet a couple of people working on the shrubs and vegetation. Breathing deeply, I enter the small wooden building that I had only visited once before, nearly two years previous.

It is shortly before the 9:00am start time. Inside, five or six other people are busy talking as they wipe the walls and surfaces with damp rags. A bucket in the middle of the room has a few more rags in it. A laser cutter and other machines surround the small room. A large wooden table in the middle leaves space for only around ten people to move around and to operate the machines. Ms. Kondo says good morning. I acknowledge her with my own greeting. Joining the obvious stream of activity, I grab a rag and begin looking for a place to wipe. Up the narrow stairs seems like a good place to find un-wiped surfaces. Upstairs, along the walls of the likewise narrow loft, rest a few more machines and a lot of additional supplies. We wipe for another 15 minutes and when the others have mostly returned their rags and found a seat, I return mine to the bucket and take a seat on a small folding chair, away from the table in the middle. I will soon learn that this lab-cleaning activity is something of a ritual each week, a ritual that I will expound in Chapter 4.

Kondo is in her early twenties. Most of the people at AsaFab are twice her age or older but she leads the activity with gusto. We start with introductions. Each person says their name and the project they intend to work on that day. There is a paper handout that asks us to write down our plans for the day and includes space to reflect afterwards. Mr. Muto has created a 3D printed model of an old hotel in town that burned in an infamous fire but today he will work on a wind-up doll that he has been building. Mr. Saito (male, 50s) will need the 3D printer as usual. He is printing a wind-up spherical toy that will roll

around the table. Mr. Horiguchi (male, 50s) - obviously a regular - says: "I am a Fab Master. I am here to help people with their projects."

The next two hours pass quickly as the machines work with the patrons' instructions to turn digital designs into material artifacts. Mostly, however, there is a lot of conversation between patrons. There is talk of daily life but largely they chat about the things they are making and the suitability of various tools for various jobs. They talk about projects they have worked on or seen others working on. I ask questions about the patrons' projects and try to understand their technical and social make-up. Some designs will get posted on a website or on YouTube but most of the projects will live almost exclusively in FabLab Kamakura.

By 11:30am, Kondo has announced that the session report meeting will begin in ten minutes - and in English, not Japanese. Youka, director of FabLab Kamakura, previously decided that a global FabLab should have an English element. Therefore, everyone should have to present their work at each AsaFab in English. Some of the patrons begin writing out sentences in English. I can tell that my presence adds pressure for them so I am relieved when Mr. Muto asks me for help perfecting his sentences. The reports are brief. Some of them slip back quickly into Japanese. I report: "Today I learned about Mr. Muto's wind-up doll and about his 3D design experience. I also met and observed some of the rest of the people in the group today." Mr. Horiguchi, the self-declared Fab Master, leans back and says: "Today, I talked to Kondo and helped people with their projects."

Kondo ends the session with thanks and directs us to take a commemorative picture at the front of the building. Most of the group leaves the FabLab but a few linger to visit. By 12:30pm, the patrons are gone. Kondo has other things to do, it is clear, and I make my way back to the station, and then home, to flesh out my fieldnotes. On the ride home, I found myself thinking: "So this is FabLab Kamakura. This is opening a FabLab to the public for all the world to make 'anything'." Over time, these people became my friends and AsaFab, my weekly ritual.

**Describing the Physical Space**  FabLab Kamakura is not a big space, taking up just the front third of a building the size of a normal Japanese house and measuring maybe 400 square feet altogether. The ground floor of the FabLab uses only about 200 square feet of floor space. There is a small kitchen on the floor, used almost exclusively

by Youka and the few people who work through the week with her, and a washroom. The small loft upstairs is just enough space for a few people to work on laptops or a small machine. The building itself was originally used as a sake warehouse hundreds of miles away. It was shipped to Kamakura in pieces and reconstructed in its present location in modern times. The owner wanted to have more buildings of traditional materials and construction in Kamakura, as the city is losing some of its older architecture. This practice is not commonplace but is also not unheard of, especially for an ancient city like Kamakura. It was not initially transferred to Kamakura for use as a FabLab but the owner was advertising a lease in 2010 when Dr. Hiroya Tanaka connected with Ms. Watanabe and she began to look for a place to establish the FabLab.

As I explained earlier in the segment about Youka, Dr. Tanaka was at MIT in 2010 and actually Youka found and recommended this unique building for use as a FabLab. Tanaka lived briefly at the lab and loves to tell people that he had saved for a BMW but used the money to buy a laser cutter instead. After less than a year living in the FabLab, however, Tanaka tired of the lack of privacy and secured a second portion of the house - more designed for living - as his own residence. He later moved out of the FabLab and since then, the front third of the building has functioned full time as a FabLab and its rent shifted to Youka's company. I have only seen Tanaka drop in a few times.

The main entrance is on the side near the front of the building but the actual front side, facing the street, is adorned by two giant doors originally built to allow sake barrels in and out. Now, when they are opened wide, they let the world see the machines and people inside. The exterior wood is dark and is contrasted by white walls of rough plaster. The landscaping is simple but carefully maintained by the patrons. The home is set against a hill. There are only dense woods behind FabLab Kamakura.

*Figure 9. Interior Second Floor "Loft" Workspace at FabLab Kamakura. Reprinted with permission from FabLab Kamakura 2019.*

*Figure 10. Caring for the Wooden Exterior of FabLab Kamakura. Reprinted with permission from FabLab Kamakura 2019.*

To get to FabLab Kamakura, you ride the train to the Kamakura station (~70 minutes south from Tokyo). The city is one of the top five tourist destinations in the country boasting world-famous shrines and the inimitable "giant Buddha" statue. In recent years, however, behind its old-Japan veneer, a technology-centric revival is brewing in Kamakura. Energetic techno-preneurs are moving there to start online businesses and have begun to call the region: "Kama-con Valley", with reference to Silicon Valley.

FabLab Kamakura juxtaposes ancient & new. Inside the building are top-of-the-line machines and computers used to make small goods that often require big-city design teams and factory floors to produce. Except for those machines, however, the traditional Japan ambiance is carefully preserved. The same dark, old wood fills both the interior and exterior, constructed by craftsmen while Japan was still closed to the Western world. There are traditional sliding walls inside and sliding paper window covers. The staircase to the loft is extremely steep and narrow, the wooden stairs worn down to a slippery sheen that can be treacherous in socks. An old coal burning stove with a stove pipe leading nowhere sits in the corner on the main floor. The stove is often in the way of people using the small workspace but there is purpose in leaving it there. Preservation of the past is one of the shared values of the people I met at FabLab Kamakura. Tanaka, Youka, and the patrons seem to share the sentiment of the building owner, who reconstructed the warehouse in Kamakura, that preserving the past is a way to remember and learn from the past. Youka consistently designs spaces and projects with this messaging, asserting that their work is not the ephemeral disarray of many technological innovations but rather anchored to history and tradition.

The enduring strength of traditional Japanese wood-based construction is widely praised and the past indeed seems to live in this building. The building itself is made of wood, of course, but the inside furnishings are also wood. The central table is wooden. So, too, all of the shelving. A few modern tools are the only exceptions: the fabrication machines, the books, the kitchen, the washroom fixtures, and a large TV mounted on the wall. Along the entrance hallway downstairs, a six-foot-long tree trunk felled at the base of Mt. Fuji rested for more than a year as decor. Eventually, a project idea was conceived and we sawed the old wood into five pieces by hand for display at an exhibition. Even the

workbenches are made of wood, with a soft cushion on top for comfort. Wooden beams in the ceiling only reveal secreted Bose speakers when you look for them, curious about the source of soft jazz music in high definition. The lights run along an electric panel, also hidden between the ceiling beams. There are a few sign boards with various notices to patrons, all made of wood. The main clock on the wall is made from wood taken from a cross section of a different Mount Fuji tree.

I have now given thousands of words to describing a day at FabLab Kamakura and the physical space itself. I wish to pause and emphasize the careful consideration that Youka and her colleagues paid to how the lab looks and feels. This makes it more amenable to the message that FabLabs are part of the 'real' Japan: permanent, simple, steeped in history. The wood contributes to the sense of permanence, nature, and human construction. Videographers and international visitors love to come to FabLab Kamakura.

**Machines and Activities Inside**  The marketed purpose for all of the FabLabs is to make manufacturing accessible to laypeople. This all depends on the machines that can now be purchased altogether for around $5,000, sometimes far less. FabLab Kamakura has a nice Trotec laser cutter, easily the most expensive fabrication machine in the lab, so the machines there probably cost more than $25,000. There are always at least two 3D printers, usually one in some state of disrepair, and a new one was procured once or twice during my time there. Other less commonly used machines were upstairs, such as a CNC mill (computer numerically controlled drill bit that carves into material), a paper cutter (cuts shapes out of flat paper), and a programmable sewing machine.

Different kinds of "gatherings" take place at FabLab Kamakura. Outside of AsaFab and YoruFab, the space is in use by Youka, Kanda, Kondo, and others. The most common other use is freelancers using the machines and desk space, as well as persons from business, academia, or government invited to meetings with Youka . Occasionally there is an interested international visitor who could not schedule around the open FabLab sessions on Monday and Wednesday. There are also additional events such as classes on "maker" skills, design meetings, and other groups that gather because people appreciate the ambiance of the FabLab or want access to its tools. There are also times when businesses that need prototypes for their products in the design process will pay for some time using the machines at FabLab Kamakura, but that is less common. Or,

meetings are held there with businesses that purchase consulting services from Youka and the staff. The lab is usually closed on Tuesdays and Thursdays. No one stays there overnight but sometimes there are conference calls with distant time zones, or projects that go far past midnight.

When the staff are there, they may be working on their own business projects or one of the FabLab's consulting projects. They work on their laptops or sometimes the fabrication machines. The freelancers often become regulars, and end up supporting the FabLab work with their knowledge, skills or networks. These people, like Senko Kuniaki, also support the patrons and projects with some of their time. For a long time, as noted above, he led the YoruFab in the evening on Wednesdays but most of the week he simply used the loft as his workspace for freelance design projects.

Youka herself is in and out of the FabLab often. She is out meeting with people to bring new revenue projects to the Lab as well as with other FabLab enthusiasts at other makerspaces, corporate or government offices. I sometimes joined her for meetings at a major Japanese electronics manufacturer and with JICA. Sometimes, Youka works from her home near a US Army base and she attends a few different international conferences each year. When she is in, she works with her staff, conducts Skype meetings, gives tours to guests, makes patrons feel welcome, eats a meal, or perhaps cleans up.

While of course the expressed ideal of the FabLab network is that they are open to the public and proactively sharing the knowledge of "making" with the public, there are only six hours per week when FabLab Kamakura is officially "open" to anyone who wants to come use the machines. In general, if someone walks in at any hour of the week, they are welcomed, but only AsaFab (which I described above) and YoruFab, are scheduled for the patrons each week. AsaFab, or: Morning Fab, is held every Monday morning from 9am until 12pm and YoruFab, or: Evening Fab, is every Wednesday from 6pm until 9pm.

Compared to the busy AsaFab, YoruFab on Wednesday evenings is more subdued. The crowd is certainly smaller - more like three-to-ten patrons. Sometimes none, or maybe just one. There is not a cleaning activity at the beginning and the staff sometimes orders in dinner. The folks who come for YoruFab do often bring projects to work on, but just as with AsaFab, the time is often spent in conversation. Whereas AsaFab tends to

bring people on time and keep them occupied the full three hours, sometimes longer, YoruFab sees people come later after work or leave well before 9pm.

Unlike some other FabLabs around Japan, FabLab Kamakura stays busy during the week. The most concentrated visitor numbers occur during the AsaFab and YoruFab sessions but with Youka's external projects and counting the freelancers, there tends to be five or more people there during any time the business is open. A common sight is to watch people come for their first time to learn about the space, to hear the gospel of Fab, or to wow at the cool things people are doing. Professionals, young students, and government officials tend to show up and say the same thing: "my friend, (so-and-so), told me I should come see this place". Then they get an introduction that confounds their sense of what is possible for laypeople to do with software and machines.

**How the Space Shapes the Community**  The physical space and the activities held in that space, which require people to come in person, shape the community in Kamakura and are familiar to the directors at all of Japan's other FabLabs.

The large wooden table is one element of this shaping. Because the physical space is small, nearly everyone will focus their attention to what is occuring at that single table. The groups are more likely to talk together, everyone in the lab at once. One downside is that there is a limit to how wide any single person can spread out their projects. Regulars such as Morita told me that they prefer larger "makerspaces", such as the sprawling DMM Make facility in Tokyo, for when they really need to get machine work done on their projects. Morita also told me that because such interesting people come to enjoy FabLab Kamakura, he likes to bring and show off his projects there.

Another result of the traditional design of the space seems to be that it makes senior citizen patrons feel more comfortable there. Many of the regulars at AsaFab are retired. The early hour of the event also of course contributes to this trend. The familiar, welcoming ambiance attracts all ages, however, and the frequent outsider curiosity that I have mentioned keeps new visitors coming in like oxygen to the lungs.

A final important way in which the space shapes the community, especially relative to FabLab Kannai, which I profile next, is its small size. With just one room for meeting, only around 400 square feet with a large table in the middle, it is not possible to hold events for more than twenty people. I have seen more in the space but with standing room

only and there was not space for all of those guests to be working on projects on tables. Youka and team hold large events at other venues as their own FabLab is best used for smaller gatherings.

Gathering at FabLab Kannai

In almost opposite contrast to FabLab Kamakura, FabLab Kannai is a large open space - two large rooms actually - where there are always dozens of people. Most of these people, however, are not affiliated with FabLab Kannai. They are members of Yokohama Community Design Lab (YCDL), the non-profit company that manages the workspace in the middle of sprawling Yokohama, Japan. The actual name of this shared working space is Sakura Works, managed by YCDL, and it occupies the whole second floor of an old office building. FabLab Kannai borrows a small space for its machines from YCDL and opens to the public a couple days each week. FabLab Kannai also holds special events periodically, which I have seen draw nearly 100 people. The space is very large, open and accessible. During the week, young freelancers and the staff of YCDL populate the space and the FabLab machines are dormant. When the FabLab is open, the patrons blend in with the YCDL members who are there working.

**Inside FabLab Kannai**  In late summer 2013 I was in Japan for the first time as a field-researcher, as I described in Chapter 2. It was not, however, my first time in Yokohama. I had lived in that large city as a two-year-old with my family, though I remember virtually nothing. In 2013, it is all new again.

 I may not have found FabLab Kannai if Ohnishi had not taken me there that first time. The entrance is set back from the street, up a staircase that looks like a service entrance. At the time it was not marked with any sign visible from the street. A few times when I tried to go back by myself, I got lost. I chose a few buildings as landmarks to help me navigate my way but still had trouble, relying on Google Maps like a treasure map until I eventually established a regular path.

On this first visit, we wal over from the Kannai train station. Like most stations in large cities, Kannai Station is underground and has six or seven exits. We take one of these exits out to the surface and then walk for a few minutes through a maze of buildings five-to-fifteen stories high. Inside these buildings, millions of workers spend sixty - or

many more - hours each week at work, slipping out at meal times to the restaurants. We pass many restaurants, featuring every kind of global flavor.

When Ohnishi stops his walk in between two restaurants and says: "Okay, here it is," I am unsure where "here" is. I see a small sign for Sakura Works but nothing for a FabLab. I see mailboxes hung on a concrete wall and a set of concrete stairs leading up. No door. We walk up the nondescript flight of stairs and through a couple of doors into a wide room. The room is busy, like a newsroom floor, with tables and computers and machines and people strewn across about 2,500 square feet of floor space. The people seem to be producing a product that lives somewhere far beyond this functional space. A solitary kitchen sink stands in the middle of the room and dishes dry in a rack next to it. An adjacent entry door is lined with three shelves of books on display about technology, "making", politics, and other coffee-shop-conversation interests. In one corner of the room, derelict digital equipment occupies about 300 square feet. I now find it ironic that this is about the same amount of space that FabLab Kamakura utilizes altogether. Outside the door, across a hall through another door is the YCDL event space, which occupies around 3,500 square feet. The two YCDL rooms together total an estimated 6,000 square feet, of which the FabLab machines occupy just a small corner in the co-working room.

The event space is often used for FabLab events but is also rented out to the public for events from concerts to wrestling matches to weddings. The event room is mostly painted black around the walls, decorated in an intentionally "unfinished" style with rafters and electric and HVAC lines visible. Some of the walls and counters in the room are painted by local artists and small tea lights are scattered all over the room to provide warm incidental lighting. Folding tables and chairs are crammed into one corner and set up when more tables are needed. Random boxes, machines, and flotsam - useful to someone at some point - litter the edges of the room in the absence of more formal storage for them. A bonafide kitchen with a high counter top around it, upgraded in 2015, takes up a quarter of the room. This does not function as a regular cafe but is frequently a prep center for the various events that come through the space.

I enter the space for a variety of events during fieldwork. I once watched an old man and young man, dressed as, but not physically built like, professional wrestlers,

stage a tag team wrestling match for our crowd. Their opponents were a balloon, a broom, and a newspaper and the scrimmage was both violent and protracted. There was fake blood, real blood, and a referee caught up in the action. We laughed our heads off. This was part of a weekend social gathering that YCDL organized for fun with some local chefs cooking their specialties. FabLab Kannai is one function within YCDL's larger ambitions as a Yokohama-by-the-people gathering place. Still, within that melee, FabLab Kannai draws members who pay $100 per quarter for their membership.

In 2016, FabLab Kannai moved most of its machines to a 350-square-foot apartment upstairs, which they completely gutted and rebuilt as a group project, to suit their purposes. The remodel had almost no eye for decor or design: only for function, with many fixtures being built by "makers" on the machines, on the spot. I only visited the new space a few times. The members continued to hold events in the larger space downstairs, but the apartment space allowed them to stay open 24-7. The new lab in the upstairs apartment is now always open and no longer at the scheduling mercy of YCDL downstairs, but it is only open to members, invited visitors, or for events.

**How the Space Shapes the Community**  FabLab Kannai changed significantly during my fieldwork period. Perhaps one key outcome of its being situated inside YCDL's sprawling, always-open public space, is that it always felt ad hoc. For a long time, I could go on a Saturday and find a group of people there, but this schedule would change. Many of the activities were seminars on specific skill-sets, organized by the three leaders who took over management from Ohnishi. After less than a year, as I have explained previously, Ohnishi gave up his role at FabLab Kannai and took full-time work in another city. Then, in 2016, when the leaders moved most of the machines upstairs to the apartment and remodeled, a young student of Tanaka's: Mr. Osagawa (male, 20s), who got his start as an intern at FabLab Kamakura, took up residence at this FabLab-cum-apartment. This was a unique arrangement that the FabLab leaders worked out, since they wanted to have someone available to monitor the machines and also help patrons. The condition of Osagawa's residence was that he would manage FabLab Kannai in order for it to stay open 24/7. He often slept in a corner on his futon while people worked around him. As a graduate student, he appreciated not having a rent payment but when I spoke to him during this period he told me that he did not get much restful sleep.

The FabLab Kannai community does not seem to have the permanence of community that FabLab Kamakura enjoys. However, located in a major metro region and in the orbit of YCDL, the group does have an active flow of newcomers. The space is designed to be a playground for the enthusiasts who want to hang out and use the machines. FabLab Kannai is not a business. It just has a small budget funded by quarterly $100 membership donations and has no permanent staff like Youka maintains. Only Tachikawa is there throughout the week. And he is there very often, and every night. FabLab Kannai and FabLab Kamakura, my two primary fieldsites, thus gathered different crowds but their use of machines to draw in a curious public was powerful nonetheless.

Gathering at Other Labs

There are of course many more labs in Japan - nineteen today, as I introduced with a chart in the introductory chapter. I spent time observing "makers" at work in most of these labs, excluding those that opened since I left the field. I attended workshops organized by "makers" and followed online conversations between "makers" on Facebook and other online spaces, analyzing that content for patterns. I interviewed FabLab directors and patrons in many of those labs. Each one "gathered" people by somewhat different means and were built on different business models, as indexed in the chart on page 21.

Dr. Tanaka told me that he was very keen to help each FabLab grow from its own local context. He wanted the spaces and their host cities to shape the labs. In this section I will describe two additional FabLabs in Japan, both started in 2013: Sendai and Kitakagaya (Osaka). Mentioning just a few notable features of each lab, my purpose is to give readers a sense of the distinctions in character between them, and how the space shapes the activities and people in them.

**Sendai**  The FabLab in Sendai is located in an apartment on the fourth floor of a tall building right next to 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

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

All of the staff work for the Anno Design Lab (ADL), officially. 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 earthquake and tsunami disasters in March, 2011. This business model is unique among Japan's FabLabs - exclusive funding from government. 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. The cost to use the machines is low and there is no entry fee.

One patron was a long-time dollhouse maker, a woman in her sixties. She was thrilled to find the place because it helped her learn to design dollhouse furniture on computers and print or cut them in the FabLab. She was a regular patron. Many of the other patrons I saw 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 the files in CAD software to work well on their machines and sent the files to be print or 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, 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 through "making" (more on this in the Chapter 4 segment: Hopeful Rhetoric).

The government-funded FabLab Sendai space was out of the way and not actively promoted by enthusiast-founders, quite like some of the other labs. Though open much more often to the public, it did not attract many guests nor develop a rich community of regulars, as far as I could tell from my two visits.

**Kitakagaya (in Osaka)**  FabLab Kitakagaya is not open to the public during the week. Core staff may use it some during the week but its public activities happen over the weekend, when it is opened to its members and invited guests. The FabLab occupies an emptied-out industrial machine shop near the Osaka port. This port is second in commerce only to Tokyo. 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 am offered when I arrive is bug spray for the swarm of mosquitoes hovering in the open-air lab at night. Second, I am offered a drink from the full bar, built with wood cut on a CNC router. One enclosed room is inside the roofless lab, to enclose the machines. Outside the wall of that enclosure sits the large CNC router used to cut the big wood pieces needed for various 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 a professor, an artist (in Kyoto), and designer. The leaders I meet are in their 20s or 30s. Lab income is generated from $20 monthly memberships, held by about sixty members. Thus, this lab functions more like a club for people who like to use the machines. Though there are female members, the majority are male. One weekend, they wanted to try to make a shoe. Each FabLab member applied his or her own skills to different parts of the shoe to see what the team could create in a couple of days, well lubricated 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." The tools are mostly the same as in other labs but the open air layout, the people, and the funding model are all quite different. This space, by design, shaped a community of friends who gathered to socialize and work on projects all together.

Analysis

From the traditional sake warehouse that became the small but communal FabLab Kamakura, to the crowded, often-changing downtown FabLab Kannai, to the quiet government-funded FabLab Sendai, to the weekenders' league of "makers" at FabLab Kitakagaya, to unique FabLab groups across Japan, the spaces themselves were actors in the network. The FabLabs were home to the people and machines and these homes were procured and designed by founders and regulars who had localized visions for the function and outcomes of their homes. These spaces shaped who felt welcome, who stayed, what they chose to do there, and how they would form - or fail to form - a community there.

Machine Intermediaries

In addition to people and spaces, the shape and coherence of the FabLab actor network in Japan is also influenced by machines. I observed machines acting as intermediaries to "transmit the force of cohesive action" (Oppenheim 2007:474). I could not exactly interview the machines but I could observe what they were doing with materials and with the other actors. The tools did not always function as intended by the human agents or their programming in the network (Downey 1998) but they did extend human capacity for manufacturing and they also drew people to each other, in the network.

I will focus primarily on 3D printers, adding a few additional observations about other machines. Inside the FabLabs, I observed dozens of machines doing manufacturing work: printing, cutting, or milling. These machines also did social work. This section on "Machine Intermediaries" will interpret this cohesive function of machines as a component of the FabLab network in Japan.

3D printers

3D printers have been around for at least four decades. 3D printers are categorized as an "additive" manufacturing tool: they "add" a material - plastic, ceramic, metal, etc. - layer by layer through a nozzle that moves on an x-y-z axis. Within the limits of the

material and the law of gravity, operators can "print" the 3D model they have downloaded or designed themselves.

Once liquified and dispensed from the nozzle, the material must solidify with a high degree of fidelity to its intended shape. No shape can form properly unless resting on a secure layer beneath it such that gravity does not misshape the design. These are just two of the limits on the manufacturing capability of 3D printers. There are many such limits that previously inhibited commercially available applications of the technology. The last decade, however, has seen accelerated development in the field and 3D printers are nearly mainstream. Every FabLab in Japan has a 3D printer. Common brands include Cube, Makerbot, Affinia and Mutoh (designed in Japan), but there are dozens of brands available.

Nearly all 3D printers in FabLabs in Japan print with plastic filament. A few Labs have DLP printers that work with a powder base and produce smoother results. Recently, materials scientists have made progress with metal, ceramic, and other materials - even chocolate. Layer by layer, up to thousands of layers, the 3D printer moves on its x, y, and z axis to lay down melted filament and then move up around 100-300 micrometers to deposit the next layer. Each layer is printed on top of the quick-drying layer beneath, eventually producing a full 3D shape.

The first time I met a 3D printer was on July 20, 2013, when I first went to Japan for fieldsite reconnaissance. Ohnishi taught an intro for a group of high school students at FabLab Kannai. The students were respectfully attentive as he showed them slides and talked about the tools of "making": 3D printers, laser cutters, microcontrollers, and the 200 FabLabs around the world (at the time). When he fired up that 3D printer, however, the room came alive. Watching a machine create a shape from nothing is a show - somewhat like art-in-action - that seems to captivate people.

**3D Printers Make Something Tangible**  One way in which 3D printers act as a cohering agent in the FabLab network is by producing a material output from the human imagination. A pen and paper can be used to create visible text that can communicate ideas or pictures. A computer can show with pixels what a human has imagined or designed a program to display.

A 3D printer, as outlined above, takes a design from the human imagination and creates a material object reflecting that design - usually in cheap plastic.

FabLabs in Japan are positively littered with the plastic-printed objects of human imagination. One popular printer: Cube, comes with a quick-print file. The Cube can quick-print a castle piece for a chess board. As I began to visit the various FabLabs, I noticed this castle sitting in many of the labs. Another common sight was the bright colors of printed objects. Filament plastic for 3D printers comes in a wide range of colors and is often bright. Shelves and tabletops and displays in FabLabs are brightened by these colors and small shapes. Also, the commercial 3D printers all tend to have a size limit of 6" x 6", maybe a little bigger. Therefore, the human imagination as expressed in 3D printed objects, tends to live in a world of bright, plastic, single-color, small objects. One day I met a college student visiting FabLab Kamakura. The first thing he did was pull out the 3D printed glasses he had made, as if it were his self-introduction. No lenses. Just blue plastic frames.

Not all projects are frivolous, of course: I saw a technician in FabLab Sendai printing out a spool to hold plastic filament right on that same 3D printer. I once printed a camera mount for my GoPro so that I could attach it to 3D printers and film the printing process in time-lapse (it did not work well). Someone told me that Tanaka 3D-printed the mouthpiece for his trombone. Also, in Tanaka's slides about the power of FabLabs, he always shows a picture of a thin medical arm cast that can be fitted based on a scan of the arm. On the University of Kentucky campus in a workshop with faculty interested in "making" tools for pedagogy, this same idea was given as evidence of the power of the 3D printer.

There is an effervescent feeling known among enthusiasts that comes when a design that you have worked on inside a computer appears in tangible form. It feels like you have a new power - the ability to call things from a computer into existence.

**People Love to Use 3D Printers** The ability of a 3D printer to make something tangible - its ability to extend human agency into material form - makes access to the machine desirable for millions of people. The machine helps people to do something they could never have done themselves otherwise. While the cost to own a machine has dropped to sub-$1,000 levels in the past decade, most people will still choose to travel to

use or observe one. In this way, the 3D printer draws people to FabLabs who want to produce a plastic model of their ideas.

One 3D printer enthusiast was Mr. Saito, whom I saw nearly every week  I spent at FabLab Kamakura's AsaFab. In his sixties, he does not interact as much with the other participants, though he is certainly friendly. Mr. Saito was very focused on 3D printed projects. In particular, he made toys with springs in them. One morning, he worked on a small machine with functioning gears inside. He shook with anticipation as the printer finally finished. He told me he had worked on this design for a couple of weeks - longer than he wanted. The AsaFab event was basically over but he was just at the pivotal point when he could piece together his creation to see if his design could work in real life. He grabbed a ratchet to tighten the interior spring with a quick, impatient movement. He wound up the spring. He released the catch. And. Nothing. Saito grimaced. Not today. Not this design. He mumbled that the shaft seemed to have broken. Then, he slowly packed up and made his way out of AsaFab for the day. He was never deterred, however. I always saw him back the next week.

In an interview with Saito I pointed out how often he comes to the FabLab, almost always to take the 3D printer for a spin. I asked him if he had considered buying a 3D printer for his home. The cost of a printer and filament could surely not be prohibitive, considering how much time and money on filament he had spent at FabLab Kamakura. They charge patrons a small fee for filament but it is a markup from retail. Saito replied quickly and definitively: no. He would not buy a printer. He explained that he likes to be at FabLab Kamakura with people like Kondo who can help if he gets stuck. He told me: "At my work, in the past, I had these skills, but no way to really use them. I just made what they told me to make. If I had an idea, they just didn't change directions. That's not how companies work." Saito told me further that learning to use the 3D printing software had really changed his life. He was now learning to design and make things for completely different reasons. However, he was not going to buy a printer and then not have reasons to be at FabLab Kamakura with his compatriots.

Nearly anyone with interest and a little patience can get from zero experience to printing in an hour. Ohnishi told me: "high schoolers can do this." This accessibility is a

recent development and the FabLab network in Japan is flooded with printed products from people who enjoy using them in ways not dissimilar to playing with toys.

**3D Printers are Also a Pain Sometimes**  While fun for many, 3D printers - like many machines that promise novelty - can be frustrating to many people who use them. The 3D printer does not simply do whatever a human actor commands. The 3D printer also acts against and at the least, non-parallel to the intent of human operators.

At FabLab Kamakura's AsaFab Monday morning event, Mr. Saito was very often the only person who said he wanted to use the 3D printer that day. He often used it during the whole two hours of free time. As in the story above, I watched his hopes of printing an intricate part for his spring-loaded cylinder toys sometimes deflate. The machine failed to print as instructed. Saito got lost in the world of these gears and toys. He spun the gears over and over again. He often talked to himself as he confronted the challenges they posed. His mind seemed lost in battle with the intricacies of the 3D printer and how it fed filament. He sometimes stood next to the printer and held the filament by hand as it fed into the nozzle, to be sure it did not get detached if the spool got stuck. Other times he sat with a metal file and rounded off improprieties where the reconstituted plastic was not naturally smooth enough for his precision systems.

After one particularly frustrating day for him, he set himself to preparing his English report for the end of AsaFab. He asked me to help him translate. He wanted to tell everyone that he tried to print a new part for an old machine (toy) but it just didn't fit. A couple of times, the printer malfunctioned and Saito would call Kondo over to help. His patience was thin. But once it was clear that there was not a fix (some days there was not), he resigned himself to the fact. One time he was very frustrated with poor print quality because he had tried to use a 3D scanner to scan himself. He blamed the filament that time, which had not done a good job of reflecting the extra hair he had added. On another morning, Japan's national broadcaster, NHK, came to film a segment for TV at Kamakura. Mr. Saito was going to be the operator of the 3D printer for the planned shot of a patron using this trend-setting machine. To the surprise of very few people who frequent the lab, Saito kept the video crew waiting while he tweaked his designs, yet the printer did not work properly once engaged.

Advocates tend not to mention the slowness of the 3D printer to newcomers. 3D printers often take hours, sometimes a dozen or more hours, to complete a project. One afternoon at FabLab Sendai, a few patrons were working on projects. The staff had helped them with design hang-ups and eventually, a file went to print. I was shadowing the director, Yonezawa, that afternoon. I had been impressed with how he could assess a patron's dilemma and help find a solution fairly quickly. He did this with a shared enthusiasm for seeing the design arrive in material form. As Watanabe and I saw one design go to print, and stood there watching the machine at work, we both realized that we might be standing there for a while. Indicating that he would excuse himself to another project, he said to me: "Well, I guess we just wait then (fieldnotes, 2013)." To save time, a designer could increase the height of each layer but then you lose curvature. They could shrink the object but then the object is, well, smaller. And for every minute the printer is working, the chance of a malfunction increases.

When I once spoke with friends at FabLab Kannai about a large "makerspace" called "Makers' Base" (not a chartered FabLab), they told me that it is useless to go there for 3D printing. They explained that on any given day at Makers' Base, where you pay $30 for one-day access to their machines, you are lucky if all three printers are working. You might end up waiting most of the day for a turn, if you get one at all.

**Eventually, 3D Printers Get Left Alone**  A final observation about how the 3D printer functions in the FabLab network in Japan is the reality that after they serve an initial "wow" purpose, they often get left alone.

It only took me a handful of FabLab visits before my field notes first recorded the lack of people using the 3D printers. Then, I started to hear about it from folks I was interviewing. Iwanishi, a student of Tanaka's and co-founder of the swanky FabCafe in Shibuya (ritzy shopping district in Tokyo), told me that while the 3D printer is often used as evidence of the future of "making", the laser cutter gets more use overall. Part of the reason, he said, is that 3D design software is much harder to master than 2d. Another FabLab notable person: Mr. Susutawari, the director of FabLab Tsukuba (one of the original two in Japan), said something similar to me. In his lab, he has a shelf from which he sells things that he has designed and made (he specializes in making circuit boards). When I commented on the ubiquity of printed plastic that has negligible value, he

laughed a little and said: "yeah, after a month or two the coolness of a 3D printer wears off and you wonder what to do with it." In Oita, Japan, FabLab director, Mr. Iwasaki (male, late 30s), told me that he really did not see anything particularly special about 3D printers, but that they do get people thinking about the possibilities of "maker" technology.

Mr. Morita (male, 50s) is a regular at Kannai and Kamakura. He is somewhat ascetic about his "making" activities and philosophy. To him, "most people are making junk with their 3D printer, and not even things they themselves designed." He pointed out to me that the output size limit made it difficult to be really creative, and very few people will ever have any real reason to keep an at-home 3D printer.

Even Tanaka himself, who has vaunted the 3D printer across Japan, posted on his Facebook page that the 3D printer was losing steam. RepRap, an early pioneer in DIY 3D printer kits and designs, was closing. Consumer printer products like the Cube were being discontinued. It is not a secret that the 3D printer had an arc in popularity and is not the hot-ticket it once was.

The plastic output creations - novel and valuable as they can seem at first - most often end up in the trash, or at best: recycled. One morning at FabLab Kamakura, Youka was spring cleaning and it was clear that the printed models and other miscellany produced by the stream of "makers" had become a burden on the FabLab. Youka tried to preserve some of the value of certain objects, asking around to patrons if they wanted to buy certain things for a low cost. Then, she just began trying to give things away. She did not want to toss things, she warned, but she would be forced to if people didn't give them good homes.

**3D Printers as a Cohering Actor**  For all their function and failures, 3D printers are like a tractor beam: a parlor show, a magnet. People who have read about the novelty but never seen it in action, often see it for the first time at a FabLab. Tanaka speaks for these actors. He enlists them as a tool for recruitment. So do all of the other FabLab directors.

The scene of newcomers fawning as they watch their first print became a very normal part of my field observations. And the FabLab leaders were quite earnest in their descriptions of the power of this little machine to change our society and future. Still,

sometimes I could catch a tinge of their boredom. One woman and her daughter came in to FabLab Kamakura in the morning and were given the introduction by an intern. They watched the 3D printer working for at least twenty minutes while I was there, discussing it with exclamations like: "Oh my!" and "Amazing!" The intern had set a special design to print for them: a chain. It prints in one motion but with a thin layer between links so that once removed from the platform, it is easily separated into loose but still linked pieces. "It is so durable!," they said. The possibilities feel endless when you start at zero and are designing and making your own objects. This is a key function of the 3D printer in cohering the FabLab community. This machine shortens the path for people to a technological capability they never imagined - holding an object in hand that you just drew yourself. This conceit of human capacity carries energy to all parts of the FabLab network but the energy seems to only flow through the intermediary 3D printer for a short time before moving on to other objects of action in the FabLab network.

Other Machines

Besides the 3D printer, most FabLabs also have a laser cutter, a milling machine (which carves into a material to create a shape, a mill (drill bit on an x, y, and z axis), a router (saw blade that cuts into a flat material on an x, y axis), a sewing machine, and other machines for "making." The concert of them all is important to preserve the capacity for any patron to make whatever they imagine but the average patron uses just one or two, and usually it is the 3D printer or laser cutter.

The laser cutter is really the work horse in most labs, I came to learn. In comments about the passé function of the 3D printer in FabLabs such as I listed above, regulars such as Iwanishi often told me that the laser cutter was the machine used by the most people, most of the time, in FabLabs today. I observed this to be true often in the field. Laser cutters were frequently in use. The laser cutter uses a 2D design and its depth of penetration can be programmed according to the material into which its laser cuts. It moves on an x and y axis inside an airtight system that is ventilated to the outside. Programming the depth of penetration, or the amount of energy focused through the laser, can function something like a z axis dimension, though not like on mechanical tools such as the milling machine or 3D printer. The laser cutter also requires an exhaust tube to be

run outside because fumes and remnants from burning into wood and plastic and metal can be troublesome.

I observed patrons with great enthusiasm for what they could do with the laser cutter, much like the 3D printer. At FabLab Saga, the furthest FabLab to the west in Japan, I met Ms. Otsumoto. FabLab Saga is a small shop in a small town. When I visited the Lab, Ms. Otsumoto (female, 40s), a Japanese woman who teaches English at the local university, came to the lab to use the laser cutter. Ms. Otsumoto's interest in using the laser cutter was fervent. She told me that for twenty years she has imagined making a series of small boxes with English words on each side that can be changed out to create sentences. She had finally been able to do this on the laser cutter: cutting, then piecing flat plastic parts together to form her boxes.

In Sendai, at the FabLab paid for exclusively with a government grant from the City of Sendai, I met a woman in her fifties. The director, Mr. Yonezawa (male, 30s), told me she was one of their regulars. She was very focused on small objects that she was often cutting from acrylic panels on the laser cutter - or sometimes 3D printing. This was the woman I mentioned in a previous segment who designs and makes doll houses for people. For decades, she has been hand-crafting the pieces. Now, she told me, she goes to sleep every night thinking about what she can design and make the next day. She said she has a lot of fun, like she is back in school again. She still does hand-made work but the FabLab allows her to expand her creativity: especially the laser cutter.

Laser cutters also draw people to FabLabs. They are not so effervescent with 'wow' factor enthusiasm from newcomers but they help a lot of people to make objects they tend to use for longer and with more precision. They are a staple of the FabLab machine lineup.

**The Fabbot Robot**  When talking about machines that are designed for a specific function, such as to print plastic in layers or to cut with a laser, it is natural enough to conceive of them as tools - though they are not simply dumb legatees of human agency. I have tried to show with 3D printers and laser cutters how they act as functional machines but also how they are part of the network of actors, drawing people to the network, frustrating well-laid plans, or becoming partners in invention. In this segment, I will describe a machine - a robot - that was largely invented in Japan by one person and then

94

adapted by others. This story of the Mugbot and its derivative: the Fabbot, helps to show how machines can function in the network in even more nuanced, iterative, and integrated ways.

The Mugbot is the precursor to the derivative Fabbot. The Mugbot was invented by Osamu Koike, a professor of Engineering at Tokyo City University. The Mugbot's brain is a micro-controller (miniature computer board): the widely used Raspberry Pi. The mini-computer sits inside a circular plastic casing around ten inches tall and six inches wide. On top of the casing is a large plastic mug turned upside down. The Mugbot sits on a dish, though some versions rest on a motorized wheeled chassis and can move. The head of Mugbot is a servo (hinge that can turn in degrees as directed by programming) with LED lights for eyes (also programmable). A speaker inside the body of Mugbot can project a voice. And the last core component is a power source.

The Mugbot, compared to many human-like robots that a person may imagine, is fairly simple. There are many such simple robots around the world, invented by a single person. Many of these designs are shared publicly, just like the Mugbot. Koike did not design it to change the field of robotics. His aim, as he told me, was to teach his students about multiple tools at once, and encourage open sharing and adaptation on his invention. It may in fact be more precise to say the Mugbot was compiled rather than invented. The machine's parts were not invented by Koike, but their assembly, programming, and operation is unique enough that Mugbot can certainly be called an invention.

Around 2014, two people who frequent FabLab Kamakura took an interest in the Mugbot and one of them - Mr. Koizumi (male, 40s) - recruited the other, Dr. Kunda (female, 30s) who was not previously any particular friend or collaborator, to help him. Koizumi's idea was to fit the Mugbot inside a smaller body: a Starbucks cup. Over the next year, the two would recruit a half-dozen other specialists to help them with aspects of this project. They built it in time to share at Japan's largest Maker Faire in Tokyo in 2015. Koizumi was not a technical expert. He had more interest than aptitude, whereas Kunda was a Ph.D. roboticist trained at the elite program at Kyoto University. She was lighthearted about Koizumi's role in the project, telling me that he was big on ideas and then she would figure out how to make them work. Koizumi told me the same thing independently about himself. His role was more of a facilitator. Still, Kunda was

interested enough to partner with Koizumi to make the Fabbot work. She wanted to use the robot to teach people about robotics as well. The pair turned Fabbot into a kit and they frequently held small seminars where they would walk people through the steps. I attended one such seminar with my son. They were especially thrilled to have a child participating. They gave my son a great deal of attention.

When it comes to creative projects, a machine such as the Mugbot becomes a unifying agent in the network, helping to hold together the agencies of people, machines, organizations, and other network components. The Mugbot was doing more than a discrete manufacturing task and more than just recruiting wide-eyed enthusiasts. It was the touchpoint for a shared aspiration, and the Fabbot became a compelling telos of intent and energy. The path of invention from Mugbot to Fabbot is an instructive scene of network components in vivo.

Projects like the Fabbot are machines that bring people together. The machines that sit along the walls of FabLabs act to recruit and to challenge people in the FabLab network. The ambition to invent a new machine, as with the Fabbot, is a target that puts the network into action. One idea from Koizumi, derived from an invention by Koike, drawing on the skills of a robotics expert: Kunda, brings many network actors together. Then, in the FabLab network, because it is actively shared, the invention rolls back out to new people who add their enthusiasm and perhaps - as with my son - may continue in a path of interest in fabrication technology.

Conclusions

The components of the FabLab network in Japan, such as people, gathering spaces, and machine intermediaries, keep the network coherent. There is no salary compelling the sharing of energy for the perpetuation of the FabLab movement. No religious foundation. No geographic proximity. Individuals like Youka, Tanaka, other FabLab founders, and enthusiastic patrons use free time to choreograph the activity of FabLabs. They design FabLabs that reflect their personalities and their host cities. Those spaces then act as shaping agents, helping to cohere the community with open space for newcomers, regulars, and machines to interact. The machines inculcate a sense of wonder and give people the ability to make things they never could have made otherwise.

These components each have a role in the actor network, serving to cohere its disparate energies into a growing movement.

Chapter 4 - Coherence of an Emerging Network - The Practices

Intro Remarks

I have in the previous chapter described components of the improbably coherent FabLab network in Japan: people, places, and machines. In this next section, I turn attention to two social practices that act as cohering, centrifugal agents in the network, beyond the capitalist practices that drive most manufacturing networks. Those are ritual practices: a social adhesive observed across cultures, and also what I call "active ideas": rhetoric that engenders hope and spurs action.

The components of the network, of which capital (money and labor) are certainly one, have only emerged in Japan as the FabLab network since 2010. Most of the relationships, the venues, and the structure of the FabLab network in Japan were formed since then. These "new forms of life" (Fischer) are emerging in a national context where manufacturing is a well-established and globally dominant regime. However, the FabLab community is designed and driven by enthusiasts who don't seem driven by commercial ambitions.

In this political economy, in the information age, the technological tools available to a broader public can seem to have created a new playing field. However, in taking a social practice theoretical approach, I intend to make legible in this chapter how the field is yet structured (Gurumurthy and Singh 2005). Other anthropologists of technology tools creating new practices have led the way. Ilahiane (2011), for example, showing how Moroccan micro-entrepreneurs could bricolage work with a mobile phone to create new pathways, while always adjusting themselves to the existing structures. Horst and Miller (2006) showed how Jamaicans used the same tool - the cell phone - to manipulate their social networks for daily needs or romance, but not so much to look for work.

As introduced in my first chapter, I found it more insightful, after reviewing my data, to show how social practices contend with the dominant capital-centered regime of manufacturing practice, rather than simply to show that capital is a component of the network. Japan's FabLabs create a coherent community adjacent to the corporations focused on industrial manufacturing, where people can find meaning without pressure for commercial success.

In the modern sociotechnical system that all of us inhabit, in one transaction or another, manufacturing is primarily done by corporations. The means of production such as steel, plastics, human labor, and of course the machines of production, cost large sums. The simple cost of starting a manufacturing operation has protected the wealthy class as denizens of manufacturing, inviting other classes only as laborers. Capital is also required to expand, sustain, and practice this regime, primarily by people who are driven by commercial ambitions.

The social practices I observed to be cohesive in the FabLab network in Japan suggest that it is fundamentally different. I do not suggest that the emerging technologies operating in the FabLab network in Japan have manifestly shifted this regime. The FabLab network is not a powerful social movement that has companies running scared. But it does exist. And companies do know it exists. At the very least, they hope to supply the network and perhaps locate any commercially viable ideas that might emerge from within it. The technology corporation is always in the background of the FabLab network in Japan.

However, Tanaka tells everyone that he had saved for a BMW and bought a laser cutter instead, to open the first FabLab at Kamakura to the public. This is an example of how individuals and the community as a whole, are turning aside from the capital-intensive, commercial, expertise-driven manufacturing sector to find and create a community of meaning and purpose. Tanaka chose to create a lab for laypeople instead of consume or fetishize a BMW (which no doubt carries semiotic relevance to a wide audience when he tells the story this way).

Side-stepping the capital-driven manufacturing practices in another way, only a few of the FabLab directors derived their primary income from the work. The machines shared with the public in a FabLab can cost less than $5,000, compared to what would have been tens of thousands, just ten years ago. Capital just seems to work more in the background of this network, and not at nearly the same scale to which capital has driven the dominant manufacturing regime. The story of this chapter is that in the shadow of the dominant manufacturing regime, the operation of additional social practices such as ritual and ideas are legible in FabLab network cohesion. Legible because capital is not the central factor it has been in manufacturing practice elsewhere.

Not central, but still a factor. In this chapter, I will talk about how the need to generate income does yet disrupt the ambitions of some actors and about how patrons with commercial ambitions, however small, negotiate the ideals of sharing and openness in the community. But I will talk about these along the way. My focus is on ritual and what I have called "active ideas."

Ritual

It was not long in the field before I started noticing ritual-like practices among some FabLab network components. As I observed "makers" working against the grain to organize the coherent FabLab network, I sought to understand how ritual was used as one means to this end.

In anthropology and social theory, the theoretical concept of ritual has served many ends and takes many forms. In considering how to employ ritual in analysis of my field data, I reflected on what Edmund Leach wrote in 1968: "Ritual is clearly not a fact of nature but a concept, and definitions of concepts should be operational; the merits of any particular formula will depend upon how the concept is being used."

I agreed with Leach and decided to work out a "formula" fitted to this project. At length I settled on the following operant definition for ritual in my analysis of the FabLab network: rituals are repeated practices that follow a discernible model and bear transcendent meanings that also function to cohere the group.

I have parsed the data that I collected for this project with this definition in mind. I selected a handful of examples that show how ritual - by this operational definition - affects the FabLab network in Japan. I stress that this limited definition is intended solely for this study.

I observed traces of ritual behavior - repetitive, modeled, meaningful, cohering - across all labs. I noted especially that the observed presence or absence of ritual in FabLab Kamakura and FabLab Kannai seemed to affect how strongly the members felt connected to each other. To put it simply: FabLab Kamakura has established ritual practices and fosters a sense of community more coherent than that which I observed at FabLab Kannai, where rituals - by my definition - do not seem to operate.

After analyzing this observed difference in community coherence as mediated by ritual in Kamakura and Kannai, I will describe a few scenes of ritual at work elsewhere around the network and offer summary commentary on ritual in FabLabs in Japan.

AsaFab

FabLab Kamakura is known by all the FabLab proprietors in Japan for being a well run and close community, an exemplary FabLab. Each week, as I have explained in Chapter 3, they hold two open lab sessions, where anyone can come to use the machines. The Wednesday evening YoruFab charges 500 yen (~$5.00) and is much more casual than the Monday morning AsaFab, which is free on the condition that you help to clean the FabLab before the "making" begins. Attending this AsaFab dozens of times, I took a great interest in this cleaning ritual that I will elucidate as a cohering practice.

Youka, of course, established the cleaning requirement. Everyone is to arrive at 9:00am and spend fifteen minutes cleaning FabLab Kamakura as an in-kind contribution, in lieu of an entry fee. AsaFab runs until 12:00pm. This cleaning practice, referred to in the lab as *o-souji* ("cleaning time"), fits my definition of a cohering ritual. Aggregating notes from my many visits, I will describe an imaginary *o-souji* episode from my perspective. Then, I will discuss how my definition of ritual applies and what can be learned by thinking of it as such.

The *O-souji* Ritual

**8:45a**  I disembark the train at Kamakura station and walk the short five minutes to FabLab Kamakura. The sun is out and Monday-morning tourists are preparing to explore the shrine-filled city.

**8:50a**  I arrive at FabLab Kamakura to find seven other patrons there, as well as Kondo-San, who will lead the three-hour AsaFab session. Yamakawa-san is a man in his 50s. Muto san is an older man: 70s. Saito is another older man in his 60s. Inaba-san is a woman in her 50s. Imakawa is a man in his 50s. There are also two college-age-looking kids here today, new to the group: a boy and girl. As I step in, everyone says: "good morning," in chorus. Mr. Muto adds a more personal: "Oh, hello Matt-san. Good to see you again." He and I exchange brief greetings and I ask how his Scratch project is going.

I introduce myself next to the new people - the college students, who are talking with Ms. Kondo. She seems to be giving them a primer on what will happen during the AsaFab block. Kondo explains that they will be asked to clean the FabLab in a few minutes.

**8:55a**  Mr. Hayama arrives with a bucket of damp washrags and places it next to the big table at the center of the lab. Everyone welcomes him with the same "good morning", and reaches for a rag in turn. Thus begins the *o-souji* ritual. Kondo does not announce the beginning. It just sort of begins. Five minutes early, in fact.

**8:56a**  Everyone, including me, has a washrag now, except for Mr. Imakawa and Mr. Yamakawa who have gone outside to the front of the FabLab to work on gardening tasks. I look around for something to wipe down. Already, Muto is working on the table and chairs. The college-aged pair is sort of wiping randomly as they look for some real dust to wipe. Ms. Inaba, the female patron who is a regular, is in the narrow entry hallway wiping the walls and shelves. Saito must have slipped upstairs to clean. I scan the area for a few moments, looking for a place that is dirty and also not already being cleaned by another patron. That can take some thinking.

**8:57a**  Knowing that there is usually work to do upstairs, I slip off my shoes and walk up there with my washrag. Saito has indeed set to work wiping down machines and shelves around the perimeter. This upper floor is really a long, thin loft. There are many, many objects up here: tools, projects on display, derelict machines. There is a banister running across the flooring above the staircase. It has a bunch of wooden posts along it, so I first wipe down the main rail. I then carefully wipe over all the surfaces of the posts.

**9:00a**  I use my finger under the washrag to scratch around the joints where the posts meet the rail, to be sure I get every spot clean. A cursory wipe will miss these connection points. One does have to train an eye for where there is possible grime not caught by a slapdash cleaner.

**9:01a**  I think that it would be nice to visit with Mr. Saito a bit but I cannot think of a question that would not divert us from our work. And we are here to work right now. So, I just keep wiping. I wipe the windowsill near the top of the stairs. Just left of the stairs is a nook and a shelf with a 3D printer on it. I wipe down the printer lightly, then the chair, and then the walls around the nook.

**9:02a**  As I finish up that nook I decide to work next on the stair area. The floorboards of the loft surround the stairwell so I stand on the stairs and reach up to wipe these floors boards and the walls on either side of the stairs. I look at my washrag. Hey: pretty dusty! I am actually getting a little bit of work done, if big dirty dust lines are an indication.

**9:03a**  Someone new arrives through the doorway downstairs. I know because a bell hangs on the door and rings as it opens. Also, I hear a chorus of "good morning" from downstairs. I will wait to find out who it is until I head down there shortly. I continue with the floorboards and walls.

**9:04a**  There is also a banister around the stairwell on the far side from where the machines are. No one ever walks over there and no one gets up there to clean so I tippy-toe on the stairs and wipe down what I can reach. Lucky for me, there is plenty of banister post and floorboard work to do here.

**9:06a**  As I finish what I can do in the stairwell, my washrag is actually quite dirty with dust. I refold it to keep a cleaner portion out and do a long swipe across each actual stair. I go from top to bottom.

**9:07a**  I have never seen anyone actually wipe the stairs. Maybe they think that is gross, it occurs to me, to wipe stairs by hand. As I get down to the bottom, I slip my shoes back on.

**9:08a**  I set my now-very-dirty washrag back in the bucket. The clean rags are hung over the sides of the bucket. I grab a clean washrag. There are always plenty of washrags remaining. I scan the main room downstairs with my eyes to see what I can do next. I notice that it was Youka who came in a couple minutes late.

**9:09a**  I head over to the window sill, although I know Muto already did this. Event after I wipe down the wall edges all around the sill, my washrag is still dust-free, so I also wipe the window itself.

**9:10a**  I hear Kondo, who has just emerged from the kitchen area, say: "okay, let's start wrapping up". A half-length curtain divides the kitchen from the work area. Not a door but still an effective divider. The kitchen is not a place where patrons hang out. As Kondo comes out of the kitchen and announces the wrap-up, she distributes session report sheets around the table.

**9:12a** No one is quitting or sitting, so neither do I. I scan the room again for something that may still have some dust on it. I settle for the long shelf across the front of the room under the TV. I know this has also been done by others today but no one is there right now. Luckily, Kondo seems to be finishing her prep and setting down her laptop on the table. Muto and Saito pull the chairs (wooden stools on which a cushion is placed) off the top of the table and replace the cushions.

**9:13a** As Kondo takes her seat, most people have put away their washrags. Imakawa comes in from outside with a small trash bag filled with leaves and branches and other debris retrieved from tending the small shrubs. I am one of the last patrons to drop their rag in the bucket.

**9:14a** After Kondo sits, I watch the others, sensing their satisfaction that we have "paid our cleaning dues," today. We have shown our commitment to caring for the FabLab.

**9:15a** Now that we all have our seats, Kondo tells us: thank you, and says: "I would now like to begin AsaFab."

## Making Sense of *O-Souji*

We can apply my bespoke definition of ritual to the AsaFab *o-souji* and explore its function.

### Repeated practices

*O-souji* happens every week during AsaFab. So, at the very least, we can say that it is a "repetitive practice." Many social activities are repeated, however, that are not necessarily ritualistic. The other parts of my definition can say more about what makes the experience meaningful for participants beyond its weekly occurrence. Youka directed that it happen and Kondo carries it out with patrons each week. It is now part of the weekly session. All participants arrive in time to clean (usually early) - with just intermittent exceptions.

### Follow a discernible model

At a glance, the basic model of *o-souji* is: for 15 minutes, find something dirty and clean it. Decisions about what to clean and how to clean are largely left to the patrons themselves. Still, other patterned behaviors are discernible, and this sets the practice up

to take on more coherent meaning. It is also telling that these patterns emerge without instruction: newcomers may hear a brief explanation but otherwise there is no written or spoken guidance.

The early start time that I noted above is one unscripted but consistent point. People arrive early so they can show that they are full participants. When Mr. Hayada brings the rags, which is usually five or ten minutes before the hour, the ritual begins without an order or instruction.

Another practice in the model is that patrons' cleaning is limited to wiping surfaces and landscaping out front. These cleaning tasks are helpful but certainly don't cover all of the tasks needed to maintain the lab. The FabLab staff could certainly do the cleaning that AsaFab patrons do. In fact, staff does its fair share of cleaning. I have never seen a patron clean the dishes in the kitchen but the sink is always empty and the shelves tidy. I have never seen a patron clean the toilet but the bathroom is always clean. Patrons seem to end up choosing to clean what they see others cleaning.

Another point of the model is that patrons tend to a repetitive spot. Imakawa tends to head outside. Others inside tend to head upstairs or to the hallway, the patterned choices indicating that the practice is more performative than practical. Also, patrons tend to stay focused, not chatting much. And then, Kondo invites us to wrap-up, signaling the end.

Bear transcendent meanings

Still, even the repetition of discernible practices does not quite rise to the full social import of a ritual. It seemed in Kamakura that the meaning these practices take on is what make them agents of coherence.

For example, cleanliness is a value that Youka clearly wishes to enact across the FabLab. Cleaning together, the patrons begin each session with a sense of ownership for that cleanliness. I heard Youka, at one academic conference, tell the audience that to her the ritual reflected the practice of monks who turn the daily cleaning and maintenance of their temples into a meditative practice. She said it is very important to community building.

While working, the group talks only a little but - working alongside one another - people silently communicate shared commitment. Also, even though the ritual is limited to dusting and landscaping, order and beauty are enhanced in those places. Certain "effervescent" feelings (*a la* Durkheim) are felt by those who work *on* the lab, rather than just working *in* the lab.

Another meaning that seems to be experienced or communicated across the group through *o-souji* is a sense of ownership of the FabLab. None of the patrons pay its rent. In fact, Youka (or, the company she created) does pay the rent and is not often present for *o-souji*. Kondo oversees this ritual but usually works on AsaFab prep rather than cleaning. Youka has made it clear that *o-souji* is designed intentionally to give patrons a way to contribute. She has referred to it as a non-monetary fee, helping the FabLab to preserve its free and open to the public role.

There is meaning in the quotidian act of cleaning as a group. Feelings that transcend the cleaning itself. Sentiments such as:

"This is our lab."

"I am committed to this lab. So are the others here."

"I have made the lab better with my own work."

"We as a community work together for the betterment of this lab."

Function to cohere the group

Perhaps I have already introduced the function of coherence in the preceding section about meaning. Experiencing or communicating something meaningful across a group can be said to give people in the group a sense of sameness or unity. This happens at AsaFab.

There is a core group of patrons who come nearly every Monday - the *jouren* - or "regulars". When one is gone, the others notice. Most of them, I named in the example up top. Others come for a period of weeks and then their schedules or interests change. But this core group shapes the way I and others experience FabLab Kamakura. This cleaning ritual is part of why I think they keep returning. This structured observance becomes part of their weekly routine. The unity they feel among these people creates

deep personal meaning for them. They feel that they owe something to future patrons who may benefit from the lab, and if they were not there, people would notice.

Even patrons who are not *jouren* seem to perceive the attitude of commitment and unity of thought when they enter. They see the cleaning ritual unfold and become part of it. They observe the patrons' familiarity with each other. Their work on cleaning gives them right away a sense that they have paid their dues and are welcome to the community. They feel a sense that there is a groundwork of history, a shared purpose, and principles by which the community maintains itself.

I once observed the ritual after the New Year after AsaFab had taken a few weeks off. The place was not in need of special cleaning. The cleaning proceeded as usual. If they dropped the ritual itself for a month, I do not think the Lab would look much worse for wear. I highlighted in my ritual outline the extra effort everyone takes to find dust to wipe. The lab with its weekly activities remains clean enough, and of course there is staff do cleaning if the ritual were discontinued. And patrons are quick to clean their own spaces. However, FabLab Kamakura's community, without the cleaning ritual, would lose some of its central identity as a welcome place for all "makers" and a shared resource that requires the effort of its patrons to persist.

Other rituals at AsaFab

Perhaps it will help to complete the picture of how ritual affects FabLab Kamakura to quickly name additional ritual-like practices within it.

First, AsaFab and YoruFab, as activities themselves, happen weekly - or, regularly. And these events themselves have their internal models that engender transcendent meaning and cohere the group.

At AsaFab in particular, after the cleaning, Kondo follows an opening sequence. Each week, she asks the patrons to introduce themselves in turn and describe what they plan to make during the morning session. The outcomes of this ritual include: breaking the ice for newcomers, giving everyone the stage briefly, establishing a queue for using the machines, and putting everyone on the same page about basic rules. To mark the end of each morning session, a closing ritual also happens. Each person sits around the table again and shows off what they have "made" that day. Then, the group is invited to the

double doors that are opened up facing the street (weather permitting) to have a group photo taken. The photo is quickly placed on the FabLab Kamakura website, creating a long series of group pictures. Each element happens weekly, a programmed internal model for every AsaFab

YoruFab is different. The group gathers around the same time but without an opening or closing segment, cleaning ritual, or reporting practice. YoruFab seems to only draw a few patrons. Sometimes none. The group tends to talk a lot more than work: more of an evening social. Sometimes, dinner is ordered in. It is not clear whether the lack of attendees is a cause of effect of the lack of ritual. The weekly event itself does provide a regular opportunity for patrons to "make" things, but in contrast to the Morning Fab, there does not seem to be the same kind of consistent community.

*Figure 11. Post-AsaFab Commemorative Photo 1. Reprinted with permission from FabLab Kamakura 2019.*

*Figure 13. Post-AsaFab Commemorative Photo 3. Reprinted with permission from FabLab Kamakura 2019.*

Kannai in Contrast

In applying the bespoke definition of ritual that I introduced for this study, a certain lack of ritual activity at FabLab Kannai became legible.

In Kannai, for more than half of my visits, the open hours were Saturday and Sunday, 12p - 7p. People came and went at will. There were regulars, of course. Mr. Ohnishi was almost always there as the director and Mr. Kuwamoto was the laser cutter assistant. Because FabLab Kannai was housed at YCDL, the machines sat on shelves surrounding a scatter of tables. Even during their open hours on Saturday and Sunday the space was not exclusive to the FabLab. The FabLab patrons who came did not have an opening introduction or a session report to bookend their sense of permanence in the space. Much was left to serendipity as far as what you would do and whom you might see.

FabLab Kannai is orderly enough when in session. One can always ask Ohnishi or another patron for help or schedule to meet up with colleagues in advance. There is a great freedom to the use of machines (though there are seldom more than one or two people wanting the same machine). However, without ritual, the sense of a coherent community is fleeting. The ideals of "making" and "sharing" may rest in the convictions of each person who comes and goes, but they are not regularly revisited by the group, as a group. Everyone tends to focus more on the project they themselves brought to work on. While the lab is upbeat and sociable for those who make their own introductions, many FabLab users do not build relationships with the others as cohesive as those in Kamakura.

Two women I spoke to about FabLab Kannai addressed this difficulty in meeting people and interacting with people. Curious about whether the distance they felt at FabLab Kannai, where most of the leadership and even the patronage are men, was the result of gendered practices, I inquired.

Ms. Kunda, the robotics expert in her 30s, said to me:

It does seem harder to speak up as a woman in Kannai. Youka and other ladies in Kamakura seem to create more of a: 'let's all work together,' kind of atmosphere. In Kannai, everyone is working separately… Sure, there are men in Kamamkura, too… Youka just seems to pay more attention to helping people work together so the feeling of community is a little more developed there (interview, 2015).

Kunda told me that once she finished the major Fabbot project, where she needed the machines in Kannai to make parts, she stopped going. So, it was not clear to her that she was treated differently as a woman in Kannai but she certainly noticed that as leaders, the men in Kannai did not attend as much to the prerogative of making everyone feel part of a community as Youka seemed to do in Kamakura.

Ms. Nakayama, a young lady in her 20s who was tinkering with Coke bottles and solar LED lights in my FabLab Kamakura introductory description, had this to say:

> Yes, I suppose there are things that are more difficult for me as a woman but there are also ways in which it is easier for me, I think. For example, if I was a man, I suppose I would not perhaps be as free to work on things that interest me. My parents would probably be harder on me, saying: 'go make money,' or something. Actually, my parents are pretty stereotypical so, yeah, I'm not sure what they would say about FabLabs… (interview, 2015).

I asked her if she had shown her parents the Coke bottle project that she has been working on, with an LED light at the top, powered by a solar array inside. She gingerly replied, with an embarrassed chuckle:

> Well, yeah, I actually got scolded for that one. They were like: 'All you do is goof off. And Coca-Cola is a big company. If you're not careful, they might sue you.' But I have been at it so long now, regardless of what people say, so I think they kind of half-way gave up trying to discourage me… And as far as being treated differently as a woman in FabLabs, I suppose there could be something if I thought about it. But that is such a personal, subjective experience, I would find it difficult to point to some particular instance where I thought I was treated differently as a woman. I guess I do wish that I could get more girls to come to the FabLabs. I have made a couple friends [at FabLab Kannai] but overall the place is kind of dry. Like, there are times when people talk about their projects together but no one is really like: 'let's go grab dinner together.' It would be more fun if it were more like that (interview, 2015).

Nakayama told me in a later interview that eventually she got a little burned out going to Kannai. She just used it for the machines (similar to Kunda's experience) and not because she had any relationships there. She had wanted to find others to work with on projects but that never really happened so she stopped going.

Perhaps if I had a closer connection with these two ladies, I would have learned more about their experiences as women but these comments point to more of a difference in how the three men leading in Kannai led, as compared to Youka in Kamakura. And I

believe the implementation of designed rituals, leading to a more effervescent feeling in Kamakura, accounts for a lot of the warmer, more cohesive, friendly atmosphere that Kunda and Nakayama did not seem to find in Kannai.

In Kannai, while there were no weekly embedded or directed rituals to compare with AsaFab's cleaning, intro, reporting, and memorial picture, there has been a steady stream of special events. Ohnishi established this pattern of bringing people together for events. The frequency has varied greatly, depending on the planning efforts of the lab's leaders, but there are usually at least a few per month. These events tend to draw a mostly unique crowd each time, though some people come often, of course. I attended a number of these events. Topics included: how to make a microcontroller, how to use a 3D printer, how to use CAD software, and other topics to give beginners a start in "maker" skills.

Lack of ritual certainly does not equate to lack of visitors and users. After all, FabLab Kannai is located in Yokohama, with 4 million people, and is 20 minutes from Tokyo (populated by 36 million). Events attract newbies who come for the topic that perhaps they read about on Facebook, in the local business publication that YCDL produces, or in other public media. Some come just to check out the place. Some even come regularly. But while the feeling is friendly, the focus is more about personal projects or about the topic of a particular event. The lack of ritual does seem to make the community less, well: communal.

The overlap with YCDL seemed to be enlivening for FabLab Kannai, increasing its user base. YCDL's Sakura Works space, which I described in detail in Chapter 3, is an open office for independent workers in Yokohama. The tables are always crowded with people working on laptops. Many YCDL shared-office patrons - initially going there to work on their own gig - learn about FabLab Kannai while there. They attend some of the events that FabLab Kannai plans. Likewise, FabLab Kannai members often attend YCDL events, which often have themes that overlap with FabLab patrons' interests.

The role of Mr. Sugimoto, head of YCDL, is significant. He helped Ohnishi to establish FabLab Kannai, giving him space and a built-in audience. A long-time friend of Tanaka's, Sugimoto sees to the ongoing success of the FabLab. Sugimoto was central to the planning and hosting of the International FabLab Conference in Yokohama in 2013,

to which Dr. Gershenfeld also came. Sugimoto is a maven for many other Yokohama-based citizen engagement projects.

With all of these events and activities, FabLab Kannai is a creative place that draws a stream of users and visitors. The flow of extra people and events through Sakura Works may have become burdensome to its shared-office mission. This led to the move upstairs that I described in the "Gathering Spaces" section, and Osagawa's appointment as live-in steward. The leaders hoped to open the space to much wider use. Mr. Masuno was the lead agent in preparing the space. He recruited members and volunteers to help him gut the apartment and put in new flooring and walls to make it feel like a FabLab. There was a crowd at the opening reception for the new space but curiously, use of the lab is less now than it ever was, I was told.

The total number of machines at FabLab Kannai increased after a dedicated space was available. With the lab open 24 hours, a certain logic would suggest that the use of its machines would increase with permanent open access but Mr. Osagawa reported to me that in fact fewer people were coming. This may be the effect of moving physically out of Sakura Works and also reducing the number of events to draw in new people. There are still people coming to use the machines but with the focus shifted to functional use of machines for personal projects, away from events, and in the absence of rituals, it seems that the FabLab Kannai community has dwindled somewhat.

The Showing-Off Ritual

There are certainly more ritualized practices that help to cohere the FabLab network in Japan beyond those I have described at work in Kamakura and - in contrast - lacking in Kannai. One additional category of ritual is what I call the showing-off ritual.

Many Japanese people are self-deprecating and demur when placed in the spotlight. It is an honorable and widely admired trait to be humble and circumspect. This seemed to be still true in Japan's FabLabs. Patrons overall were deferential - waiting their turn, listening more than speaking, keeping accolades quiet. However, there is a clear pattern of what I consider ritualized showing-off, which makes it more comfortable to pursue and receive praise for one's inventions and creations. This opportunity to show-off, in a

society where show-offs tend to be outsiders, if not pariahs, creates an important opening for people who love to "make" and want their work to be complimented.

Small interactions happen often around the FabLab network that can be considered a repeated practice, making it admissible to show-off one's "made" object. The producer will have an object out and be working on it. A complimenter will notice and ask about the object. The producer says: "oh, it is not much," and add detail about the process or amount of time they took to produce it. The complimenter asks follow-up questions and a dialogue proceeds. The complimenter pays effusive compliment, sometimes invites others nearby to ogle to object, and the producer tries to mask their delight at the recognition. The verbal and non-verbal play here, where the object is brought to view and then the socially observant complimenters take the first step to inquire, begins this ritualized dance. The reliability of having such observant complimenters in supply around FabLabs makes them reliable avenues for patrons seeking opportunities to show-off without raising social eyebrows.

Patrons were self-aware and honest with me about this pattern.

Morita (male, 50s) told me:

So, yeah: I do get a personal satisfaction from "making" but my motivation is also to hear people say: 'That's really cool,' if not make them kind of happy as well. All of these "Makers" are not so much in it to pursue money - they just want to hear someone say: 'That's really cool (interview, 2015).'

Morita went on to add, later as we spoke:

I mean, when it comes down to it, I just want to brag through what I make. When I can make something that makes people say: "that is really cool," I am motivated to do it again and again. I guess that is really what the FabLab, as a place, is all about (interview, 2015).

Uehara (male, 30s) pointed out:

This has been part of Japanese culture for a while, but people who are thought of as geeks (otaku) want to be told by friends in the inner circle: 'That is really cool.' This is what brings satisfaction. It is not really that we want people to say: 'I want one of those,' and give us money. Our biggest payoff is for the people around us to say: 'That is cool' (interview, 2015).

Ohnishi, our friend who founded FabLab Kannai, told me that this motivation to be recognized was a unique Japanese addition to the Gershenfeld FabLab model. Ohnishi said:

> If you talk about what Japan adds to Gershenfeld's 'make anything you want' model, it is that here we help you to "make" something that will surprise and delight others. Here we have this strong desire to make something that can surprise people with how cool it is (interview, 2013).

This latent need to find an avenue for eliciting complimentary reactions makes the MakerFaires around Japan especially important as sites where this ritual takes place. As noted in Chapter 2, the annual MakerFaire in Tokyo brings thousands of people together to show off their creations at booths and installations. The FabLab patrons I worked with often would spend the month before a MakerFaire focused diligently on producing a product worthy of showing off. Morita told me: "After showing my stuff to people in FabLabs for a while, I decided that I wanted to put things on display at the MakerFaire (interview, 2015)." That annual event is the big league for reaching a large public audience with one's creations. The MakerFaire itself is a ritual dedicated to showing-off, surprising people with coolness, and receiving the compliments that appear to be the primary currency in the political economy of FabLabs - certainly more compelling than money as reported by my informants.

Conclusions on Ritual

There are of course many ways to reproduce and advance the coherence of a community besides ritual. However, while there are multiple factors that boost participant volume in Kannai: the density of population in Yokohama, the built-in audience at Sakura Works, and the steady stream of events, my observation is that the community is not as cohesive as in Kamakura. In Kannai, the machines are often in use but I could see that the lack of ritual practice with a discernible model bearing transcendent meanings contributed to the ephemeral nature of FabLab Kannai's audience. Whereas in Kamakura, as I have tried to show, thoughtfully implemented ritual practices seemed to have a cohering effect, at least on the regulars.

Active Ideas: Rhetoric, Hope, and Action

A second cohering practice that I observed in the FabLab network in Japan is less codified in anthropological literature than ritual. However, "active ideas," as I call the rhetoric and the hope it inspires to action in the community, are an important cohesive force.

In all the social interstices between physical and digital spaces, customary and ritual practices, individual people and their producing machines, are the communicative practices - the rhetoric and the sentiment these words excite. The general ontology of communicative practice in FabLabs is beyond the aim of this segment but I will endeavor to portray the ways, purposes, and function of rhetoric (what people say) and hope (how people may respond to rhetoric) in the coherence of the FabLab network in Japan.

Rhetoric in this dissertation is simply communication intended to persuade. Rhetoric is everywhere in the FabLab network, employed by proprietors and patrons to perpetuate the purposes of the community.

Hope is used in this dissertation along the lines established by Dr. Hirokazu Miyazaki in his anthropological work in Fiji and Japan. That is, that hope is a "reorientation of knowledge" (2006:151) making ideas fit desired circumstances in the future or past, and the anthropologist interrogates how these "ideas generate concrete effects (151)." Miyazaki has suggested that capitalism has become dominant on its ability to create action from hope, whereas alternatives to capitalism have wavered in generating sufficient contravalent action (162-163) by the same practice. Hope is of course a term general enough to have nearly no analytic power across epistemologies. I therefore focus as much as possible on how expectations of future circumstances generate concrete action in the FabLab network in Japan.

When rhetoric engenders hope and actors act on that hope, anthropologists should - phenomenologically - be able to observe this in practice. This is what I have tried to capture in this section: the practices in the FabLab network that stem from the cooperative use of rhetoric and hope, turning ideas into action: active ideas.

Hopeful Rhetoric

The vast amount of writing and talking about "makers" and of course Gershenfeld's own instigation of the FabLab network comprise a body of rhetoric from which I wish to extract three particular "active ideas". These ideas, I will aim to show, generate concrete action but also sometimes leave those who pursue them short of their aims, and disappointed. These ideas, as introduced in the introductory segment: "What is a FabLab?," will each be considered in its own section in this chapter:

- A new future is possible with your efforts.
- The "maker" movement is by the people.
- Everyone should open their work to others by sharing it publicly.

A New Future

Aspiration is fundamental to our humanity, directing our actions. There is unspent time ahead of us - a future to be lived. The new possibility of crafting this future through fabrication is frequently expressed in the hopeful rhetoric around FabLabs in Japan.

Gershenfeld employed sketches of the future throughout his book. In one passage, he writes: "My hope is that Fab will inspire more people to start creating their own technological futures (2005:loc296)." This hope of his leads to projections such as this:

> The past few centuries have given us the personalization of expression, consumption, and computation. Now consider what would happen if the physical world outside computers was as malleable as the digital world inside computers. If ordinary people could personalize not just the content of computation but also its physical form. If mass customization lost the "mass" piece and became personal customization, with technology better reflecting the needs and wishes of its users because it's been developed by and for its users. If globalization gets replaced by localization. The result would be a revolution that contains, rather than replaces, all of the prior revolutions. Industrial production would merge with personal expression, which would merge with digital design, to bring common sense and sensibility to the creation and application of advanced technologies. Just as accumulated experience has found democracy to work better than monarchy, this would be a future based on widespread access to the means for invention rather than one based on technocracy (loc557).

Notice in this quote the central idea that "people" have the power to create those futures. For Gershenfeld and the FabLab community, they are accelerating a historic turn

akin to the industrial revolution but this time the future is in the hands of laypeople: local actors personalizing technology to their own ends. The future seems theirs to make.

In another passage, Gershenfeld suggests that we can now give kids the tools to discover science instead of trying to feed it to them ready-made. Then, he asserts: "Instead of building better bombs, emerging technology can help build better communities (loc239)." Gershenfeld later tells the story of young girls who learned to use an inner-city FabLab, one of the first outside of the MIT campus. They set up a table outside on the street and sold personalized items that they ran through the machine, "discovering that they can create one of the most valuable things of all: a job (loc374)." Gershenfeld's message that kids with machines can redefine the future rings true with believers across the world (and in Japan). FabLabs are thought of as a place to recruit and train these children and citizens who will lead the revolution.

These words. These ideas. These anecdotes. Many of the FabLab participants in Japan have read them - in Japanese. Yet it is not simply the reading of these ideas that engenders a desire to learn and do more "making." In Chapter 3, I mentioned that one day when I was at FabLab Sendai, I sent a design to print that I had myself worked on just a little bit. When I saw that design come out of the 3D printer and I held it in my hands, I had a palpable feeling of wonder. I felt that I could really learn to produce things that I never before imagined were within my purview. I also wrote in that chapter about how the 3D printer shortens the path for people to creating things they never before imagined, even if perhaps this dramatic sensation wears off. In another telling anecdote, a Japanese government official, in front of an audience at an event featuring Tanaka at JICA (Japan's USAID equivalent), told the crowd: "until you experience ["making" things] for yourself, you cannot fully understand the significance." That feeling of power is experienced often when people try out FabLab tools and it keeps them motivated to experience more. The tools help these laypeople to have more access to the means of manufacturing production. "Making" may not often be designed to scale up, extract labor value from others through a corporation, and compete directly in the global economy. However, the citizens who experience this moment of wonder are doing more than reading a text. They are recognizing that the tools have created a pathway for personal expression, the ability to imagine, design, and produce something tangible, a community

of peers who share this enthusiasm, and meaning where they did not find meaning before. In succeeding segments, I will write about how reality does not match rhetoric but I want to first describe how practices do emerge from people who share Gershenfeld's (and Anderson's, and Tanaka's) vision for the future.

Jinnohara

"Would-be entrepreneurs and inventors are no longer at the mercy of large companies to manufacture their ideas." (Chris Anderson 2012:18)

Mr. Jinnohara is in his late forties, the founder of FabLab Saga. Around 2012, he was working successfully as a systems integrator for a large tech company. He read Chris Anderson's book: *Makers: The New Industrial Revolution* and was inspired. Jinnohara was ready for a change in life and decided that he wanted to open a FabLab in his hometown: Saga, a city of 240,000 people near the southwest tip of Japan. Jinnohara resigned from his job, set up his own business, and moved to Saga with his wife and newborn son. He opened FabLab Saga in a small storefront in a quiet part of the quiet town. There, he helps anyone who comes in to the lab, reserving only Tuesdays to himself if he needs to focus on his business. The lab is open every day from 10am - 7pm otherwise.

Jinnohara told me that he had become bored with his work and decided that at his age, this was his last chance in life to try something awesome, and meaningful. As he told me about reading Anderson's book, his eyes communicated the depth of his earnest belief that people in Saga should have access to the tools to make things - to make the world.

He spoke to me about the Japanese religious (Shinto) tradition holding that there were spirits in all things, even inanimate, and that this makes manufacturing more meaningful. His philosophy is that he will not give people ready-made instructions. He wants them to decide what they will make, to begin making it, and then he will step in to help when needed. In his speaking to me, he referred back to Tanaka often. He knew in great detail the story of Tanaka going to MIT and coming back and starting other FabLabs.

Jinnohara is an active participant in the network of FabLabs across Japan, well known by directors in other cities. He traveled to Boston in 2016 for Fab11, the global FabLab conference. While visiting his lab in 2014, I got to meet a newcomer, Ms. Otsumoto, whom I introduced when describing "Machine Intermediaries" in Chapter 3. She was quite excited about the tools and the ideas she had found at FabLab Saga. Otsumoto had heard the FabLab philosophy of a more social future through Fab from Jinnohara and accepted it easily. She had been told by a university colleague in the school's media art department about FabLab Saga. Ms. Otsumoto told me about her long-held idea to make small boxes with words on them that could be interchanged to help students practice making English sentences. When she realized she could possibly do this herself at FabLab Saga, she got to work right away. She showed me the boxes she had cut on the laser cutter and assembled. They were rudimentary but she was ecstatic.

There is no membership fee in Saga, just a small charge for use of the machines. I saw a few young men and an older man in his 70s come in just to work on projects, not interacting much. FabLab Saga was not bustling with patrons - it is not in a major population center - but certainly Jinnohara is not alone in his hope to build a new future for people in Saga.

His commitment has had an impact on his family. Moving back to his hometown. Setting aside the stability of his work in Tokyo. On one night when I was there, Ms. Otsumoto had received the good news that her university team had won a national competition. She invited Jinnohara and I to dinner to celebrate. I overheard Jinnohara calling to let his wife know, after a long day, that he would be missing dinner at home. He said goodnight to his toddler over the phone. Over dinner, the three of us talked about the Fab vision for the future with great enthusiasm, and celebrated the home team victory. Gershenfeld, Anderson, and Tanaka are not just producing words for Jinnohara, they have given him a vision of the future that has reoriented his life.

By the People

The future-making rhetoric and the practices that it encourages include - as noted in the previous section - the idea that this particular movement is: "by-the-people", and that this makes all the difference.

Gershenfeld asserts that the purpose of making these tools available to the masses is to: "put control of the creation of technology back in the hands of its users (loc144)," and to: "develop and produce local technological solutions to local problems (loc232)." Then: "users rather than pundits can decide which problems need solving (loc2686)." Gershenfeld even positions FabLabs in the global security context:

> Bad guys are already impressively effective at acquiring the best available technology for the destruction of their enemies; fab labs are likely to have a far greater impact on the stability of the planet by helping everyone else acquire the technology they need for their survival (loc2676).

Though he never makes the reference explicit, Gershenfeld is suggesting in Marxian terms that the FabLabs and their movement to give machine tools to laypeople marks a historic turnaround, handing the means of production back from the bourgeoisie to the proletariat. Anderson, on the other hand, lays this important philosophical reference out explicitly: "Talk about 'controlling the tools of production': you (you!) can now set factories into motion with a mouse click. The distinction between amateur and entrepreneur has been reduced to a software option (2012:26)."

People in Japan who become intrigued and then become part of the FabLab network use the tools in FabLabs for their own ends, just as foretold by this kind of rhetoric. "The people" now have this previously throttled access to the tools because the tools are so much less expensive today than even a decade ago: even a few years ago. Also, laypeople realize quickly that they can learn to use these complex machines, which is something that most people never would have otherwise imagined for themselves. Fab tools are now being designed with ever-more-simple interfaces and sold at prices accessible to millions more people.

In FabLabs in Japan, hundreds of people really are accessing and making something out of these machine tools every day. People like Saito are making toys with springs and uploading them to YouTube. There are people like Ohnishi who use their young energy to develop FabLabs for others to access. One teenager I met in Kamakura had built a hydroponic garden in his home and written software to manage its maintenance with automated systems, including a video feed so he could watch the garden remotely.

In Dazaifu, Ms. Nakazomi had made battery-powered books for kids out of felt with each page a unique hands-on play experience. One project in Kamakura was designed to show the possible effect of a tsunami on the city: a printed plastic topographic replica, over which they would pour soy sauce to more visually show where the trouble spots would be in the event of a real emergency. Mr. Arayama (male, 20s) invented a technique for laser cutting carefully spaced slits in flat wood strips to make the wood flexible without becoming breakable. One innovative designer in Saga, a professional calligrapher, was expanding his business by laser-cutting and paper-cutting silhouettes of his hand-drawn calligraphy to imprint on iPhone cases.

I saw projects in motion at every FabLab visit: laypeople using the tools of production, just as Gershenfeld posited.

Sharing / Open

The third idea that is magnified in rhetoric and engenders hope throughout the FabLab network in Japan, is that the community is based on the principle of openness to all and sharing for the common good. Ostensibly, in this context, openness means that the FabLab should be open to anyone who wants to learn or use the machines. Sharing usually means that designs created in the lab should be freely shared with other people and other FabLabs. Really, this is two ideas that I have combined in one, their concordance tied to the notion of liberality.

Gershenfeld's FabLab Charter, to which a proprietor must simply accede to become part of the network, codifies these concepts:

- Sharing: Fab labs share an evolving inventory of core capabilities to make (almost) anything, allowing people and projects to be shared," and: "Designs and processes developed in fab labs can be protected and sold however an inventor chooses, but should remain available for individuals to use and learn from.
- Openness: Fab labs are available as a community resource, offering open access for individuals as well as scheduled access for programs (Fab Charter 2012)

Naturally, there are a wide range of practices and practitioners interpreting these core concepts in Japan's FabLabs and defining their scope of liberality. In general, however, all of the FabLabs are open to the public for free during at least some part of

the week. And people inside FabLabs tend to share what they are doing, often including design files that may have market value.

Sharing

Mr. Sugimoto, the proprietor of YCDL and host of FabLab Kannai, told a group gathered for a class on 3D printers at FabLab Kannai that to him "share" was the keyword for the whole movement (fieldnotes, 2015). In the previous segment of this chapter, I spoke about how at the FabLabs, sharing a project that one was developing is a kind of ritual.

I observed extreme generosity and fidelity to the idea of sharing. Many "makers" in Japan, when telling newcomers about the sharing component of FabLabs, refer to stories of freely shared printables that change lives. Prosthetics such as Robohand are one example. A woodworker in South Aftrica who lost his hand in an accident designed a printable prosthetic hand and then shared the Robohand design online (2019). The National Institutes of Health now has a webpage (2019) dedicated to freely shared printable prosthetics. This is a particularly eye-opening example of what can be possible, and these stories convince many newcomers of the power of sharing and "making".

I observed a lot of project-sharing happening right inside the FabLabs. In Kamakura, Mr. Saito was intent on making his 3D printed, spring-loaded toys work so that he could upload how-to videos to the web. Dr. Koike's Mugbot project that I profiled earlier was built on the idea that great learning could come from freely sharing design details.

People loved to share and be generous, not just with designs but even with equipment, with time, and - most especially - expertise. One afternoon in 2013 at Dr. Tanaka's off-campus Super FabLab for his graduate students, Mr. Masuno, who would eventually become one of the proprietors of FabLab Kannai, was building a 3D printer as tall as a human. Ohnishi and I admired it as he told us about the work he was putting in. Then, he told us with a grin that he was going to give the printer to Tanaka's lab when he was done. Ohnishi blurted out: "Are you kidding me?". That was an expensive machine built by Masuno's own hard work. I could tell in his twinkling eyes that he was all too happy to be contributing to the FabLab. Masuno spent the next few years helping to

develop printers and new, more flexible printable filament to produce prosthetics for less-developed economies with support from the Japanese government and other agencies.

In order to share designs, certain websites have become common. Thingiverse is particularly notable for 3D printer designs (Robohand is shared here). You can search for nearly any object and find a free design on there that someone has shared. Tanaka's students built a platform called Fabble (fabble.cc), that is used widely across Japan for sharing designs along with the stories of their creation.

Then, of course, there is direct sharing:

"Can you share that design with me?"

"Sure, what is your email?"

Not everything is shared, of course, but the FabLab directors think about the boundaries carefully. FabLab Sendai was established and fully funded with a grant from the City of Sendai in 2013. Mr. Yonezawa received the funds for the space and manages it under the umbrella of his employer, the design company: AnnoLab. Sendai is one of the only FabLabs that is indeed open all of the time to the public, even beyond the normal work day. In an interview, Yonezawa told me that he thinks about sharing often. His company is using the lab to design things that it sells, and it keeps that data secure - not sharing this valuable design data. Yet when patrons are in the lab, they are encouraged to share their designs. Yonezawa recognizes the contrast but without AnnoLab allowing him and his colleagues to run the FabLab during the day, they would simply do AnnoLab design work and not have any chance to help the public at the open FabLab.

Openness

The sister concept to sharing is the belief "makers" share that knowledge and tools should be open: available to anyone and everyone. While recouping some costs from membership or usage fees is common, the FabLab charter quoted above requires "open access for individuals". All of Japan's FabLabs are open to the public, though at many of them, not for the whole week, and at some, only for a few hours each week.

FabLab Kitakagaya, in Osaka, as explained in Chapter 3, is run by a few guys who have other jobs during the week but they get together on weekends with the other

members to work on projects together. One young woman named Mao who goes there some of those weekends told me that it feels so open, she goes there to just hang out, even though she often does not make anything.

I realized after a few weeks visiting FabLab Kamakura that a few of the regular AsaFab visitors tend to not usually make anything. The space is open to them. The people are interesting. They just like to be there as a social activity.

Noticing this pattern of people socializing more than "making" opened my eyes to a deeper value and purpose in the openness of FabLabs in Japan - beyond just the fact of accessibility to all people. That is, the FabLabs are a social safe-place because of their openness. It is likely - and very important - that one will find friends with overlapping interests in a FabLab. Tanaka, it turns out, talks often about this underlying purpose in FabLabs. He longs to give his socially reticent compatriots a place to meet others and express themselves through making and sharing. The plight of "hikikomori", or people who live shut-in lives, is aa frequent topic on the news in Japan. And the social distance, even loneliness and despair, that fills the hearts of many people is observed by some to be epidemic in modern Japan (such as in Anne Allison's work on *Precarious Japan*, 2013). Tanaka told me that this nationwide plight is the aim of his "social fab" movement - getting people not just to "make", but to "make, together". One patron in Kamakura told me: "The fact that we are here together is much more important than any work we might actually do here (fieldnotes, 2015)."

Analyzing Sharing and Openness

The liberality espoused by Gershenfeld and his FabLab Charter is practiced in varying degrees across FabLabs but as in the example projects and practices above, has concrete outcomes. Sharing and openness give the FabLab movement a unique philosophical undercurrent, especially relative to the hegemonic social backdrop of corporatized capitalism in most other design and manufacturing endeavors. This generous undercurrent has its limits but does appear to create a space for fulfilling social interactions.

In the paragraphs above, I have explained three ideas prevalent around the FabLab network in Japan, along with their concrete effects. These ideas engender hope and lead

to actions: human and machine. However, the actions that follow do not always match the ebullience of the rhetoric, and hopes can be discarded, unfulfilled. The next segment will explore these moments of let-down and how they affect the network.

Hopes Run Dry

Hope for a new future, for a historic return of power to the people, and for sharing and open communities sets a light up in the distance. In this section, I will continue the story by noting other examples where the realities fell short of the rhetoric: where the hope ran dry.

A New Future - Reconsidered

I wrote in Chapter 2 and Chapter 3 about Mr. Ohnishi who was, in the summer of 2013, in graduate school in Yokohama. He was busily planning events for FabLab Kannai, which he would be officially opening in just a couple of months with support from Tanaka and YCDL. On my next short visit in November 2014, he was no longer leading the lab. I only saw him a couple of times during my extended fieldwork in early 2015 when I asked to meet with him. As I wrote previously, Ohnishi was working full-time for a startup tech company and had dropped out of graduate school. FabLab Kannai was now co-managed by three men who had all been involved early on, supporting Ohnishi. I sensed no ill-will and certainly no one mentioned any friction when I asked where Ohnishi had gone and what he was doing now. But things had changed and the folks at FabLab Kannai told me they had not seen much of Ohnishi in the past year.

In late 2015, I reconnected with Furomoto to catch up. Over pizza, we talked about where he was now and how things had changed for him. I had once asked him, early on in 2014, if he thought he would work at the lab for a while. Even then, I wondered how long the young man could sustain the responsibilities without real income. His reply at that early time was: "it is the thing I want to do the most right now." When we talked over pizza in 2015, he was sentimental about his time in the FabLab but told me he saw no way to continue. He was impressed by Youka and other friends of his who had stuck with it as their central career activity but could not make that work himself. I reminded him about the wide-eyed Ohnishi I met in 2013 and he replied: "Yeah, I was not able to

quite hit my imagined goal. It was fun. And it was cool to see people coming in and having a lot of fun (interview, 2015)." He told me that it made him really happy to see people like Dr. Kunda starting interesting projects in the FabLab (referring to Fabbot). He admitted to me that while he once thought of himself as a "maker", and would love to return to it, he no longer sees himself that way.

Just a few years ago, Ohnishi saw the future - his and Japan's - through the lens of "making" and FabLabs. Now, to him, it seems that future may be out there for some, but not for him.

Another individual whose progress into the FabLab network I observed was Hiroyuki Osagawa, the live-in manager of FabLab Kannai about whom I have written a few times now. I met him when he joined FabLab Kamakura as an intern. He was well liked by the regulars at AsaFab. After a few months of volunteering, he told me with hope in his voice that he had applied to be in Tanaka's graduate student cohort at Keio SFC. Shortly thereafter, we all cheered when he announced that he had been accepted. He became much more active in FabLab Kannai and in Tanaka's circle after that and we didn't see him around Kamakura anymore. Then, in early 2016, I spoke with him at FabLab Kannai, now up in the apartment, after he had taken residence there. To me, he looked a little older: worse for wear even. I asked him how everything was going.

He was finishing his capstone project for Tanaka, a bee sanctuary and hive on the roof of the building, printed on a 3D printer and covered with lilac. The project was not going great. When asked if he enjoyed being at the FabLab all the time, his wan smile said everything. Osagawa had bet it all on the Fab community, even now living and running a FabLab 24/7 while finishing graduate school. And he was sticking with it. I don't presume to speak for him. He did not say that he regretted or planned to change his course. Still, it was clear that for him personally, at that particular point, the enthusiasm had given way to drudgery. Dying bees and constant problems to solve for "makers" who could interrupt his sleep anytime were his reality. If this was the future, it was not quite as bright as it had once seemed.

Ms. Nakazomi, the student from Tanaka's original undergraduate class whom I wrote earlier had "watched him become famous" and now oversees FabLab Dazaifu, shared her boredom with FabLab work with me inadvertently. She was telling me about a

patron who recently came in after reading Tanaka's book. The patron was bubbling with enthusiasm and wanted to design bespoke clothes for people with unique handicaps, something not in the scope of market-based clothing production. As Nakazomi told me about this patron, she commented off-hand that this was the first time she herself had been exited in a while. The patron's enthusiasm - her expanded vision and hope for what was possible - must have awoken Nakazomi's dormant hopes in the future that had previously pulled her across the country to work and build her life in Dazaifu. But her reflection betrayed to me the boredom she felt in the bulk of her work.

Ohnishi's leaving to take full-time work. Osagawa's exhaustion with his FabLab life. Nakazomi's boredom with running a FabLab. These are not hallmarks of a failed endeavor. Most ambitions hit rocky terrain. They are, however, field-observed moments from real people's lives where hope and reality diverge.

My awareness of this divergence magnified to my mind the meaning of a comment I heard Tanaka make to the FabLearn Conference audience in Yokohama in 2015. Tanaka told the audience that during his time at MIT, what he had really learned was not so much about how to use the advanced machines of FabLabs, but rather he learned how to tell stories. Indeed, he was telling stories. Stories that people believed. And people were changing their lives because of these stories, and sometimes finding that their initial hopes fell short on certain measures.

By the People - Reconsidered

In the segment above I pointed out how, in practices observed in the field, the hoped-for future vaunted rhetorically around the FabLab network in Japan can fizzle, dwindle, and even die. A distance was likewise observable between the propounded idea that this movement by the people could reorient history and the actual practices and projects that I observed in the FabLab. The people are certainly doing interesting things but it may be a stretch to see in their work a trenchant affront to the existing global order.

Remember Gershenfeld's story about the girls who stepped out onto the street and made $100 selling bespoke goods that they made on machines on the spot? He wrote that they were on their way to 'inventing a job' for themselves: changing the whole course of their lives. I do not know what happened to them but if my observations in Japan's

FabLabs are any indication, it is not likely that they are running a successful fabrication-based business today.

In Japan's FabLabs, I observed more than a hundred "maker" projects. I talked with many more than a hundred people - often about projects - and learned their stories. I would find it difficult to describe any watersheds of global social change from among my sample of projects. This observation of mine, of course, does not eclipse the possibility that these projects have cracked the door to bourgeoisie control of the means of production and will lead to a revolution in economic and social systems. At the very least, the FabLab movement, and even more: the "maker" movement, appears to have fostered millions of people learning and using technological tools to pursue personal visions. From my observations in the field, however, there is nonetheless a chasm between rhetoric and reality that can be described from ethnographic evidence.

One way to see this disconnect is in what the people themselves actually yearn for in their FabLab work. The machines allow them to make many things. Yet the projects, such as battery-powered felt books, plastic spring-loaded spinning toys, and a remote managed hydroponic garden (to name just a very few) are not a salvo aimed at the denizens of the global economic system. FabLabs tend to be wonderful nurseries for learning about design and build tools but their production tends to skew toward novelty. A far cry from "the technology they need for their survival (loc2676)" that Gershenfeld described.

Chris Anderson noticed this variance when he visited an early FabLab in England. He wrote:

> Projects made on free days are supposed to be documented online so others can share them. On other days, members pay to use the facility, and those projects can be proprietary and closed. It is, to be honest, a little hard to see this makerspace as the seed of a new British manufacturing industry. Most of the work is being done by local students, and is the sort of modest stuff you might expect to find in any design or shop class. No hot startups have been spawned here yet; unlike such makerspaces as TechShop in the United States, the place is not abuzz with entrepreneurship (2012:46).

Japan's "makers" in FabLabs are doing remarkable things in a network that coheres against the grain but in my observations, this effort does not in practice seem to rise to the rhetoric of a by-the-people affront to the global economic, political, or social order.

Sharing - Reconsidered

Thirdly, just as with the active ideas forecasting a "new future" and "by-the-people" challenge to the global order, the liberality of "makers" in FabLabs who share their work and expertise openly has its limits. I wrote already about how Yonezawa in Sendai balances his company's private interest in not sharing with his injunction to his FabLab patrons to share their work. These subtle negotiations happen constantly around the FabLab network and, sometimes, liberality seems reduced to little more than friendliness and goodwill: barely distinct from what could be found in most corporate design studios.

Some of the FabLabs are themselves running as companies - not even as NPOs (though that legal structure is not as common in Japan). Youka's FabLab Kamakura is one of them. I observed some telling moments of decision - regarding sharing - with Youka.

Youka and her team have worked hard for a couple of years to develop a course curriculum called "FabBasic", for beginners. They also developed an intermediate and advanced course to follow. This was a revenue generator for FabLab Kamakura. Interest in "making" was growing, and they could train people in the skills they would need to make the most of the new tools. In 2015, Youka had organized a "FabLearn Conference" for educators, with support from Stanford University, which I have written about earlier in this dissertation. At the conference I found myself in a conversation with Youka and a female teacher who was asking Youka about the FabBasic curriculum. Assuming a lot (but perhaps fairly, given the philosophy of the FabLab movement), the teacher asked Youka if she would share her FabBasic curriculum. The teacher wanted to use it with her students. Youka paused to think. "Well,…" Youka hesitated. Then, she found a way to deflect the question. Youka did not want to share her valuable course curriculum, nor did she want to tell this teacher that sharing has its limits.

Another subtle but instructive moment where the limits of sharing were negotiated was at FabLab Kamakura. I was speaking with Youka and a female patron who had designed cookie cutters for a 3D printer. This time it was Youka who put her patron friend on the spot. "Matt has kids, you know. They would love cookie cutters. You should share your designs with him." The woman smiled but only half-way. She said:

"oh, sure," but with hesitation. I had just met her and learned that she had plans for selling these designs. I told them: "That is nice. Thank you," but I let the conversation move on and of course neither I, nor she, ever followed-up (fieldnotes, 2015).

These anecdotes highlight the reality of the expectation of sharing. It is not specific or codified, but rather locally interpreted. The gray area can be tough to navigate when people do not, in fact, want to share. Youka played the pressured and pressuring in turn in these moments.

Sometimes, the rules are fairly explicit. At FabLab Tsukuba, Mr. Susutawari has a rule that is unique in Japan's FabLabs, he bragged to me. He clarifies up front to all of his guests: if you design or invent something in this FabLab, you need to share it publicly. This clarity can help. It could also discourage people who may in fact intend to design something of value that they do not wish to share.

The limits of sharing also become legible against the constancy of corporations in the background. Most of the global economy pays no mind to the tens of thousands of hobbyists who may believe they will change the whole system. But there are companies thriving and dying on the energies of the "maker" movement: companies manufacturing the machines and software and educational materials, for example.

Many more companies at least design to profit financially from the movement. This can seem at odds with the army of enthusiasts who see the future as based on more liberal sharing. But they co-exist.

I met Mr. Hagino (male, 30s) with Youka at the headquarters of a major Japanese electronics manufacturer in Tokyo. Hagino works for the company but in a division that experiments with new ideas and markets. He was given a budget to develop a product based on his idea to make basic sensors usable for beginning "makers." The product consisted of a set of small handheld plastic blocks that each held a useful sensor and a chip that spoke the data back to a mobile application. The sensor product was invented to give the widest variety of "makers" access to sensors for their projects. For example, a movement sensor block could be taped to a student's project. Then, if the project fell over, the signal could trigger another block, programmed for sound, to say: "Ouch!".

Mr. Hagino and colleagues from the company showed off the tools at the biggest convention for "makers" in Japan: MakeFaire Tokyo. They also brought them to Youka's

FabLearn, to try to get them in front of educators. These were useful. They could be used to expand what one could build or invent. But they were neither free nor were their designs shared.

When Youka let me tag along on her visit with Hagino, to prepare for his participation in the FabLearn Conference, their conversation was a nuanced negotiation of corporate and FabLab principles. They discussed the company's pitch, aiming to balance the need to sell the product with the expectations of the K-12 educators. The teachers would expect to hear mostly about unleashing student creativity and would not expect a hard sell. Hagino told us that there were actually a lot of people at his company who had ideas for education-based projects but that the market was just not quite big enough to get these ideas into design and production.

Intel made a splash in 2013 when they shared their microprocessor with the world. They selected an older microchip from their design stock that was not still in production but was plenty powerful to handle intelligent tasks for "maker" level machines. From this design they made a mini computer (microcontroller) that could fit in the palm of the hand. They called this Galileo and sold them to "makers" around the world. In 2013, as I explained in Chapter 2, I had done a research report with support from Intel that led to my doing this dissertation in Japan. When I was in Hillsboro, OR, reporting about the work they had funded, one of the folks on their social research team talked with me about the Galileo strategy. It was quite straightforward: give away a little intellectual property at a sub-$100 cost so that a wider audience would get more familiar with its products. Corporate ambitions are not anathema to "makers" but the balance of hobby and corporate interests and values is actively negotiated.

The degree to which ideas, designs, and materials are shared in FabLabs is constantly negotiated and in the background. All the while, companies like Hagino's company and Intel are finding ways to make in-roads without spooking the visionary nature of the "makers".

The principle of openness also hits limits that I observed in the field. I have mentioned that only a few of the FabLabs are actually open to the public for more than a day per week. It is fair to wonder if one can describe a lab as "open" at just a few hours per week. Also, openness does not directly lead to broad FabLab usage quite in the

measure perhaps that Gershenfeld makes it out to be. Many of the FabLabs are empty or quiet even during their public hours. Then, of course, openness does not itself push big ideas to fruition. I watched certain projects like Fabbot and Makerbot get some traction outside of their lab-based design and production. This is indeed significant evidence that important products of group action can emerge from the FabLab network. However, the openness of FabLabs in my observation in Japan has not so far germinated projects that reach as far as Hagino's sensors or Intel's Galileo. In the FabLabs, you can build it and share it but there is little assurance that it will be adopted at scale.

How Active Ideas Act

People do act on ideas, and that is what produces concrete effects. Rituals like the cleaning each Monday in Kamakura connect the group in a practice that transcends its function. In Kannai, in contrast, the lack of ritual seems to leave the group somewhat less unified as a group, if still active. Hope in a new future, in by-the-people revolutions, and in liberal sharing and openness lead to the creation of FabLabs, to thousands of "maker" projects, and to a web of social relationships that create meaning for thousands of people. In spite of running dry, and falling short of its ideals, leaving real people in real pickles with real disappointments, I hope I have shown in this chapter how the practices in FabLabs in Japan lead to its against-the-odds coherence as a social network. While remaining a loose confederation of people who share rituals and active ideas, the FabLab network in Japan seems held together not by traditional sameness, such as economic interest or religion, but by practices such as newly invented rituals and active hopes for the future that they are making together.

Chapter 5: Making Expertise in Japan's FabLabs

Building on the preceding chapter where I described the network components that bring the FabLab network in Japan into its coherent shape, I have further sought in this research to examine the culture of expertise in the FabLab network in Japan, that I may contribute to an ongoing conversation in STS and anthropological research regarding cultures of expertise. With this theoretical purpose in mind, I have written below a longer review of literature than in previous chapters, to show more precisely how I think my findings fit in that literature.

My research sub-question focused on expertise is: What social practices shape the culture of expertise in the FabLab community and how is expertise negotiated or contested in this "open hardware" community?

I will formulate a response to that question in this chapter. First, I will outline literature that led to the question. Then, I will present data about the social practices I observed that shape the culture of expertise in the FabLab community, indexing three types of FabLab experts. Finally, I will describe the negotiations and contests that make legible the constructed nature of the FabLab open-hardware community.

Literature Background

The anthropological interest in cultures of expertise has grown from the fundamental anthropological interest in knowledge and power (Foucault 1977, 1980, 1982, Marx 1867a, 1867b, Wolf 1990) and a special attention to social practices that can render institutions of power legible. When certain knowledge practices become ascendant or legitimized, a power accrues to them. Such domains or institutions of expertise can become fruitful sites for anthropological inquiry, depicting in ethnographic detail their fundamentally social construction. Below, I outline phases in the development of inquiry on expertise to clarify where my data from the FabLab network in Japan contributes to the multidisciplinary conversation on cultures of expertise.

To set the stage for my consideration of expert practice in this chapter, I would cite Dominic Boyer, who suggests that we: "define an expert as an actor who has developed skills in, semiotic-epistemic competence for, and attentional concern with, some sphere of practical activity (Boyer 2008:39)." This definition matches the character of "experts"

I studied in Japan, accepting even persons who show "attentional concern" for an activity, alongside those who can demonstrate specific technical skills or competence for signaling their expertise.

Bounded Domains

The rise of interest in the socially constructed nature of expert domains - the cultures of expertise - has generated studies of expert domains that have distinct boundaries from the lay-world outside.

This expert/layperson dichotomy emerges as certain knowledge production practices set an expert apart. In the quotidian notion of expertise, experts create walls around their knowledge and laypeople stand without those walls to receive knowledge and facts. In 1998, Emily Martin established the notion - reviewing studies of how scientific knowledge is produced - that many thinkers perceive these domains of production as "citadels". This notion has been useful to scholars as shorthand for the boundaries around knowledge production sites and the experts whose power operates within them (Downey & Dumit 1997). Martin's purpose, however, is to show where anthropology can unveil the fissures and cracks: "What sets the sciences apart is that they claim to construct reality but not to be themselves constructed (1998:26)." When, in fact: "The walls of the citadel are porous and leaky (31)," when examined ethnographically.

Drawing on examples from high-energy physics and molecular biology labs (1999), Karen Knorr-Cetina establishes for STS and anthropological researchers the idea of: "epistemic cultures". While across the sciences, objectivity is buttressed by deference to the guarded, citadel-like functioning of laboratories. Yet each of these laboratories builds a culture of knowledge-approval, of epistemological fact-making, that is at its heart a cultural construction.

Paul Rabinow's study of Kary Mullis - credited with "inventing PCR" - lends another up-close perspective on a laboratory's epistemic culture (1996). Rabinow shows how the idea for PCR was Mullis' but the invention of the technique was the product of a large team at the highly socially configured Cetus Corp. Inside the lab, a team of epistemologically coherent scientists is focused on replicating DNA sequences. Outside, the public wants to award a singular expert for invention.

The rich body of literature on science labs as sites of knowledge production and expert power is filled with such examples of these lay/expert boundaries (Downey 1998, Gusterson 1998, Koch 2011, 2013, Latour & Woolgar 1986, Latour 1987, Montoya 2012, Rapp 2000) where citadel-style knowledge production can be unveiled in its social dimensions. In science, as Knorr-Cetina shows, cultures often revolve around particular epistemes. Across other domains of social activity, other scholars investigate similar social dimensions of a kind referred to in the literature as: cultures of expertise. There are studies of expertise in government, examining the establishment of colonialism and the building of infrastructure (Birkenholtz 2008, Good 2007, Harvey/Knox 2015, Mitchell 2002, Moore 2013), in economic development (Eggen 2012, Mosse 2011, Scott 1998), and of course in technology (Boyer 2015, Coleman 2009, 2014, Cool 2012, Howe & Boyer 2015). Holmes and Marcus have led an inquiry into anthropology itself as constructed expertise (2005).

In all of these domains, anthropologists have used the near-field lens of participant observation to show how domains of expertise imprint the marks of their social construction on the specialized knowledge produced. In recent decades, the field has progressed to sites much less fortified by an expert-and-lay-person dichotomy and my project, as I will describe, interrogates a novel site where expertise becomes largely a tool for laypeople.

Going Outside of Domains

The operation of social construction *inside* labs and other citadel-style domains of expertise continues to be a fruitful field of inquiry but one strategy for seeing expertise in practice more broadly has been to step outside of the configured boundaries of walled-in expertise. Scholars begin by paying more attention to the laypeople - the non-experts. For there to be experts inside citadels there must be laypeople outside of them. And the modern dynamism in cultures of expertise is often located by focusing on the interactions between experts and laypeople, when the configured knowledge hits the streets.

These studies tend to observe lowered barriers to expertise regimes that once operated with a higher degree of "expert agency" (Carr 2010:22). Deborah Heath undertook ethnographic research inside and outside of labs where Marfan Syndrome was

researched (1997). She spent time with Dr. Sakai, eminent Marfan Syndrome researcher, and then followed her to the National Marfan Syndrome conference. Dr. Sakai reflected, when outside the lab meeting actual patients at the conference, that inside the lab her field of vision was limited to scientifically observing a protein with mutations. At the conference, Dr. Sakai interacted with activists who reinterpreted her configured science. Heath's study highlights the porous nature of the modern border between labs, experts, and the public.

Paul Rabinow, in following the invention of PCR noted above, also extended his inquiry to the changes that PCR underwent after its release from Cetus Corp to the world (1999). The product of the lab's configurations and expertise in this case - the technology produced - continues to change in the hands of other experts in other labs.

Gusterson wrote about his rare access to a culture of expertise inside the Livermore nuclear research facility (1998). He observed a culture that kept people on the lookout for sneaks who would steal nuclear secrets from them, reinforced through trainings and warnings. Then, going beyond the walls of the lab, Gusterson followed these experts into their home communities. He observed that this culture inside affected their personal lives outside, wherein they were more paranoid in public situations of specific or generic threats. Cultures inside expert domains can easily spill over into other domains of life. Or, in Gusterson's lens, the experts are also laypeople in another context, and exhibit the traits of their lab socialization even when at home or out about town.

Howe & Boyer (2015), studying the operation of wind power in Mexico and elsewhere, keep their inquiry open to the electrical utilities, wind farmers, local governments, and the public, who each approach the expertise of wind power differently. Some claim technical expertise, others presume expert comprehension of its social impact. But taken together, the authors argue that there is no "singular" wind power (1). Boyer wrote in another report: "These politics make entities like electrical utilities into hypercritical nodes of governance, buttressed by cultures of electrical expertise that help to guarantee smooth operation (2015:533)."

Studies such as above give us a body of data in consideration of what happens outside of the citadels where expertise is practiced.

Assailing Expertise: Outside/In

Boyer has pointed out that, as I mentioned in this thesis introduction: "cultures of expertise … routinely encroach upon one another, challenging jurisdictions, borrowing ideas and re-functioning them for new purposes and audiences" (Boyer 2008:43) Anthropologists are on the scent. There is increasing interest in expertise research that moves a degree closer to laypeople as informants on expert practice. Especially on outsiders trying to get in. Laypeople becoming experts. Co-opting established semiotics and practices. Detractors assailing the expertise and arranging social movements against existing spheres of expert power. New optical access to citadels in the information age allows laypeople more room than ever, perhaps, to assail expertise.

David Hess, in the 1990s, observed as outsider proponents of alternative cancer therapies succeeded to a degree in achieving "critical concessions from the state, industry, and medical profession (Hess 2005)." Hess addresses the growing momentum of the open source movement in the same article (528-530), which movement is a precursor to the FabLab movement.

Gabriella Coleman has shown us the ambitious assail of hackers against all manner of government, commercial, and social nodes of power (2017, 2014, 2012, 2009). The hacking collective: Anonymous, has been responsible for very public attacks on institutions such as: the Church of Scientology, the WTO, ISIS, and Donald Trump's website. Coleman points out that organizing in secret to combine skill against adversaries is only part of the story. Other hackers "study up" - to use Nader's call for anthropologists to pursue extra-disciplinary expertise (1972) - by studying US law and "tinkering" with it (Coleman 2009).

Christopher Kelty has interviewed and written about technical "polymaths" in his research on software expertise (2008). The fluid nature of activity across domains today requires a particular kind of supra-expert who enters multiple domains of expertise and becomes expert in a range of fields in order to link and operate among them. These polymaths offer further evidence that ambitious laypeople can engage expert spheres of activity rapidly and with effect.

Another story of laypeople changing established traditions of expertise is told by Heather Paxson in the context of craft cheese-making. When the proprietor of a new craft

cheese label stood to present at a workshop, one long-time cheesemaker commented to Paxson: "He started making cheese last year and now he is the expert giving the workshop (2012:125)?"

This scholarly body focused on assailants and organizations of laypeople against spheres of expert activity helps us see how - as Boyer said - expertise is challenged and re-functioned.

Proactively Open/Sharing Communities

Among studies emphasizing the layperson dimension of expert practice, my study of FabLabs presents data on a proactively open network of many experts and many laypeople. Anthropologists have interrogated experts in their citadels and labs, showing us the very social contests that create cultures of expertise within them. We have a growing body of data about the flows of knowledge and practice in and out of those citadels as well as stories of how spheres of expertise change as they are assailed from outside. Laypeople are no longer simply the foil for experts in whom we take an interest. We have observed many dimensions of expertise and how it acculturates. What is somewhat unique about the FabLab network that I have examined in this research, and what allows for a novel contribution to the anthropology of expertise, is that the FabLab network is a community that proactively recruits laypeople in order to make experts of them. I provide fresh evidence of how today expertise is practiced in communities where openness and sharing are the fundamental values - and yet are still impinged by negotiations and contests familiar to studies of the expert/lay dichotomy.

As introduced already, the FabLab network worldwide - and I am presenting data from a distinctive Japanese version of it - establishes workshops that are open to the public where machines are available for making things. Neil Gershenfeld at MIT's Center for Bits and Atoms launched the FabLab network worldwide with the idea that anyone should be able to make almost anything (paraphrasing the title of his MIT class: "How to Make (almost) Anything" (2005:loc300). The vision for this manufacturing and social model is to bring manufacturing expertise to the masses, mimicking the spread of shared software development that Cool (2012) and others have examined (Aksulu & Wade 2010, Coleman 2009, Karanovic 2008, Hess 2005, Kelty 2008, Raymond 2001).

Gershenfeld wrote:

> ... possession of the means for industrial production has long been the dividing line between workers and owners. But if those means are easily acquired, and designs freely shared, then hardware is likely to follow the evolution of software (2005:loc 261).

Today, this vision has been adopted by tens of thousands of people in more than a thousand FabLabs around the world: teach manufacturing to the masses and let them change the system. Laypeople can be experts, they believe. The FabLab charter as a simple document expresses this fundamental values structure (2012). The rest is up to the enthusiasts who form a lab. This has created the novel space where I seek to elucidate new perspectives on how cultures of expertise form: this time not in a walled-in garden but in a proactively open/sharing workspace that promotes expertise for all.

Who Are the Experts?

In approaching this open / sharing community, I often asked people: "who do you consider an expert?" The community is purported to emerge and exist organically without intent to coalesce around a reputation of ascendancy in knowledge production but rather an aggressive dissemination of knowledge formerly inaccessible to laypeople themselves. And it is said to be organized by laypeople. So: who among them do they consider an expert?

The responses reflected many different ideas about what an expert is in the community. I tried not to answer their questions about how I defined expertise, but used the same word to signify "expertise" with everyone: *senmonka*, curious to hear what their interpretation of the concept was in this context.

Mr. Koizumi, an active participant at FabLab Kannai, named seven people that came to his mind for their technical expertise: Dr. Kunda is a robot expert. Mr. Kawakami (male, 40s) helped us early on to source parts and such for the Fabbot. Mr. Otani (male, 50s) is an expert in Android. Hata is an architect. Tosa designs furniture. And Mr. Kanda (male, 40s) at Kamakura taught him about Arduino. This list represents quite the range of manufacturing skills. Also it reflects his recognition that others' efforts made to train him as a layperson was a marker of expertise.

Ms. Nakayama (female, 20s) began her list with: "well there is Tanaka, of course," suggesting that his obvious position as an expert hardly needed to be mentioned. She also mentioned Mr. Kato for his skill with the laser cutter at FabLab Kannai. Another person that came to her mind was Mr. Toto, not a FabLab regular but he had visited most of Asia's FabLabs and she was impressed by the design work his company: Team-Lab, does. Nakayama also said that when she first started coming to Kannai, Mr. Ohnishi helped her to learn things she did not know about the machines. This and his work to organize the FabLab in the first place led her to think of him as an expert, she said.

Mr. Morita's thoughtful response to the question began with Youka. Morita said that Youka was an expert in his mind for the way she manages FabLab Kamakura. She doesn't get outside financial help but rather is independently profitable, whereas some other labs get funds granted to them. Or, they have separate jobs and revenue-generating projects so they don't focus full time on running the FabLab. He called Youka's expertise "management expertise". He added that the people running FabLab Sendai have also recently impressed him with their wide range of activities and projects, though he only knows about them through their Facebook posts, not personal experience. He named Ms. Obuchi specifically, who recently took the helm from founding director Mr. Yonezawa a few months before the interview.

An important contextual note, considering Morita's focus on management and organizing as a key expression of expertise, is that Youka began without technical skill and still relies on others for most technical teaching. She has also organized a corporation in recent years that operates the FabLab and she has a number of revenue-generating projects going. I think Morita's point is that all of this centers around operating the FabLab itself and feeds back into it, whereas other lab directors have day jobs separate from the FabLab and they operate it for the public as a hobby.

Mr. Tarumi, who is a director at the FabLab in Oita, named his friend, Mr. Samson. This friend is an American living in Oita who has become active in organizing activities for the Fab community, and he has a wide range of technical knowledge and skills plus DIY experience. Tarumi went on to name sub-categories of what he called technical expertise: designers (a term that in this context generally means: people who draft CAD designs for objects and build them, usually for sale) and seamsters (such as people who

can make cool cosplay costumes). He added that some experts serve to connect other people to each other, which he also said is his own role in the Fab community. And finally, there are experts who teach others the skills of fabrication. Mr. Tarumi's colleague, Mr. Iwasaki, commented that it would be very difficult to find a single definition of expertise in the FabLab community.

As an observer, I would interject that MIT and Gershenfeld, introduced above, are influential experts in the overall operation of FabLabs. The semiotic power of MIT and of its expert - Gershenfeld - advocating the cause sets a tone of importance and qualification for the endeavor writ large. Just as Tanaka was so influential as an expert as to not even need mention, in Nakayama's mind, Gershenfeld was not mentioned but does stand as a pinnacle expert. Nearly everyone I spoke with about him knew Gershenfeld's book and knew that his ideas were the spark for the movement. Association with MIT carried heavy symbolic weight in legitimizing the open and non-commercial foundations of the community.

It may be said that, in general, most informants interpreted *senmonka* roughly as "really good at" something of relevance to the community - certainly not a coherent notion of what expertise is and does. However, this summary of interview responses about experts: who they are and what they do, sets the stage for a categorization that I will describe with further examples below.

What are the Types of Expertise?

MIT anthropologist Michael MJ Fischer has written that: "technoscientific worlds draw in multiple worlds of expertise (medicine, law, economics, politics, engineering)" (1999). This is corroborated by the stage-setting remarks outlined above. To help answer my research question about what social practices shape the culture of expertise in Japan's FabLabs, I considered the many practices I observed and distilled three categories of expertise. In this next section I describe those categories of expertise. Those are 1) the technical expert, 2) the organizing expert, and 3) the as-needed expert - a synthesis of the first two.

Technical Expert

As outlined above, most people I asked to talk about expertise spoke of people with skills that help accomplish a technical task: technical experts. They are referring to the people in the FabLab network who have knowledge about how a tool works. The technical expert can get through a technical challenge: reshaping the CAD design with better supports for the 3D print, setting up the laser cutter to achieve a cut more accurate to the designer's vision, or determining the best raw material for a given project idea.

As I have noted previously, the FabLabs in Japan have anywhere from five to dozens of machines available to fabricate objects. Then, there are the computers where CAD software is used to produce the files that give instructions to the machines. In a large technology company, for contrast, employees would be hired to deal with each subvariety of technical task. In FabLabs, it is more like a bazaar of technical skills (Raymond 2001).

One of the first fabricated objects I came across in fieldwork was the plastic jello mold I mentioned in Chapter 2 when I introduced Ohnishi. He was thrilled to have designed the mold successfully with assistance. He was making jello in the mold for an upcoming Fab event he was hosting. Ohnishi's CAD skills were not quite adequate for some advanced curves in the mold, however, so he turned to Dateyama, who does CAD designs professionally, for extra help with the design. Dateyama shared his technical expertise. This kind of exchange happens dozens of times a day at every FabLab in Japan. When the milling failed, Ohnishi went back to Dateyama and eventually they solved the underlying problems.

Another common way to distinguish a technical expert is that they teach others. This raises their profile, of course, as one who holds knowledge of value. I observed workshops taught about microcontrollers, many about 3D printers, laser cutters, and other tools in labs. FabLab Kannai invited the founder of FabLab Tsukuba (the first established after Tanaka's return from MIT), Susutawari, to teach the microcontroller classes that I attended. Susutawari also publishes books about the subject and his FabLab is very focused on making microcontrollers, though most makers simply purchase microcontrollers because they are inexpensive.

Another expert of note is Koike, whom I wrote about in Chapters 3 and 4: the inventor of the Mugbot. Koike is an engineering professor at Yokohama International University. He makes a career passing down manufacturing expertise to students. Yet he has an active role in the FabLab community in Japan. As I have explained, Koike developed the Mugbot for use in teaching: students develop new functions for the robot. He also interacts with a worldwide community of hobbyists who use his design and work to improve it, as Koizumi and Kunda have done with Fabbot. In this way, Koike projects his technical expertise to multiple communities, moonlighting as a "maker" but also using his "maker" work to enhance his classroom pedagogy.

Mr. Kitanaka was another expert. Kitanaka teaches CAD at a technical high school. Another co-manager of FabLab Kannai, he taught a series of CAD workshops there that were always well attended. He commuted three hours by train to Sendai to teach and spent his free time in FabLab Kannai.

Mr. Masuno is another expert whose work caught a lot of attention. He was also a manager of FabLab Kannai but not always around. He had worked with a unique plastic filament, drawing on his technical understanding of 3D printers, to design prosthetics that were durable and easy to print and mold to the patient's body based on a 3D scan. Doing this on 3D printers allowed the artificial limbs to be produced at a fraction of standard costs. The novel filament material was much easier on the skin for patients. Masuno was working with a partner to bring the technology to nearby developing economies in Asia with grants from Japan's development agency. I understand that some of this was brokered by Tanaka, and the technology was partly developed in Tanaka's university-based "super FabLab".

Susutawari, Koike, Kitanaka and Masuno are each technical experts of a high order, and widely recognized as such. Many similar figures are part of the FabLab community in Japan. However, technical experts in FabLabs are often not recognized as experts outside of that limited context.

In FabLabs, some claim expertise with just a degree or two of experience beyond the beginners in the FabLab. There are always more beginners coming through. In FabLab Kamakura, Mr. Saito was nearly always present for AsaFab. He is very skilled in woodworking, which he does professionally and artfully. At each session, however, he

would introduce himself self-assuredly as a "FabMaster". I would observe him helping beginners with a laser cutter or 3D printer dilemma periodically but most of that he left to a few others who had more skill. Saito was a regular at Kamakura, however, and usually knew more than those who sought his help. Expert? Maybe, in that context.

Some expertise that is within the scope of vision of FabLab participants is not quite accessible. Hundreds of engineering professors, unlike Koike, for example, do not have any interaction with FabLabs or "makers." They teach - as they were hired to do - to university students exclusively. Therefore, in the FabLab context, their expertise is essentially invisible. On the other hand, one of the "experts" named by Morita in an interview was the technician who worked for Trotec, a laser cutter company with machines priced at the high-but-accessible end. Many Trotec laser cutters sit in FabLabs. These carry service contracts, just as copy machines have done for decades (Orr 1998). Morita commented to me that when the Trotec technician is called for service to a FabLab, he is open with his knowledge. When available, he is a visible expert, although since he does not come to FabLabs on his own time, that opportunity is rare.

Technical expertise is thus available in FabLabs in a range of shapes and forms and is a fundamental category that all participants recognize and utilize. Across my observations and interviews, there was not a preference for a particular skill in the aggregate. Rather, expertise was drawn in as-needed and as available, from laypeople with just a little more training up to high school teachers, professors, engineers, and others with objectively very high skill levels.

Organizing Expert

The other category that multiple people described when asked about expertise was the organizing expert. In Japanese, the concept "*unei*" was used by Morita, Tarumi, and Iwasaki when discussing this category, signifying the administration or management of people. I chose the word organizing because this kind of expert is the person who brings everyone together. They put in the time and effort to establish physical spaces, organize group activities, bring in teachers, and many other tasks that the "makers" rely on to bring their community together. Not all informants tagged this category but it nonetheless emerged as a concept independently raised by different informants.

Any FabLab director is recognized as an organizing expert. Although Ohnishi, for example, was only involved in FabLab Kannai in the beginning, while he was still a grad student, Nakayama still cited him as an expert because of his efforts to help her get started. Ohnishi himself told me: "While I am here wanting to "make" things, I really have no special skill at that. However, I really like being able to create a place for many people to study and "make" things together."

Takemoto in FabLab Hamamatsu was a garage tinkerer whose parents had a large empty shed on their farm. He put a few machines in it, bought or borrowed himself, and started that lab in a rural community of otherwise no particular reputation for upstart technology. Susutawari is of course a technical expert mentioned above but he quickly organized his FabLab an hour outside of Tokyo shortly after connecting with Tanaka.

This category is not secondary in importance to the technical expert. It is a skillset that makes the recruitment and maintenance of the community possible. Organizing experts need to comprehend and communicate consistently the messaging that keeps new recruits engaged. I sat in on planning meetings for the FabLearn event that I described earlier: a partnership with Stanford University, held in Yokohama in 2016. At one planning meeting, as Youka and Yanagi were discussing the main stage event schedule, there was a few minutes' discussion about where and how to use Tanaka in the program. Tanaka was not an event organizer but all Fab activities are legitimized by his presence. And his remarks are always engaging. They decided carefully where to place him in the program to achieve maximum "firepower". This shows a nuanced exercise of organizing expertise, cognizant of the needs and interests of the community and Tanaka's influence.

Youka was second to Tanaka in organizing the global FabLab conference promoted by MIT and Gershenfeld. In 2014, the FabLab International Conference was held in Yokohama, organized by Tanaka, Youka, and others in his orbit. This was a watershed for the FabLab network in Japan. Bringing Gershenfeld to Japan and winning broad press coverage for the conference was no small feat of volunteerism. I attended the press conference. Dozens of agencies were there to cover the news of MIT on its way to Yokohama as part of this new wave of technological activity. The organization of this event ramified for years following. I heard it spoken about by many informants.

Youka is well-known throughout the FabLab network. Her Kamakura lab functions - while it is not open to the public all the time - as one of the most active. She has organized a training course that takes individuals through beginner, intermediate, and advanced skills. She organizes a trip to Mt. Fuji each year where trees marked by the forest service for removal are cut by hand and brought back to Kamakura for slicing. Then the participants use the wood for creative projects such as clocks, speakers, wall art, coasters, and more. NTT recorded a special for their national program featuring the FabLabs at Kamakura. And to support the FabLab efforts, Youka operates a technology consulting business, helping major companies to implement Fab values and set up FabLabs internally. In interviews, Youka told me she does not consider herself any kind of technical expert. This was born out by my observations. I very seldom saw Youka working on a Fab project of her own. Rather, she was ascendant as a connector and organizer of the disparate energies that must be corralled in order to keep the Kamakura Lab active, but also many additional FabLab-based projects across Japan.

Other people ascend as organizing experts for pooling energy around a specific project. I mentioned Professor Koike above, with the Mugbot, and the Fabbot derivation project. Koizumi is another person who could be considered an organizing expert for building this Fabbot variation on the Mugbot. He and Kunda worked together and recruited people around Japan to help them achieve their ambition to fit a Mugbot inside a Starbucks cup. They designed and developed until they could fit the microcontroller, the wiring, the servos and the LED lights in the much smaller container. Then, they wrote out their plans and did workshops to spread their project more widely. These two partnered to organize a specific project and became recognized across the community for it.

Organizing expertise is different than technical expertise. It is an outcome of experience in planning events, managing message, pitching external supporters, seeing a long-term strategy, and making choices about what activities fit or do not fit within the FabLab programming. Just as a short list. The organizing expert sees value accrue through the expression of gratitude for their effort and is generally motivated by the excitement they share for the future they pursue with others. Especially in the open network of FabLabs that can be overwhelming, and where things do not happen without

149

someone taking initiative, organizing experts are operationally critical. The organizer's knowledge about the actors, the tools, the venues, and their shared interests qualifies them for referral as experts.

Lay 'Experts', Using Experts As-Needed

The third category I observed is very different from the first two because it recognizes that the laypeople themselves become focal in this FabLab network in Japan. They use experts and expertise as needed for their own ambitions. The visibility and definition of expertise is contingent on their needs and their projects so much that I think we may rightly consider the laypeople as experts, at least in the sense that they wrest much of the control of the network's flow and function from technical and organizing experts. Largely because of social designers like Gershenfeld, Tanaka, and the FabLab directors, laypeople indeed seem to exercise a heightened degree of agency in the domain of manufacturing than they might have otherwise done.

Mr. Tarumi (FabLab Oita) said to me, in our discussion about expertise, "you start with what you want to make and the experts are the people who help you get there (interview, 2015)." This insight has become a central finding in this chapter. Across all of these various notions and expressions and dimensions of expertise in the FabLab community, the participants determine which expertise is of value to them. Expertise in the FabLab community is more a tool for accomplishing one's own goals than a position of aspiration, though it can also be that. The laypeople themselves in this ethnographic case appeared to me to maintain a degree of agency sufficient to blur the lines between themselves and the identified experts.

Many research populations where expertise is interrogated dwell on a coherent skill set, tradition, history, or configuration of knowledge, with "a high degree of expert agency" (Carr 2010:22). The FabLab community gives our discipline a chance to consider a community established proactively as a space for laypeople to exercise a high degree of agency - ostensibly. Most domains of expertise garner over time a degree of deference from their lay audience. Fabbers tend to prefer not to defer to experts - seeking to learn through their own experience. Morita told me that he prefers not to ask for assistance, even when he knows someone who could help him. He could only name one

time when he did. He prefers to problem-solve and be left to his own creativity. He nevertheless frequents the FabLabs where he can share what he has built and discuss with colleagues. He said:

> A good FabLab is where people gather with their several skill sets and then supplement each others' weak points as a community… I don't think it is good for skills to be taught by FabLab leaders because then it makes it less of a community. The people who come, teaching each other, that is the best pattern, I think (interview, 2015).

Morita is certainly a purist. He does think that technical and organizing experts are helpful for those patrons who are seeking a greater expertise. Morita told me that for him, the Fab community is ideal because: "everyone brings some expertise and everyone shares (interview, 2015)."

Ohnishi spoke to me of this pattern as well, in the days before FabLab Kannai was operational. He said that: "People get ideas and then "make" their own things until they get stuck. Then they ask people for help … that is the usual pattern in FabLabs. My ideal is to have a place where this is possible but it might just remain and ideal (interview, 2013)." Ohnishi and others working with him did indeed create a place for people to share expertise and help each other complete projects.

In the aggregate, a combination of organizing and technical expertise means that those who pursue a project can often find support. There are also individuals who seem to embody the synthesis of skills within themselves. Mr. Uehara (male, 30s), a widely known expert Fabber in Fukuoka, on the other end of Japan from Tokyo, took pride in not relying on the Tokyo Fab community. His ambition was to develop the community in far western Japan that could support its own local body of "makers". By day, he worked as a product designer. By night (and often during the day), he was organizing events and spaces for Fab activities. For a time, in fact, Uehara quit his work and focused on building the Fab community. He or his organization were known by nearly every Fabber I met in that region of Japan. Uehara told me:

> The usual pattern would be that people would pay someone with skill to teach or help them. However, people like me who think that the skills we possess are for everyone to use together, like to share with and teach each other (interview, 2015).

Fabbers like him synthesize the technical and organizing skill, oriented by the fundamental value of helping 'anyone make almost anything'. Their work empowers laypeople to circumvent the patterns of official sanction on the labor value of expertise and instead share or borrow as-needed, as a community.

If practices in FabLab generate any particular grand-expertise (which my informants tended to doubt was happening), it would seem to be embodied in the person that signals both technical and organizing expertise as a friend to the whole community - a servant of its shared ambitions. Tanaka, chief among them. These "experts" become so because of how they help laypeople themselves to inherit a heightened degree of manufacturing expertise and thereby wend their own path through design and production.

Expert Practice: Performing and Negotiating Expertise

I have presented commentary from Fabbers and observations from my interactions among them to suggest that Fabbers have an elevated degree of agency relative to laypeople observed in other studies of expertise. Technical and organizing experts ascend in proportion to how widely their contribution is shared and signaled as contributing to the community's ambitions. Even laypeople can advance from recruits to becoming experts and instigators.

The important dimension of my inquiry that I have not yet addressed is the operation of social practices (Bourdieu 1989) that lead to this observed state of community. There are always contests and negotiations and this is certainly true in Japan's FabLabs. I will describe some of these in this final section.

One arena where the social practice of expertise can be observed is the signaling of oneself as an expert. Will you be believed? With such an array of shades and dimensions of both technical and organizing expertise, how does the community come to accept one or the other?

Ohnishi found that his expertise became less valuable after a time. In 2013, when he connected with Tanaka and showed great organizing skill, he was supported in his efforts. The FabLab was established in 2014, in conjunction with the International FabLab Conference in Yokohama. Ohnishi put in many hours, recruited many people, and organized many events. There were other people involved, to be sure. At the time, I

didn't know how much or in what ways others contributed but Ohnishi was the central actor so far as I could tell.

This is standard signaling in FabLabs. As I have said above, organizing a FabLab is noticed by everyone. There is fanfare throughout the network when a new FabLab is established. And Ohnishi's was among the first ten. When I returned in 2015, and he was nowhere to be found, he told me that, primarily, he found that he could not sustain his involvement alongside his full-time work. He did not disclose any push from Tanaka or the current managers to leave. Still, he was never at the FabLab in the remaining 18 months that I was visiting regularly. It was clear that his organizing capacity had diminished, and perhaps his interest in the promise of FabLabs - anyone making almost anything. Also, the three current leaders were retired or had flexible work schedules. Ohnishi simply did not. He needed to work and get paid. Ohnishi was very interested in the techniques of FabLab manufacturing and seemed a quick study, but was not a technical expert to many.

I do not describe his story as one of discord so much as one of atrophy. There may have been a time when the three managers now constituted: Masuno, Kitanaka, and Otani, made clear to him that he did not have a place in management anymore: none would tell me if there was. However, it is clear that when his organizing expertise lost its value and his technical expertise fell short, he did not any longer feel he had a place, and he left.

Another intriguing story of negotiating a path to expertise is that of Kanda, who participated in FabAcademy and sought to build something of an income as an expert in the FabLab community. FabAcademy is the course taught with sanction by the non-profit Fab Foundation in Boston, established by and ancillary to Gershenfeld's ongoing work at MIT. Completion of this course earns a certificate that is widely understood as indicative of technical mastery of Fab manufacturing skills. The course is taught online through live classes. Students do projects that they share as they go. Kanda worked nearly daily on projects at FabLab Kamakura alongside Youka. His idea was to earn this expert designation and then teach others online through a global video-teaching platform. Because of time differences, Kanda was often awake very late at night attending the live sessions. He told me that the classes were great and he was learning a lot. I watched over

his shoulder a bit and the technical content was certainly way beyond my beginner grade. Kanda was the most knowledgeable technician of the machine skills at FabLab Kannai. Until I left the fieldsite in 2016, he was telling me that he would like to have more students but his online classes were getting some attention. When I visited a year later, he said he had mostly stopped teaching. He was working on other projects and was close to taking employment that would limit his time at FabLab Kannai.

Both Ohnishi and Kanda are good examples of people navigating the path of signaling oneself as an expert. Ohnishi took the sure path of establishing a FabLab. I don't suggest that his goal was to be seen as an expert but he certainly bet hours of his young life on the endeavor of FabLab Kannai. Kanda, for his part, took the path of the FabAcademy certification. Though not a university degree, in some circles this carries credential. It was not quite enough to carry his ambitions for online teaching. Again, other factors are in play throughout the story - maybe Kanda's online topic was not relevant or his style not compelling enough. Still, both stories get to the point that in an ad hoc and open range community such as the FabLab network in Japan, it is easy to make bets that don't pay off. Fabbers offer a lot without an established path indicating progress or likelihood of success. In the rhetoric, the shared greater good is paramount: more people with more manufacturing knowledge. In practice, people like Ohnishi and Kanda have to pursue their income without a marked path or script, as in established professions.

Another arena of practice is looking to find an expert. The boast of the community of course is that people can find the support they need for their individual project or a community for their community project. This is likewise - in practice - a path somewhat fraught with potential error and aborted quests.

Consider the example of a few experts I described above: Susutawari, Professor Koike, and Saito. The first two are technical experts who have credentials outside of the FabLab context, and deep involvement in the FabLab community. Saito, on the other hand, claimed each week to be a FabMaster but in fact did limited advising in my observation. Innocuous, perhaps. Still, for new recruits to a FabLab, or for someone who comes seeking support, the lack of clarity about who has which skills can be befuddling.

Many people who enjoy the sociality of FabLabs and who may know a bit more than the person they are helping are not also raising the technical capacity of the whole network. In another scenario of social practice, back to the Fabbot, Kunda and Koizumi worked together on the project. Koizumi was the idea originator with Kunda as a happy participant. However, when I asked them at length about the project, they both said to me independently that Kunda did the real design work for the robotic parts inside. When I participated in building the machine in their workshop, they had a kit all ready for me and the others. Our effort was scripted and simple. I accomplished the task, much to the delight of my young son. I could not tell at that time who had designed the robot. Because I inherited their kit and their real-time instructions, it really did not matter to me. What is significant in this anecdote is that Kunda in fact has a Ph.D. in robotics from Kyoto University, where she studied with a globe-leading expert in the subject. If I was looking for help with an advanced robotics project, I would have found a goldmine. In this case, however, her advanced expertise was not required by me. I was a consumer only of a small portion of it. She seemed to take satisfaction in her effort and our pleasure at our success. However, for FabLab patrons who are seeking particular expertise, the effort can be complicated by the soupiness of claims and the realities of helpful knowledge.

In practice, the development of a comprehensible body of expertise within the FabLab community in Japan is a patchwork and a terrain without signs of sanction akin to the professions or to the epistemic cultures in the sciences. Laypeople who dedicate much to the community can find themselves at dead-ends as a result, rather than ascendant as experts. Newcomers and skilled Fabbers alike, looking to draw on the collective brain of the network, can seek and not find when anyone can claim to be an expert. And world-class expertise can fade in value when not in demand by an audience of laypeople. People are attracted to the Fab movement but people also leave when their expectations are not met. Sometimes this is because the community has not fully constructed the rules of play. This is perhaps a natural aspect of a culture that is yet emerging.

Conclusions

Technical and organizing expertise synthesizes in FabLabs in Japan, based on my observations, into an array of social practices. The overall shape of expertise could be summarized in the synthesized third type: as-needed expertise. The fundamental reorientation, relative to many other communities where expertise is studied, is that in FabLabs in Japan the layperson has the higher degree of expert agency. They do not defer to experts but rather use their expertise, and that of others, as a tool in pursuit of their own personal project. Still, the practices I outlined above show that these laypeople and these experts, in the affinal network of mutual support, do yet find their path difficult to forge. They may pursue an end without support so long that they get out of the network. Some may look for expertise but not find it. Nevertheless, the stories of these actors shows that in the modern technosocial world, a new form of expert practice is indeed emerging. The function of expertise in this community shows how much our comprehension of citadel-style, or even "assailed" expertise now gives way to communities where expertise becomes simply a tool for laypeople exercising their agency in novel ways. The as-needed expert is a means to the hobbyist's end.

Chapter 6: Synthesis

The preceding chapters have presented insights, stories, and perspectives about the FabLab Network in Japan and how technology is used in this network to shape an emergent sociotechnical community. Drawing on key points from this data presentation, I can now synthesize the report and justify its findings, bringing the dissertation back to its roots in anthropological and STS theory.

The fundamental question that I sought to answer, to contribute to our understanding of technology and how it functions in our modern society, was: "How are emerging technologies used to shape an emergent sociotechnical community among "makers" in FabLabs in Japan?"

The Argument

It is my argument, based on the data I have presented, that because certain "experts" have made the technologies accessible to laypeople, a culture of expertise has emerged that recurs authority to laypeople. Thus granted a heightened agency, the laypeople becoming experts exercise agentive practices that bring this modern "emergent culture" (Fischer 2009) into its coherent shape, creating this "actually existing alternative" (Kelty 2005) to the dominant regime of capital-driven manufacturing. They organize people, gathering spaces, and machine intermediaries into a surprisingly coherent network. They accomplish this coherence not through traditional social forces so much as through practices such as newly invented rituals and rhetoric that incites hope that leads to action.

This argument is built on three findings that I have tried to justify in each of Chapters 3, 4, and 5.

Finding 1

The components of the community: people, gathering spaces, and machine intermediaries, emerge in concert in spite of participation being highly elective.

The Marxian notion of political economy (1867b) is built on the historically persistent failure of laborers to gain ownership of the means of production, such as financial capital, working capital and factories. In a sense, their labor is compelled by the

157

need to have a wage: to buy bread. This remains of course true in our present economic system for billions of people. And in the shadow of this global economy, many people's daily choices - not just where they will labor - are impinged upon by their native social class, their religious community, their nation, and many other factors that are orchestrated within this political economy. People's choices are seldom free from these external social forces.

The FabLab network in Japan, somewhat in contrast, I have tried to show, is the social outcome of a uniquely elective group of actors. While I could never argue that a sociotechnical system is unfettered by political economic forces, I have given examples for consideration of network components whose mutual participation is highly elective. I am trying to show that within this political economy, people are electing to organize a coherent community that differs from the dominant regime.

People such as Youka, yes: raised in first-world Japan, able to graduate college, and able to sustain herself primarily in residence with her parents, yet chose to start FabLab Kamakura in spite of already having a successful career in design. She aimed to press back against the dominant manufacturing regime by creating pathways for laypeople to learn the skills of manufacturing. In a sense, she elected to organize against that regime by helping to foster acolytes who know how to "make" things for themselves.

Many patrons, one may say, are simply enjoying a hobby. This is just another avenue that people elect with their free time, such as bingeing Netflix or going hiking. The modern world has websites like Meetup.com that connect communities for thousands of hobbies and sometimes ambitious projects. Aren't all of these just more examples of highly elective social networks? Yes. They are. And they would also be possible sites where one could observe findings similar to mine.

FabLab Kannai on one hand is just a pile of machines in the corner of a co-working space in a nondescript corner of Yokohama. On the other hand, hundreds of people gather there during the year in their free time to "make" things. They also socialize there, anchored in share values and ideals. They are not compelled to be there in any obvious way. Young Ms. Nakayama, for example, told me that her parents, if not opposed to her active involvement, are at least bewildered by it. She could be at home watching "Once Upon a Time," but she elects to gather with others at FabLab Kannai.

In a Latourian sense, although the machines are a product of the human actors in the network, they are no less active in producing objects far outside of the commercial political economy. The 3D printers in FabLabs produce volumes of objects that are simply "cool" for patrons. Empty eyeglass frames. A single chess piece. A plastic chain. Youka had to spring-clean these trinkets with prejudice. A small percentage might be justifiably useful for a purpose, like mounting a video camera or prototyping a more complex machine. The same machines are used inside companies for prototyping, for example. However, in FabLabs, they perform highly elective tasks. They also give newcomers and long-time patrons, every day, the sense that the means of production are closer than ever.

I believe I have shown in this dissertation that the FabLab network, inside the strictures and liberties of the current political economy, maintains a coherent concert of components such as people, gathering spaces, and machines. And this is the product of actors and actants in a network that can reasonably be said to have a high degree of elective agency. Ironically, in real ways, this is possible because the political economy has robbed so many more actors of their elective agency. Nevertheless, in the midst of distressing political economic forces, of labor detached from the outcomes of its own work, unable to recoup justly the value of that labor, people in FabLabs (and perhaps many other hobby and elective communities) are in fact creating communities that take shape against the dominant political economic regime - the manufacturing industry in this particular case. A new entity is emerging, perhaps, "in the teeth of the alienating consequences of commerce," using a phrase from Daniel Miller's study of consumption (1995:146)."

Finding 2

The cohesive social practices in this emerging network, beyond capitalist practices that drive most manufacturing networks, are rituals and ideas.

Trenchant critics such as David Graeber (2011) have shown how deep and historic the deleterious force of capital, capitalism, and the ambition of commercial ventures has been for millenia, weakening the health of our societies. Manufacturing, as noted above in the context of Marx's earlier writings, has long been a system driven by these ambitions.

I have argued in this dissertation that the FabLab network in Japan is not compelled into its coherent shape by these capitalist practices. Certainly, the whole world of technological capabilities built on these practices has enabled it. Actors within it are not journeying without purse or scrip, as they say. Money still talks. However, the FabLab network in Japan is indeed different and I have isolated two very different kinds of social practices that appear to bear a strong cohesive force on the network.

Drawing on my data, I have elucidated the AsaFab weekly morning cleaning ritual. Established by Youka and designed to echo the ritual cleaning performed by Zen monks, I saw each week how the nature of the service put everyone on an equal footing and with a sense of ownership. The ritual, while it may not have increased total participant numbers and been highly performative rather than productive, was an important cohesive force among the group that attended. It further welcomed newcomers. And Youka's FabLab has a far more permanent personality among its patrons than I observed in FabLab Kannai. In Kannai, there is certainly an affinity among members but the lab has become more of a tool for personal projects, with high turnover in patronage.

After ritual, the second force that I pinpointed is the ideas communicated through rhetoric. Tanaka's books. His talks. Gershenfeld's heady ideas. Day in and day out among the FabLabs, these core sympathies are shared and reinforced. In a socially disconnected Japan, where life can feel precarious (Allison 2013), hope (Miyazaki 2006) can lead us to act in concrete ways. Ohnishi certainly did act. He saw a future for himself as a "maker" and took opportunities to work with Tanaka and YCDL to start FabLab Kannai. Yet hope can run dry, and sure enough, I found just a year after he opened FabLab Kannai that Ohnishi had moved back to regular employment, telling me that his ideals just had not played out. Yet the effect of this action, spurred by rhetoric and hope, is that FabLab Kannai indeed is still gathering people who elect to join others there to "make" things that corporations will never make for them.

The emerging technologies used in FabLabs in Japan have enabled people to shrug off the high demands of capital in manufacturing design and production. While not free, it is inexpensive enough to start a FabLab that more than twenty groups have done just that in Japan. Some exist inside corporations as outlets for the public to learn to "make" things. Others are simply the hobby project of a very committed "maker." This diminished role of capital as the dominant cohesive force makes legible ritual and active ideas as elements of social cohesion, which can be helpful in evaluating many other modern, tech-enabled, social networks.

Finding 3

The technologies enable a culture of expertise that recognizes technical skill and organizing skill but they also grant the laypeople a high degree of agency (expert power).

The lynchpin of my argument in this dissertation, which I have been describing obliquely in the Finding 1 and Finding 2 sections above, is that I observed laypeople themselves, in the midst of expert manufacturing professionals, to command a degree of expert power.

Under Finding 1, I argued that my data show people electing to participate in the network of people, spaces, and machines. Under Finding 2, I argued that my data show actors responding to rituals and acting on ideals against the grain of capitalist ambition. It was through my examination of the culture of expertise in this FabLab network in Japan that I saw a final critical sign of this elevated agency. The whole, emerging, network, enabled in part by the emerging technologies that comprise the FabLabs, is developing a culture of expertise that considers laypeople themselves to be experts. At least, experts in training. The network defers to laypeople, is shaped by their ambitions, and provides category experts as-needed to help them "make" their projects.

It should be clarified that laypeople cannot be credited with the architecture of this network. The FabLab concept was coined at MIT. It was promoted through academics in Japan. Establishing the FabLabs, while less capital intensive by far than previous manufacturing operations, has been accomplished with real yen and the determined efforts of people at the top of the food chain. And that is precisely why my observation that within the FabLab network, laypeople have expert power is the crux of my argument.

A network that grants this degree of expert agency to laypeople is novel in the anthropological study that my literature review explored. Not only are the walls protecting a socially constructed expertise down and the justifications for expert designation changing, laypeople are being granted the expert's power to design and produce. And they are using it.

In Chapter 5, the first two expert categories that I codified could be found perhaps in other, bounded, "citadels" of expert production. Science labs certainly recognize technical and organizing expertise. FabLab patrons saw and respected the same within their network. However, Morita never called on an expert unless it was unavoidable. Kunda lent her Ph.D. robotics expertise, from the top program in Japan, to facilitate Koizumi's big idea to fit a Mugbot inside a Starbucks cup. Scientists. Engineers. Elected officials. Corporations. 3D printers. Laser cutters. These "experts" became the tools of the laypeople I observed in Japan's FabLabs.

Conclusion

More sociotechnical systems with more technological power exist today than ever before in history. Science and technology studies has helped us to see that our culture is co-constituted by these machines of our invention. Anthropological studies of these sites has shown how rhetoric and reality can differ in ways that hurt us. This study of "makers" and the new culture of expertise that they are producing in Japan's FabLabs, has shown further, along these research lines, that laypeople are empowered as experts by this new culture. Experts become a tool in this new culture. And this heightened agency facilitates a coherent community in the midst of, and sometimes against the trajectory of, capital and its pursuit. When rhetoric inspires hope and laypeople take action, they can fall short as with all ambitions, but I observed laypeople also "making" real things.

I have reflected many times on the feeling I felt when I printed my first object on the 3D printer and then held it in my hand. It was profound. I felt like I was powerful. I comprehended that I could do so much more, all of a sudden, than I had ever realized. Was I right? Is a plastic pinwheel my modern banquet of agentive power? Perhaps. Have I manufactured anything substantive since? No.

Yet something had indeed changed. I was not wrong that I had access to power that was once unavailable, behind walls of capital and expertise.

The FabLabs in Japan, in a similar vein, seem to me - after spending nearly two years studying them ethnographically - to be both quotidian and remarkable at the same time. Among social communities or actor networks in the information technology world today, they may not seem unique or particularly powerful. Technocracy is still ascendant today. The rhetoric seems often overwrought and in service to elites. Beyond manufacturing technology, dozens of additional powerful forces are shaping our future through information technology. Artificial intelligence, for example, is being granted authority over more endeavors and is bluntly tuned to quantifiable representations of our humanity. Robots are gaining capacities we only once imagined. The data we produce is either privatized or co-opted by state authorities, eroding our trust in any right to privacy. States and corporations monopolize this technological power. However, I think that networks such as the FabLab network in Japan presage a new kind of social community that speaks back to and creates new possible pathways for our society.

In this dissertation, I have not presented evidence that the FabLab network has jolted the future in favor of democratized means of production or technological power. Yet still, the evidence I have presented has shown that laypeople in Japan's FabLabs, and experts among them, make up a modern, impressively coherent, network that is acculturated to utilize more of that distributed expert power. The FabLab community represents an "actually existing alternative" that is expanding and brings meaning to the lives of thousands of hobbyists in Japan. This is what I saw emerging from the use of technology in the FabLab network in Japan.

<center>END</center>

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**2005** **M.A.** Patterson School of Diplomacy & International Commerce, University of Kentucky
**2004** **B.A.** Kennedy Center for International Studies, Brigham Young University

**EMPLOYMENT**
**Non-Academic**
**2016 – 2019** **Executive Director** Japan Society of Boston
**2014 – 2015** **Research Analyst** KelCor, Inc.
**2007 – 2011** **Executive Director** Japan/America Society of Kentucky
**2005 – 2007** **Economic Development Specialist** Bluegrass Area Devpt District

**PUBLICATIONS**
**Conference Proceedings**
**2014** Manufacturing Expertise for the People: The Open-Source Hardware Movement in Japan. In Ethnographic Praxis in Industry Conference Proceedings. New York.
**2013** The FabLab Network in Japan: Preliminary Ethnographic Observations. In Proceedings from the Fab 9 Research Stream. The International FabLab Association. Tokyo.

**Industry Reports**
**2014** (Second Ed. 2015) The WebRTC Ecosystem: A Comprehensive Segmented Analysis and a Directory of WebRTC Vendor Product and Service Offerings.

**AWARDS AND HONORS**
**2015** **Graduate Certificate in Applied Statistics** The Graduate School, Univ. of Kentucky
**2011** **Leadership Central Kentucky** Program Graduate, Commerce Lexington
**2005** **High-Pass** Comprehensive Exams, Patterson School for Diplomacy and Intl Commerce
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