Fall 2014

Makers: Technical Communication in Post-Industrial Participatory Communities

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Entitled
Makers: Technical Communication in Post-Industrial Participatory Communities

For the degree of Master of Arts

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Head of the Department Graduate Program Date
MAKERS: TECHNICAL COMMUNICATION IN POST-INDUSTRIAL PARTICIPATORY COMMUNITIES

A Thesis
Submitted to the Faculty of Purdue University by John T. Sherrill

In Partial Fulfillment of the Requirements for the Degree of Master of Arts

December 2014 Purdue University West Lafayette, Indiana
To my parents, and in memory of Jim Sherrill.
ACKNOWLEDGEMENTS

Thank you to my parents, my brother, sister-in-law, and nieces for your love and support, and for attempting to make this process easier wherever you could. I love you all. And now I can finally tell you how many completed pages I have written.

I would also like to thank you, Noshi. You made this journey worthwhile and far more fun along the way. Thank you for keeping me hopeful when things felt overwhelming, and for the many nights of working together on Skype. Bahut shukriya, meri jaan.

This thesis also wouldn't have been possible without my committee: Michael Salvo, Samantha Blackmon, and Nathan Johnson. Thank you for your guidance and encouragement throughout this process. I look forward to transforming your continued suggestions into stronger work in the future.

Thank you also to Patricia Sullivan, for approving an extended deadline so that I could study in Scotland.
Additionally, I must thank the many individuals and communities who contributed to my research from the beginning of this project, to whom there is not enough room to thank appropriately in this space: Jill Quirk, Janeen Redman, John Walter, Kristin Arola, Wendy K. Z. Anderson, Alex Klinkhamer, Patrick Love, Kyle Vealey, Jeff Gerding, Don Unger, Amelia Chesley, Charlotte Hyde, Adam Strantz, Emily Legg, Tony Bushner, Dan Liddle, Carrie Grant, Nick Marino, Liz Lane, Tyler Carter, Katie Yankura, Dan Sherrill, Tanna Sherrill, Bushra Riffat, Wayne Losey, Quincy Robinson, Natalie Mathis, Jon Spooner, Peter Ananin, Rosemary Head, Charlie Lodge, everyone at Tin Roof in Dundee, Iain Gildea, Connor O'Neill, Richard Scott, Josh Ajima, everyone at 57North, and the entire Printrbot team!

Finally, thank you to everyone reading this. I hope that you make something as a result.
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ABSTRACT


In the past few decades, web technologies and increasingly accessible digital fabrication technologies such as 3D printers and laser cutters have made it easier for individuals and communities to create complex material objects at home. As a result, communities of individuals who make things outside formal institutions, known as maker communities, have combined traditional crafts and technical knowledge with digital tools and web technologies in new ways. This thesis analyzes maker communities as post-industrial participatory design communities and examines them as participatory spaces where technical communication occurs between individuals with varying levels of expertise and sometimes drastically different knowledges. Ultimately, this thesis asks what technical communicators can learn from maker communities about international post-industrial economies and the future of technical communication.

This thesis explores how the emergence of interdisciplinary maker communities is rooted in earlier open source movements and the web, how open source principles change when applied to material development processes, how makerspaces and maker faires
function as sites that bring together makers in development, and how maker communities serve as examples of post-industrial configurations of participatory communities.

Through participating in and analyzing maker communities, I suggest that participatory communities are a fundamental component of post-industrial development processes, and that technical communicators are well equipped to deal with the socio-cultural, rhetorical, and technological challenges such communities face. Furthermore, drawing on Liza Potts’ theory of Experience Architecture, I suggest that technical communicators will continue to act as guides in decision making processes and as creators of communities, while also creating systems that enable greater exchange of information across platforms and communities, in both physical and digital realms.
CHAPTER 1. OPEN(ING) DESIGN AND MAKER COMMUNITIES

1.1 Introduction

Makers create material things outside formal institutions. Over the last decade, they have gained greater public attention thanks to events such as maker faires, as well as news stories about homemade drones, prosthetic devices, and 3D printed weapons. Despite existing in industrial settings for over twenty years, 3D printers are still a seemingly new technology to many. Essentially, 3D printers are programmable robots that move along three axes and create objects using a variety of liquid or powdered materials, typically plastic, by building them layer-by-layer. Increasing access to affordable desktop manufacturing technologies, such as 3D printers and laser cutters, has also opened opportunities for individuals, educators, and businesses to participate in maker communities. Although some scholars have investigated maker communities from the perspective of critical design and constructivism, my interest in makers stems from the technical communication and exchange of information that happens within maker communities, as well as the information structures that help facilitate participation and community interaction. Thus, I investigate maker communities from cultural, rhetorical, and technical perspectives informed by theories of participatory design, collective invention, and post-industrial theory.
I argue that maker communities provide a window into configurations of post-industrial businesses and cultures, and that this perspective is important to technical communicators, as it can help us understand the potential promises and challenges of communicating within post-industrial organizations and communities. Access to desktop 3D printers and the increasing use of additive manufacturing technologies are unlikely to spark the new industrial revolution that many claim is coming. By comparison, home printers did not cause the demise of greeting card companies any more than 3D printers will cause the end of LEGO production. Rather, I suggest that technical communicators will encounter the physical manifestation of digital means of expression in new ways. In part, the physical becomes digital in how we think of modification, remix, distribution, community building, persuasion, and communication. For example, although plans for creating weapons from everyday objects have existed for many years through media such as The Anarchist Cookbook (in both print and digital versions), the ability to design and distribute files to directly print weapons changes the way we think about production processes and matter in relation to source code and writing. In other words, we will likely see ways of thinking rooted in digital media applied within physical spaces and systems. Such understandings are becoming more important as we see aspects of participatory culture manifested in the fabrication of material objects, a process which deals with different constraints than digital production, and as formerly industrial cities attempt to reinvent themselves within post-industrial economies. Thus, for technical communicators, my investigation of maker communities, makerspaces, and maker faires, both in the United States and abroad, offers insight into the skills and perspectives that will help technical communicators succeed in post-industrial economies.
I am tracing these networks of makers because they have social, cultural, and technological impacts while enabling a wide range of audiences to create knowledge and material artifacts. As such, these networks reinforce the social and collective nature of invention while presenting interesting challenges related to ownership and participation to technical communicators. Ultimately, these networks interest me because of the rhetorical challenges that maker communities present for technical communicators. By participating in maker communities through visiting makerspaces and maker faires, as well as through hands-on experience and teaching with 3D printing, I have been able to better understand some of the social, rhetorical, and technological issues that many maker communities face. Though my investigation is limited to largely normative definitions of maker communities, I have chosen to investigate 3D printing as a technology, and dominant forms of makerspaces as primary physical sites, in part because they offer perspective on the ways forms of digital production manifest themselves directly in communities of material production. Open source philosophies and participatory design are fundamental to maker communities. As a result, I suggest that developing material objects using frameworks that emerge out of digital media production shares many of the same legal and documentation challenges as digital open source development. Furthermore, makerspaces and emerging businesses may face legal issues due to untested configurations of resources and people, alongside issues of funding and accessibility. In addition, I suggest that one of the primary challenges for technical communicators working within an age of participatory culture is to effectively articulate how participation changes within communities over time. Secondarily, technical communicators will also help guide users through such transitions, and help mediate
connections between individual producers and subject-matter experts. Finally, building on Liza Potts’ work in *Social Media in Disaster Response*, I suggest that in post-industrial economies, we will see a need for technical communicators who can think from an ecological perspective and suggest connections across different systems, but who are also skilled experts in particular systems. To do so effectively within maker communities, technical communicators must analyze rhetorical situations through both technological and socio-cultural lenses in order to enact solutions through discursive means, which includes the design and implementation of information systems and technologies. In other words, my analysis of maker communities reinforces that technical communicators must be able to respond to situations in ways that are simultaneously rhetorically, socially, and culturally fitting, and technologically effective. And as Michael Salvo argues in “Rhetoric as Productive Technology,” “...the postmodern expert has the added responsibility of helping educate and prepare those interested and invested in the solution to be able to effectively engage dominant exercises of power” (225). Maker communities deserve our attention because they are networks that value technical communication and that help prepare individuals to participate in the design of systems and technologies that shape our everyday lives.

1.2 Making in Everyday Life

I was driving to Purdue University early one Thursday morning, to teach my First-Year Composition students about 3D printing, headed downhill in a torrent of rain. Suddenly, the windshield wiper on the passenger side of my 2001 Buick Century Limited started flopping against the windshield like a dead fish. Distracted by the alternating sounds of the wiper blade hammering into its rest and stuttering wet “squees” each time it flopped
part way up the windshield, I slowed from the 35 mph I had reached to the legal 25 and turned off the road into a parking lot. I knew what had caused the wiper to fail on this rainy morning, but it hadn’t been a problem until now.

During the winter, I had turned off my car with the windshield wipers still running, stopping them mid-swipe. I had done so purposely, as the ice at the bottom of my windshield had only partially melted during my prior, brief trip. Because the wipers on my Buick don’t fold up, I didn’t want the blades to freeze to the icy slush at the bottom of the windshield overnight. Unfortunately, during the night, a thick layer of ice and snow had enveloped my car. Not thinking in the morning, I turned my car on to defrost the windshield while I cleared away ice and snow. However, when I turned on the car, the wipers tried returning to their resting positions. With the blades frozen in place, the motor turned until it came to a stop at its resting position, leaving the blades exactly where they were. Of course, this created an offset, and once I freed the blades and turned the wipers on, they pushed about 6 inches further than they should have and never returned to their proper resting position. So, trying to resolve the problem quickly, I turned the wipers off and forced the blades back into place by hand. The problem seemed to be resolved, and my wipers worked normally for the rest of the winter. On the rainy Thursday morning, however, when I tried the same approach, my wiper seemed permanently limp and floppy, no matter how far I rotated the blade by hand. Frustrated and soaked with rainwater, I drove to campus with the right wiper still weakly rising and thudding back into place. I passed two police cars along the way, hoping that neither would notice the flopping fish on my windshield. Fortunately, neither seemed to notice.
After a very wet morning of teaching, with most of the class of students being similarly soaked and dreary, I did a quick Google search for how to fix floppy windshield wipers. From the search results, I learned that luckily all I needed to do was remove a plastic cap on the passenger side wiper blade and tighten a nut. Knowing that I had a set of screwdrivers and some pliers in my trunk, I decided to try fixing the problem before I left campus. However, my attempt failed, as I wasn’t able to tighten the nut using pliers. But, in the process, I learned that the plastic cap on my driver side wiper was cracked and breaking. For the time being, I ignored the cap and placed it back on the wiper so that I could drive to the hardware store and buy a wrench set. At the hardware store, I tried Google once more to determine if I needed a metric socket wrench set, or SAE. Unfortunately, no users had posted any answers online, and GM hadn’t provided the information I needed (either online or in the owner’s manual). So, I bought a $40 combined metric and English wrench set, rather than the $11 socket wrench and a $2.50 socket I could have purchased if I had known the exact size of the nut. Fortunately, despite the unexpected purchase, I was able to fix the wiper blade. And I took out some frustration by cranking on the nut to make sure it was fastened firmly.

Afterward, driving back to campus in the afternoon for a meeting, I thought, “I probably could have 3D printed a wrench had I known the dimensions. And I could probably still print a new cap for the wiper by taking a few measurements...” But, because GM didn’t provide any dimensions for the bolt or the cap, and there were none online, I would have needed to design and/or measure everything myself. Granted, most auto owners wouldn’t know how to 3D print a replacement part, and accessible 3D printers are just starting to become common. But, as 3D printing becomes more common,
the idea of more people encountering the same scenario becomes more and more plausible. I know very little about auto repair, but I do know how to use Google, a wrench, and a 3D printer. For many people, finding guides, parts, and solutions to common problems online is a daily process. And even if users fail to solve problems or make repairs, access to fitting technical information creates opportunities for users to have individual control of their assets. Opening up such opportunities for participation or easier use through access to information does not guarantee any competitive advantage over other producers, but it might, and even if it does not directly benefit end users, it does benefit the employees of repair services. Furthermore, there is a growing community, and culture, of makers who do understand how to repair vehicles (or even build them from scratch), among other things. This maker community is capable of not only producing replacement parts, but even improving the original designs, and producing archives of 3D printable replacement parts that are freely available to download and print (Molitch-Hou).

1.3 Makers and Participatory Culture

Makers, in the broadest sense, can be considered anyone who creates something. Although some may argue that a maker can be someone who produces strictly digital artifacts that could not exist outside of a digital computing device, I am purposely excluding strictly digital production in my definition. Most, if not all, makers rely on digital technologies as part of their production processes, whether through digital tools or simply through accessing information online. Some makers even focus primarily on digital technologies as production tools, for example, makers who hack electronic and digital children’s toys to produce music. And the maker movement would be far less
influential without digital technologies and the web. However, restricting definitions of
makers to those who produce tangible things emphasizes a critical awareness of the
“thinginess” of composition materials and the resulting objects, which digital production
and distribution overlook. Understanding the unique constraints of developing physical
objects is critical to understanding how the maker movement differs from the similar and
earlier development of the web and open source software. However, the two are not
entirely distinct, as the maker movement emerged from hacker culture and depends on
the web for information sharing and digital services.

In *Makers*, Chris Anderson describes three defining characteristics of the maker
movement which are shared with web communities. The first characteristic Anderson
describes is “people using digital desktop tools to create designs for new products and
prototype them” (21). Second, “A cultural norm to share those designs and collaborate
with others in online communities.” And third, “The use of common design file
standards.” Thus, based on this description, taking a photo using a digital camera and
then uploading and sharing the photo on Facebook as a JPEG file could be considered
part of the maker movement. And this broad definition makes sense, as images are vital
to understanding how to make things. Anderson’s definition also fits equally well if
someone were to use a 3D scanner to create a model of their head and upload the STL file
to Thingiverse for others to download and print using a 3D printer. Though Anderson’s
definition is limited in that it leaves open the possibility for considering solely digital
work part of the maker movement while overlooking material constraints, it is impossible
to examine the maker movement without acknowledging that digital tools and online
sharing are fundamental to makers. In essence, the production of material objects through
newly accessible digital fabrication technologies, such as 3D printers and CNC machines, is a continuation of what Henry Jenkins calls “participatory culture” (Jenkins).

Jenkins’ definition of participatory culture is similar to Anderson’s definition, but was written three years earlier in 2009, and covers a wider array of communities. Jenkins defined participatory culture as follows:

A participatory culture is a culture with relatively low barriers to artistic expression and civic engagement, strong support for creating and sharing creations, and some type of informal mentorship whereby experienced participants pass along knowledge to novices. In a participatory culture, members also believe their contributions matter and feel some degree of social connection with one another (at the least, members care about others’ opinions of what they have created). (Jenkins xi)

Online communities, maker faires, and makerspaces, all serve as sites that facilitate participation and sharing among community members, and encourage learning while giving members a sense of meaningful contribution. While much of my attention will be directed toward online communities and services, it is important to understand the roles that Maker Faires and makerspaces play in developing participatory communities of makers as well. While I will address them briefly here, I will discuss both Maker Faires and makerspaces in greater detail in chapter 3.

Maker faires are physical sites where makers of all types come together to showcase what they have made, and to share technical knowledge with other makers and broader publics. According to the Maker Faire website, the events began in 2006 and are described as:
Part science fair, part county fair, and part something entirely new, Maker Faire is an all-ages gathering of tech enthusiasts, crafters, educators, tinkerers, hobbyists, engineers, science clubs, authors, artists, students, and commercial exhibitors. All of these “makers” come to Maker Faire to show what they have made and to share what they have learned. (Maker Media Inc.)

These events emphasize learning how to make through play and other tangible interactions with tools, technologies, techniques, and people. Diverse interactions between different types of makers—ranging from those who knit and paint to those who carve wood and build robots—and broader publics, is fundamental to maker faires. For example, at the Cincinnati Mini-Maker Faire (a smaller localized version of a maker faire), I happened to meet Wayne Losey, an expert toy designer who created and designed ModiBot. I met Wayne as I was walking with my girlfriend, Tehmina, through the various tents and booths set up in the central park of Cincinnati. I had come to the maker faire to gain a better understanding of how 3D printing was situated within broader maker communities, as well as how technical information was communicated at the faire. Tehmina, being an international scholar of Theory and Cultural Studies, found the ideological aspects of maker faires in the U.S. interesting, and was curious about who was participating in the faire and for what purposes.

The two of us walked by a tent that had bins of small plastic parts and a long table covered in partially assembled creatures and structures. There were several young children playing with the pieces, assembling humanoid figures with arms, legs, hands, torsos, heads, and accessories. The most interesting were the configurations of eight-
limbed mythical beasts that only a child could invent and explain. A young boy stood smiling with an older man behind the table and bins. On top of the bins of plastic parts were several multicolored human figures standing in a variety of poses, assembled from the same pieces that lay on the table, and measuring roughly the size of an adult hand. The figures had the same professional look as any you might find in a major toy store, but without the added expenses of bulky packaging and blockbuster movie themes.

Tehmina looked at the plastic figures and asked me, “John, are those pieces 3D printed?” I replied, “I think some of them are, but they look like they’re injection molded. See how they have a smooth finish?” The man behind the bins overheard our conversation and explained that the production process for the pieces involved both 3D printing and injection molding. First, prototypes for new pieces are 3D printed using high-resolution printers that precisely build up layers of plastic. The pieces are later mass produced through injection molding, while all accessory parts are 3D printed as needed. The core body components were thus injection molded, but Wayne also explained that he was trying to find an affordable mold supplier for larger scale production. At the time, Wayne could only produce several thousand parts before the inexpensive but soft aluminum molds he used from a supplier in China wore out. Higher quality steel molds produced in the U.S. would last much longer, but would cost thousands of dollars more. Because accessory parts are entirely 3D printed, Wayne could avoid this dilemma for the majority of the parts. Less than one year later, entire figures are now virtually customizable and 3D printable through the Modio app (Modio Inc.)! At the time, however, I had not expected such a thorough explanation of the production process. But this intimate knowledge of the production process and supply chain, coupled with the
coolness of the figures, sold us on buying two ModiBots for $10 each. Wayne’s son bagged the parts for us, put a copy of the printed assembly instructions in the bag, and we thanked them both for being awesome.

As Wayne had been explaining the production process behind ModiBot, children standing near the bins between us continued assembling new configurations of parts, and Wayne assured one of them that “You can play with these all day long if you want to! You just have to leave them here when you’re done playing unless you buy them.” Many booths at the Mini-Maker Faire shared this approach of learning through play and making, using strange musical instruments and sampled sounds, robots, and even shirt and poster screen printing (in which participants could take their creations home), though not all were commercial endeavors. Furthermore, a willingness to share the “how” and “why” behind everything participants made, and an often spoken philosophy that everyone present knew how to make something valuable, were ubiquitous. It was almost impossible to walk through the Maker Faire without feeling included in the community, as every person who attended was participating in some way. Unlike walking through an average craft show or art fair, where cameras are often frowned upon or forbidden in order to protect secrets and unique designs, at the Maker Faire, invitations to touch, play, comment, listen, question, challenge, and “try it yourself” were everywhere. Additionally, the makers behind tables were interested in learning from attendees about their interests, projects, and assumed expertise. Unlike a traditional expo or fair, in which the guiding principle is generally, “Behold what science and industry hath wrought,” Maker Faires equally emphasize, “What can you make?”
As Henry Jenkins notes, “James Gee calls such informal learning cultures ‘affinity spaces’” (Jenkins 10). Affinity spaces are often successful at facilitating learning for four reasons: 1) “because they are sustained by common endeavors that bridge differences—age, class, race, gender, and educational level” 2) “because people can participate in various ways according to their skills and interests,” 3) “because they depend on peer-to-peer teaching with each participant constantly motivated to acquire new knowledge or refine their existing skills,” and 4) “because they allow each participant to feel like an expert while tapping the expertise of others” (Jenkins 10). Thus, in the example above of Wayne Losey and ModiBot, both Tehmina—a young, female, Pakistani, PhD student with a background in English language and currently studying female Pakistani authors in Literature—and I—a young, male, white, American, PhD student with a background in Technical Communication and currently studying 3D printing—were fascinated by Losey’s description of ModiBot’s production process, as well as the children playing. As further example, at the 3DKitbash booth, I spoke with Quincy Robinson about testing the capabilities of 3D printers and he asked me about using 3D printing in an English course. Tehmina, bored of this technical conversation and interested in the cultural value of 3D printing, asked Natalie Mathis if it was possible to print a Barbie doll. Natalie responded with a jubilant, “Yes!” Clearly excited, she whispered, “Since you asked, we’ll show you a secret project we’re working on, but we haven’t told many people about it yet.” To our surprise, Natalie opened a box that had 3D printed doll heads inside (prototypes of what would eventually become Quin: The 3D Printable Fashion Doll). Quincy proceeded to
explain the technical details of the prototypes, while Natalie talked about the
customizability of the dolls.

Getting to know these individual makers was an important part of the faire. Even
though some of the people I met were working with mass-manufacturing companies to
produce their designs, in many cases they were not simply representatives of larger
companies. They were company founders, and sometimes were the sole employees of
their own businesses. Individuals often had direct control over the design and production
of their artifacts. As a result, they also often possessed tacit technical knowledge gained
through experience; knowledge of tools, techniques, and troubleshooting that is usually
devalued when designs are mass-produced. In short, the diversity of technical yet
accessible knowledge at the Mini-Maker Faire was astounding.

Despite showcasing a greater diversity of knowledge than I anticipated,
participation at the Maker Faire, though encouraged and inclusive, was not as ideally
diverse as Gee described. Race was still a major marker of separation within the localized
Cincinnati maker community. Out of the hundreds of people who attended, the majority
of participants were white. In contrast, Cincinnati’s total population in 2010 was 44.8%
Black, 49.3% White, 2.8% Hispanic or Latino, and 1.8% Asian (U.S. Census Bureau).
Thus, despite the culture of knowledge sharing within this local maker community,
particular forms of knowledge and making are privileged based on race, culture, and
other factors. Unfortunately, little quantitative research has been published on race,
gender, class, and identity within maker communities. However, some scholars, such as
Leah Buechley, have undertaken initial research in this area and are calling for further
research (Buechley). In order to understand the broader cultural impact of maker
communities, such research is crucial and timely as maker communities become more established.

Despite the lack of racial diversity, Maker Faires do appear to have roughly equal participation from different genders. But, the various technologies involved (e.g. robots, woodworking, knitting, jewelry making, etc..) are often still subtly gendered along more traditional lines. At the Cincinnati Mini-Maker Faire, textile and jewelry crafting tended to be practiced more by women, while electronics and robotics were practiced by men. The same held true within the Paris Maker Faire. Within broader maker communities, as Leah Buechley points out, although organizations such as DIY Girls and Maker Ed promote and practice inclusive making, more work needs to be done to challenge definitions of making that privilege electronics, robots, and digital technologies as most important. And while many of the examples I refer to in this thesis focus on robotics—an area of making that is primarily accessible to white, upper-middle class, males—this single area does not define the broader complexity of maker communities. Rather, it is the broader tapestry of maker communities, which are intermixed with histories of culture, technologies, labor, industry, feminism and masculinities, craft, rhetoric, communication, and play, which creates opportunities for rich exploration and play.

In particular, for technical communicators, maker communities offer opportunities to learn from and help facilitate communication between people with various levels of technical expertise and disciplinary backgrounds. Furthermore, focusing on 3D printing technologies within maker communities provide a window into the types of roles technical communicators are beginning to play in post-industrial businesses and communities. And there is far more than just robotics and 3D printing for technical
communicators to explore within maker communities. For example, histories of bookmaking in relation to modern paper circuitry, indigenous and feminist philosophies of physical making in a digital era, and histories of textile production as they relate to soft circuits, are just the beginning; but such a complex exploration would require an entire book. Thus, I attempt here to investigate some of the relationships between participatory communities, open source development processes, technical communication, and manufacturing as they relate to digital fabrication technologies and maker communities. To do this, I will first provide an overview of the essential concepts and theories relevant to maker communities, focusing primarily on open source development philosophies as a way of understanding open information sharing. I will then discuss historical and modern examples of what R.C. Allen terms “collective invention” processes alongside the involvement of participatory communities in design processes (Allen). Then, I will discuss maker communities in relation to physical makerspaces and what such spaces afford. I will then briefly cover the important role that maker faires play within maker communities. After covering the physical foundations of maker communities and maker faires, I will return to the web architectures described by Anderson which are essential to the open sharing of information that occurs within maker communities. In doing so, I will discuss the relationships between participatory philosophies of open source software development, open source hardware, and open design as they relate to the topics listed above. Finally, to suggest how the roles of technical communicators shift in post-industrial economies and communities, I will look at maker communities through the lens of Liza Potts’ “experience architecture,” specifically as this framework applies to the organization of physical and virtual communities that share technical information.
In order to better understand maker communities and how they offer windows into post-industrial configurations of technical communication and design, it is important to understand some fundamental concepts of what post-industrial societies and economies look like. In *Three Lectures on Post-Industrial Society*, Daniel Cohen outlines several features of post-industrial societies and economies. To do so, he argues that, “the industrial society of the twentieth century linked a mode of production to a mode of protection,” i.e. protecting employees and shareholders from economic dangers, and was based on assembly lines and mass production (2). However, in wealthy nations, economies have shifted from depending on mass production and industrialism, to a service/information economy in which it is less work to produce material goods than to generate the ideas necessary for production. Cohen uses the example of developing software, explaining that, “It costs a lot to conceive a piece of software, but it does not cost much to manufacture it” (6). Similarly, for “first-world” countries that have outsourced labor and mass production to developing countries, the process of actually producing physical objects once they’re designed is relatively simple in the modern globalized business world. This change has been largely due to improved manufacturing technologies that allow for rapid prototyping and customization of objects with little or no added cost. Although designing a bicycle and producing thousands per day is less expensive today than in the past, and producers are able to build highly customized units on demand, creating a bicycle still involves the modification of physical materials, which brings different constraints than software development. I will return to the differences between producing software and hardware in Chapter 3, and must first address the question of why, if the value of production in a post-industrial economy lies in the
development of ideas and designs, such designs are being shared openly and often freely within maker communities. One possible reason for the open information sharing and knowledge exchange that happens within maker communities is because many of the people involved in maker communities are familiar with open source software and open source philosophies. Additionally, many of the machines used for producing physical objects (CNC mills, 3D printers, laser cutters, etc.) are controlled by computers running free and open source software such as Repetier-Host (a program used for 3D printing objects). Furthermore, the web and participatory culture have driven the spread of information and the formation of maker communities in ways that would not have been possible during the early and mid-twentieth century when DIY culture in the U.S. gained popularity. Finally, as I will discuss in the next chapter, although it may seem contradictory to openly and freely share designs files and ideas, given that they are more valuable in terms of production and labor than the physical objects themselves in a post-industrial economy, R. C. Allen argues that such information sharing often takes place during times of technological exploration and is advantageous. Before doing so, however, I will discuss some important concepts from open source software development, open source hardware, and open design.

1.4 Open Source Software, Hardware, and Open Design

At its core, “open source” can be thought of as a form of transparent access to information about how to recreate or modify something that already exists. As such, making something open source implies a design philosophy of openness as well. For my discussion here, I will focus on open source principles as they apply directly to creating and modifying software and hardware, though these discussions are situated within
broader conversations about intellectual property, information sharing, Creative Commons licenses, and the roles that technical communicators play in shaping such exchanges of information. For now, I will focus on the most basic principles of open source development as they apply to creating software and hardware.

By software, I mean sets of digital instructions that direct computers to perform specific actions. I refer to hardware as a concept that encompasses both computer hardware that operates or otherwise influences software, and tangible configurations of materials. In other words, I am referring to hardware as computer hardware such as processors and monitors, as well as more general objects like tables, chairs, blankets, hammers, and machines. However, hardware may also contain sets of instructions or procedures that are acted out through physical means. For example, the gears and levers in a combination lock facilitate certain possibilities for use, while limiting others, but the gears themselves are designed to react in a predictable manner given the correct input. This is the same principle that computers are based on in operation, which complicates definitions of software and hardware. But, complicating such definitions is not my primary purpose here. Therefore, I will also distinguish between the instructions that are embedded in software and objects, and the instructions used for creating objects and software.

To refer to the embedded instructions, I will use “code,” which generally refers to languages that are machine and human readable, e.g. Java, C++, etc. Second I will use “documentation” to describe anything that describes the code and resulting software/hardware as well as how to use its various functions. Thus, documentation may also describe assembly or operating instructions for hardware, circuit diagrams, etc., and
in some cases may even include code necessary to create other objects. It follows then that open source software and hardware begin with open access to code and documentation. Furthermore, as I will show through comparing principles for developing open source software and hardware, code and documentation are closely related in that they are the instructional building blocks of digital and physical objects.

According to the Open Source Initiative, “Open source software is software that can be freely used, changed, and shared (in modified or unmodified form) by anyone” (The Open Source Definition). Similarly, “Open Source Hardware (OSHW) is a term for tangible artifacts — machines, devices, or other physical things — whose design has been released to the public in such a way that anyone can make, modify, distribute, and use those things” (Open Source Hardware Association). Both definitions emphasize facilitating an open exchange of information and the ability of users to change their copies of the software/hardware. It is important to note, however, that “free” may not always mean “no financial transaction.” For example, Printrbot is a company that produces and sells 3D printers, and makes its designs and documentation available online free of cost. Yet, the assembled printers or parts themselves are not free, nor are the material resources required for someone to build their own using freely available designs. This creates two implications, first, that creating open source hardware requires different tools than creating open source software; and second, that the materials used to produce a piece of hardware may vary between producers. Regarding the variance in physical quality from producer to producer, the Open Source Hardware Association writes the following:
Hardware is different from software in that physical resources must always be committed for the creation of physical goods. Accordingly, persons or companies producing items ("products") under an OSHW license have an obligation to make it clear that such products are not manufactured, sold, warrantied, or otherwise sanctioned by the original designer and also not to make use of any trademarks owned by the original designer. (Open Source Hardware Association)

For example, if Ikea were to release an open source chair and I decided to produce and sell my own version of the chair using cardboard, I would have to make it clear to users that my version of the chair was not produced or guaranteed to work by Ikea, because there would be no way for Ikea to regulate my production. Thus, seemingly minor differences in materiality between open source software and open source hardware lead to important distinctions. As such, it is no surprise that the ten criteria for creating open source projects are largely the same for both software and hardware, but also share important differences.

1.5 Further Defining Open Source Software and Hardware

Open source software is not simply software with accessible code. Rather, the Open Source Initiative defines ten criteria for licensing open-source software projects:

1. “Free Distribution”
2. “Source Code”
3. “Derived Works”
4. “Integrity of the Author's Source Code”
5. “No Discrimination Against Persons or Groups”
The Open Source Hardware Association uses a similar list of twelve criteria, including,

1. “Documentation”
2. “Scope”
3. “Necessary Software”
4. “Derived Works”
5. “Free Redistribution”
6. “Attribution”
7. “No Discrimination Against Persons or Groups”
8. “No Discrimination Against Fields of Endeavor”
9. “Distribution of License”
10. “License Must Not Be Specific to a Product”
11. “License Must Not Restrict Other Hardware or Software”
12. “License must be technology-neutral” (Open Source Hardware Association)

Overall, the two lists of criteria are similar, but with a few important exceptions. The list for open source hardware lowers the priority of “free redistribution” from number one to number five, equates “documentation” with source code, modifies “Integrity of the
Author’s Source Code” to be “Attribution” (with less emphasis on maintaining the original design), and adds two sections covering “Scope” and “Necessary Software” (Open Source Hardware Association). In particular, the wording of “Documentation,” is worth analyzing further, as it illustrates the connection between documentation and code as the instructions that physical and digital forms are based on.

As shown in the appendix, the section on “Documentation” follows the same format as “Source Code” for open source software. The major difference is the substitution of the words “documentation” and “design files” for “source code” (Open Source Hardware Association), indicating the close relationship between these concepts and their functions. The last two sentences of the section further reinforce a connection between the function of source code and documentation in digital and physical contexts. These last two sentences read, “Intermediate forms analogous to compiled computer code — such as printer-ready copper artwork from a CAD program — are not allowed as substitutes [for design files]. The license may require that the design files are provided in fully-documented, open format(s)” (Open Source Hardware Association). In other words, design files that would be difficult or impossible to modify are not considered open source, just as releasing a compiled version of software is not open. Furthermore, establishing design files and documentation as analogous with source code, and defining both objects and software based on the instructions used to create them, blurs the boundaries between the creation of digital artifacts, and physical objects. In order to more clearly describe the application of open source principles to both software and hardware development, I will use the term open design (AdCiv).
1.6 Open Design

Open design applies open source software development principles to the production of physical objects, including, but not limited to, open source hardware. Concepts resembling open design have existed long before the development of digital technologies and software development. Though open design has recently been adopted by maker communities, the open sharing of instructions for creating physical objects has existed for centuries. One pertinent example of open design from the 19th century comes from R. C. Allen.

Allen associates open design communities and development processes with periods of technological uncertainty and invention, noting that collective sharing of information and research often leads to effective, low cost, peer produced research and development (Allen). However, within capitalist economic systems, Peter Meyer argues, the use of open design as a business model is short lived. Because open design communities rapidly generate ideas and opportunities for profit, they quickly establish competitive markets which encourage blackbox research practices that yield higher profits for individual companies. This shift toward privacy often leads to changes in the way community members participate, if such shifts do not entirely dissolve the original communities. However, it is important to first understand the various ways members of open source and design communities participate. Although my descriptions of community participation are not comprehensive, they provide a starting point for establishing different roles technical communicators and community members play.
1.7 Participation as One Goal

As I have shown in this first chapter, users are often able to troubleshoot their own problems, and potentially even create physical solutions given access to the appropriate resources. Opening technical information to users can help facilitate such processes, and can help foster participatory user communities. Maker communities function as one example of this approach to technical communication, and are also an extension of participatory culture through material objects. As I will show in more detail in the next chapter, the information sharing that takes place within maker communities can be viewed both through the lens of open design, and R.C. Allen’s theory of collective invention. Specifically, such information sharing takes place online and in face-to-face communities at makerspaces and maker faires, which also highlight race, gender, and economic inequalities within emerging communities. Thus, technical communicators should be aware of the limitations of maker communities and information sharing in order to better facilitate the development of user communities.

One of the primary roles for technical communicators within open communities is that of creating and maintaining spaces for participation. As I will demonstrate in the following chapters, spaces for participation can be face-to-face and online, temporary and sustained, serve multiple purposes, and have many incentives for participating in addition to the many personal motivations of participants. Second, technical communicators and participants take part in shaping discourse about the development of projects and communities, including creating starting points for conversations, documentation, deliverables, etc.; moderating such exchanges; and asking questions about developments or soliciting feedback. Additionally, technical communicators and participants can take
part in the direct production of material and digital deliverables, including but not limited to coding or making, providing input and feedback, bug testing, and documenting projects. Participants and technical communicators can also take part in promoting projects to audiences as well as sponsoring projects and communities through providing crucial resources, e.g. money, materials, space, and equipment. Furthermore, all of the ways of participating I have described involve rhetorical choices about who participates in communities, through which channels, when and where, and how. Looking at a historical example for further detail, I will examine how open design and collective invention constitutes one phase in the development of post-industrial companies, its limitations, and what implications that holds for technical communicators.

It is important to remember moving forward that open design communities are not universally inclusive and do create systems of power. Though maker communities may invite a diverse range of participants, they are not inherently democratic or equal in their distribution of power and influence, and often function within largely capitalist economic systems. As with open source software, free doesn’t always mean freedom from the constraints of production costs or profit, social structures, or inequalities. Furthermore, as I will show in chapter two, open design may not be an effective business or community-building strategy in all contexts. That is not to say that participatory communities are not important to technical communicators or post-industrialization though. Rather, it is important to understand the social complexities of working with participatory communities. As I will demonstrate through the historical example of blast furnace development coupled with Karen Burke LeFevre’s theory of Invention as a Social Act, all design is rooted in social systems to varying degrees. Chapter two begins with Allen and
LeFevre as examples to discuss how Economics and Composition theory inform our understanding of open design and participatory communities. I then discuss the cultural, legal, and workplace expressions of open design through examples of a web development firm, 3D printer producer, and a software development team. Finally, chapter two ends with a discussion of pedagogical and workplace concerns for technical communicators and designers as they relate to channeling user participation.
CHAPTER 2. ESTABLISHING LIMITS OF COLLECTIVE INVENTION AND OPEN SOURCE

2.1 An Historical Example of Open Source Development: Collective Invention

In *Collective Invention*, R.C. Allen describes the development of taller, hotter, more efficient blast furnaces in Britain and the United States during the 19th century. Allen uses the concept of “collective invention” to describe an iterative development process through which furnace developers openly shared information about their experimental designs, as well as their results, in order to innovate and understand the potential limits of blast furnaces. Allen writes that, “In the nineteenth century there was no theory of the blast furnace that would have allowed an engineer to deduce the optimal design from general principles. As a result, building a furnace with a new design was an experiment whose result could not be predicted in advance.” (Allen 11) Applying this theory to modern contexts, I suggest that in a post-industrial economy, in which a critical mass of participants have easy access to established components and resources which are being arranged in untested ways, the concept of collective invention informs our understanding of how participatory communities develop and change over time within a broader participatory culture. More specifically, maker communities illustrate how new technologies and surrounding communities develop from DIY exploration to stable and often regulated configurations. The information sharing involved in this stabilization process is particularly relevant to technical communicators, as the information exchanged
does not simply create itself. Rather, the infrastructure used to share information (i.e. the forums, websites, file sharing interfaces, face-to-face events, documentation, etc.) is all designed to facilitate and constrain certain uses, implying that ideologies and conceived uses are embedded within such infrastructure. However, the ownership or authority over the invention of information and infrastructure is complicated, as the two always emerge out of social and cultural contexts.

In *Invention as a Social Act*, Karen Burke LeFevre argues that any invention process is inherently social, collective, and collaborative. LeFevre specifically discusses rhetorical invention as part of writing processes, as opposed to invention in broader terms, though I will demonstrate that her work also applies to the invention of many things. In defining invention as a social process, LeFevre writes that even individuals are “not merely socially influence but even socially constituted” (2). She also points out that, “one invents largely by means of language and other symbol systems, which are socially created and shared,” which makes any act of invention based on language or symbolic meaning inherently social (2). And even if inventors are separated from any other individuals, if the inventors are considering how others will interpret their work, LeFevre argues that such an inventor demonstrates social awareness (2). Most significant to discussions of information infrastructure, LeFevre argues, “invention is powerfully influenced by social collectives, such as institutions, bureaucracies, and governments, which transmit expectations and prohibitions, encouraging certain ideas and discouraging others” (2). In other words, any form of invention is shaped and potentially constituted by the society and the institutions in which it exists. This is not to say, however, that individual authors have no authority or control over how things are shaped. Rather, for
the purposes of this discussion, it helps to frame user participation with inventors in design processes as a default, rather than an exception. In other words, recognizing that invention is inherently social constructs user participation as inherent to design processes. This shift in perspective helps to reframe discussions of participation along spectrums of openness and closedness, rather than a binary of open or closed. Thus, inventors have some influence over the channels through which other individuals can directly participate in the invention process. While no inventor can ever completely remove themselves or their inventions from social systems, or control how users interpret any invention in an attempt to create “closed” systems of invention, inventors can restrict access for practical purposes. Based on this information, we can identify that one of the defining characteristics of Allen’s collective invention theory is that it assumes openness regarding information sharing. Additionally, as I will demonstrate in chapter four, access to information does not necessarily mean that individuals can directly participate in invention processes. As Bruno Latour argues in *Science in Action*, creating a distinction between “author and reader is not only the ability to utilise [sic] all the rhetorical resources [such as secondary research written about a topic]” (70). Latour points out that the ability to acquire and arrange the many material and social resources necessary to produce a rhetorically fitting artifact also distinguishes inventors and authors from users and viewers (70). Thus, while post-industrial economies are based on the idea that it is relatively easy to accumulate the necessary capital to produce tangible goods, the need for such capital can still significantly influence how users are able to participate within systems. Additionally, the infrastructure for sharing information is always consciously designed, and thus rhetorical. Thus, it is important that technical communicators devote
attention to how information has been shared in the past, and how information sharing is different in the modern, post-industrial economy.

One modern example of the information sharing strategies Allen describes occurs within 3D printing communities. Similar to blast furnaces in the 19th century, the development of desktop 3D printers in the 21st century is a situation in which, “the operating characteristics of a novel design can only be forecast by extrapolating the behaviour of existing designs” (12). Allen notes that when there are no theories for producing optimal designs, two patterns emerge: “overshooting” and “replication” (12). Replication is simply replicating existing designs that have been proven functional, or testing for functional consistency through repetition. Overshooting, on the other hand, means, “overshooting ...the optimal value of the relevant parameter” through leaps, rather than gradual increments. Both replication and overshooting can be seen in communities developing new designs for 3D printers. Like blast furnaces, taller 3D printers mean greater production from a single run of materials, and enable printing taller objects. Consequently, one might assume that the maximum height of a printable object would be limited only to the height of the machine itself, which is partially true, and many users modify their printers to be taller. However, this can lead to problems. One potential example of overshooting height is RepRap Squad’s “Simple XL,” a much taller, modified version of the earlier Printrbot Simple (a 3D printer produced by the Printrbot company) produced by an independent group of users (RepRap Squad). While RepRap Squad’s design did not have any fatal design flaws, it did produce a “small issue” of z-axis backlash (a problem caused when there is too much space between moving parts), which was never fully eliminated from the design, but was mostly reduced through a tensioning
system (RepRap Squad). However, a look at the build volumes (the maximum dimensions of an object that a 3D printer can print) of the RepRap Squad Simple XL, the Printrbot Simple XL, and the Printrbot Simple reveals the ambitiousness of the RepRap Squad’s design. The maximum build height on a Printrbot Simple, the smallest and oldest of the three, is 100mm (or roughly 4 inches). The Simple XL, also produced by Printrbot, has a maximum build height of 185mm, just under twice as tall as the original Simple. The RepRap Squad’s XL design, however, towers over the Printrbot Simple XL with a maximum build height of 308mm (approximately 1 foot tall) and is over three times as tall as the original Printrbot Simple—large enough to “print the size of an assembled original Printrbot Simple!” In this case, although no formal theory as to the maximum height of a Printrbot Simple configuration has been published, it is clear that a rough middle ground was established. However, this did not prevent further innovations in the design of the Printrbot printers. Rather, Printrbot began producing printers with metal bodies, while alternative configurations that offered greater build heights already existed (e.g. delta style printers). Thus, overshooting helps establish the limits of a particular configuration or factor contributing to the success of a design. As I will describe in chapter four, overshooting can also lead designers to abandon a particular approach entirely, beginning the process of overshooting and replication once more.

In addition to overshooting, replication occurs throughout the 3D printing community, and a quick Google search yields numerous examples of similar and duplicated designs. Of particular note is the community of RepRap builders. RepRap is short for “Replicating Rapid-prototyper,” and is a machine developed to be capable of partially self-replicating. The long-term goal of the RepRap community is to create a
machine capable of full self-replication (About RepRapWiki). More significant than the ability of RepRap printers to replicate themselves, in this case, is the replication of printer designs that occurs in the RepRap community, and the open source information sharing that goes with it. The RepRap wiki is a central location for sharing design details and different printer configurations, bills of materials, experimental designs, as well as discussions about modifications and new printing technologies. Users can visit the wiki and access important information about how to build printers from scratch, and the community is devoted to promoting 3D printing. The wiki also serves as a partial historical record of the collective invention process, listing iterative designs of different printer configurations, and the modifications and improvements that went with each design, dating back to the original RepRap printer. Allen establishes that the significance of such replication and information sharing is the ability to collect mass amounts of data and innovate/theorize from that collection, though he notes that mass replication is probably unnecessary given modern statistics (13). For the average hobbyist 3D printing enthusiast, however, it’s easier to build the most recent update for a particular printer than to do complex statistical analysis in order to determine the maximum build height. This is not surprising though, considering that Allen’s theory was focused on industrial innovation rather than hobbyist, and was written before the rise of online communities. Thus, Allen’s theory could not fully account for the issue of financial risk as it relates to innovation in post-industrial and web-connected economies, though it is still a valuable framework for analyzing post-industrial participatory communities.

Allen argues that in industrial settings, a “high rate of capital formation lowers the cost of experimenting,” which coincides with a rise in information sharing at early stages
of innovation (13). However, as capital formation slows, and common practices and standards are established, the risk of experimentation for companies becomes much higher. In other words, within industrial economies, as standardization occurs, companies take fewer experimental risks, and the need for participatory communities to drive experimentation diminishes. Information sharing slows or is entirely contained within internal research and development teams, which carry on experiments in a less risky environment. As Bruno Latour argues in *Science in Action*, an alternative explanation for the closing of research stems from the process of blackboxing. That is, as conflicts are resolved among those conducting research, ideas become blackboxes that are no longer challenged and are broadly accepted, or which are at least prohibitively expensive, complex, or risky to challenge, as any opening of blackboxes requires exponentially increasing time, resources, etc. (108). Eventually, understanding how or why blackboxed technologies and ideas function is no longer as important as understanding how they are used based on inputs and outputs. For example, as I will explain in greater detail in chapter four, once a design for a 3D printer is widely accepted and improved, understanding the complexities of how and why it functions in particular ways is less important than understanding what the machine can produce.

In post-industrial economies, however, previously risky research processes are beginning to carry fewer risks due to changes in manufacturing processes, and are thus lengthening blackboxing processes. The ability of companies to experiment by producing small volumes of highly customized prototype designs, at relatively low costs thanks to new technologies, means that there is less pressure for an untested design to be a massive success and thus justify the cost of design. In particular, 3D printing is making rapid
prototyping much easier, less expensive, and less risky for large and small companies, and is leading to new sales strategies such as bridge manufacturing.

2.2 Bridge Manufacturing

Bridge manufacturing by using 3D printing is effective for producing small runs of parts (several thousand or less), or for creating complex parts that would otherwise require expensive machining. According to Elisabeth Eitel, “3D printing is starting to evolve from a prototyping technology into a production technology. It’s what’s called a bridge-manufacturing technique, a means of making moderate quantities of parts to go into real working products” (Eitel 44). In a nutshell, 3D printing allows companies to create small volumes of usable prototype parts in a matter of days or weeks, without the need for machining expensive molds or dies that might take weeks or months to produce. Although this might seem like a small change, it has major implications for design processes that involve multiple iterations of a part. Take for example, the “materials and racecar-parts maker” described by Eitel:

Cevolini Rapid Prototyping (CRP) Group, Italy, recently designed an electric motorcycle called the Energica Egos (for sale starting in 2015). The e-bike sports myriad 3D-printed parts — including the fairings, cooling ducts, seat, and intake manifold — made by SLS granules of CRP’s carbon-fiber-and-polyamide Windform SP. But once Ego sales ramp up, CRP plans to make the plastic parts by traditional mass production — molding. CRP also plans to swap the current engine frame, forks, and battery pack for ones out of cast aluminum. The benefit of
delaying is that CRP can revise the design and resume production in a few days if market reaction to certain features is lukewarm. (49)

Similar to the earlier example of Wayne Losey and ModiBot, CRP Group is able to experiment with new designs at a relatively low risk, even though motorcycle manufacturing is a thoroughly established industry. As the example of CRP Group demonstrates, because designers don’t have to wait for the expensive production of long-lasting molds or mass-production systems, new products can go to market faster and with fewer risks. As I will also show in the example of Printrbot, bridge-manufacturing processes also apply to some open source communities, and can be used effectively even during the early open information sharing stages of collective invention. Furthermore, Printrbot follows the trend of moving from participatory information sharing toward closed research while continuing to rapidly alter designs and configurations, and taking more control over designs as research becomes more closed and designs are standardized. This change in development processes also poses interesting challenges for technical communicators.

When products are being designed and sold to customers in a matter of days, this sometimes means producing usable documentation in the same amount of time. However, much like in open source software development, documentation frequently lags behind the developer releases of software, and is often refined after major software updates. One advantage to creating participatory communities then is that end users can improve minimalist documentation “seeded” by technical communicators, and can provide community support. For example, many of the pages on the RepRap wiki have started from a page created by a single user, and were then developed over time by other
community members. Similarly, with each new iteration of Printrbot machines, the company produced assembly instructions using a platform that allowed users to comment on steps and provide additional content to improve the original instructions. Eventually, based on user input, the technical communicators at Printrbot used user input to produce more refined and accessible instructions. But, technical communicators face the challenge of facilitating and establishing participatory communities before such communities can augment communication processes. And even if technical communicators succeed at establishing communities, as product development continues, the role of such communities may shift, and producing documentation will require more traditional user-centered but designer managed processes. Furthermore, there are financial and legal limits to participatory processes as well.

2.3 Limits of Participatory Communities and Open Source Software

To learn more about the limits of open source development and participatory design processes, I called my brother Jason. Jason is an entrepreneur who founded and owns InetSolution, Inc., a web development company in Michigan which provides software development and web hosting services to banks and credit unions. In other words, InetSolution serves clients who need highly secure, highly developed design and e-commerce solutions with minimal risk. I told Jason that I was looking at situations where open source software (OSS) development principles were being applied to the development of open hardware, and this raised his interest. For most projects, Jason uses commercial off-the-shelf (proprietary) software, or develops the necessary software in-house, rather than using free open source software for anything other than personal use (e.g. to operate a blog or perform daily computing tasks). Although open source software
is often free software, there are significant costs associated with its use. There are two major reasons Jason does not use free and open source software for his company: 1) Free OSS typically lacks reliable, immediate, direct support, and 2) his company is legally liable for any software produced or services provided.

2.3.1 Unreliable Support

For personal use, having to Google an unexpected error doesn’t usually ruin one’s day. But imagine for a moment that you’re on vacation. You’ve just gotten out of the airport. You have all of your luggage with you, and you’re about to rent a vehicle for your scenic drive along the California coastline. But, when you go to pay for the rental, your credit card is rejected. Frustrated, you call your credit union to find out why your charge has been denied. You learn that not only has your card been rejected, but their entire online system is down due to server problems. As it turns out, the software controlling the credit union’s servers has a little known bug causing major issues. Though the handful of unpaid software developers are aware of the issue, the bug hasn’t been patched in their spare time. Unfortunately, the credit union is left to scour online forums for solutions, and until things are back online, you’re stuck at the car rental place with only the $50 you brought in your wallet. While this extreme scenario is unlikely to occur anytime soon, it illustrates the importance of thorough documentation for industrial software, and one limit of documentation produced by participatory communities.

In a less dramatic example, for most online service providers, if a server needs to be taken offline nightly for an hour of maintenance, or a weekend if there’s a major upgrade, it’s not a big deal. They simply notify customers ahead of time, or post an announcement that “the service will be unavailable from 7:00PM to 1:00 AM Saturday.”
But when servers supporting banking and financial institutions go down for 30 seconds or more, it takes about as long for frantic emails and phone calls to start rolling in. Consequently, from a business perspective, it would be suicidal to depend on free open source software that requires users to track down solutions to problems via forums and individual users when something goes wrong. No software is perfect, and even professionally produced software will have bugs. But with free and open source software, if a group of developers decides not to tackle a particular bug, since they may not be paid, they have no legal or financial responsibility to do so. Of course, some developers of open source software are paid, and many companies do rely on open source software (such as Linux-based systems or Apache) to operate. However, many free open source projects depend on voluntary labor, and there are compelling reasons for paid developers and software development companies to keep their source closed. One reason for closed source development is legal liability and designer accountability.

2.3.2 Legal Risks

Similar to the personal use of free open source software, if an independent developer copies code from an existing piece of software and forgets to attribute the work to its original developer(s), the repercussions are relatively mild. But when a larger company or community grabs code from somewhere else and claims it as their own work, lawsuits become a serious threat. If JP Morgan Chase is accused of using software that runs on stolen code, the company that produced the software is a clear target for legal actions from Chase and from the people who the code was stolen from. One way of avoiding this situation is to hire a legal professional to examine source code and verify that it doesn’t depend on plagiarized code. Of course, this is an expensive process even with the help of
source code databases to automatically check against, as software can consist of millions of lines of code. Furthermore, it’s impractical to check every single line of code, so a company is essentially paying a lawyer to take legal responsibility for the company’s code by verifying, to the best of his or her reasonable ability, the originality of any source code. Keeping this expensive legal process in mind, when a company has invested countless hours and $20,000 or more into developing proprietary code that has been rigorously tested and verified as original, all while paying employees, providing benefits, etc., it doesn’t make sense to take a risk by opening up source code to anyone with a computer and an internet connection, even in the initial stages of development. In Latour’s terms, there is no financial incentive to open a blackbox that was intentionally kept as closed as possible from its beginning.

Thus, InetSolution is also constrained by the same principles Allen describes, in that it is legally and financially too risky to depend on an open community for highly developed, reliable, immediate design support beyond a point of collaborative invention and exploration. Because of this, it makes sense that established companies would charge fees for access to information that was relatively financially and legally risky to produce. If InetSolution fails to develop effective software, their clients are at risk and may refuse to pay, or in the worst case scenario have the right to file a lawsuit. Thus, regulations and standardizing legal bodies have emerged to help minimize risks to both customers and producers, but in the process have also created barriers to entry and participation by requiring a greater investment from producers. However, banking software has existed long enough, and has been economically important enough, to become thoroughly regulated. Many desktop 3D printing companies and other emerging maker industries are
still too new to have established regulations. Although some established companies, such as MakerBot, have transitioned to less risky models of operating, many emerging companies and organizations are openly sharing information and attempting to create new designs, hardware configurations, and business models. With time and increased interest in maker communities and the technologies associated with them, it is likely that increased regulation will also create barriers for participation and open information sharing. As companies and communities develop and respond to regulations, and as they transition from open participation to more restricted participation, it becomes increasingly important for companies and communities to articulate how such changes impact participatory communities.

2.4 Limiting the Participation of Communities

One of the challenges of leading participatory communities for design projects is that generally, at some point, it is no longer effective to have everyone from the community participating equally in making major design decisions. Much like the development of blast furnaces in the 19th century, as the design develops, trends or patterns in design choices emerge and ideas stabilize. Whether developing software or hardware, centralization, and sometimes privatization, of decision making processes becomes a useful way of reducing risks, maintaining timely development, and effectively organizing information. This is not to say, however, that participatory engagement with communities of users doesn’t work or doesn’t have value. Rather, that participatory processes have limitations for both designers and technical communicators. Furthermore, when transitioning from a highly participatory design phase toward a more centralized phase, designers and organizations face the challenge of articulating to communities that the
organization’s needs are shifting, and that the roles of community participants will change.

Effectively articulating shifts in priorities and participatory channels becomes critical for companies that exist thanks to crowdfunding, online support communities, and many forms of volunteer participation. Failing to explain to participants that they’re still valued in the face of structural changes can be potentially disastrous. Furthermore, technical communicators need to be aware of the social and rhetorical impacts of restructuring information infrastructure and communication channels. Fortunately, technical communicators who have experience with participatory design and usability, as well as information architecture and management are well positioned to take on this communication challenge.

To illustrate the importance of effectively communicating to participants that their efforts are valued, and that the types of contributions that are most valuable change as an organization or business grows, I will discuss two examples of organizations that were successful because of their participatory communities. Both of the communities I will discuss began as open and participatory communities, one of which explicitly endorsed open design philosophies from its beginning, and both eventually transitioned toward more private design processes. The first example I will discuss centers on the development of the Printrbot Simple 3D printer, an open hardware project. The second example, Uneditions, is a community-developed open source software project for presenting play scripts in a more readable format.
2.4.1 Printrbot

Printrbot is a company that produces 3D printers, which was started in 2011 by Brook Drumm. According to the RepRap wiki page on Printrbot, Drumm designed the machine to create a 3D printer that could be simple and affordable enough to exist within every home and school (Printrbot RepRapWiki). The first Printrbot designs began within the RepRap community, but Drumm designed the majority of the printer himself using some existing designs from the community, sparingly, for several components. As such, the original Printrbot started out as any other RepRap printer—with as many 3D printed parts as possible. In an example of successful bridge manufacturing, the designs quickly transitioned from 3D printed prototypes to the Printrbot LC edition (short for “laser cut”), which the wiki notes was “presumably optimized for mass manufacture” (Printrbot RepRapWiki). The transition from plastic printed parts to laser cut wood did not undermine the open source philosophy behind Printrbot though, as the design files were still released along with assembly instructions. Additionally, the Kickstarter page that funded Printrbot makes it clear that one of the foundational goals of the company was to maintain “the original RepRap.org purpose: to build a self-replicating machine – one that anyone can build given time and materials” (Printrbot Kickstarter). The Kickstarter page also mentions that in part, participation via funding the project meant lending “your support to scale production.”

Through the end of 2013, Printrbot continued releasing upgrades to their wooden printers, as well as releasing design files for the printers, and began releasing some metal components. In other words, transitioning from 3D printed plastic parts, to laser cut wooden parts, to including some machined aluminum parts did not create substantial
barriers for challenging the Printrbot design. By 2014 though, the company announced a new design for an all metal Printrbot Simple (PB Team). Although I was initially excited by the announcement, as the Simple Metal would allow for higher quality prints and speeds with less assembly, I quickly realized that transitioning to metal printers would change the way people participate in the Printrbot community.

Since I could not afford to purchase a Simple Metal as an upgrade to my wooden Printrbot Simple, and I knew that even if I could, I wouldn’t be able to modify a metal printer and contribute to the community in familiar ways, I felt betrayed for supporting the company. I had invested hours of time and money into building, modifying, and configuring my printer while also sharing some of that knowledge with others in the local community. In part, my reaction was also caused by the way the new printer was presented as a sleek, enclosed, actual black box. The new printer was no longer a lesson in the mechanics and experiential knowledge of building a 3D printer piece by piece, but was instead a modular kit that hid from view the electronics and mechanical elements that define the aesthetic of the wooden Simple and other Printrbot machines. The Simple Metal was a machine that no longer needed users to modify or understand its design and experiment with their own wooden and plastic customizations in order to innovate. The new machine was already designed for manufacturing in bulk with a simple, uncomplicated assembly process. In short, the Simple Metal redefined participation within the Printrbot community, and set a precedent for future releases that were less about open design than manufacturability. Through transitioning to an all metal design, Printrbot redefined what knowledge was most valuable about their 3D printers. The blackboxed metal design privileged understandings of input and output of the printers,
and devalued technical understandings of the more complex internal mechanics, while making it more difficult for users to create their own hardware designs by requiring greater capital for metal fabrication than wood or plastic.

Despite a clear shift from prioritizing open source design to prioritizing manufacturing and ease of use, Printrbot has maintained the design files and documentation for earlier models, and still sells a “Maker’s Simple” (Simple Maker’s Kit). I’ve also recognized that the transition to metal printers, despite limiting the ways community members participate in certain ways, creates opportunities for broader participation in the future by offering a simple and straightforward machine for people who might otherwise be intimidated by a physically and philosophically open printer. Although users may not be able to easily modify and customize metal printers, and have less need for technical knowledge of how the machine works, this shift toward metal allows for a greater emphasis on designing and prototyping 3D printable objects. Rather than troubleshooting the machinery used to print objects, users can focus on designing and developing ideas, which are more valuable than the labor of transforming ideas and designs into physical form within a post-industrial economy. Thus, Printrbot’s shift to metal printers is not without good reason, nor would it be fair to demonize Drumm as a sellout or an exploiter of the many communities he helped foster through his own investments over several years. Similar accusations were directed toward Bre Pettis when MakerBot transitioned from an open source wooden printer to a blackbox design, and again when it was purchased by Stratasys. But as MakerBot and Printrbot have shown, accessibility is an important part of participatory processes, and access can take multiple forms. I will return to this point of accessibility, as well as other implications of such
transitions from more open to more closed design for technical communicators, at the end of this chapter. However, I will first discuss a similar transition from open participation to more closed development, which occurred within the development of a digital product through a participatory design process.

2.4.2 Jon Spooner and Uneditions

Jon Spooner is the Creative Director of Unlimited Theatre, and a co-creator of Uneditions, and has been involved with maker communities in the UK. I met Spooner when he presented on co-designing a digital platform for reading play scripts known as Uneditions. According to Spooner, “Uneditions is a sincere, rigorous exploration of how we—as theatre makers and as a wider arts community—can better transpose the stories we’re telling to other mediums” (Rogers et al. 3). Spooner and his theatre company (Unlimited Theatre) collaborated with a design company (Storythings) and volunteers from the local community in Dundee, Scotland, to produce Uneditions. Being an exploratory project produced by a team that explicitly practices participatory design, it is unsurprising that the team chose to include a diverse and engaged group of participants. Unlike the Printrbot community, however, participants in the development of Uneditions were individually selected by Spooner and the design team (10). To ensure diversity among the participants’ perspectives, they were selected according to the “VOWEL” principle used by the South by South West Festival (10). This acronymic principle stands for “Variety,” “Opinion,” “Women,” “Ethnicity,” and “Location” (11).

Once a group of engaged participants was selected, the design process resembled one familiar to many technical communicators and usability specialists. Participants met with designers in small groups and had conversations about essential design elements to
include in the project, developed lo-fidelity prototypes, and evaluated the prototypes. In this case, theatrical design played a major rhetorical role in the development of the final product, as the entire process was themed around a three-act performance, complete with goals for each session presented as posters for the “show,” i.e. the project. The team met with participants three times to discuss the project and its design before completing a final version for launch. However, by the end of the project, it was unclear who owned the intellectual property of the design, and who would profit from any sales.

The design team quickly decided that the intellectual property would be shared by all collaborators, and that any profits would be shared with participants (58). Furthermore, because there were features that participants wanted included in the design that didn’t make the final cut, the code for the platform was released as open source code and is available online so that people can develop add-ons (62). Thus, like Printrbot, Uneditions relied on a community of participants for the design process, and ultimately worked under an open source philosophy, but eventually reduced the role of participants in the continued development of the product. Articulating the shift from an open source, participatory community, toward a more closed development team, however, proved critically important in both cases.

After Spooner’s presentation on Uneditions, I met with him to talk more about the project. Shortly into our conversation, the issue of transitioning between an open source participatory development process to a more private, blackboxed design process came up. Specifically, Spooner wondered how designers can articulate this shift to a community that has helped develop the project, without angering said communities or causing them to abandon ship. I explained to him the transition at Printrbot from very open and easily
modifiable wooden printers toward metal, and how I had reacted. Spooner said that Uneditions was reaching the same transition point of needing to close off some channels of participation, without driving participants away and making them feel cheated or used. In essence, we were both interested in answering the question of, “How do you thank people for their help and participation, but then tell them that you don’t need that kind of input anymore?”

Unfortunately, neither Spooner nor I had good answers for how to articulate the transition from participatory invention process to in-house development, or that what had once been open source would likely close gradually. But we both agreed that the communication was risky, and that fitting solutions were highly context-dependent. In both cases, there was a real risk that participants could completely walk away from the project and any resulting product, if they felt they had been taken advantage of. However, Spooner and I also recognized the necessity of centralizing control over designs to enable further development, and the affordances such centralized control offers.

As an instructor and technical communicator, I see value for users in enabling greater access to technologies that are easier to understand, as this increases participation overall and promotes diverse communities of users. Creating machines, software, and other technologies that are less intimidating and easier to learn opens participation to broader audiences, and enables access for people who would otherwise be excluded. Encouraging greater diversity within communities generally helps to create more socially ethical communities. And while participatory design promotes an ethic of considering users valuable, knowledgeable, and trustworthy, technical communicators can ethically serve user communities through limiting participation and channeling it through other
means as well. For example, restricting design decisions and the ability of users to modify designs by closing open access also gives designers and technical communicators greater control over the final deliverables released for public access. That is, rather than attempting to maintain multiple versions of a design over multiple websites and then troubleshooting idiosyncratic issues, by restricting participation and access, designers can plan releases and phase out older designs. Furthermore, rather than “seeding” communities with rough documentation to be improved, technical communicators can create high fidelity documentation and support networks that enable new users to more easily participate.

Yet, limiting the ability of users to participate in the design process, as well as their ability to gain experiential knowledge through the sometimes intimidating or frustrating process of working with prototypes, limits the agency of users in some ways too, as many in maker communities are quick to point out. While blackbox designs may allow wider participation, by limiting the ability of users to understand the inner workings of designs, designers also limit the ability of users to troubleshoot and solve problems for themselves, or to create alternative designs.

I suggest that an important part of restricting participation is articulating the importance of such restrictions for participatory communities. All of the changes I have discussed above are potential implications for the Printrbot community and others like it, rather than explicitly stated outcomes announced by designers. As the examples of Printrbot and Uneditions show, making the goals and outcomes of decisions explicitly clear for participants, in terms of how their participation in communities will be impacted, may be helpful in situations where open source projects become more closed. In other
words, articulating the social impact as well as the technical impact such shifts have may be equally important for technical communicators. Because invention is an inherently social act, as LeFevre’s theory explained in chapter one, and blackboxing processes influence who is able to participate in communities and how, it is critical that technical communicators are able to inform participants early in design processes that eventually they may no longer be able to directly participate. Otherwise, they run the very real risk of losing future participants and community support.

Furthermore, technical communicators should consider the multiple needs of community members, as well as the ethical goals of the communities and companies they serve. In particular, as the roles of technical communicators change throughout individual post-industrial participatory design processes, it is important to consider “openness” beyond open access to designs, particular forms of documentation, and communities. Open source philosophies and open design development processes privilege access to users with the necessary literacies and capital to understand early documentation and designs, while excluding many others from participating at all. Thus, while Printrbot enabled me to participate in 3D printing communities by simplifying the electronic components (as I was leery of soldering and electronics at the time I built my Simple), what seemed accessible to me, despite having nearly destroyed my printer during assembly, is still intimidating to many others. Blackboxing the design of the Printrbot Simple Metal enables greater access and participation, even while limiting participation in the design and development process.
2.5 From Digital Spaces to Material Spaces

As the examples of InetSolution, Inc., Printrbot, and Uneditions in this chapter have shown, practical considerations enrich theories of social and collective invention, while also highlighting some limitations of open design processes. In particular, developmental, legal, and social challenges arise when considering who is invited to participate in design processes, as well as how participants are involved. Moving forward, in chapter three I will examine how makerspaces create and exist within social spaces, and how makerspaces face legal and social challenges in light of funding and accessibility issues. I will also discuss how makerspaces unite individual makers and offer a view into post-industrial development. To do this, I will describe several different types of makerspaces, including an artist collective, a digital fabrication studio, a hackerspace, and a more traditional makerspace, along with the challenges that makerspaces currently face as they relate to post-industry and technical communication. Unfortunately, during my research I was limited by time and distance to exploring mainstream makerspaces that were accessible primarily during a six-week visit to Scotland. As such, the following chapter does not specifically address spaces that are often overlooked but play important roles in maker communities, such as feminist hackerspaces, crafting collectives, bio hackerspaces, etc. However, the sites I have visited so far contribute to understandings of what many makerspaces look like and how they function. Furthermore, by focusing on spaces outside and within the United States, I explore how makerspaces are organized internationally, as well as how they fit into the creation of post-industrial cities, and create a foundation for illustrating how makerspaces function in relation to maker faires in chapter four.
CHAPTER 3. MAKER SPACES AND MAKER FAIRES

If blackboxing creates opportunities for participation by simplifying and closing complex designs, makerspaces provide opportunities to help curious and passionate users overcome the intimidation of emerging technologies while understanding their complexity. As such, makerspaces are locations where technical communication happens between knowledgeable experts, professionals, hobbyists, and general users alike in a highly social invention process. Makerspaces are physical locations that enable access to makers who seek tools, education, and community. In short, makerspaces help provide the capital necessary to open particular black boxes. In other words, a makerspace is not just a workshop or a space with tools, but is also a place which facilitates learning and fosters community. Maker Media Inc. emphasizes this idea clearly in their definition of makerspaces:

...makerspaces are community centers with tools. Makerspaces combine manufacturing equipment, community, and education for the purposes of enabling community members to design, prototype and create manufactured works that wouldn’t be possible to create with the resources available to individuals working alone. These spaces can take the form of loosely-organized individuals sharing space and tools, for-profit companies, non-profit corporations, organizations affiliated with or hosted
within schools, universities or libraries, and more. All are united in the purpose of providing access to equipment, community, and education, and all are unique in exactly how they are arranged to fit the purposes of the community they serve. (Maker Media Inc.)

Based on this definition, makerspaces perform three critical functions within maker communities: providing access to space and tools for production, providing education, and providing face-to-face community.

3.1 Providing Tools, Community, and Education

Within an age of participatory culture, in which users expect to be able to download content and repurpose it using easily available tools, “manufacturing equipment,” such as laser cutters and table saws, is still expensive compared with computers and other digital media production equipment (Maker Media Inc.). In a strictly digital community such as a Flickr group, users can easily and affordably download photos from the web, modify them on their own machines, and upload new images using inexpensive cameras and computers. Alternatively, students at a university might have access to digital cameras and computer labs, and local libraries often have media studios and computers available for public use. Similarly, makerspaces are becoming more common on college campuses and other public spaces to provide equivalent access for tools used to make physical objects.

Physical making, either in an individual or communal space, requires physical tools and space different from those used to produce digital media. Although digital design and production also requires physical devices (such as computers for coding on and servers for hosting), unlike a web designer writing a line of code to pull images from
a distant server to build a web page, a maker building a quadcopter requires the physical propellers, motors, frame, and other pieces, to be in the same physical place. In other words, a maker can’t simply print a sticker that references the physical address of four motors, put the sticker on the frame of a quadcopter, and have a flying machine. In one sense though, makers can reference physical objects through the web much like web designers, and can get exactly what they need delivered for assembly (or preassembled). But, no matter how distributed a supply chain, or how much outsourcing occurs, a space with tools to produce the parts must still exist somewhere.

In practical terms, makerspaces often provide the space necessary for building things which creating digital media doesn’t typically require. For example, it’s affordable for an individual to acquire 500GB of storage on a laptop hard drive or server, and to have a self-contained digital media studio in less than the space of a pizza box. Even a minimal setup makes it possible to produce an entire digital museum of images and have room to spare. But building physical wooden photo frames for a 500GB collection of images would require far more space than a pizza box. It would take at least one saw, space for wood, a hammer and nails, a space to stain and finish the wood, etc. Without a workshop, such production is difficult, if not impossible, and expensive. And for someone that only needs 50 custom picture frames, rather than thousands of identical mass produced frames, having access to appropriate tools can open up opportunities for individualized production. Furthermore, for small businesses or entrepreneurs that produce small batches of customized products, renting a space with appropriate production equipment for less than the cost of renting machine time from mass producers creates a new market niche. Thus, makerspaces enable those who could not afford tools
or space on their own to “design, prototype and create manufactured works,” which in turn creates opportunities for new businesses and markets (What’s a Makerspace). As such, makerspaces aid in the development of ideas and concepts, and serve as a miniaturized example of post-industrial fabrication processes.

Much like with online services that offer 3D printing or laser cutting, makerspaces often allow individuals to produce even a single project, or to create several copies or iterations of small projects. Whereas in the past, an individual might have had to negotiate with a wood shop or machine tooling business for a few hours of floor time if they wanted to create anything less than a refined, mass-produced product; makerspaces enable individualized, on-demand fabrication and rapid prototyping. Furthermore, makerspaces facilitate information exchange and knowledge transfer among technical experts and novices, as well as between individuals with different socio-cultural backgrounds and areas of expertise. And unlike online services, makerspaces allow makers to gain experience through hands-on practice, enabling them to better understand the technical craft of fabrication and share such knowledge with others. Thus, within makerspaces, learning can take many forms. Makers can learn through fabricating objects, from interactions with other makers, and through formal classes that some makerspaces offer. However, every makerspace is slightly different, and all emphasize equipment, community, and education to varying degrees.

In order to convey the range of forms and labels makerspaces take on, I will discuss three makerspaces in and around Dundee, Scotland, as well as a large makerspace in Cincinnati, Ohio. Although there are hundreds of makerspaces around the world, the four I have included in this chapter represent a range of configurations, and offer a
rhetorical perspective on how the spaces facilitate community and education through their layouts and equipment.

3.2 Makerspace Descriptions

Over the course of a six week study abroad in Scotland, I visited three makerspaces near Dundee, Scotland. The first, Tin Roof Arts Collective, presented itself as a collection of artist studios. The second space, MAKE Aberdeen, identified itself as a “digital fabrication studio” (make-aberdeen). And the third, 57North, is a hacklab. Each of the spaces differed from the others in physical configuration, membership, and their goals, but each worked to provide equipment, a sense of community, and education (What’s a Makerspace) The differences between the three spaces also highlight the sometimes subtle nuances of each type of space—nuances which can be easily erased when using the blanket term “makerspace.”

3.2.1 Tin Roof

Dundee, like other post-industrial cities in Scotland, is working to develop a community with new artistic, technological, and historical capital after the decline of its industrial era. Maker communities within Dundee unite art, technology, and history by drawing together artists and equipment, often within historical locations. Due to Dundee’s industrial past, the city contains many empty mills and storage buildings from the jute industry. However, Dundee has adapted to a post-industrial economy through its two universities that have focused on digital technologies and design, through Ninewells Hospital (the largest teaching hospital in Europe, according to hospital officials), and through investment in museums and cultural centers alongside major renovations to Dundee’s waterfront. One of the investment strategies Dundee has employed is to gradually sell empty mill spaces
to small businesses working in technological industries at a discounted price. Although Tin Roof Dundee Arts Collective is not a technological business, it does exist within a former mill, and was established for under $2,000 (Lorri). Furthermore, as I learned through interviewing current members and visiting the space, Tin Roof was established as a way to keep highly skilled and well educated designers and artists in Dundee.

The space itself was formed over three years, growing from a group of 30 people in an open mill space with only lines on the floor, to a group of about 120 members who work in walled workspaces and have created a showroom. All of the walls were created by members from whatever materials were available, leading to an eclectic mixture of doors, lumber, and drywall to create rooms that members can use for around $200 per month. The only other option in Dundee for studio space costs roughly twice as much, and includes only half the space. Thus, Tin Roof plays an important role in fostering maker communities within Dundee by simply existing as a space. Unlike some other makerspaces, however, Tin Roof is less focused on providing openly accessible equipment than space and community.

Functioning primarily as a studio space for artists and designers, Tin Roof members generally need to provide their own materials and equipment, which are often donated or salvaged. However, despite the compartmentalized layout of the space, there is a strong community among members, and it’s often possible to find a tool by simply asking around a corner. For example, as I toured the space and wound through its ever-evolving corridors, I passed individual spaces configured for building small boats, painting, carving, ceramics, and more, all within a few meters. I was led through the maze of workspaces by Rose and Charlie, two Tin Roof members who shared a
workspace. As I entered Rose and Charlie’s workspace, I was amazed by how much they had fit into one small, hand-built room with a storage space above. Even more astounding, however, was the diversity of skills the space and community had enabled Rose and Charlie to develop.

In the brief time I visited, Rose explained that she attended the University of Dundee, and had worked primarily with ceramics, specializing in smoke firing and haptic ceramics (i.e. ceramics which are intended to be held and touched). Since joining Tin Roof, she had learned to angle grind in order to repair sewing machines, learned printing techniques, photography, how to replace a window, how to build walls and ceilings, needle and threadwork, and textiles ranging from sewing to bookbinding. Charlie shared a similar experience, studying 3D design and doing work with 3D printing for her thesis project before tiring of work in front of a screen. She currently works with linotype, a form of printing similar to woodblock cuts, but using linoleum. Her materials came from a roll of scrap flooring, and she was using a press made from a modified car jack to create her prints. Additionally, Charlie was familiar with the concept of using a CNC mill to produce linocuts, and had experimented with designing 3D printed corsets in her past work. Rose and Charlie also explained their work processes to me, providing details about how to sculpt and fire ceramics to create unique patterns and colors, and how to linoprint using non-traditional materials without distorting the images.

Many of Rose’s and Charlie’s technical skills were developed outside of their formal education, within the studio space of Tin Roof. That is, through interacting with others who possessed different knowledges and skill sets, and through experiential practice, they were able to develop their own understandings of technical processes.
Furthermore, Charlie and Rose were able to effectively communicate their technical practices to me and other makers. The collaborative community within Tin Roof, as well as educational workshops they led outside of the space, created opportunities to practice and refine such communication skills. In other words, the face-to-face environment of Tin Roof enables individuals to practice communicating technical concepts to others in a familiar environment, affording pointing at pieces of a machine, or physically demonstrating a particular technique. Such opportunities can help makers practice and develop the communication skills necessary to explain abstract concepts through writing and other media, and in online spaces. However, not all makerspaces create opportunities for communication to the same extent as Tin Roof.

One of the reasons Tin Roof has been particularly successful in fostering an educational community is its diversity. When I spoke with Peter Ananin, one of the founders of Tin Roof, he mentioned that the space could only work when 9-year-olds through 90-year-olds were working in the same space on very different projects. Part of the reason behind this is that when participants possess different skills and knowledges, they are constantly learning from each other and engaging in new activities. Furthermore, because Tin Roof members often work in the space for several hours at a time, and pay for a dedicated space, they are able to develop and sustain educational and collaborative relationships that exist beyond a single question or project, as Rose and Charlie suggest. Thus, Tin Roof, like other makerspaces, functions as a space for bringing together individual makers to share knowledge and gain experience, in relation to broader communities.
Much like Dundee is attempting to bring together educated and skilled individuals in order to provide community and an infrastructure for developing ideas in a post-industrial economy, Tin Roof has succeeded in becoming a generative center of ideas and physical production through providing space and diverse community, more so than providing equipment for mass artistic production. Furthermore, Tin Roof creates a space for events such as the summer showcase, which provide opportunities for Tin Roof community members to exhibit and share their ideas. In doing so, much like the Cincinnati Mini Maker Faire discussed in the first chapter, as well as those I will discuss in the following chapter, showcases create opportunities to engage with other artists and makers, and to share specialized knowledge. These gatherings in the form of faires and showcases share a similar purpose within post-industrial economies. They are both attempts to display new knowledge making, and to create connections between communities of makers, designers, and developers, through the open exchange of specialized information. However, such events are often centered on the ability to interact with materialized forms of the ideas generated by makers. That is, although conversations at faires and gatherings often include the exchange of abstract information, tangible objects often mediate the conversations. Doing so requires tools for production.

3.2.2 MAKE Aberdeen

If Tin Roof as a studio-based makerspace emphasizes space and community, MAKE Aberdeen emphasizes equipment and communal education, reflecting a slightly different but important variety of makerspace. The space is located within a ground floor office building, and includes a front desk where members can purchase materials and check out equipment. Unlike Tin Roof, MAKE Aberdeen exists within an established space, neatly
organized and designed for public accessibility in a single, brightly lit room, rather than providing sustained private space for individual makers. As such, one can see the entirety of MAKE Aberdeen from anywhere in the space, as well as anyone else who occupies the space during regular daytime hours. It is not intended to house long-term projects or personal tools, but rather provide a more temporary workspace for those who need access to shared equipment, like many other makerspaces.

MAKE Aberdeen identifies itself as a digital fabrication studio, though it is closely aligned with more traditional descriptions of makerspaces that include hand tools, equipment for working with electronics, textiles, wood, and metal, as well as laser cutters, CNC mills, and 3D printers. One of the unique features of MAKE Aberdeen that distinguishes it from other makerspaces is its emphasis on digital fabrication.

MAKE Aberdeen includes 3D printers, laser cutters, a CNC router, sewing machines, computers, and other staples of many makerspaces, but with few hand tools or manually operated machines. Surprisingly, when I visited MAKE Aberdeen, a large video camera sat on the counter at the main entrance. As I stood talking with Iain Gildea, the Studio Coordinator at MAKE Aberdeen, a young woman approached the counter and started asking Iain about how to use the camera. Iain explained the fundamentals of how to operate it and adjust some of the camera's advanced settings. Soon after, the young woman moved about the space, giving the camera a test as Iain and I continued our conversation. A little while later, she returned to ask whether the makerspace had any microphones, lighting equipment, and a tripod. To my surprise, Iain produced a quality DSLR tripod from behind the counter (noting that they did have a much bigger, bulkier, dedicated video tripod if needed), along with a large backpack containing a microphone
and other accessories for the camera. Iain suggested that Peacock studio across town also
had basic studio lighting equipment available for checkout.

Surprised to find such an extensive array of video recording equipment at a
makerspace, as many makerspaces focus on producing tangible designs and can even
exclude the production of solely digital media, I promptly asked Iain about why the space
included digital recording equipment. Iain explained that the camera equipment is often
used by makers for documenting other projects, or for film “making” on its own. In part,
this inclusion is no doubt a result of the relationship MAKE Aberdeen shares with
Peacock studios, as well as Iain's background working with video. But it also illustrates
awareness within this space of the important roles technical communication plays within
maker communities and to broader audiences.

Including video recording equipment emphasizes that communicating about a
project and producing tangible objects are equally important if the goal of a project is to
share the outcome, design resources, etc. Thus, although MAKE Aberdeen itself doesn’t
provide a large space for hosting showcases or even mini maker faires, the space’s
developers are conscious of the vital role information sharing and technical
communication play in sustaining maker communities. Furthermore, MAKE Aberdeen is
situated in the same building as Seventeen, which provides some space in Aberdeen for
“artists and arts organizations to present, showcase and create new work in a variety of
media” (Aberdeen City Council). Thus, much like Tin Roof, MAKE Aberdeen offers
a space to build, showcase, and exchange knowledge as well as physical objects, while
emphasizing digital production as a means of fabricating tangible objects. Furthermore,
by including camera equipment for producing digital video and digitally controlled
machines for producing analog objects, all in the same space, MAKE Aberdeen draws attention to the different literacies and media required for production, as well as transferrable skills.

MAKE Aberdeen’s inclusion of video and emphasis on digital production highlights the potential transferability of production skills. For example, a designer trained in using Adobe Illustrator for creating web and print graphics could easily apply the same skill set to producing vinyl cut stickers as well as laser cut objects, all of which could be produced in MAKE Aberdeen. Transitioning from designing a wireframe prototype of a web site to producing a series of two-dimensional laser cutting paths is not a giant leap, but assembling the result into a model Tyrannosaurus means thinking differently about the uses and purposes of the deliverables. That is, producing an illustrated poster for children about a T-Rex and producing a laser cut wooden model for assembly could both have educational purposes. But prior to affordable and accessible digital fabrication tools and services, producing a poster and a wood model would likely have involved different authors and skill sets. In this fictional example, however, because both a poster and wooden model can be digitally designed, the skills used for documenting and promoting a project become transferrable and can be used to produce a three-dimensional object, not just to document its assembly. This transferability of skills is significant because it blurs the boundaries between technical communicator as someone who produces and structures information, and technical communicator as engineer or designer. The distinction, in this case, is technical expertise, rather than a binary of rhetorical vs. technical knowledge. Furthermore, rhetorical knowledge is
foregrounded in both cases, whether or not makers are consciously aware of it, due to the emphasis on information exchange and communicating technical knowledge.

3.2.3 57North

Of the three Scottish makerspaces I visited, 57North most heavily emphasized community over equipment, space, or education. More specifically, 57North can be considered a hackerspace, as it provides limited equipment in the form of server access and storage space, WiFi, and predominantly other computer equipment, with the exception of a small soldering station and some other tools primarily used for working with electronics. The space’s website reinforces this point, highlighting “electronics,” “software,” and “communications” hacking, with a smaller section on “materials” hacking (57North Hacklab). As such, 57North is located in a small single-room office space on one of the main streets in Aberdeen, Scotland. At first glance, the working space itself consists of server racks, oscilloscopes, a small soldering station, a large table and chairs, and rows of electrical outlets. Compared with the shared private space of Tin Roof, and the more public space of MAKE Aberdeen, 57North provides space to meet and sit comfortably with a laptop at a table, surrounded by other equipment that is accessed virtually more often than physically.

Like with other makerspaces, the location of 57North is also significant given its role in post-industrial society. The office space 57North occupies is in the same building as a counseling provider, nail salon, and pole-dance studio for fitness instruction, all of which require minimal equipment other than space and clients/community. Several members of 57North agreed that they primarily showed up to the weekly meetings in order to feel a sense of face-to-face community, rather than to access equipment which
they could easily use from home. One member joked that they show up weekly for the beer, which played a central and serious role in building the community and welcoming newcomers.

Unlike makers who need access to equipment such as laser cutters or studio space, most of the makers at 57North brought their own laptops and worked on virtual projects rather than tangible projects. The space was comparable to a private coffee house with digital electronics and servers, providing workspace and an atmosphere of shared conversation, identifiable as a hacking group largely by the literacies and technologies members employed. Thus, in large part, with the exception of introductory workshops to create programmable blinking LEDs, much of what 57North members produced during my visit was visible only in a digital space or through conversing with the members. Much like a group of writers working together in the same room, without viewing the screen of someone else or inquiring as to what they were working on, one couldn’t tell if the members were writing a small program, testing a server, or building a game.

The invisibility of members’ projects also made it difficult to understand what was happening within the space without already understanding the terminology used to describe projects, which illustrates the communicative affordances of physically making objects as opposed to programming. That is, one can point at something to help explain it, rather than describing it through language and metaphors. However, my research was limited to a single publicly accessible meet up, rather than a members-only meeting, so I may have developed a better understanding of the space given a longer interaction with the group. The purpose of the space, however, was clearly to foster a sense of community through a common meeting place, knowledge sharing, and shared projects. Thus,
although information sharing and visibility function differently within 57North than in other makerspaces, they are still very much a part of maintaining the space and its community.

3.2.4 The Manufactory

In addition to the three Scottish makerspaces I visited abroad, I have been interested in The Manufactory, a large makerspace in Cincinnati, Ohio, since my first visit to the Cincinnati Mini Maker Faire in 2013. The Manufactory also offers some insight into what a “mainstream” makerspace often looks like, as compared with a studio space, digital fabrication studio, or a hackerspace. In terms of layout and equipment, The Manufactory is most similar to MAKE Aberdeen. However, The Manufactory is significantly larger, occupying 17,000 square feet, or roughly ten to twenty times as much space as MAKE Aberdeen (Floor Plan). Furthermore, The Manufactory emphasizes a wide variety of making in addition to digital fabrication, including welding, woodworking, plastics, textiles, electronics, and almost anything that one could find materials for at a large hardware or craft supply store. Thus, one of the primary goals of The Manufactory is to provide the necessary space and equipment to fabricate projects. However, due to its size and complexity, The Manufactory requires formal safety training to operate any of the equipment, rather than informal guidance with public access. Additionally, the space offers classes on a regular basis, but is also expensive compared with smaller spaces, as membership costs over $1,000 annually for an individual (Memberships). Thus, compared with other types and sizes of makerspaces, access to The Manufactory community is a more formal affair, but also comes with trained industry professionals and a broader range of facilities.
3.3 Challenges Faced by Makerspaces

Despite the increasing prevalence of makerspaces, and an established history of hackerspaces that date back several decades, many are still emerging spaces and face substantial legal, financial, and social challenges. As I have shown through examining only four makerspaces, configurations can vary widely and do not necessarily adhere to established standards. As such, not only do makerspaces serve as locations where technical communication takes place, and where it can be practiced, but also as spaces that create opportunities for technical communicators to play a role in shaping the future of their existence. Furthermore, makerspaces highlight some of the potential challenges faced by post-industrial businesses as well, given that new configurations of equipment, knowledgeable workers, and space are challenging older paradigms of industry and industrial regulations.

3.3.1 Legal Issues

Makerspaces face legal challenges as new configurations of equipment, locations, and people emerge. Much like earlier configurations of industrial equipment raised concerns about the health and safety of workers, so too do makerspaces raise questions about health, safety, and legal status in the absence of updated standards. For technical communicators, establishing standards is not a new task. However, the emerging configurations of technologies, space, and people return our attention to the important political and ideological decisions that technical communicators make as part of standardization and information architecturing processes. At first glance, it may appear that such decisions are strictly practical and straightforward, rather than ideological. For example, many makerspaces are reconfigurations of existing spaces, and begin simply as
spaces that afford access to tools and equipment that many people wouldn't otherwise have. Tin Roof serves as an interesting example, in that it began as an empty space, and is legally considered a storage space. However, it has evolved into a shared storage and workspace. Makerspaces also often mix amateur or hobbyist makers with professionals and seasoned experts, all of whom are trying to put together something that is safe and effective for a variety of users and uses. Plus, because equipment, tools, materials, etc., are sometimes donated, or purchased gradually, spaces evolve and reconfigure over time. That is, makerspace don't necessarily start out with a floor plan that details exactly where the 3D printers, welding equipment, laser cutters, materials, and fire extinguishers will be stored. Consequently, it's easy to end up with an interesting mix of equipment and projects all existing in a space that was never intended to be used for so many different purposes. Regulation then becomes a major issue, especially when these spaces grow into something that gets used by the public, rather than a small group of makers that are taking individual risks.

When an individual has a few 3D printers and some CNC machines in their garage, they are probably not worried about having a sprinkler system and emergency electrical shutoffs. But, move that workspace to an old warehouse, add in materials such as paints, glues, and various chemicals, open the space to the public, and safety becomes a much bigger issue. Thus, it is important for technical communicators to understand both how such spaces are evolving, and how they are being regulated, given the role makerspaces play in informing people about what it means to work and exist in a post-industrial society and economy.
3.3.2 Funding

For the three Scottish makerspaces I visited, funding created potential challenges, as the value of such spaces within post-industrial cities is only beginning to become clear. Tin Roof and 57North were funded by membership fees, but this meant that the size of the space influenced how many members could use the space at any given time, and thus constrained the growth of the spaces when they reached capacity. Furthermore, the majority of the equipment in Tin Roof and 57North was donated or loaned by members or the local community, rather than purchased. MAKE Aberdeen, on the other hand, had new equipment, but was nearing the end of its initial grant funding which was provided by the Aberdeen city council for a 6-month trial phase. To sustain MAKE Aberdeen, it was suggested during my visit that corporate sponsorship would be the most plausible next step in funding the space. Rather than relying on membership fees as the primary source of funding, MAKE Aberdeen saw potential in marketing itself as a space for creating future Engineers due to the prominence of the oil industry in Aberdeen.

Similar to MAKE Aberdeen, Skillshare Dundee, an educational organization related to Tin Roof via shared members, was also seeking funding after grant money ran out. At the time of my visit, grant funds and donations from workshop participants had been completely used up, and it was unclear whether Skillshare Dundee would be able to locate continued funding. As of the time of writing, volunteers from the organization have been working with an established art centre in Dundee to conduct community design workshops, and the future of Skillshare Dundee is uncertain. What is certain, however, is that even across a small number of spaces, several models for funding emerge, each with advantages and limitations. But, other spaces continue to experiment
with different funding strategies, for example, spaces that offer short-term leases with office space and access to equipment for entrepreneurs and new businesses (MatchBOX). Thus, technical communicators can also play an important role in exploring the possibilities for new business configurations by helping emerging companies articulate why they are valuable. Additionally, given maker communities and makerspaces as examples, technical communicators can help foster information exchange between emerging companies.

3.3.3 Accessibility

Within physical communities, makerspaces play vital roles in bringing together knowledgeable experts and amateur makers with different backgrounds, ages, income levels, races, genders, educations, and geographic locations. For many makers, makerspaces are the only affordable or practical way of gaining access to equipment such as laser cutters and CNC machines. For others, makerspaces provide a sense of community and support while new makers explore emerging or unfamiliar technologies that might otherwise feel overwhelming, and for some spaces this is the primary purpose. For other makers, learning from the first-hand experiential knowledge of individuals in a face-to-face setting is the primary draw, one which may not be available through more established formal educational institutions. In other words, makerspaces play a crucial role in helping to engage with makers who might otherwise have limited resources or sponsors for developing new technological literacies. And while makerspaces are important for increasing access and literacy to new and old technologies, it is equally important to understand that makerspaces and communities are not comprehensive solutions to differences in access and literacy within different communities, nor will they
totally bridge technological divides in access to new technologies for everyone who wants access. Simply put, no matter how “open” emerging technologies are, there are constant barriers to entry, which largely impact women and racially and economically marginalized groups. Thus, given their rhetorical understanding of information architecture and design, technical communicators can help create communities and organizations that promote greater inclusion of individuals who might otherwise be excluded from post-industrial institutions. For example, makerspaces can help provide technical guidance and community for what would otherwise be an intimidating or overwhelming technology. Emerging technologies often have limited, if any, documentation, which tends to be minimally refined and highly technical. So-called “nightly builds” or developer builds of open source software are created for advanced users who wish to test new updates before they are stabilized for general use, and are considered “use at your own risk” by anyone who uses them. For a new user, or even an average user, such builds are frustrating and/or intimidating because they are unrefined and only minimally documented. From the perspective of developers and technical communicators, however, it makes little sense to provide a variety of refined and accessible forms of documentation, as the software and hardware documented is rapidly changing. Fortunately, makerspaces may provide expert guidance that can help make sense of the limited information available for new technologies. But for mass audiences, innovation will continue to happen among a smaller group of individuals with technical skills and knowledges, a group which has money and time to pursue such developments. Thus, while makerspaces and the technical communicators that exist within them perform
a crucial function in the broader post-industrial society, they are not enough to ensure that individuals are able to participate in a changing economic landscape.

Although technical communicators may not always be able to resolve challenges related to laws, funding, and accessibility, it is important to be conscious of them. In particular, the legal issues faced by makerspaces are not unique, and can be considered part of the transition process toward post-industrial economies. As rapidly customizable and personalized products become more commonplace in post-industrial economies and businesses experiment with new and untested configurations of resources and people, conflicts arise between old laws and new configurations. While Tin Roof is one such example of trying to legally classify a space and configuration of resources, another example comes as a result of the speed of new configurations. In 2014, a new type of tracheal splint was designed and rapidly prototyped to save a baby's life using a 3D printer (Masson). The splint was untested, however, and required “emergency clearance from the Food and Drug Administration” before being implanted (Masson). Fortunately, the device was approved quickly, and worked as expected. Both of these examples highlight the growing importance in post-industrial economies of being able to articulate a problem effectively and propose a solution that is not only functional, but rhetorically fitting as well. However, fit is largely determined by context, and what may seem fitting in one country may not apply in another. As such, it is important to recognize some of the differences between Scottish makerspaces and communities, U.S. makerspaces and communities, and French maker communities.
3.4 International Differences and Similarities among Makerspaces

Although none of the makerspaces I visited in Scotland stood as outliers incomparable with other spaces, there was one major difference between makerspaces in Scotland and in the U.S. According to the Scottish makers I spoke with, the primary difference is scale, due mostly to the cost of space. For example, the small single-room office space (approximately 600 square feet) that 57North occupies costs roughly 850 USD per month. Though it is difficult to accurately compare costs given the variety of factors that can affect the expense of leasing office space in the U.S. and Scotland, the Scottish residents I've spoken with have agreed that property and buildings are generally more expensive in Scotland than in the U.S. However, if other cities in Scotland follow Dundee’s initiative to open abandoned industrial spaces at a discounted cost, the difference in costs could be negated.

In addition to differences in scale, visiting Scottish makerspaces enabled me to access the sites and do research differently than if I had focused on U.S. makerspaces. By visiting Scottish makerspaces, I was able to physically enter the spaces because I had easy and affordable access to public transportation systems, trains and buses specifically, as well as walkable streets. Having physical access enabled me to interview individual makers and to see first-hand how the spaces were configured, who was using them, and how. Furthermore, I was able to learn about how the makerspaces were connected with local businesses and community organizations through face-to-face conversations with makers in the spaces. For example, I heard about Tin Roof in Dundee through attending a free, public class through Skill Share, as the space is not listed on Hackerspaces.org. From the makers in Tin Roof, I also learned about a local business using 3D printing to
create parts for airsoft guns, a local co-working space, and learned more about some of the coffee houses in Dundee, Scotland.

Within the United States on the other hand, to visit any hackerspaces listed online near Purdue University, I would need to drive at least one hour. While this distance is comparable to the hour-long train ride from Dundee to Aberdeen in Scotland, traveling from Purdue to the nearest makerspace depends on access to a personal vehicle rather than public transit. And although Purdue does offer restricted access to tools such as 3D printers, and to other spaces on campus that could be considered makerspaces, they are inaccessible to local community members and are restricted to current students and faculty. Similarly, MatchBOX Lafayette, a local co-working studio that provides some digital fabrication equipment, is only accessible to paying members and does not consistently offer public events or access. Consequently, in both the U.S. and other countries, distance to makerspaces is often an issue. However, effective public transit systems in the U.K. and other European countries help reduce the impact of distance on how easily makers can access makerspaces. Within the U.S., however, although spaces are often more distant, they are typically larger as well, potentially offering greater access to a range of equipment in a single location. Similarly, maker faires bring together large groups of makers and their creations in single locations, though they are most often held locally or regionally.

By visiting the Paris Maker Faire, I was able to view the work of makers from around France and other countries. I also became more aware of the gatekeeping mechanisms at work within maker faires. In part, this was easier to recognize at the Paris Maker Faire because I was keenly aware of my subject position as an outsider due to my
nationality and language abilities. During my previous trip to the Cincinnati Mini Maker Faire, in addition to being a native English speaker, there was little to physically prevent people from simply wandering through the event because it was held in an open park. In stark contrast to this, the Paris Maker Faire was held in a museum that had one main entrance, which was gated, locked, and guarded by security personnel before the faire opened. And, as I describe in detail in the next chapter, security was tight within the faire. Although I was welcomed as a member of the maker community based on my technical knowledge once I was inside, there were still significant barriers to entry to the faire from cultural and linguistic perspectives.

In the next chapter, I will address the challenge of creating functional and rhetorically fitting documentation across languages, and explain how maker faires and online spaces can help bring together groups of makers across physical distances. Additionally, I will provide an example of how online information sharing helps foster participatory communities with open design communities, and will also discuss the process of building an industrial 3D printer in order to illustrate the potential for technical communicators to take on leadership roles within post-industrial economies.
CHAPTER 4. MAKER FAIRES AND ONLINE INFORMATION SHARING

As I mentioned in the previous chapter, makerspaces help to draw individual makers into groups in order to share and build knowledge. Furthermore, such spaces can also provide opportunities to share ideas among makers within the local community through showcases, community events, and open nights. However, the potential reach of such events is limited by proximity. For example, I was only able to visit Tin Roof, MAKE Aberdeen, and 57North because I was in Scotland for a study abroad, and because I was able to travel via rail to Aberdeen. However, makerspaces and makers are able to connect over farther distances via maker faires and online communities. Maker faires draw people together to showcase ideas and share knowledge, while uniting individual and small groups of makers in a shared space within local communities. For example, a local makerspace might have a membership of fifty individuals, but a regional maker faire could draw several makerspaces together, thus providing greater connectivity between groups, much like industry conferences do for businesses. But, maker faires also rely on web connectivity to succeed and draw broader communities together, which reinforces that the spread of information online and easy access to technical documents is an important part of maker culture. Additionally, within international maker communities, access to information online is even more important than in regional settings, as online spaces create opportunities to bridge language barriers that would be difficult to
overcome in face-to-face conversations. To further illustrate this point, I will refer to my experience at the 2014 Paris Maker Faire.

4.1 Language Barriers

As I discovered upon arriving at the 2014 Paris Maker Faire, not quite everyone at the maker faire spoke English, nor did I speak French. I had been nervous about the potential language barrier, and assumed that participants at a French maker faire might not speak English. But, I had the privilege of assuming that most people would speak some English, and I had been reassured by the Paris Maker Faire Twitter account that most makers would indeed speak English. While most of the makers who attended did make humbling efforts to accommodate my lack of spoken French literacy, communicating was a considerable challenge. In fact, I was almost kicked out of the faire within 10 minutes of entering.

Upon arrival, I had purchased a ticket as the Paris Maker Faire website had instructed, received my map of the faire, and was wished a good visit. Just after taking some pictures of the Make robot near the entrance, a security guard started assertively directing me in French. I understood something about “no entrance... security” as he pointed toward my wrists. Meanwhile, I wondered what was going on as I showed the guard my ticket, pointed toward the table where I bought it only minutes before, and fruitlessly tried to explain my situation in English. “No speak English” was the guard’s response. He radioed something in French and shouted across the hall to another guard, trying to get the attention of someone in power who would understand my garbled nonsense. I continued holding up my ticket and pointing, as we repeated the same conversation, eventually walking down to the ticket table. Apparently, I had needed an
all-important wristband to enable my physical access to the faire. Fortunately, it was as simple as showing my ticket and holding out my arm.

With my new blue wristband equipped, I strode past the guard, and then I recognized that all the signs at the faire were in French. Not one to be intimidated by my lack of written French literacy, I hoped the first maker I talked to might speak eloquent and effortless English. I was wrong. We didn’t make it past “bonjour.” At the next table, I repeated the same process. By that point, I was feeling that my power-granting wristband wasn’t so powerful after all, and that maybe I had made a huge mistake by planning my entire day around an event where I couldn't even communicate. I contemplated leaving, but after an internal argument with myself, I decided to stick around and give things a fair try.

Throughout the day, I was surprised by how familiar many of the projects at the Paris Maker Faire looked, felt, sounded, smelled, and tasted. The 3D printers, knitting needles, and hotdog vendors were all recognizable, as were the mechanics and processes behind most displays. And none of the projects at the Paris Maker Faire would have been out of place at a maker faire in the United States. Rather, the primary marker of difference was everyday language, while the technical jargon was often easier to recognize. To clarify, although I often couldn’t understand the general text-based information on signs and displays around the faire, I could often understand the kinetic and tangible processes or science behind projects. For example, I could figure out how to solder together an LED pin based on pictures, the physical pieces of the pin, and the examples I had seen people wearing, but I couldn’t read the written instructions or ask for help. Consequently, it took three attempts for me to properly solder and assemble the pin,
but I could explain (in English) to someone else how it worked. By comparison, had I visited a French hackerspace and tried to code, it would have likely been nearly impossible for me to understand what was happening, as I would have had very little to reference other than words and metaphors.

For other displays and interactive exhibits at the faire, the nuances of context came from information online—information that had been translated, even if only rudimentarily by software. Although rough translation meant losing many of the subtleties of any given project, at least it provided some further explanation, and the better translations provided more nuance. For example, there was one table at the faire with images of a small boat, a list of questions, and what I assumed were explanations written in French. I could tell from the images of the boat, as well as a top-down view showing abstractions of plants, various tubes, and other systems, that it was probably a self-sustaining vessel. However, the two makers present didn't seem to speak English any better than I speak French, so I took a few informational handouts and wandered the faire. Afterward, I visited the Gold of Bengal web site to learn more about the “Nomad of the Seas” project (gob-association). From the site, I could learn exactly which systems were present on the boat, how and why the project started, and other important information. Although the English version of the website is not an eloquent translation, and nuances are lost in any translation, it put the configuration of the system into context and helped make it more meaningful for me. My ability to understand the project was thus facilitated by effective technical communication which used multiple media, including images, text, diagrams, color and patterns, etc. In the case of the Make pin, the physical design of the
components was also as much a part of understanding the design and system as the written instructions.

Thus, while maker faires can play a vital role in bridging distances between individuals and groups of makers, they are also based on the assumption that face-to-face communication will function effectively. Furthermore, even in situations where face-to-face communication is effective, makers at faires often provide additional information in written form or online. Consequently, makerspaces and maker faires can help individuals develop communication skills across multiple media, which are necessary to function in a post-industrial and international economy. Furthermore, such situations illustrate the importance of having multiple channels, whenever possible, where technical communication takes place. For example, had I only participated in online communities, I might have never interacted with French makers, but it is equally possible that I would have had an easier time understanding the concepts of French makers via web documents written in English, or even via automatically translated documents as opposed to spoken word.

4.2 Online Information Sharing

While maker spaces and maker faires help facilitate face-to-face interactions, maker communities are largely fostered through online interactions. Historically, technical information has generally been shared orally and through writing or images. Returning to the example of R. C. Allen’s collective invention, prior to the invention of the internet and online social networks, in 19th century England, information sharing about blast furnaces took place through meetings with furnace operators, shared business records and operating data, papers presented at various engineering society gatherings (as well as the
proceedings of such gatherings), and eventually technical and trade journals (Allen 8-9). While these same channels are still used today, much of the information exchanged among maker communities can also be found online in the form of forums, wikis, and file repositories. Furthermore, social networks such as Facebook and Twitter help connect individual makers and organizations in ways that are often familiar to technical communicators, but which are increasingly important to forming participatory communities of users. As an example of how such networks function, I turn to my experience building a Printrbot Simple 3D printer.

After almost a year spent researching 3D printing technologies and teaching a college course on 3D printing in English, I decided to build a 3D printer for my own use. Given hours of comparing different printers and communities, I was ultimately drawn to Printrbot’s design because of its open source philosophy and modular wooden printer that allowed for upgrades. My decision was finalized, however, after I casually tweeted to a colleague about Printrbot, and @printrbotships (one of the support teams for Printrbot on Twitter) replied to my tweet. That unexpected social interaction with the company was as important to my purchase as the technical design of the machine. In part, Printrbot also fostered a strong community of builders who could provide support as I assembled my own printer from a kit and continued working with the printer, and I was immediately drawn into that community through Twitter. Thus, I was not only purchasing a 3D printer from an online vendor who had helped to build a sense of trust, but I was also being welcomed into a community of makers.

Knowing that there was also a central company supporting the community gave me confidence in investing in the printer, as I could always contact the company directly
and talk to a technical expert if something went horribly wrong. Much like with ModiBot and other companies, the majority of sales at Printrbot are made online rather than face-to-face. However, despite the small size of both companies, neither had the ethos of an individual selling something independently, in which their responsibility for customer service ends at the point of sale. Rather, by engaging with the participatory community Printrbot created, and continuing to provide open design files that reflected community input, the company developed its credibility through user engagement, which provided additional accountability. Unlike within the RepRap community, in which I would have to rely on forums or email for support, I knew that with Printrbot there would be an employee paid to provide support in the worst case scenario. This isn’t to say that I didn’t depend on community to provide technical information or troubleshooting either, as that was a significant part of my experience.

Through building my Printrbot Simple, I relied heavily on online assembly instructions, which were created using Dozuki (Drumm). Dozuki is a web platform that enables technical communicators to create online instructions which can include images, video, audio, and text, and which allows users to comment on different steps and to add their own notes to improve the instructions. Printrbot used this platform to release “seedling” instructions created by technical communicators within the company, but which were not thoroughly refined and tested but were usable. As users followed the instructions, they offered constructive feedback and suggestions for improvements through comments. Thus, users directly participated in improving the assembly instructions through a centralized channel rather than through producing their own instructions from scratch on sites like Instructables (though some users did still produce
their own instructions elsewhere). Such community participation enabled technical communicators at Printrbot to focus their energy elsewhere, rather than on producing refined instructions for product releases that were constantly developing, while also fostering community participation. Additionally, the Printrbot forums, as well as sites like Thingiverse (a repository for 3D design files), provided information about configuring and modifying Printrbot printers. Such spaces helped build community through sharing technical information, and user feedback was ultimately reflected in the design changes Printrbot made to its wooden printers and to the new metal printers as well. Such changes demonstrate the potential impact of participatory communities in an online space, though as I’ve pointed out in the previous chapter, explaining to such communities that their roles may change over time is crucial to fostering strong user-designer partnerships. Furthermore, participatory communities can help explore the possibilities, as well as the limits and boundaries of emerging technologies and designs, but do have limits, as I will show in the next example.

4.3 Building a Better Printer with Expert Guidance

After spending four months with my wooden Printrbot Simple, I became familiar with its limitations, and began looking toward the RepRap community for a larger, faster, and higher resolution printer at a price I could afford to build or buy myself. Because I teach 3D printing and design in my classes, I wanted to be able to fit multiple student projects into one build plate, and to print them quickly from my own machine rather than relying on a shared campus lab running multiple MakerBot printers. For this, I would need a printer with a larger build volume than a MakerBot Replicator 2, a solid frame, and highly precise and fast drive train for around $2,500 or less. To go about designing such a
precision printer, however, I couldn’t rely on the commonly used methods within the RepRap community. Because of the community’s open source foundations, the designs are meant to be at least partially self-replicating, generally affordable, and as such are usually assembled with parts available from a local hardware store or online supplier. However, this also means that linear motion is most often produced using belts and pulleys, or lead screws. Belts create an issue of needing to be properly tensioned, otherwise they can easily create backlash (i.e. slippage and vibration caused by gaps between moving parts which occurs when the pulley/belt changes direction quickly), which reduces print quality. Similarly, lead screws, which are designed to hold things in place rather than for linear motion, face the same issue of backlash, and are thus less accurate and precise than other systems. However, without the RepRap wiki and community I wouldn’t have access to such technical information, and would be unable to engage in discussions about my particular printing needs with experts.

Once I realized that I would need a better printer than I could build using components from the local hardware store and even an aluminum frame, I decided to consult an automation design and engineering expert. My dad, Tim Sherrill, has been drafting, designing, selling, and managing automated robotic systems for over twenty years. When I told him about my plans to build a 3D printer to fit my needs, he offered to help by suggesting modular linear actuators that are typically used in pick and place machines and other industrial manufacturing applications. This led to many conversations about the technical requirements of what I needed, how much I could afford to pay for components, and quotes on components from several vendors. And although technical specifications for various components were available online through part vendors, it was
clear that most brochures and catalogs were designed to provide some idea to customers about what components they might need, but that the ultimate goal of the documentation was to have customers directly contact an expert for advice on what would best suit the needs of a project. Furthermore, without the guidance of a subject-matter expert, I would have had to rely on the design of commercial printers such as the Hyrel 3D, online forums, and personally contacting designers (HYREL).

Thus, as the open source RepRap community helped me understand and explore the limits of typical desktop 3D printers, I encountered firsthand the black boxing of research and development. None of the linear actuators I have considered using are something that I could disassemble or build on my own. In some cases, they are quite literally modular black boxes that should not be opened, though documentation provides some insight into how they function. Furthermore, companies have invested thousands, if not millions of dollars, into developing compact, high-precision, high-speed, highly customizable linear actuators, which makes it risky for them to simply share all of their design information openly. But, the components used to produce linear actuators are also widely available thanks to industrial mass manufacturing, and one company often doesn’t offer significant technological advantages over any other. As such, sourcing the components for building an industrial 3D printer for home use illustrates another feature of post-industrial economies, and another role which technical communicators can take on. Configurations can be more valuable than components, and technical communicators can help facilitate the process of choosing fitting components for various configurations.

Because the components of a desktop industrial printer, i.e. the linear actuators, the print head, the motors, etc., are easily mass-produced and have been standardized,
there is less room for creating better components than for creating new configurations, or recontextualizing older configurations. That is, 3D printers are not a new technology, nor are cartesian coordinate robots (i.e. robots that move in three directions). However, placing such machines, produced with industrial-grade components, within the context of a home or classroom and web-connected communities is an emerging situation. As such, because of the wide array of choices available to users, technical communicators can take on leadership roles by interpreting technical information in order to help users make informed choices. As shown by this example of building an industrial 3D printer compared with a Printrbot Simple, in some cases, technical communicators may need to offer guidance face-to-face or remotely. In other cases, they can help users through creating effective information architecture in the form of catalogs, websites, and online communities. In either case, if maker communities are a representative example, it seems likely that within post-industrial businesses, technical communicators may take on more advisory and leadership roles in addition to more familiar roles such as creating documentation.

In addition to taking on new roles as guides to helping users make decisions which require interpreting technical information, in post-industrial economies, Lisa Potts suggests that technical communicators should become experience architects. In the next section, I will discuss what Potts means by the term “experience architect,” and will partially outline some of the roles technical communicators may play in coming years.
CHAPTER 5. IMPLICATIONS OF POST-INDUSTRIALIZATION FOR TECHNICAL COMMUNICATION

5.1 Future Roles of Technical Communicators in Post-Industry

In order to understand how technical communicators will function differently within post-industrial economies, it is important to understand what a post-industrial economy might look like. To help illustrate some of the defining characteristics of post-industrial economies, I will draw from Chris Anderson’s *Makers*, Liza Potts’ theory of “experience architecture,” and several examples from within maker communities. Thus, much of the work of this section is in outlining what characteristics are likely to continue being important to defining post-industrial economies and organizations. Furthermore, I will return to how information architectures and online communities play a vital role in shaping both maker communities and post-industrial economies, and will explain how technical communicators can enact socio-cultural changes through designing online systems. Finally, I will discuss how maker faires and maker communities simultaneously represent and constitute broader shifts in the post-industrialization of cities and organizations, thus illustrating the broader social connections between invention and post-industrialization.

5.2 What Do Post-Industrial Economies Look Like for Technical Communicators?

A post-industrial economy does not mean we will no longer see mass production or industrial manufacturing occurring. Rather, post-industrial businesses and communities
are founded on the idea that things can be easily mass produced, and that ideally, the majority of producers have equal access to the same components and building blocks. Of course, this ideal is just that, as much of the mass production available to First World markets takes place in developing countries in order to lower production costs, which recreates inequalities that existed in industrial economies. Recognizing this, many of the features of post-industrial economies that I describe will primarily apply to First World countries.

One of the main features of post-industrial economies is that, as mentioned, manufacturing will continue to play an important role. As Chris Anderson writes, “the new era will not mark the end of the blockbuster, but the end of the monopoly of the blockbuster,” (229). Microsoft hasn’t been undermined by Linux, nor has Microsoft Word been replaced by free and open source software or services such as Google Drive. That said, as an example, much of this document was written using the free and open source text editor Notepad++, as it offered control over text in ways that Microsoft Word limits. These are examples of software, however, and a wide array of specialized software has existed for years. In terms of hardware, custom cabinets for houses have existed for many years as well. But one of the major shifts that emerging technologies and the web have opened up is the ability of mass-producing companies to create customized products in small quantities without losing profits or significantly raising production costs. Furthermore, from a user’s perspective, if major producers aren’t creating products that suit their needs, it is simply a matter of finding an alternative producer whose business does support individualized needs. For example, when I failed to find any existing 3D printers that offered the speed, precision, consistency, and size that I needed, I was able
to find off-the-shelf components to build my own given research into open communities and expert guidance, and the availability of options was overwhelming.

As Anderson points out, post-industrialism doesn’t mean that standardized options or massive companies disappear. Rather, new highly specialized opportunities are opened up within niche markets, which highlight the limits of mass-market products and call forth something suited to niche demands. Because of the web, however, even a niche of less than 1% of the entire market can generate sustainable revenue or interest. Furthermore, with the rise of crowdfunding, groups that would have previously been too small to warrant attention from big companies are now able to support organizations that provide exactly what users need or want. In Latour’s terms, groups that would have been excluded from challenging blackboxed designs are better able to create counter-designs through collective social action. As an example, it is quite possible that if I successfully build a 3D printer that works well for my particular needs, at least several thousand other people in the world have similar needs for which my design would be a solution. Thanks to cheap manufacturing and short production runs, producing several thousand printers could yield profits and create a small change in the world. Contrary to theories of user-centered design then, post-industrial economies assume that to some extent, the needs of users may very well be the same as those of designers simply because of the volume of potential users. This does not mean that technical communicators should abandon user-centered design approaches though. Rather, it reframes theories of user-centeredness by suggesting that in post-industrial economies, technical communicators should have a familiarity with the limits and capabilities of different technologies, as well as the ability to evaluate the social, cultural, and ethical implications of designs, in order to help
facilitate users’ decision making processes, and to recognize multiple potential applications for individual designs.

One example of the ability to recognize potential applications comes from a recently invented 3D printer for producing concrete structures such as houses (Fung). Many have speculated on the effectiveness of concrete printers for building houses, and how such a shift in technology and production would impact laborers who construct buildings. However, the printer has several major limitations that make it ineffective for producing large structures. The printer is still relatively slow, prints at a low-resolution, and only prints concrete while houses are made out of many materials. But, the invention of concrete printing isn't a failure or novel curiosity even if it doesn't change how houses are built and never fulfills its original purpose. Rather, the success of the machine depends on finding the right niche of consumer. While most people probably won't be printing a house anytime soon, there is likely a market for a machine that can produce lightweight, aerated, structurally sound, affordable concrete structures that can't be made with a traditional mold, or that can be made more quickly than the mold itself. However, with such a niche audience, there is also likely to be a demand for customization to suit very specific use cases, which will require communicating specialized information between producers and clients. Additionally, documenting the different applications of technologies, and explaining how and why various applications are effective, will continue to be an important part of what technical communicators do in the future. Technical communicators who are able to recognize and capitalize on such opportunities while also building broader user communities will likely be successful in post-industrial economies.
Technical communicators can begin to develop a critical socio-cultural, rhetorical, and technological awareness of the capabilities of technologies through close interaction with and use of technologies that they are communicating about, as well as an immersion within communities of practice that develop and use said technologies. Much like the concept of being well read, technical communicators within post-industrial economies will be better suited to engage with users when they have evaluated what particular technologies afford and limit. Doing this requires practice with technologies from rhetorical, socio-cultural, and technical perspectives. As the prior example of Printrbot has shown, the ability of technical communicators to foster communities and facilitate decision-making processes is limited and can have negative consequences when only one perspective of the three mentioned is considered, or when technical communicators have limited practice with technologies. Thus, the broader the range of perspectives through which technical communicators can view the affordances and limitations of technologies, the more potential applications they will be able to guide users through. This does not only apply to hardware, however, and in the next section, I will discuss how Liza Potts maps a similar perspective onto the development of online systems.

5.3 Recognizing Potential Applications across Platforms

In *Social Media in Disaster Response*, Liza Potts calls for technical communicators to take on the role of “Experience Architects.” She defines experience architects as designers who “consider participation across an ecosystem [of information and experiences] rather than within one single website or application” (18). Thus, the goal of an experience architect when designing a new information ecosystem, website, application, etc., is to facilitate participation across a wide range of possible uses. Potts
uses this framework of information architecting to examine responses to disasters in which individuals use social media as information architectures in order to share and transform various forms of information, for example, to organize ad hoc reporting communities and services for locating individuals. In doing so, Potts extends the call for participatory design approaches beyond the scope of single products or development cycles, toward systems of participation. Ultimately, Potts argues that technical communicators should apply the knowledge gained from observing participatory communities that emerge in response to disasters, to the creation of APIs and digital information systems for everyday use. In short, Potts writes that, “People want to interact and participate with and across systems; they do not want to be trapped in one system, application, or website. We need to research and architect systems that support the flow of information across the social web, not just within a specific segment of it” (108). Thus, in much the same way that Potts calls for technical communicators to design systems that account for the many ways users can use and repurpose systems and content, seeing potential uses for physical objects across systems and configurations requires a similar perspective. Designing a 3D printer does not only mean designing a machine that 3D prints objects. Rather, it means looking at the many potential configurations and applications of a Cartesian coordinate robot that may exist, and how information and physical components can be designed to facilitate a variety of uses and applications.

5.4 Familiar and Emerging Roles of Technical Communicators within Post-Industry

Overall, technical communicators will likely continue to perform many of the same functions within industry that they have for decades. Despite the prevalence of participatory communities, new products will continue to need documentation in various
forms, e.g. websites, video tutorials, written instructions, etc. However, if they are able to successfully foster participatory communities, technical communicators may be able to devote less attention to refining technical documents during the early stages of development, as shown by Printrbot. Additionally, technical communicators will continue acting as mediators between subject-matter experts and broader audiences while advocating for user needs and including users in design processes. More frequently, as the example of building an industrial grade printer as a consumer suggests, due to the ease with which home users can access highly technical information, technical communicators will increasingly serve as guides in the decision making processes of users. Thus, in shaping the relative openness of technical information, technical communicators should also be aware of who can access information, and how such information serves multiple purposes for different audiences. They should also take note of how the openness of information impacts user communities from technical, rhetorical, and social standpoints. Finally, technical communicators should become familiar with how information is used in multiple contexts across multiple platforms, in both online and offline spaces, in order to better guide users to solutions, and to create effective APIs and platforms for the exchange of information.

What is new in the case of post-industrial technical communication is not that technical communicators will ensure users get what they need, but how they facilitate the process. The web and online technical communities have helped facilitate access to previously inaccessible information. What before might have only been accessible to an end user through an employee at an auto repair shop and restricted database access can now potentially be found online. Such access to information has helped form online and
offline communities that participate in design processes; create, test, and modify their own designs; and explore the boundaries of what is possible with various technologies. Furthermore, enabling greater access to such information can also help build new communities of experts and amateurs alike, both locally and nationally.

After interacting with countless maker communities and individual makers in the past two years, the ability of people to connect across disciplines and nations when they are passionate about the work they do has astounded me. But more than being passionate about their own work, many makers view the work of others as inherently valuable, and see opportunities for further exploration of their own work through the creativity of others. Although R. C. Allen suggests that the information sharing that takes places alongside a perspective of curiosity is often temporary, I hope that maker communities will continue to bring together curious and passionate individuals who hope to learn something from others and to share knowledge, regardless of how technically skilled or identifiably different individuals may be. Moreover, I hope that technical communicators will see this same value in maker communities, and will learn from them about how to encourage participation and communication about technical subjects. At the same time, it is equally important to recognize the limitations of maker communities as participatory spaces. There is more work to be done about who participates in maker communities based on race, gender, income, and class, among other identifiers. Given the importance of maker faires and makerspaces as locations that bring together people across many different backgrounds, cultures, and areas of expertise, it is crucial that they are as inclusive as possible. Additionally, my work has focused primarily on emerging businesses and communities in relation to maker communities. However, many long-
standing businesses are adapting to post-industrial economies as well, and can further inform the work of technical communicators in the future. But, given the increasing significance and scale of maker communities, they can continue to provide technical communicators an important window into the development of post-industrial economies and cities, as well as insight into our own technical communication practices. Cities such as Cincinnati, Dundee, and others are reinventing themselves as centers of post-industrialized work and systems of participation, and are creating new opportunities for technical communicators to work, learn, and create change in the world.

5.5 Conclusion: The Difference a Year Makes for a Post-Industrial City

In 1878, Judge George Hoadly professed a vision of Cincinnati as an industrial city of manufacturing and cultural production on par with Edinburgh, Boston, and Paris (Picturesque Cincinnati 154). Today, Hoadly’s description could apply just as fittingly to a modern post-industrial Cincinnati, Paris, Dundee and Aberdeen (as opposed to Edinburgh), as they host maker faires and strive for similar goals:

A city fair to the sight, with a healthy public spirit, and high intelligence, sound to the core; a city with pure water to drink, pure aire [sic] to breathe, spacious, public grounds, wide avenues; a city not merely of much traffic, but of delightful homes; a city of manufactures, wherein is made every product of art,—the needle-gun, the steam-engine, the man of learning, the woman of accomplishments; a city of resort for the money-profits of its dealings, and the mental and spiritual profit of its culture,—the Edinboro' [sic] of a new Scotland, the Boston of a New England, the Paris of a new France. (Picturesque Cincinnati, 154)
The primary difference between Hoadly’s address and modern visions lies in manufacturing. Cities such as Cincinnati and Dundee are no longer identified as mass producing industrial centers with secondary industries built around producing a primary staple product. Rather, mass manufacturing has been optimized to a point that entire cities no longer need to be built around a single large industry, although they may maintain manufacturing businesses. Cincinnati no longer needs to be “Porkopolis,” much as Dundee no longer needs to be “Juteopolis,” with the many sub-industries that come along with mass production of pork and refined jute. Rather, post-industrial cities offer a variety of services and forms of capital beyond machinery and space for physical labor. Post-industrial cities facilitate the growth of culture, ideas, and education to generate knowledge and ideas that are then mass produced as objects and goods elsewhere, or created on-demand nearby. And this is not to say that mass production or manufacturing are by any means dead or irrelevant. Rather, it is assumed that mass production in a post-industrial economy is a black box, and that once an idea for a material item is developed as input, manufacturing is largely a matter of finding fitting suppliers and generating output. Furthermore, the labor of generating ideas has become decentralized from material production, and physical labor and capital, making it unnecessary to locate idea generation and production in the same geographic location. What becomes more important is the location of many individuals who generate and share ideas within their respective communities.

A year later, after visiting the Cincinnati Mini Maker Faire in a new location, it is amazing to see how the event and surrounding maker community has changed since I began my research there for this thesis. The most noticeable change was the location of
the faire itself. The first year, it was held in an open park, meaning that one could see, hear, smell, feel, and taste the entire faire from almost anywhere inside the park. There were few physical boundaries between different clusters of makers, with the designated arts and crafts vending stalls blending into the 3D printers, robots, and electronics. The 2014 faire, however, was held in the Cincinnati Museum Center. Instead of encountering an open expanse of makers as the first perception of the faire, attendees this year were greeted with a large museum, and a few small signs leading down escalators to the basement, or food trucks if they entered from the museum’s west side.

The entrance to the faire consisted of t-shirt printing and several booths geared toward children, leading to a room full of vendors selling handmade goods such as soaps, jewelry, photographs, and textiles. After moving through this room, and an empty hallway, the faire continued in a room labeled “STEM, Robotics, and 3D Printing.” Despite being spread over a greater area, the 2014 faire was smaller than the previous year. And although makers had been clustered into different groups in 2013, the segregation of different ways of knowing into clearly defined rooms a year later was striking. The smell of food trucks no longer blended with the smell of PLA plastic and laser cut wood, and there were no sounds of power tools, chip tunes, and drum circles drifting in unison throughout the booths of robots and plush animal makers found side-by-side.

Given the significant impact the location change had on the overall experience, one might assume that the move was in part weather related. The 2013 faire was held on a cold, lightly rainy day, on which it was physically uncomfortable to remain outside for more than half an hour at a time. If I hadn’t been able to return to the heated shelter of my
car after walking through the faire once, it would have been a very short trip. Thankfully, the 2014 faire was comfortably warm. But it was also clear that moving the maker faire from an open, public park, to an enclosed, public museum, had rhetorical implications that may suggest a broader shift in the purpose and existence of maker faires, and which reflects the post-industrial themes of maker communities and blackboxing processes.

Although I have not yet confirmed with the individuals who organized the Cincinnati Mini Maker Faire what the rationale behind their choices for planning were, I suggest my interpretation as one possible way of reading the changes in the faire. Furthermore, the Cincinnati Mini Maker Faire is a relatively new faire compared with the hundreds of other longer-running and larger faires in other cities, and therefore provides a limited perspective on much broader trends. However, given the industrial history of Cincinnati, its former reputation as “The Paris of America” in the late 1800s, as well as its modern diverse population, development as a post-industrial city, and the corporate sponsorship of the faire, I assume that the organizers were very aware of the city’s history and the rhetorical impact their current decisions have.

As mentioned previously, the shift from an outdoor open-air venue to an indoor one for the Cincinnati Mini Maker Faire created barriers between different groups of makers and facilitated and constrained different forms of participation. Yet, setting the faire in a museum helped build an ethos of cultural significance for the maker faire that a collection of tents and enthusiasts in a park does not easily promote. Furthermore, placing the maker faire in a museum center draws people into the museums as well, and reflects the adaptation of museums to post-industrial society. Additionally, juxtaposing the maker faire with Cincinnati’s historical development brings attention to the future of Cincinnati
as a post-industrial “#CityOfMakers” (the hashtag of the faire), and thus fits into larger conversations about what it means for Cincinnati to become a post-industrial city. As for the relationship between the faire and museum center specifically, the Cincinnati Museum Center houses three distinct museums: a children’s museum, a natural history museum, and a Cincinnati History Museum. While maker faires do draw together children, natural history, and local histories, the Cincinnati History Museum is of particular significance in this case.

The Cincinnati History Museum focuses primarily on the industrial growth and development of the city from a hub of water-based transportation, to a hub for rail systems, to a modern city connected by trains and roads with a vibrant culture and an industrial past. The exhibits within the museum include histories of machine tooling, steam engines, textile production, and mass manufacturing technologies, which are all connected to the various displays found within the maker faire, e.g. lathes and CNC mills, steampunk computers and electronics, cross-stitch and programmed sewing, and desktop manufacturing.

Finally, an exhibit near the end of the Cincinnati History Museum displays replicas of announcements for industrial exhibitions from the 19th and early 20th centuries. This exhibit explains that Cincinnati held annual exhibitions to “show off the area’s commercial and artistic splendors,” which included “machinery... horticultural exhibits; and art exhibits,” noting also that “By the time of the 1910 Ohio Valley Exposition, Cincinnati was the machine tool capital of the world” (Cincinnati History Museum). Thus, not only does situating the maker faire within a museum build an ethos of cultural importance, but it also places the faire in relation to a much longer past of industrial and
cultural development. Although maker faires are not just displays of emerging technologies, individual accomplishment, and industrial wonder, they are an exhibition of a changing post-industrial society which has explicit ties to an industrial past. In part, this juxtaposition could be viewed as an attempt to reopen the modern blackboxed industry, though it is an impossible endeavor as the complexity of doing so grows exponentially. Paralleling this short endeavor, the exhibitions of the 1800s did not last indefinitely, and became unsustainable as they began losing money just before the end of the 19th century (Cincinnati History Museum).

Unfortunately, if the museum exhibits, R.C. Allen’s theory of collective invention, and Latour’s blackboxing offer suggestions as to the future of maker communities, it seems that this period of open information sharing may be unlikely to continue over a longer span of time. Even within broader participatory cultures, it is unlikely that we will witness the same level of openness and inclusion regarding emerging technologies as we see today. Although online and face-to-face communities will continue bringing together makers of many different backgrounds in new configurations, it seems that communities will become more specialized, and the channels for participation and engagement will become more formal and regulated as emerging technologies and industries stabilize and settle into recognizable forms. It is possible that broader maker communities, like smaller communities that emerge around open source projects, will soon face gradual shifts from open participatory communities toward more focused communities that solicit particular input from participants. As such, it is important that technical communicators within maker communities, organizations, and companies, be prepared for helping to facilitate transitions between open to more closed forms of participation. It is important that
technical communicators help ensure such transitions, via standardization and regulation, take place ethically, and serve the interests of the individuals who established such communities, the interests of participants, and the interests of post-industrial economies and society.

Additionally, standardization and regulation of the technologies used within maker communities may also lead to greater participation of people who are currently excluded by technological barriers to entry, which will shift what information is shared openly rather than how. In this case, it is even more important that technical communicators be critically aware of how information infrastructure shapes communication and participation socially, rhetorically, and technologically. As the Cincinnati Mini Maker Faire showed, a change in venue drew a more diverse crowd, with noticeably more women attending, as well as an increase in Black, Latino, and Asian attendees at the 2014 faire. Thus, it would seem that closing opportunities for some types of participation—by refining technologies and creating specializations within maker communities—opens other possibilities for participation, especially for people who might otherwise never participate. And it is possible that some maker communities will maintain a strong commitment to openness and a thoroughly DIY approach, as demonstrated by companies such as UltiMaker and Lulzbot, in order to sustain a sense of continued participation and importance among community members. In any case, technical communicators will play a vital role in shaping and creating the future of post-industrial configurations that integrate both amateurs and professionals as valuable participants in creating knowledge, and which connect individuals within broader social institutions.
WORKS CITED
WORKS CITED


<http://reprap.org/wiki/Printrbot>.


<http://opensource.org/osd>.


APPENDIX
APPENDIX

Open Source Software Definition

“The program must include source code, and must allow distribution in source code as well as compiled form.”

“Where some form of a product is not distributed with source code, there must be a well-publicized means of obtaining the source code for no more than a reasonable reproduction cost preferably, downloading via the Internet without charge.”

“The source code must be the preferred form in which a programmer would modify the program.”

“Deliberately obfuscated source code is not allowed.”

“Intermediate forms such as the output of a preprocessor or translator are not allowed.”

Open Source Hardware Definition

“The hardware must be released with documentation including design files, and must allow modification and distribution of the design files.”

“Where documentation is not furnished with the physical product, there must be a well-publicized means of obtaining this documentation for no more than a reasonable reproduction cost, preferably downloading via the Internet without charge.”

“The documentation must include design files in the preferred format for making changes, for example the native file format of a CAD program.”

“Deliberately obfuscated design files are not allowed.”

“Intermediate forms analogous to compiled computer code — such as printer-ready copper artwork from a CAD program — are not allowed as substitutes.”

“The license may require that the design files are provided in fully-documented, open format(s).”