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Makerspace Models and Organizational Policies for Technological Inclusion

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**MAKERSPACE MODELS AND ORGANIZATIONAL POLICIES FOR
TECHNOLOGICAL INCLUSION**

A Dissertation Presented

by

CHRISTINE OLSON

Submitted to the Graduate School of the
University of Massachusetts Amherst in partial fulfillment
of the requirements for the degree of

DOCTOR OF PHILOSOPHY

February 2021

Department of Communication

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**MAKERSPACE MODELS AND ORGANIZATIONAL POLICIES FOR
TECHNOLOGICAL INCLUSION**

A Dissertation Presented

By

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ABSTRACT

MAKERSPACE MODELS AND ORGANIZATIONAL POLICIES FOR TECHNOLOGICAL INCLUSION

FEBRUARY 2021

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In the early part of the 21st Century, discourses about the “Creative Economy” rose to prominence resulting in educational, economic, and policy initiatives supporting what became known generically as “makerspaces.” As interdisciplinary sites where arts, technology, design, and entrepreneurship meet, makerspaces were heralded as transformational organizational models for learning and innovation. This dissertation explores the social arrangements opened and foreclosed by makerspaces through ethnographic case studies of how different institutions introduced and adapted makerspace models from 2013-2019. Using a communicative ecology approach (Foth & Hearn, 2007), this study interrogates the structures and practices that shape participant experience of these collaborative media, technology, and design spaces, analyzes the construction of “maker literacies,” and traces the broader evolution of technology access concerns in the U.S. This study thereby contributes to the research literature on social production practices, technological literacy, and technological inequality as well as offering recommendations for similar initiatives.

The Maker Movement refers to the early 2000s rise in visibility of Do-It-Yourself (DIY) “making” activities aided by the advent of publications such as *Make* magazine, online communities such as Instructables, in-person meetups called Maker Faires, and localized communities of practice in makerspaces. Unfortunately, many of the independent makerspaces that were opened during the height of The Maker Movement from 2011-2016 have since closed due to leadership issues, funding shortfalls, and other organizational challenges. As of 2019, libraries, universities, schools, and museums are the most common places to find makerspaces. Rather than a unique phenomenon, makerspaces are conceptualized here as an evolution and re-branding of community access points for social inclusion like that of the community technology centers (CTCs) that arose throughout the U.S. when policy concerns for “digital divides” were at their height. Examining these spaces from a communication perspective as part of a longer history of technology access initiatives reveals how emerging technologies continually reorganize activities and influence priorities for organizations with social inclusion goals.

Through in-depth case studies of three makerspaces in Massachusetts with different institutional ties—a community access media center, a public library, and an economic/community development project—this study explores the contributions of makerspaces to local ecologies with special attention to how media and technological literacies are enacted in makerspace initiatives. In particular, the study documents how policies and practices shape participation through questioning the impetus for creating a makerspace and what activities are recognized and valued in these spaces. The study also explores the sustainability of initiatives concerned with media and technological literacies amidst the changing terrain of digital inequality in the U.S.

While political and economic transformations in the U.S. continually change access initiative priorities, interrogating discourses related to digital inequality, creativity, and innovation are still important for supporting equitable community development. A fuller understanding of the promises and pitfalls of the makerspace approach will enrich our understanding of social values related to technology and may be used to inform media and technological literacy initiatives.

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CHAPTER 1

INTRODUCTION

In the early 2010s, collaborative workspaces, known generically as “makerspaces,” gained popularity. These makerspaces were often promoted as a way for individuals to take advantage of new opportunities opened by emergent design technologies and growth in the so-called “creative economy.” Many of these spaces provided access to software and hardware for media production, wood working tools, and desktop fabrication technologies like 3D printers and laser cutters. The breadth of activities and interests that were subsumed under the generic term of “makerspace” mirrored a challenge faced by educators, policy makers, and researchers interested in social inclusion in the 21st century. Namely, preparing individuals to work, learn, and thrive in an increasingly mediated, commodified, and data-fied society requires intellectual and material collaboration.

While necessarily an interdisciplinary endeavor, this dissertation approaches the makerspace phenomenon primarily from a media and technology studies perspective. In the 20th anniversary edition of the journal *Television & New Media*, Lisa Parks (2020) attempted to update the “map” of media studies scholarship. Highlighting the rise of scholarship on networks, infrastructures, and other “‘back end’ systems” since the early 1990s, her review underscored how media-related concerns have evolved to include environmental perspectives and data-related issues. Indeed, efforts to theorize the complex and on-going ways technologies and society (re)shape one another move beyond discrete aspects of communication like production, content, and audience to understand how individuals and communities experience media and technology. Examples of this

theoretical move in the field of communication and media studies include Couldry's (2004) media as practice, Lunby's (2009) mediatization, Deuze's (2009) media life, Jenkins' (2006) convergence culture, and the field of media ecology (Postman, 1998; Strate, 2004) more generally (Deuze, 2009). Applied communication perspectives, meanwhile, sensitize us to questions of marginalization (Sakar, 2019), and data privacy concerns (Goulden et al., 2018) as networked ICTs and digital media become part of our daily routines in "smart" homes and "smart" cities. Because our social realities are shaped by interactions with these ever-evolving media and technology ecologies, more research is needed on how and where individuals develop their media and technology literacies.

Currently, there is a vast and growing body of literature on school-based educational approaches to emergent media and technology literacies as well as informal or "connected" forms of learning among youth whose media and technology uses bridge various contexts (Drotner, Jensen, & Schrøder, 2009; Ito et al., 2010; Ito et al. 2013; Frechette & Williams, 2015). To supplement these crucial discussions, more grounded research is needed on the spaces and practices with which adult populations engage. This dissertation addresses that gap through case studies that trace the role that "makerspaces" fill for local communities.

Rather than providing a singular snapshot in time, this study builds on past research and includes original insights from over five years of engagement with the makerspace scene through participation, research, and volunteering. Far from an entirely new phenomenon, makerspaces are conceptualized here as an evolution and re-branding of community access points for social inclusion like that of the community technology

centers (CTCs) designed to address the “digital divide” in internet access. The study thereby offers perspectives not only on the makerspace phenomenon specifically but also on challenges to the long-term sustainability of media and technological literacy initiatives more generally. Pedagogically, this dissertation offers insights from the literature and case studies to suggest literacy initiatives should adopt a critical perspective to contend with fundamental biases toward innovation that often exacerbate inequities both in the learning environment and larger society. Theoretically, this dissertation pairs the insights of media and communication scholars with frameworks arising out of development studies to better account for localized media and technology practices without losing sight of how media and technology mediate our experiences of the world.

Literacy and Innovation

In the contemporary political-economic context, studying technological literacies means contending with a pervasive “pro-innovation bias” (Godin & Vinck, 2017). While the terms “innovation” or “innovative” were once used as pejoratives or as a “linguistic weapon by opponents of change” (Godin & Vinck, 2017, p.4), innovation is now a prominent buzzword aligned with creativity and prosperity. Godin and Vinck (2017) suggest this change in meaning is the result of policy rhetoric after World War II which linked innovation to the economy by introducing the concept of “technological innovation” as “commercialized invention” (p. 4). From such a perspective, technological innovation is an important process for a country to invest in and innovativeness is an important quality to cultivate among individuals. For individuals, this means establishing oneself as both skilled and creative. Literacy initiatives should not, however, merely promote instrumental skills to create more products, services, and messages in service of

the market¹. Nor should initiatives promote the mythical and neoliberal view of “creative” work that promises flexibility and freedom while overlooking the precarity faced by those in so-called “creative industries” (Lee, 2017). Instead, a critical approach has much to offer future technology and media literacy initiatives.

With a focus on interrogating power dynamics of dominant institutions and practices, the field of Critical Media Literacy has long endeavored to encourage individuals to imagine alternatives to the status quo (Alverman & Hagood, 2000; Kellner & Share, 2005; Lewis & Jhally, 1998). In the current context of media and technology abundance, scholars and practitioners of emergent technology and media literacies should therefore attend to the biases of initiatives. What outcomes, services, and messages do current educational initiatives promote and what do they ignore? These choices, which may disrupt or support the status quo, are often driven by larger discourses or funding sources that privilege certain activities over others. A look at the evolution of the phenomenon of makerspaces from 2013 to 2019 provides an illustrative account of how a pro-innovation bias can have far reaching implications for media and technological literacy initiatives.

A Brief History of The Maker Movement

“Make” magazine, a publication by O’ Reilly Media was first published in 2005 to provide an outlet for enthusiasts from various DIY communities. A year later, the first

¹ Blikstein (2013) explains how digital fabrication lessons may promote consumerism rather than creativity in his discussion of the “keychain syndrome” (p. 9). When students were introduced to using the laser cutter by a lesson on making keychains, all they wanted to do was create more copies rather than engage in more complex projects. “Ironically, it is as if students had discovered exactly what manufacturing is about – mass-producing with little effort – and were making the best of it” (p. 9).

Maker Faire brought these enthusiasts together to share their creations in “The Greatest Show (& Tell) on Earth”:

We call it the Greatest Show (& Tell) on Earth. As a celebration of the Maker Movement, it’s a family-friendly showcase of invention and creativity that gathers together tech enthusiasts, crafters, educators, tinkerers, food artisans, hobbyists, engineers, science clubs, artists, students, and commercial exhibitors. Makers come to show their creations. Attendees come to glimpse the future...and to learn to become makers themselves. (Make Community, 2019)

Evident in the celebratory rhetoric promoting this so-called Maker Movement in the 2000s were concerns for the future of employment, education, and social cohesion at a time when institutions were attempting to adapt to a changing global economy. Social and economic relations were restructured by the move from a society based on industrial logics to a global system dominated by the production of immaterial goods such as “ideas, knowledges, languages, images, code, and affects” (Hardt, 2009). Castells (2011) posits that society is now structured around the logics of networks and this transformation is reflected in changes in human experience, labor, communication, and culture. The collaborative and flexible nature of making was thereby offered as one way to address the employment and education gaps opened in the wake of such global shifts.

The White House administration under President Obama (2009-2017) frequently promoted The Maker Movement to encourage American innovation and economic competition:

American ingenuity has always powered our Nation and fueled economic growth. Our country was built on the belief that with hard work and passion, progress is within our reach, and it is because of daring innovators and entrepreneurs who have taken risks and redefined what is possible that we have been able to realize this promise. Makers and builders and doers -- of all ages and backgrounds -- have pushed our country forward, developing creative solutions to important challenges and proving that ordinary Americans are capable of achieving the extraordinary when they have access to the resources they need. (Obama, 2015)

In 2014, the Obama administration called on mayors to encourage “making” in their communities and over 100 cities signed on through the “Mayors Maker Challenge.” In 2015 and 2016, the White House declared a week in June a National Week of Making.

Three years later, in 2019, the swell of support for The Maker Movement largely subsided. The political support for “making,” and STEM education more generally under President Obama’s Whitehouse has not been renewed by the current administration under President Trump (2017-). President Trump’s budget for the 2020 fiscal year, for example, proposed significant cuts to STEM education initiatives such as the elimination of the 21st Century Community Learning Centers that provide a variety of after school art, media and technology programs for underserved youth (Budget of the U.S. Government, 2019). There have also been unfortunate changes in support from the private sector as well. TechShop, a chain of membership-based Do-It-Yourself workshops well-known in the makers scene, closed their doors suddenly in 2017 and filed for bankruptcy in 2018. RadioShack, a popular small electronics dealer in the maker scene, filed for bankruptcy twice, once in 2015 and again in 2017. Most devastatingly for the branding of The Maker Movement, the 2019 World Maker Faire was cancelled as Maker Media could no longer support its operations (Corcoran, 2019). As of 2019, Maker Media had not yet filed for bankruptcy but the founder, Dale Dougherty, told interviewers that corporate support had largely pulled out: “‘Maybe it’s a sign of the times. Corporate America is not supporting things like this,’ Dougherty says. ‘They have valuations in the billions; that’s a sign of where their attention is. It’s not on youth, education or even culture. That should be disturbing’” (Corcoran, 2019).

Hacking to Making to Working

The activities subsumed under the heading of The Maker Movement have far longer histories and futures than the movement itself. These histories will be explored in more detail in Chapter 2. However, to introduce and contextualize “making” I will briefly outline the features of a few of the dominant terms used to describe the kinds of DIY activities most often associated with “making.” It is important to note these terms are highly contested by participants and more flexible than this classification may suggest. Though all these terms are all still in use, over the course of this study, the popularity of the term *hackerspace* was largely replaced by *makerspace* then *coworking space*. This evolution reveals two fundamental changes, (1) a demand for undefined, flexible activity spaces and (2) a move away from practices of play and transgression to production and professionalization.

Hackerspace was the first term to emerge in popular discourse and the term is usually used to refer to emergent collectives of individuals with expertise related to electrical engineering or, more commonly, computing. Participation in these spaces is about the practice of manipulating digital devices and software to get it to do something unexpected or unsanctioned. Hacking is often aligned with transgression and disruption of the status quo and thus these spaces may stress a civic component (e.g. civic hacking) or lead to malicious manipulation (e.g. black hat hackers).

Makerspaces are more closely aligned with institutions rather than emergent collectives. Their enthusiast communities are broader than hackerspaces and include various crafts and fiber arts as well as manufacturing activities. Makerspaces are intended to be accessible to the novice though they may have experts participating and sharing

knowledge. Participation is focused on the creation of primarily physical objects. While they are playful spaces, the ethos is less transgressive and more about hobby.

Coworking spaces are theaters for a variety of productive activities. While some may simply be set up as a communal office space, others have more focused creative goals. The expert/ novice spectrum that is useful when explaining hackerspace and makerspaces is less useful to understanding coworking spaces. Instead, an amateur/professional spectrum is more applicable here as the productions in these spaces are largely intended for an outside audience. The space is the tool or technology that serves as the resource for the community. Outcomes can include products (e.g. paintings, hand-sewn articles) but often are more social in nature and include lessons about how to network or run one's own business.

Despite the struggles of Maker Media and other businesses related to “making,” “makerspace” was still part of the popular vernacular in 2019 when this analysis was conducted. The GuideStar USA database which provides information about non-profits, lists 219 organizations in the United States that have “makerspace” in their name or description as of June 2020. Twelve of these 219 non-profit makerspaces are in Massachusetts, the focus of this study. Unfortunately, reliable figures on the total number of active makerspaces are not currently available as there remain definitional debates about what constitutes a “makerspace” and how it may differ from a “hackerspace,” or “coworking space.” Furthermore, in-line with the DIY ethos of making, many of the directories or counts are user-submitted and thus not maintained with current information. For example, browsing the directory of the over 700 makerspaces listed in the U.S. on makerspaces.make.co reveals many broken links and

defunct spaces. Available data from user-maintained databases such as hackerspaces.org did suggest a significant global rise in such spaces, however. Citing this database, Lou and Peek's (2016) article for *Popular Science* places the number of active makerspaces across the globe at nearly 1,400. This is fourteen times as many makerspaces as there were in 2006 (Lou & Peek, 2016).

Public institutions like schools and libraries are still likely to use the term "makerspace" and emphasize educational tinkering while new community spaces largely emphasize entrepreneurship opportunities using the terms "coworking," or "collaborative workspaces." For example, in Massachusetts, the focus of the current study, MassDevelopment has awarded over \$4 million in grants since 2015 to support "community-based innovation infrastructure" as part of the Collaborative Workspace Program (MassDevelopment, 2018, p. 1).

The history of Google searches using data from Google Trends since 2004 for "hackerspace," "makerspace," and "coworking space" shows how the popularity of each term and each type of creative space has changed over time (see Figure 1). In the U.S., makerspace is, on average, more commonly searched than coworking space. Both, however, surpassed hackerspace by 2014. Globally, the shift to coworking space has been more drastic (see Figure 2). Around the year 2016, coworking space began to outpace makerspace in Google searches worldwide.

Figure 1. Comparative Frequency of Google Searches in the U.S.

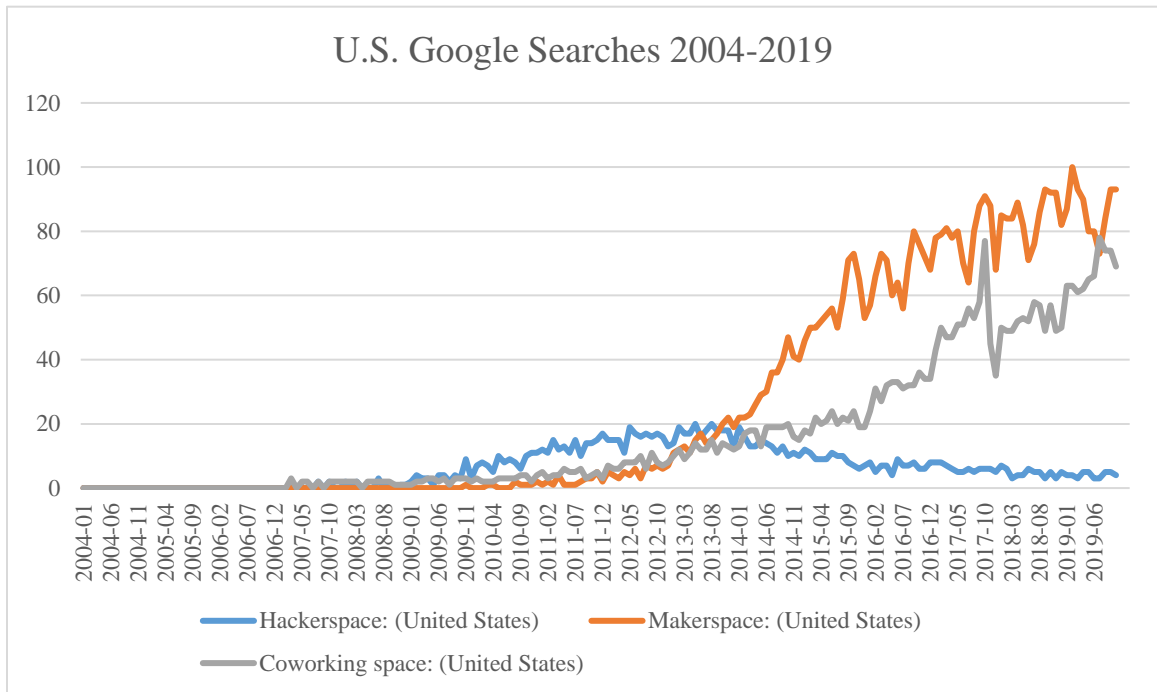
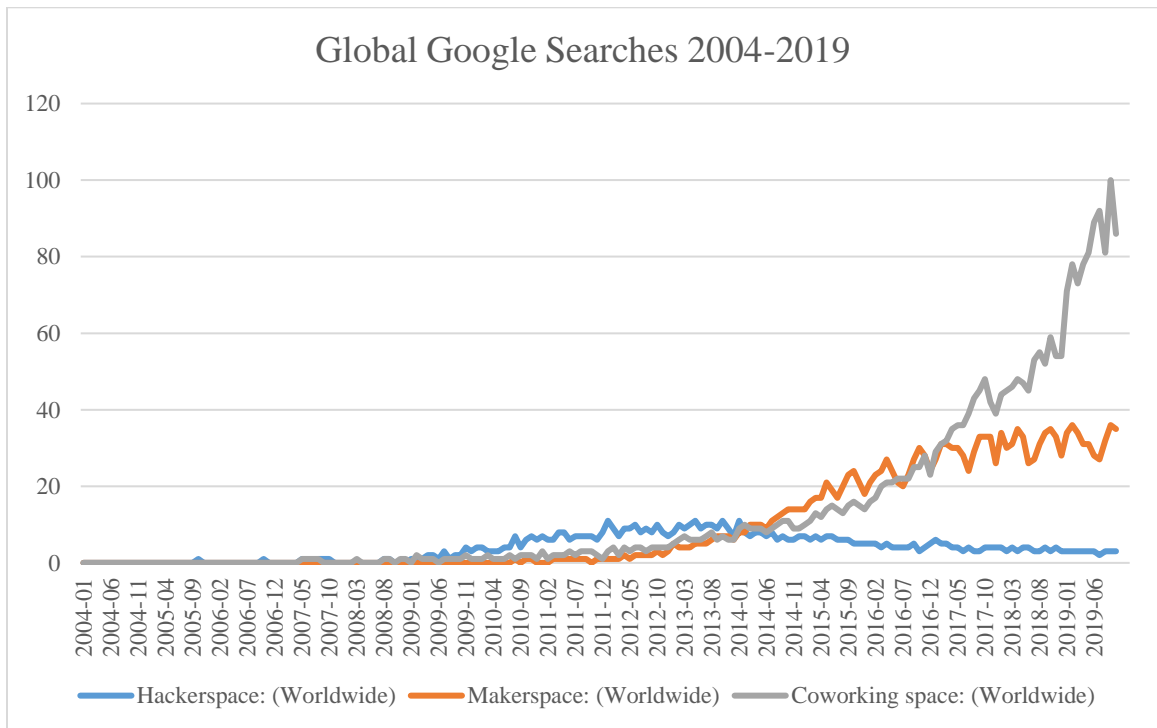


Figure 2. Comparative Frequency of Google Searches Worldwide



Making (A) Difference

Many find promise in maker models to advance the goals of progressive education and to foster technological literacy and stimulate interest in Science, Technology, Engineering, and Math (STEM) fields—particularly for underrepresented populations (Barton, Tan, & Greenberg, 2016; Rees, Olson, Schweik, Brewer, 2015). Scholars and practitioners offer several critiques that temper these optimistic accounts of the transformative potential of makerspaces, however. While the development of makerspaces indicates a move to more flexible spaces of learning, they may increase rather than address participation gaps in media and technology cultures.

The changes to manufacturing patterns and the creation or transformation of jobs related to technology may exacerbate forms of labor inequality. Citing similar patterns found by scholars in Silicon Valley, Eubanks (2011) found that flexible forms of labor brought about by the influx of high-tech jobs in Troy, New York led to more precarious working conditions for poor and working-class women there. Moreover, in her critical essay, “Why I Am Not a Maker,” engineering professor Debbie Chachra (2015) explains how an emphasis on creation obfuscates the “invisible structure of labor” that supports making such as the work of analysts, teachers, and caregivers. Understanding how the localized patterns of labor and employment relate to participation in maker practices is thus crucial to understanding their transformative potential.

From an education standpoint, a focus on broadening participation in dominant or popular conceptions of what The Maker Movement entails (e.g. robotics) may erase or delegitimize other forms of making (e.g. repair) (Vossoughi, Hooper, & Escudé, 2016). Rather than democratizing participation in media, design, and technical cultures, such an

approach risks reproducing existing educational inequalities by promoting technocratic solutions and devaluing the practices of lower income or rural individuals.

As this brief overview highlights, there was much optimism surrounding the potential of The Maker Movement to democratize engagement with technology, media, and design and advance innovation. While the promise of a concerted Maker Movement may not have come to fruition, collaborative community spaces that promote social and technological inclusion remain. The research literature has charted many social benefits of technological inclusion and largely finds “that individuals’ digital engagements and digital capital play key roles in a range of outcomes, from academic performance to labor market success to entrepreneurship to health services uptake” (Robinson et al., 2015, p. 570). However, as Eubanks’ (2011) work on technology training cautions, “continued emphasis on the development of science and technology as *the* route to greater prosperity and equality for all Americans is a familiar but dangerously underexamined species of magical thinking” (p. xv). This dissertation thereby explores those potentials for transformation with special attention to how emerging practices intersect with social and digital inequalities.

Study Rationale

Through a study of the experiences of makers and makerspace organizers embedded in different institutional structures, this dissertation contributes to debates regarding the transformative potential of the latest trend in public access institutions and industry—multidisciplinary social production spaces. At the broadest level, this study seeks to contribute to the project of designing approaches to lifelong media and technology education that are both sustainable and inclusive. In the contemporary,

converged (Jenkins, 2006) media and technology environment where consumption and production roles are increasingly blurred, more empirical research is needed to understand how media and technology practices are evolving. This study contributes to that project with a focus on makerspaces, the latest instantiation of efforts to democratize access to the tools and skills that economic, cultural, and educational policy discourses suggest will be necessary for the future. Taking a grounded approach to the actual needs and available resources in local contexts, this study seeks to complicate the optimistic assumptions which suggest makerspaces and maker activities are a panacea for addressing “the digital divide and reduc[ing] existing skill and confidence gaps” (Obama, 2016).

This study interrogates how multidisciplinary social inclusion initiatives may (or may not) create avenues for social mobility. Previous studies on digital divide interventions have called for a focus on the social elements of use to understand how and under what conditions technology is beneficial for historically disadvantaged users (Kvasny & Kiel, 2006; Eubanks, 2011). Kvasny and Kiel (2006), for example, suggest that social access depends, in part, on “the quality of training and opportunities for continued use” (p. 50). Using an ethnographic approach, this study looks specifically at the meso-level social interactions and arrangement in spaces that could contribute to technological inclusion or reproduce existing inequalities. Sims’ (2014) study in a school-based initiative to encourage digital media literacies suggests studies of technological and digital inclusion should conceptualize digital media in ways that explore how particular practices, in context, create social differentiation. Rather than presuming maker communities of practice are motivated by civic, entrepreneurial, or activist goals, or

arguing their activities are intrinsically empowering or exploitive, this study explores the implications of practices that legitimize certain media and technological engagements and delegitimize others. A qualitative methodology that allows for thick description (Geertz, 1973) is best suited to this effort.

This study takes a grounded approach to analyzing the practices and policies of the makerspace initiatives at three different institutions through ethnographic case study. The analysis is structured around the communicative ecologies—the technical, social, and discursive contexts—these institutions are embedded within (Foth & Hearn, 2007, p. 9). This approach allows for the identification of gaps in communicative infrastructures and the ways in which local policies shape participation (i.e. technical layer), exploration of social groupings or networks that promote inclusion or exclusion (i.e., the social layer), and gaps between how users, organizers, and other community stakeholders understand the outcomes of participation in these spaces (i.e., the content layer). Through exploration of (1) stakeholder interests in encouraging the development of makerspaces and (2) the actual practices that occur in these spaces, this project will advance understanding on what kinds of opportunities are opened and foreclosed by different approaches.

Conclusion

This dissertation critically examines the potentials of these multidisciplinary social production spaces to influence existing institutional practices and democratize participation in technological development by interrogating the role of makerspaces in their local communicative ecologies. Chapter 2 offers a review of the literature related both to the biases and underlying perspectives of inclusion initiatives as well as the maker phenomenon specifically. The chapter ends with a theoretical framework that builds on

Foth and Hearn's (2007) communicative ecology approach to provide an analytical framework applicable to makerspaces or similar collaborative design initiatives. Chapter 3 offers a description of the study's methods and articulates the research questions that guided the analysis. More specifically, the chapter details the evolution of the project from initial entry into the scene, through the data collection and analysis phase, and offers some initial insight regarding the challenges of grounded research in a changing media ecology. Chapter 4 uses qualitative textual analysis of interviews with participants in the maker scene and mission statements from makerspaces in Massachusetts to capture the breadth of "access" concerns that give rise to maker models. Chapters 5, 6, and 7 are in-depth case studies of three different institutions that adopted makerspace models. Chapter 8 provides a cross-case analysis that brings the three case studies into conversation with the larger media ecology and technological literacy frameworks. The discussion in Chapter 9 responds to the study's research questions by reflecting on the relevant tensions observed in the case studies. Finally, Chapter 10 offers a concise summary of how this dissertation contributes to the field and to future media and technological literacy initiatives. Chapter 10 also offers reflections on methodological limitations and directions for future research.

Over the five-year period between the design of this study and the final write up, the overarching research questions related to technological literacies and digital inclusion became more pressing. As the world worked to stop the spread of the novel COVID-19 pandemic in the spring of 2020, social, economic, and educational life moved almost entirely online. This crisis highlighted the importance of resilient public institutions to serve the common good and led to renewed public concern for the very real technological

inequalities facing Americans. Though perhaps more visible in times of crisis, these technological inequalities are persistent and pervasive. Scholars, educators, and policy makers must therefore constantly interrogate the approaches we forward regarding learning through and about technology.

CHAPTER 2

LITERATURE REVIEW & THEORETICAL FRAMEWORK

A Divided Discourse

To support meaningful adoption of ICTs among adults who cannot benefit from the formal instruction youth do in schools, scholars have offered various ways to capture ICT “skills” (van Dijk and van Deursen, 2014) or analyze “digital readiness” (Horrigan, 2016). However, to be fully included in the current media and technological ecology, individuals need not only the knowledge to use products and services that benefit them, but also the opportunity to engage with the processes of product and service creation. By prioritizing only the understanding and use of the software and services we risk neglecting literacies related to the materiality of the technologies themselves. Few studies using taxonomies of digital skills are engaging with this question of theoretical technological literacy or skills. One exception is the work by Gui and Argentin (2011) which expands on van Deursen and van Dijk’s operational/formal skills framework to encompass the “theoretical skills” necessary to understand the logics that underpin the digital spaces of users: “Some of these resources...are not of direct use for ordinary activity online but they are nonetheless important for a critical participation in digital environments, in finding creative solutions, and in being aware of the sources of possible problems” (p. 977). Gui and Argentin’s inclusion of “theoretical skills” thereby moves beyond skills for *use* to skills for *shaping* ICT. Conceptualization of technology and media practices must move away from conceiving of individuals as either producers or consumers to capture the complexity of the social realities that shape interactions with media and technology.

Furthermore, research on how individuals and communities experience technological change often attends either to those considered innovators—“early adopters” (Rogers, 2003), “digital natives” (Prensky, 2001), “pioneering collectivities” (Hepp, 2016), etc.—or those feared to be at risk of not adopting new technologies or inventions —“have-nots” (NTIA, 1995), “know-nots” (UNDP, 1999), and “dropouts” (Rice & Katz, 2003), etc. Drori (2010) has critiqued this “bifurcation” regarding the impacts of technological change between these supposed “laggards and leaders” globally (p. 64):

[C]urrent discussions of the global digital divide and the global innovation divide are completely separate from each other: attention is split between concern for the impeded access of the poor to ICT, on the one hand, and the race to lead the world in creating the next “hot” technology, on the other. (p.80)

Drori (2010) further argues that this policy split between studies of the digital divide and innovation divide lead to very different assumptions about the role of technology in development. For example, scholars have critiqued the tendency to approach development as an innovation problem because it foregrounds entrepreneurship and the market over citizenship and well-being (Jiménez & Zheng, 2018).

On the one hand, researchers and policy makers in the U.S. are concerned with “digital divides” or, more recently, “digital inequalities,” regarding the information and communication needs brought about by the ever-changing ICT landscape (DiMaggio, Hargittai, Celeste, & Shafer, 2004; Robinson et al., 2015). Broadly speaking, this branch of research and policy making addresses inclusion at the individual level. Such research has found that divides in access to and use of ICTs persist in the U.S. For example, of individuals with incomes less than \$30,000 a year, only 56% have home broadband, only 54% have a computer or laptop, and only 71% have a smartphone (Anderson & Kumar,

2019). Given these disparities, how can the U.S. ensure all individuals and communities can reap the benefits—and avoid the harms—of technological change? Alternatively, there is interest in *promoting* technological development through fostering entrepreneurship and emphasizing research and development (DeVol, Lee, & Ratnatunga, 2016; Sachs, 2003). Again, broadly speaking, this branch of research and policy making concerns innovation and is more often aimed at meso- and macro-level analyses. Indeed, scholars have highlighted the tendency of innovation studies to focus on economic and technological issues while the people involved in innovation are rendered invisible (Agnete Alsos, Ljunggren, & Hytti, 2013 as cited in Jiménez & Zheng, 2017). This approach asks: How can a region attract high-tech industry and create jobs? Or, more charitably, how can technological change be leveraged to address the problems of individuals and communities? While there are clear differences between the concerns of inclusion and innovation as well as contradictions inherent in these goals, both look to education reforms or media and technological literacy training initiatives for solutions.

Funding sources, institutional pressures, and larger policy discourses may force media and technological literacy training initiatives to attempt to simultaneously tackle goals of inclusion and innovation. This focus merely on individual access to educational opportunities often ignores the cultural and structural inequalities that lead to exclusion in the first place. Such a scenario can be likened to the “double bind” educational researchers found in Europe regarding media and information literacy initiatives. Namely, that cultivating such literacies is “on the one hand, an opportunity for collective critical citizenship, on the other hand, a tool for increased neo-liberalism, individualism and marketization” (Drotner, Frau-Meigs, Kotilainen, & Uusitalo, 2017, p. 269). To

further explore this “double bind,” in what follows, I first review existing literature surrounding approaches to the “innovation divide” and the “digital divide.” Next, I draw on science and technology studies and digital inclusion literature to explore how “makerspaces” may serve as a contemporary example of an intermediary where concerns with innovation and inclusion are negotiated. Finally, I argue for a situated, communicative ecology approach to improve the design of digital and technological literacy initiatives.

Approaches to the Innovation Divide

The innovation literature is vast and spans many disciplines. Globally, the innovation divide refers to the “gap in technology creation and thus in ownership of the related intellectual property” (Drori, 2010, p. 64). One indicator of this divide is the incredible global discrepancy in patent applications (Sachs, 2003). Statistics from the World Intellectual Property Organization (2018), for example, show that “China, the U.S., Japan, the Republic of Korea, and the European Patent Office received 84% of the 3.1 million [patent] applications in 2016. The office of China alone received 42.8% of applications.” While such inter-country analyses position the United States as a global innovator, economists in the United States have identified intra-country innovation divides due to uneven regional development of high-tech industry. Unsurprisingly, this line of research has a decidedly neo-liberal and “pro-innovation bias” (Godin & Vinck, 2017).

Efforts to analyze “innovativeness” in the U.S. are largely based in exploring the institutions and processes that support productivity and skill among the workforce. In the U.S., the Milken Institute, the think tank of the “junk bond king” Michael R. Milken, has

created an index to capture innovativeness by state. They have consistently found Massachusetts, Colorado, Maryland, and California to be among the states with the highest “science and technology capabilities and broader commercialization ecosystems” (DeVol, Lee, & Ratnatunga, 2016, p.1). West Virginia, Arkansas, and Mississippi, meanwhile, were found to be the lowest performing states in 2016. The Milken Institute ranks states using their State Technology and Science Index (STSI), a benchmark measuring a state’s “innovation pipeline” (p. 1). The STSI uses the following five composites to create its rankings: “Research and Development Inputs,” “Risk Capital and Entrepreneurial Infrastructure,” “Human Capital Investment,” “Technology and Science Workforce,” and “Technology Concentration and Dynamism” (p. 9). A state’s comparative “innovativeness” is thereby evaluated by its various governance structures, its workforce training environment, and its current and future promise as a site of high-tech industry.

On a state-level, economic development initiatives in the U.S. have turned their attention to revitalizing older industrial cities to create jobs in the high-tech sector. A report from the Brookings Institute, for example, discussed the challenges faced by the nation’s 70 “older industrial cities” which previously depended upon manufacturing for employment and which were largely “not sharing in the dynamic growth of high-tech companies and jobs” (Berube & Murray, 2018, p. 2). The Brookings Institute report emphasizes the role of human capital in contributing to a city’s economic future and thus measures economic development in terms of growth, prosperity, and inclusion. Using this framework, the institute identified 16 Strong, 24 Emerging, 16 Stabilizing, and 14 Vulnerable older industrial cities in the United States (p. 34).

Initiatives to close such innovation divides are often focused on creating “innovation centers,” initiating infrastructure reforms, and fostering a culture of creativity and entrepreneurship (Drori, 2010, p. 79). One prominent approach that emerged in the 1990s to address this divide is the policy emphasis on fostering a “creative economy”:

[T]o compete in the new creative economy, cities should seek to encourage creative industry clusters, incubate learning and knowledge economies, maximize networks with other successful places and companies, value and reward innovation, and aggressively campaign to attract the ‘creative class’ as residents. (Kong, 2014, pp. 273-274)

Richard Florida, for example, posited that the economic shifts observed after the 1950s were primarily driven by creativity and the rise of a Creative Class. According to Florida’s definition, the Creative Class, “whether they are artists or engineers, musicians or computer scientists, writers or entrepreneurs—share a common ethos that values creativity, individuality, difference, and merit” (2014, p. 8). Leadbetter and Miller (2004), meanwhile, praise the rise of “Pro-Ams” or “innovative, committed and networked amateurs working to professional standards” (Leadbetter & Miller, 2004, p. 9). While scholars have critiqued the concept of a coherent, singular Creative Class and questioned the causal connection between Florida’s criteria and economic development (e.g., Berry, 2005; Markusen, 2006), such formulations have encouraged economic development policy to focus on creativity and entrepreneurship to encourage innovation. The “smart city” discourse is a contemporary example of this conceptualization of innovation for urban development. Hallmarks of the “smart city” discourse include emphasizing the cultural or creative industries, building networked infrastructure with the latest in ICTs, and fostering entrepreneurship (Hollands, 2008).

Education policy has also been mobilized to address concerns with the innovation divide. Following the National Research Council's (2002) report, *Technically Speaking: Why All Americans Need to Know More About Technology*, advocates and organizations such as the National Governor's Association connected technological literacy to advancements in U.S. economic competitiveness and the country began directing more funding toward Science, Technology, Engineering, and Math (STEM) initiatives (Fitzpatrick, 2007). Recently, aptitude in creative design-thinking has been heralded as an important and logical addition to traditional components of STEM learning. The acronym STEAM (i.e. Science, Technology, Engineering, Arts, and Mathematics) has arisen out of this discourse. According to a leading proponent of this pairing, John Maeda, "[A]rt and design are poised to transform our economy in the 21st century like science and technology did in the last century, and the STEAM movement is an opportunity for America to sustain its role as innovator of the world" (Maeda, 2013).

Education policy recommendations have largely focused on the following areas of concern: (1) K-12 STEM education, (2) the recruitment of K-12 STEM educators, (3) professional development or the "retooling" of existing STEM educators, (4) increasing STEM degrees awarded, and (5) graduate and post-graduate research support (Kuenzi, 2008, p. 27). To coordinate these efforts, President George W. Bush signed the America COMPETES Act (i.e. America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science) in 2007. This act, which was reauthorized by President Barack Obama in 2010, tasks the Office of Science and Technology Policy with managing STEM educational programming to promote a more skilled workforce in service of U.S. research and development (America COMPETES

Act, 2010). In the words of Mark Sanders, a STEM faculty member at Virginia Polytechnic Institute, it was during this period in the early 2000s that “STEMmania set in” (Sanders, 2009, p. 20).

The prevailing policy focus in the U.S. on STEM, creativity, and entrepreneurship foregrounds the cultivation of human capital in service of R&D and employment. While such a focus speaks to the democratization of access to production, it does so primarily in service of the market. Indeed, Garnham’s (2005) analysis of the policy shift in the U.K. in the late nineties from a discourse of the “cultural industries” to the “creative industries,” emphasizes how an “artist-centred, supply-side cultural support policy” shifts focus from access and quality to “jobs and export earnings in a competitive global economy” (pp. 27-28).

Approaches to the Digital Divide

The diffusionist approach that dominated early research and policy on the digital divide was similarly focused on supply-side concerns as it tracked uneven access to ICTs between the “have” and “have-nots” along a variety of demographic dimensions (Norris, 2001). Though a “digital divide” between those with and without access to technologies is often preferred in political rhetoric as it is “easily defined and, as a result, easily closed, bridged and overcome” (Selwyn, 2004, p. 345), research on technological inequalities has largely shifted from “digital divides” in *access* to technologies to explorations of “digital inequalities” which address broader conceptions of social inclusion and exclusion in the network society (Castells, 2011; Warschauer, 2002, 2004; DiMaggio, Hargittai, Celeste, & Shafer, 2004; Selwyn, 2004). Rather than a strictly technological problem of diffusion, it has been reframed as a social and political issue (van Dijk, 2005). As the 2020

COVID-19 pandemic underscored, uneven access to technologies and services is still a concern. In addressing the fundamental problems of access, researchers are now also engaging with complex social, political, and economic factors that relate to differentiated experiences among those *with* access (Fuentes-Bautista & Olson, 2018). Such studies have investigated usage and purposeful non-usage patterns (Hargittai & Walejko, 2008; Schradie, 2011; Baker, Hanson, & Hunsinger, 2013), the sites of use (Hassani, 2006), the availability and type of social support (DiMaggio et al. 2004; Newholm, Keeling, McGoldrick, Macaulay, & Doherty, 2008), and the know-how needed to engage the content and logics of technologies themselves (Warschauer, 2002, 2004; Hargittai, 2008, 2010). Despite the varied dimensions which contribute to digital inequality, policy interventions have largely focused on supply-side concerns such as broadband infrastructure with less attention being paid to literacy initiatives and community organizations which support sustainable adoption for effective use (Fuentes-Bautista & Olson, 2018).

In the United States, the first *Falling Through the Net* report in the mid-nineties by the National Telecommunications and Information Association (NTIA) suggested “community access centers” be set up in response to the uneven access to telecommunication infrastructure among different geographic regions (NTIA, 1995). However, when policy concerns with Internet access divides began to wane in the U.S., funding for public access sites such as community technology centers (CTCs) were largely cut. Kvasny and Keil (2006) describe this downturn during the early 2000s in the U.S. in detail:

[T]he Technology Opportunities Program did not receive appropriations for fiscal year 2005, and funding for the Community Technology Center (CTC) programme

was reduced from \$32 million in 2002 and 2003 to \$10 million in 2004, and to \$5 million in 2005. The proposed budget for fiscal year 2006 eliminates funding to several educational technology programmes such as Enhancing Education Through Technology, Star Schools and CTCs. (p. 26)

While community organizations and libraries remain important sites of public access and social support, Wi-Fi hotspots and municipal Wi-Fi networks have become a common approach to addressing access concerns. However, the few studies that have explored wireless access to address digital divides have found that this approach often does not meet the multi-faceted communicative needs of disadvantaged groups (Fuentes-Bautista & Inagaki 2006; Fuentes-Bautista & Olson, 2018). Moving forward, investment in long-term initiatives which are compatible with local needs and which make use of existing community assets have a better chance of addressing the constantly evolving challenges of technological changes. The divided discourse between causes and implications of the “digital divide” and the “innovation divide” is echoed in discussions of educational reforms and literacy initiatives related to media and technology. This creates a conceptual divide between technology and media initiatives directed at *users* (e.g. technology training workshops and media literacy programs) and initiatives directed at *producers* (e.g. hackathons and media arts programs)². The spaces, both physical and conceptual, where these concerns meet thereby become crucial sites of negotiation. The makerspace is one such site.

² While digital inequalities research has addressed participatory divides, such divides have primarily been conceived of in terms of content creation (Correa 2010; Hargittai & Walejko 2008; Schradie, 2011), rather than of participation in the invention and governance of media and technology.

Makerspace as Intermediary

The Maker Movement describes a rise in the cultural significance of Do-It-Yourself (DIY)/Do-It-Together (DIT) cultures where design, media, and technology meet. The term “making” has been used to refer to activities as varied as metalworking, software programming, and fiber arts. While these activities have long histories, they have recently been subsumed under the heading of “making” to give coherence to a trend in small-scale creation of “things that previously were the express domain of corporate design, engineering, and production teams” (Krebs, 2014, p.1). Sivek’s (2011) textual analysis of *Make* magazine, a publication central to the “Maker Movement³,” defined the tenets of making as putting “emphasis on knowledge and design as something to be shared openly, rather than restricted for the purpose of individual monetary gain or esteem” (p. 202). The physical sites of these activities are called “makerspaces.”

Many of the most celebrated makerspaces are in urban technology hubs like New York (e.g. *NYC Resistor*), Boston (e.g. *Artisan’s Asylum*), and San Francisco (e.g. *Noisebridge*). Support for makerspaces has reached beyond high-tech urban centers, however. Many public institutions throughout the U.S. like museums, libraries, and schools have started makerspaces to promote Science, Technology, Engineering, and Math (STEM) education, technological innovation, and foster community development (Schön, Ebner, & Kumar, 2014; Sheridan et al., 2014). Much like the community technology centers (CTCs) of the 1990s and early 2000s which were set up in the U.S. in response to the need for public internet access, makerspaces are often praised as sites of

³ *Make* magazine’s website suggests their first publication in 2005 is responsible for the popularity of the term “maker.”

public access. Many makerspaces offer, for example, access to technologies which are prohibitively expensive to own or which require extensive workshop space. More importantly, these spaces provide opportunities for skill sharing and social support for their local communities. These sites of creative exchange thereby serve as intermediaries, shaping the way emerging technologies and production practices come to be embedded in locales. They also play an important role in sustaining or undermining social differentiation around technology creation and use.

An inclusive approach for makerspaces would refocus on the practices of individuals and communities to avoid some of issues found in the larger “innovation divide” and “digital divide” discourses. Rather than technological diffusion or regional economic performance as the primary measures of development, initiatives could draw from literature based in Amartya Sen’s (2001) capability approach to highlight wellbeing. Sen’s capability approach focuses on freedoms or “the expansion of the ‘capabilities’ of persons to live the kind of lives they value” (2001, p. 18). In their study of a Technology and Innovation Hub in Africa, Jiménez and Zheng (2017) used the capability approach to re-center the human in studies of innovation and development. They assert, “innovation is not just a process to empower individuals to become entrepreneurial actors, but also the process by which people develop capabilities in multiple aspects of their agency and well-being” (p. 19). According to O’Donovan and Smith (2020) makerspace-specific capabilities include:

- (1) The capability to skilfully [sic] make and do
- (2) The capability to assume and perform a valued maker identity
- (3) The capability to establish and maintain maker community
- (4) The capability to sustain livelihood
- (5) The capability to modify one’s place in the world
- (6) The capability to participate in material culture. (p. 70)

Given their variety, each makerspace offers unique forms of support for the expansion of these capabilities.

The digital inclusion literature has long emphasized the importance of community access organizations like CTCs and libraries for social support around the adoption of new technology, particularly for marginalized populations. Powell, Bryne, and Dailey (2010), for example, took a qualitative approach to broadband adoption in low-income communities and though they found a strong preference for internet access at home, marginalized populations frequently made use of “third places” (Oldenburg, 1989) like libraries and community centers for access. Qualitative studies of these spaces have repeatedly emphasized the importance of contextual factors in assuring effective use of ICTs (Powell, 2007). The non-technical aspects of these spaces that make them most effective for the populations they serve include the variety of activities offered, their image, their accessibility, and their social scenes (Davies, Wiley-Schwartz, Pinkett, & Servon, 2003). For instance, Park (2014) explored the “path to digital engagement” in a telecentre in Australia and found a crucial factor for inclusion was “providing an immersive digital learning space in which non-users can freely practise and learn to adapt to the changing technological environment” (p. 137). Rhinesmith (2012), meanwhile, found that “support, trust, safety, and respect” were crucial to encouraging the use of the library internet hotspots he studied in Philadelphia (p. 2547).

Like other media and technology focused “third spaces,” makerspaces can foster new connections between community members. Additionally, they can link community members with other organizations to advance their goals such as educational or

employment opportunities. Makerspaces also have the potential to reinvigorate commons-based production practices by connecting citizens and enabling collective solutions to local problems (Niaros, Kostakis, & Drechsler, 2017). Makerspaces can therefore serve the dual role of being sites of *access* to media, technology, and design practices as well as sites of *recognition* for members who can connect to larger organizations, grow their social networks, and take on leadership roles. Physical makerspaces thereby serve as intermediaries, filtering various discourses and establishing localized practices related to emerging technologies such as digital media tools, desktop manufacturing devices, and open source hardware. Understanding how these social spaces relate to practices which may span various locales both on- and off-line is thus crucial for understanding the social and cultural significance of makerspaces as a tool of inclusion.

Boundary Concepts

The dynamic practices involved in making are not suited to a single or static definition. Cultural studies scholars would refer to such a phenomenon as a cultural “scene.” Ortner’s (2013) conceptualization of a “scene” is useful to describe how participants understand makerspaces in practice. Ortner describes a scene as “a space of collectiveness, of mutual pleasure and mutual recognition...the *idea* of a scene is the idea of a positively shared social and cultural world, ‘a community of taste’...” (2013, p. 91-92). Scenes are therefore dispersed but recognizable to those connected to them. Similar to Culton and Holtzman’s (2010) work on the DIY punk music scene in Long Island, the maker scene is defined both by its “intrinsic qualities” as described by members but also in how it is positioned as an “alternative” to similar scenes (p. 274-275). Defining what

the scene's qualities are, and what kind of activities or associations it distances itself from, is the continual boundary marking process of creating and sustaining a scene.

A political economy perspective on a similar phenomenon has been offered by Powell (2012, 2015) who draws on the concept of “boundary objects” (Star, 2002) from science and technology studies:

These are objects that dwell in more than one community of practice – a discipline, or a line of work, or a voluntary association. They have two important properties: they are loosely structured in common use, and become more tightly bound in particular locations. They are thus both ambiguous and clear, at different moments, for different purposes. (Star, 2002, p. 118)

Powell (2015) applied the idea of a boundary object to open source hardware licenses to explore “the negotiation between a mode of knowledge formation that valorizes distributed, peer produced knowledge and one that is attached to institutional legitimacy” (p. 391). Other STS scholars have extended this idea from “objects” to “concepts.” Löwy (1992), for example, discusses how boundary concepts allow for professional groups or disciplinary fields to retain their authority over particular practices and expertise while adapting to social changes: “Boundary concepts'... are loosely defined concepts which, precisely because of their vagueness, are adaptable to local sites and may facilitate communication and cooperation” (p. 374-375). Boundary objects or concepts lie at the nexus of various communities of practice and can lead to the creation of new norms or understandings as various knowledge structures meet.

At once a “scene” and a “boundary concept,” makerspaces offer rich opportunities to explore how makerspace initiatives confront and create new norms of knowledge production and circulation. Participants describe the maker scene both in terms of what they do as well as from what associations and institutions they seek to remain

autonomous. The “makerspace” boundary concept, meanwhile, is employed by various disciplines and communities of practice in different ways and towards different ends. The ambiguity of the term becomes more concrete in its local instantiation and thus the discourses or “topics” that circulate in the makerspace help expose the values of the group.

Disputed Terminology

A brief history of the term “makerspace” and how it compares to the history of “hackerspaces” provides an organizing framework to understand the position of these DIY activities alongside other cultural production spheres. Hacking and hackerspaces are fraught with complex connotations related to the varied narratives of the history of these activities. While both Powell (2012) and Coleman (2013b) cite Steven Levy’s 1984 book *Hackers* as one narrative which locates the origins of hacker culture at MIT in the 50s and 60s, they also present alternative histories of production practices that resembled what is now referred to as hacking. Coleman’s (2013b) work on hacker culture, for example, argued that a singular hacker “ethic” obscures the differences she observed in hacker practices and ignores the reality that hacker practices evolved differently in different places and times. Powell (2012), for example, suggests the “antecedents of [hardware hacking activities] include the DIY crafting cultures of mid-century America” (p. 697). Meanwhile, Coleman (2013a) introduced telephone “phreaking” as “another variant” of hacking that began in the 1950s: “Phreakers studied, explored, and entered the phone system by re-creating the audio frequencies that the system used to route calls” (p. 101). Other forms of hardware hacking were also emerging at this time as Hertz and Parikka’s (2012) discussion of the hacking practice of “circuit bending” revealed. Circuit

benders would open devices such as children's toys, connect different circuits, and produce experimental music with the resulting sounds (Hertz & Parikka, 2012). Hertz and Parikka's description of this particular practice exposed an important dimension of hacking; it is unsanctioned: "Circuit bending is an electronic DIY movement undertaken by individuals without formal training or approval and focused on manipulating circuits and changing the taken-for-granted function of the technology" (2012, p. 426). Though hacking is often attributed to work with computers, these alternate histories demonstrate that hacking is not technologically specific. Hacking is therefore aligned with practices that intend to disrupt the "taken-for-granted" by making new connections from existing materials.

"Making," though perhaps a more intuitive term than hacking, has a vague history. *Make* magazine's website suggests their first publication in 2005 is responsible for the rise in the term's popularity. However, variants of DIY making activities have a much longer history. Sivek's textual analysis of *Make* magazine, for instance, likened "making" to the Arts and Crafts Movement before World War I that encouraged handicrafts and "small-scale artisan production" (2011, p. 205). Making is, broadly speaking, a DIY practice blending design, art, and technology for the purposes of innovation and education. The term's lack of specificity and cultural connotations contrast starkly with the discursively laden term "hacking." "Making" and "makerspaces" thus offer much flexibility for the various organizations, communities of practice, and fields that have adopted this terminology.

Divergent Rationales for the Development of Makerspaces

Due to its flexibility and position as a boundary concept, various fields and communities of practice are exploring the potential of makerspaces for their own goals. The literature on makerspaces is therefore fragmented and offers divergent rationales for the development of makerspaces. An analysis of the literature found these rationales could be broadly classified into four key thematic areas: Innovation, DIY, Education, and Community. Throughout the review, I attend to who or what is recognized or erased by such conceptualizations of the purpose of making and makerspaces.

Innovation: Making as Progress

In *The Third Wave*, Toffler (1980) introduced the term “prosumer” in an attempt to capture on-going shifts in consumptive agency. Toffler (1980) referred to production in early agrarian societies where individuals most often produced for their own use as the First Wave. The Second Wave referred to a period of mass production brought about by the Industrial Revolution. The focus of his book, the post-industrial Third Wave, refers to the period after the 1950s when the lines between consumer and producer blurred and consumers became increasingly involved in shaping or customizing products. His explanation thus positions prosumers as both cause and effect of social change:

The rise of the prosumer, powered by the soaring cost of many paid services, by the breakdown of Second Wave service Bureaucracies, by the availability of Third Wave technologies, by the problems of structural unemployment, and by many other converging factors, leads to new work-styles and life arrangements. (Toffler, 1980, p. 293)

Similarly, Arvidsson (2008) identifies three primary reasons for the rise of social production forms in the postwar period: (1) New media increased circulation of consumer goods that were “expressive” of lifestyles and identities, (2) The transition from

industrial- to knowledge-based economies brought about a loss of stable identities, and (3) The growth of a population of skilled graduates with a goal of “active self-realization through productive labor” (p. 328). As both scholars highlight, larger societal shifts influence understandings of labor and leisure and thus have a profound impact on social organization and identity formation.

Chris Anderson’s (2012) oft-cited book, *Makers: The New Industrial Revolution* has gone so far as to deem The Maker Movement, a “New Industrial Revolution” because it has the potential to “reinvent manufacturing, and create jobs along the way” (p. 16). Many of the small-scale, open-source fabrication tools for domestic manufacturing popular within The Maker Movement (e.g., 3D printers, laser cutters, computer numerical control (CNC) machines) collapse the roles of designer, maker, and end-user, thereby returning forms of manufacturing to “the cities, communities and landscapes of consumption” (Richardson, Elliot, & Haylock, 2013, p. 145). These prototyping tools have also transformed labor flows in some industries by allowing for the move to a “‘studio’ model in which groups of engineers and industrial designers could create prototypes in days instead of months” (Blikstein, 2013). How extensively the take up of these technologies will impact the future of manufacturing remains an open question but educational institutions are responding to these future projections by re-envisioning the skills and literacies necessary for employment and citizenship in the 21st century.

Social Production

In addition to larger societal and industry changes related to manufacturing, scholars have offered frameworks for understanding how new “making” arrangements offer opportunities for decentralized forms of social production. Social production activities are “self-organized, emergent, bottom-up phenomena that are not primarily

motivated by monetary concerns” (Arvidsson, 2008, p. 326). Broadly defined, social production includes forms of commons-based peer production (Benkler, 2006), participatory cultures online (Jenkins et al., 2006), as well as “fan culture, social entrepreneurship, local service economies... alternative currencies; and alternative forms of material production, such as community based agriculture” (Arvidsson, 2008, p. 326). Though these activities are not all directly related to ICTs, emergent media have played a significant role in advancing such practices by increasing access to information and networking individuals with similar interests.

The affordances of ICTs and emergent media forms shape possibilities for social production. Zittrain (2006), for example, introduced the term “generativity” to explain the aspects of technology that can promote and accelerate innovation: “generativity increases with the ability of users to generate new, valuable uses that are easy to distribute and are in turn sources of further innovation” (p. 1982). Technologies can be “generative” like the PC which allows users to develop and run software of their own design or function as more secure “appliances” such as Apple’s iPhone (Zittrain, 2006, 2008). Zittrain’s (2006, 2008) work thus emphasizes that the development of ICTs and other technologies relies not only on technological capacities but also on corporate and social interests which intervene in setting regulations.

“Grassroots” social production activities both benefit from and are restricted by industry practices and available media. For example, the ongoing convergence of media supports forms of social production by restructuring how content flows, connecting individuals, encouraging active participation, and mobilizing forms of collective intelligence (Jenkins, 2006). Facilitated by this convergence, media is increasingly

“spreadable,” as individuals play a larger role in circulating, adapting, and transforming media in ways relevant to local contexts and purposes (Jenkins, Ford, Green, 2013).

While these aspects of the media environment may advance social production activities, “economic, social, and geographic divides preclude some communities from having a prominent role in a spreadable media culture” (Jenkins, Ford, & Green, 2013, p. 286).

Critical Perspectives on Social Production

Powell’s (2012) study of open source communities explains how industry has recognized and co-opted the “efficiency of open source processes for software production” while eschewing the political project of supporting knowledge commons which was foundational to early free software communities (p. 692). Moreover, while some celebrate the flattening of hierarchies and removal of gatekeepers in maker models (Gauntlett, 2011) others argue that forms of expertise still structure participation. In her study of DIY radio communities and activism, for example, Dunbar-Hester (2014) found that “unequally distributed expertise” led to very different experiences for participants as some were relegated to cleaning equipment while those with engineering backgrounds did much of the technical labor (p. 26). Similar concern for the division of labor in makerspace initiatives was raised by Fourie and Meyer (2015) who argued that more focus should be put on the expertise offered by those outside the STEM field. They fear, for example, that Library and Information Science students may “merely become the ‘providers and maintainers’ of makerspaces” rather than active participants (p. 523).

Although the research literature on creative production points to several convergences where former boundaries have been blurred (i.e., media convergence, professional/amateur divides, consumer/producer relations, etc.), gaps and inequalities

remain. Policy gaps persist between studies of innovation and Creative Economies and studies of technological and digital inequalities; social production participation patterns are uneven; and rather than disappearing, gatekeeping has taken on new forms.

DIY: Making as Resistance

The editor of *Wired* magazine, Chris Anderson, wrote a piece for *Make* that traces the history of the maker movement to the punk/indie music scene of the 1980s (Anderson, 2014). Radiating with affection and nostalgia, this article describes how punk, and The Maker Movement, were revolutionary because they democratized the tools of production: “Yesterday’s garage bands are today’s garage hardware startups and Kickstarter is the new indie launch pad. Punk’s not dead — it’s just traded electric guitars for soldering irons” (Anderson, 2014). It is not clear, however, that emerging DIY maker practices reflect the resistive and subcultural politics often associated with the “anticorporate and anticonsumerist values” of punk (Willet, 2016, pp. 314-315).

Those who wish to emphasize the “resistive” nature of DIY technological cultures often discuss projects aligned with collectivist movements. For example, in her discussion of DIY “technologies of resistance,” Milberry (2014) describes activism that challenges capitalism by emphasizing values of “freedom, decentralization, heterarchy, autonomy, self-determination, collaboration, collectivism, and mutual aid” (p. 53). Powell’s (2012) review of the variety of relationships between DIY hardware and the market highlights the different degrees of market resistance a DIY project might claim:

[S]teampunk redesigns take place primarily outside of the market, civic projects might well be agnostic to the market, and some forms of re-engineering, for example the dismantling and reconstruction of high-tech devices in the global South, create their own markets. (p. 697)

Broadly conceived, making activities include varied political and economic positions. However, The Maker Movement as forwarded by Maker Media had many corporate partnerships and was thus more closely aligned with hobbyist culture.

Utilitarian and Leisure DIY

Like “Making,” “DIY” is a slippery term as it can refer to many activities and include varied political and social philosophies. Knobel and Lankshear (2010) highlight the various trends of 1960s and 1970s associated with DIY: “anti-consumerist, anticorporatist, environmental, self-reliance, self-actualization, New Age, and subsistence values and practices” (p. 6). DIY practices have historically proliferated at times when non-specialists have more access to tools or practices that they would have previously had to rely on specialists for (Knobel & Lankshear, 2010). A useful framework for understanding DIY activities categorizes the varied practices as either utilitarian or hedonized (Hertz, 2011). Utilitarian DIY relates to repair or creation: “it’s a fix to get something repaired when resources and money are limited” (Hertz, 2011, p. 45). Vossoughi, Hooper, and Escudé (2016) argue this form of DIY has been largely erased by dominant understandings of making: “Working-class folk have not had the luxury of discovering making and tinkering; they’ve been doing it all their lives to survive—and creating exchange networks to facilitate it” (p. xxv). Hedonized DIY, meanwhile, are hobbies undertaken as leisure or enrichment pursuits (Hertz, 2011). Much of the research on making relates to this second category of hedonized DIY. While varied in their aims and politics, these subcultural or alternative practices are often invoked in discussions of making to help frame its spirit or character.

Technological Citizenship and Critique

Research on media-related DIY activities has suggested the need for new understandings of political and social participation as “DIY activities constitute modes of political intervention undertheorized by current concepts of civic engagement” (Deibert, 2014, p. 26). The processes and products of making may invoke social and political critique, demystify technological practices, or expose taken-for-granted assumptions about technology.

Making can be used to demystify technology or make it more transparent for users who increasingly rely on ICTs to mediate their work and social lives. Hertz and Parikka (2012) argue that users often do not understand how technologies function as they are usually encountered as a kind of “black box” - “an object with a particular input that results in a specific output” (p. 428). Producers of technology can use this relationship to their advantage through planned obsolescence, the practice of “artificially decreasing the lifespan of consumer commodities” (Hertz & Parikka, 2012, p. 425). If a user cannot repair a device, she will be forced to replace it. Making has therefore been suggested to give consumers more agency by increasing knowledge on how technologies work and providing the tools to build or repair devices.

Some forms of making are aligned with explicit social change or activist goals. Mann (2014) coined the term “maktivist” to describe individuals who make for social change to resist hegemonic systems such as forms of technological surveillance. One illustrative example of maktivism offered by Mann (2014) is the creation of a “griefcase,” a briefcase that will open for anyone but its owner thus submitting security guards to a fingerprint scan if they wish to check its contents. Maktivism, Mann (2014) explains, “often involves the moral, ethical, and lawful (‘white hat’) elements of the ‘hacker’ ethos,

but not necessarily the illegal ‘cracker’ ethos. Maktivism combines the DIY (do-it-yourself) ethos of home renovation with the DIT (do-it-together) ethos of the GNU Linux and Free Software movement” (p. 30). Conceived of as a political project, Mann (2014) suggests that making borrows from several subcultural practices. The constellation of elements selected by Mann (2014) to capture the ethos of “making” are not universal, however.

Rosner’s (2014) study of two public sites of repair, the Fixit Clinic and the Repair Café, reveals how similar civic technology projects may have different ethics and thus divergent aims. Rosner found that the Fixit Clinic members ascribed to liberal democratic ideals that valorize individualism while the Repair Café had a sustainability focus which promoted an ethics of care. These different bases led to divergent missions: “Members of the Fixit Clinic promote technical innovation and educational reform, while members of the Repair Café disseminate services for environmental care” (Rosner, 2014, p. 55). These differences are significant as they shape the transformative or emancipatory potential of an initiative.

Critical Perspectives on DIY

DIY practices do not always stand in stark opposition to consumer practices. Hackers, for example, occupy a conceptual space “situated in between a social movement, with a common history, a collective identity and shared goals, and a multiplicity of users, who lack such defining traits” (Söderberg & Delfanti, 2015, p. 3). DIY practices related to fandoms may be positioned between subcultural practices and more mainstream commercial engagement (Jenkins, 2014). Open source hardware production has a similarly ambivalent relationship to the market as the online spaces used

to exchange knowledge and designs are often commercial (Powell, 2012). Connections between DIY and corporate or market interests are therefore difficult to parse. Even for scholars who acknowledge commercial co-optation, the future is not necessarily bleak:

My argument is that maker culture has been co-opted by consumer hobby culture, but this is not necessarily detrimental because it provides an important outlet for personal exploration, increases an understanding of how electronic media actually works and assists individuals to be actors in a culture that is increasingly complex, technological and digitized. (Hertz, 2011, p. 44)

Understanding how the interests of varied stakeholders shape practices on a local level may provide a better view of the future implications of DIY making.

DIY practices are often aligned with the move from positions of passivity as consumers to agency through production. Educators, for example, describe making as one way to “disrupt the trend that puts students on the sidelines as consumers rather than producers of technology” (Kafai, Fields, & Searle, 2014, p. 536). This repositioning is crucial for inequities in education as there are “discourses of power that accompany becoming a producer of artifacts, especially when those artifacts use twenty-first-century technologies” (Halverson & Sheridan, 2014, p. 500). Making, however, has been critiqued as a trend rather than a resistive or critical disruption due to its ties to commercial interests and its focus on leisure rather than utilitarian forms of DIY. Other associations such as the connection between the Defense Advanced Research Projects Agency (DARPA) and Maker Media, for example have led many to question if making has lost any resistive edge it may have had by taking funding from powerful corporates and state entities (Altman, 2012; Mann, 2014). As Morozov’s (2014) overview of The Maker Movement for *The New Yorker* aptly acknowledges, “Makers, it appears, are not necessarily troublemakers.”

Education: Making as Learning

The rise in popularity of The Maker Movement with educational researchers and practitioners may be partly responsible for its move away from the fringes and toward the mainstream. Resources for educators intending to incorporate “making” into their curriculum have proliferated rapidly over the last decade. In 2008, building on the success of Neil Gershenfeld’s FabLab spaces for creative production at MIT, Paulo Blikstein created FabLab@School⁴, a model that brings K-12 students into digital fabrication labs to experiment and build (Blikstein, 2013). Subsequently, in 2012, the non-profit Maker Ed was founded to provide resources and training to support maker models for learning (Maker Ed, 2017). In addition to these organizations, numerous blogs, publications, and websites exist that provide tips and lesson plans for educators interested in maker projects for the classroom.

The optimism surrounding The Maker Movement was not confined to formalized education, however. Afterschool programs, museums, community centers, and libraries also provide spaces, tools, or programs to encourage learning through making. Such unstructured opportunities for informal learning have been lauded by varied stakeholders though often toward very different ends. Drotner (2008), for example, outlines three perspectives on informal learning, a liberal discourse that views informal learning as a useful supplement to learning in school, a critical discourse that positions informal learning as an alternative that can be leveraged for social change, and a functionalist discourse that focuses on vocational training as a form of skills-attainment. The discourses surrounding “informal learning” influence perspectives on education more

⁴ Now called FabLearn Labs

broadly as “informal learning immediately conjures up its opposite, namely formal learning” (Drotner, 2008, p.10).

The following sections review the various ways making has been connected to learning in both formal and informal settings. The review begins by tracing the theoretical foundations for the maker model approach to learning. Next, the review explores how making relates to conceptions of technological and media literacy in a changing media ecology. The final section interrogates the emphasis on Science, Technology, Engineering, and Math (STEM) education in the U.S. and why makerspaces are heralded as a solution to STEM labor force demands. The review reveals that current research approaches underemphasize the role of pedagogy and forms of social support in informal learning. Moreover, by centering technology, important media literacy dimensions are often elided in favor of an approach that values social and technical skills for workforce development.

Reformist and Progressive Education

The antecedents of a “maker” approach to education can be traced back to progressive educators such as John Dewey in the 20th century and the later constructionist educators such as Seymour Papert. The models suggested by these scholars foreground learning-by-doing and are contrasted with more traditional or transmission-based educational models because of their focus on playful experimentation and inquiry as part of the learning process. Explicitly centering student interest, these models position instructors as facilitators of a process of discovery rather than as an expert or authority.

Constructionism is derived from Deweyan constructivism but emphasizes the sharing of constructed knowledge as an important part of social learning (Halverson & Sheridan, 2014). As Papert and Harel (1991) explain,

Constructionism--the N word as opposed to the V word--shares constructivism's connotation of learning as "building knowledge structures" irrespective of the circumstances of the learning. It then adds the idea that this happens especially felicitously in a context where the learner is consciously engaged in constructing a public entity, whether it's a sand castle on the beach or a theory of the universe. (p. 1)

These learning activities can be supported by new technologies which become “emancipatory tool[s]” (Blikstein, 2013). One such tool, the LEGO Mindstorms kit, was developed by Papert and colleagues to support such learning (Resnick, Ocko, & Papert, 1988). These kits allow users to build and program robots out of LEGO bricks and are popular among educators teaching computational thinking.

The various tools and fabrication devices popular with the maker movement such as the LEGO Mindstorms kit, Arduino prototyping boards, and 3D printers have been heralded as useful educational resources due to their support of constructionist learning models. Nevertheless, such optimism risks “the fetishization of tools such as 3D printers and Arduinos as all that is needed for robust and equitable forms of making” (Vossoughi, Hooper, & Escudé, 2016, p. 224). Understanding the social contexts of use is crucial as technologies are not neutral. In their study of the Lilypad, a microcontroller that can be sewn into fabric to create e-textiles, Bucholz et al. (2014) found that participation involving different tools was gendered. As such, they advocate for “research exploring the vast range of materials and tools being utilized within the emerging Maker movement in order to better understand how cultural expectations materialize as mediated actions and authorize particular tool uses and tool users” (Bucholz et al., 2014, p. 295). How

certain activities are legitimized and mapped on to certain users has important implications for recognition of underrepresented and marginalized groups.

The Maker Movement in education is an extension of the idea that student-centered inquiry and creation (often supported by new technologies) helps to develop flexible, critical thinking and collaborative skills. However, many of the supposed benefits of maker models are difficult to capture with traditional measures. In their review of the maker model literature, Halverson and Sheridan (2014) suggest that such approaches not only teach content but also “practices and mindsets that are not strongly encouraged or covered in school settings, such as engineering design, multi-modal practices, creativity, and the importance of failure and iteration” (p. 3). Blikstein (2013) also offers several “outcomes” such as improving collaborative skills and increasing self-esteem through validating the forms of manual labor they and their parents may already do outside of the classroom. What none of these studies address, however, are the literacies and skills of adults and the spaces where they are most likely to be cultivated.

Mobilities of Learning

Learning, conceived of as a lifelong process, is not synonymous with education or schooling (Halverson and Sheridan, 2014). Researchers have thus begun expanding studies of learning to the many contexts in which people develop capabilities. Drawing on sociocultural learning theory, for example, a mobilities of learning or “connected learning” framework explores processes of learning across peer, interest, and academically oriented contexts (Barton, Tan, Greenberg, 2016; Herr-Stephenson, Rhoten, Perkel & Sims, 2011; Ito et al., 2013). Explicitly critical of a “banking” approach to education which conceives of knowledge as a neutral resource imparted to students, this

approach draws on Friere's (1970) call for learning to be understood as the co-construction of knowledge, culturally situated within an "evolving ecosystem of learning" (Ito et al., 2013, p. 14). For researchers, this approach makes visible "how new routines, ideas, and ways of being become legitimized in practice" (Barton, Tan, Greenberg, 2016, p. 6). Despite the frequent references to "lifelong" learning in the informal learning literature, few studies consider media and technological learning for adults in the nuanced way youth have been studied.

The value in such approaches is that they take seriously the situated experiences of learners. This is an important emphasis as studies of informal or self-directed learning often come from the liberal discourse which suggest that learning is an individual pursuit and thus people will cultivate skills of their choice on their own (Drotner, 2008). Research has shown, however, that informal learning models are not as beneficial for "have-little" students (Matzat & Sadowski, 2012). A focus on the value of learning in spaces outside of educational institutions can therefore lead to a "pull-yourself-up-by-your-bootstraps approach to education" (Vossoughi, Hooper, & Escudé, 2016, p. 222). Moreover, deemphasizing the role of instructors may undermine advancements in pedagogy. Mentorship structures and facilitation are important aspects of a learning environment and thus assuming the tools or spaces themselves will foster learning obscures the role of pedagogy in supporting students.

Digital Skills and Literacies

Engagement with the ICTs that are common to many maker activities requires consideration of how technological and media literacies develop. In 2002, the National Research Council (NRC) brought together experts from the National Academy of

Engineering and the Center for Education to define technological literacy, a concept they argued was “virtually invisible on the national agenda” in the United States (2002, p. viii). This report underscored the benefits of the ability of those even in non-technical roles to make well-informed decisions about technology as consumers, citizens, and as potential leaders in fields such as business or media (National Research Council, 2002). In other words, a technologically literate citizenry would be better prepared to make decisions of collective consequence regarding technological innovations in private and public spheres. Writing from a social justice perspective, Eubanks (2011) offers similar suggestions, arguing the goal of technological literacy initiatives should be to “produce critical technological citizens who can meaningfully engage and critique the technological present and respond to the citizenship and social justice effects of IT” (Eubanks, 2011, p. 30). While the economic and social justice imperatives behind these definitions differ substantially, they both reference a need for well-informed, ethical engagement with technology. This engagement requires a reconceptualization of technologies as at once artifacts, informational sources, and symbolic resources. Aligning technological literacy more closely with media literacy is useful in this effort. Kellner’s (1998) work on media literacy explains the role of symbolic resources in crafting our relations to others and our environment: “Because the media shape attitudes and behavior, provide role models, influence conceptions of proper and improper conduct, and provide crucial cultural and political information, they are an important form of pedagogy and socialization” (Kellner, 1998, p. 109). Media literacy is thus a method of relating to these resources in a more active and reflective way. For example, in the U.S.,

the Center for Media Literacy provides resources for educators that explain the key concepts that should guide engagement with media:

- (1) All media messages are constructed
 - (2) Media messages are constructed using a creative language with its own rules
 - (3) Different people experience the same messages differently
 - (4) Media have imbedded values and points of view
 - (5) Most media are organized to gain profit and power
- (Center for Media Literacy, 2009)

By reflecting on these ideas during engagement with media and technology, users are practicing “critical autonomy” (Masterman, 1985), or the disposition and competency to assess the media without prompting or instruction by others.

An increasingly interactive media ecology requires more than analytical or conceptual literacies, however. Dezuanni (2015) uses Actor Network Theory to suggest that media literacy education has neglected to emphasize the role of materialities in digital media literacy. Dezuanni (2015) offers a “building blocks” model of media literacy that includes, digital materials, media concepts, media production, and media analysis. In this understanding of media literacy, the tools and technologies are crucial agents in the network of activities, practices, and literacies related to technological engagement.

The theoretical frameworks supporting research and policy related to technological and media literacies may reproduce rather than ameliorate social inequalities. Some conceptions of ICT know-how create a false dichotomy between those with and without skills/literacy. They do so by viewing technical skills/literacy as a measurable attribute of an individual user. Bawden (2001) explains how defining literacy, especially in reductionist or dichotomous ways, is problematic as it suggests “there is an opposite of literacy – illiteracy – which may be ‘cured’ by well-defined means, and the

effectiveness of the cure measured” (p. 222). The task of isolating digital skills/literacies to measure them is a conceptual challenge as such skills are interwoven with reading/writing literacies and overall language abilities (Attewell, 2001; Warschauer 2004). Though invaluable in elucidating differentiated usage along various socioeconomic relationships and contexts of use, the treatment of ICT skill as an attribute of individuals may be problematic when applied to the design of educational programs or learning contexts.

STE(a)M Literacy

While workforce development remains a central concern of STEAM education scholars, another branch of research has explored the many inequities experienced by non-dominant groups in STEAM fields. According to a recent National Science Foundation report on science and engineering (S&E) jobs non-dominant groups are underrepresented in S&E employment as compared to their representation in the U.S. population: “Women, persons with disabilities, and underrepresented minority groups—blacks or African Americans, Hispanics or Latinos, and American Indians or Alaska Natives—are underrepresented in science and engineering (S&E)” (National Science Foundation, 2019). Women are similarly underrepresented in the STEM workforce and even women with STEM degrees are less likely than men to go on to work in the STEM field (Beede et al., 2011).

The implications of such disparities reach beyond concerns for U.S. competitiveness and innovation. Citing a report from the National Academy of Engineering (2010), Barton, Tan, and Greenberg (2016) explain how systematic exclusions from STEM fields impact the decision-making power of non-dominant

groups: “[L]ower-income communities of color experience the greatest levels of environmental injustice and often have the least voice in STEM-related decisions affecting their communities” (Barton, Tan, Greenberg, 2016, p. 2).

The educational outcomes of making are wide-ranging and include STEM concepts, design thinking, and the “social and personal competencies” gained from sharing ideas and collaborating to reach common goals (Schön, Ebner, and Kumar, 2014, p. 8). Moreover, this collaborative nature of making can encourage and strengthen social relations and build community (Sheridan et al., 2014). The emphasis on collaboration and common goals also make this a powerful model for higher education. Maker models have been found to build and sustain connections—connections between projects and the mission of the institution, connections between different cohorts through longitudinal projects that span various years, connections between different organizations that collaborate at a distance, and connections to nontechnology areas (Schweik, 2019). Maker-related activities, founded upon the tenets of constructivist learning, have also been offered as a potential solution to STEM disparities (Barton, Tan, Greenberg, 2016). Educational opportunities that connect to and acknowledge students’ interests and concerns outside of the classroom may promote more meaningful engagement for students who feel disconnected from their educational institutions. Additionally, the multi-disciplinary making practices themselves may disrupt common stereotypes about participation in STEM. Bucholz et al. (2014), for example, explored the gendered expectations of technology engagement during a classroom activity using Lilypads, an e-textile microprocessor popular in the maker movement. The Lilypad-based e-textile projects blend fiber arts and electronics by allowing users to sew circuits into fabric.

They found that “the replacement of the traditional circuitry toolkit with new materials and tools like needles, fabric, and conductive thread ruptured traditional gender scripts around electronics and computing” (Bucholz et al, 2014, p. 294).

While the emphasis on student-centered inquiry is an important element of constructivist, connected, and maker models for learning, more research is needed on the role of instructors, facilitators, and mentors in these spaces. If a lack of mentors is one of the reasons for decreased participation in STEM among non-dominant groups, it is important to see if these makerspaces offer such mentorship structures. Research should also attend to questions of learning among adults as educational research has primarily focused on educational institutions and their work with young people. Finally, the literature on “digital media” literacies is an important contribution to studies of maker culture.

Community: Making as Identity

Spaces of learning and exchange are important to social cohesion and makerspaces have been found to foster a sense of identity as part of a group (Sheridan et al. 2014). Given the current nature of fragmented publics in the U.S., the kinds of communities of practice (Lave & Wenger, 1991) that arise around “maker” activities could provide important spaces for sense-making about public issues. In the context of Japan, for example, Krebs (2014) suggested that the collectiveness and connection promised by the Maker Movement could help combat feelings of alienation brought on by the “existential sense of precarity” of life in modern Japan (p. 24). Physical co-location of members in makerspaces can also contribute to identity and community development through forms of reciprocal recognition. Technological cultures which

usually interact remotely online such as the hacker community, for example, find value in face-to-face meetings with likeminded individuals at hacker conferences (Coleman, 2010). These conferences, Coleman (2010) argues, make visible “labor, friendships, events, and objects” that are usually routine and unrecognized in their usual practice (p. 50). However, while physical spaces of connection like a makerspace may be important to feeling of social cohesion for some, they can also be exclusionary and thus further divide.

The Maker Identity

The coherence of “making”—which can encompass activities as varied as cooking and robotics—is maintained through identity-building activities and media. Sivek (2011), for example, offers a critique of how Maker Media’s *Make* magazine and associated Makerfaire events help to forge a “collective identity” for makers that relies on American nationalism, techno-utopianism, and a belief in self-actualization through “making” (p. 2). In addition to the branding and community building efforts of Maker Media, publications such as *Makers: The New Industrial Revolution* by the former editor of *Wired*, Chris Anderson (2012) and *The Maker Movement Manifesto: Rules for Innovation in the New World of Crafters, Hackers, and Tinkerers* by Mark Hatch (2014) foster a sense of collective purpose for makers or, using Hepp’s (2016) terminology, a “condensed ideology” (p. 922).

Maintaining a sense of collectivity despite geographic distance or differences in skillset may promote community, but it also erases difference. Vossoughi, Hooper, and Escudé (2016) summarize, for example, how the “dominant view” of making as focused on innovation deemphasizes “material repair and trade, hacking, making as social or

artistic practice, and economic survival” (p. 208). Importantly, the scholars highlight, it “assumes the universality of European-American middle- and upper-class experiences” by largely ignoring the kinds of making by those who make out of necessity rather than hobby (p. 211). A look to the demographics of The Maker Movement through the lens of the most widely known publication and distributor, Maker Media, supports this critique. Maker Media’s Media Kit (2017) for advertisers provided information on their subscriber base for *Make* magazine and Makermedia.com. The Make Media Kit (2017) revealed that 97% of *Make* magazine readers have a college education and the average maker is 44 years old with a house hold income of \$107K. The online user base, which is 70% male, ranges from 25-44 and is slightly more affluent with an average house hold income of \$119K (Make Media Kit, 2017). What “counts” as making is therefore not merely semantics but an important element of inclusion.

Critical Perspectives on Technology Cultures

While the larger movement has mainly conceived of inclusion in terms of access to tools, spaces, and expertise, some scholars have begun to interrogate who is recognized in technology cultures. Previous ethnographic studies, for example, suggest that “geek” (Dunbar-Hester, 2008) and gender (Nafus, 2012; Reagle, 2012) identities are important to shaping the politics of different technology cultures and, consequently, who participates. Dunbar-Hester (2014) suggests that activism that centers technology is often inherently unequal as it often limits “participation to those already inclined toward affective pleasure in technology” (p. 44). Even the explicitly feminist initiatives studied by Fox, Ulgado and Rosner (2015) struggle over what “openness” and inclusive technological practice means. They found that the feminist hackerspaces they explored created codes of

conduct and entry barriers for members to- perhaps counterintuitively- support inclusivity. Thus, the authors suggest that the hackerspace offered a way to make women's work visible (e.g. motherhood) but in only partial ways by limiting their visibility online or to outsiders.

A Communicative Ecology Approach

Positioned at the intersection of concerns with innovation, DIY activities, education, and community development, makerspaces are the latest site of public technology access tasked with anticipating and meeting the literacy needs of diverse communities. Not only do they serve as a contemporary boundary object for various fields and communities of practice, they also have the potential of integrating concerns with innovation and inclusion. Exploring how individuals and communities produce, consume, and otherwise engage with media and technology as part of this contemporary phenomenon offers important insights into how to design inclusive, capability-enhancing literacy initiatives.

The holistic and situated approach advanced by an ecological model is an important contribution to research on makerspaces as it makes visible the impacts of emerging technologies and social arrangements and can highlight spaces of intervention for initiative design or policy. Many strands of scholarship on media and technology use ecological or environmental metaphors to offer more holistic analyses (for an overview see Treré & Mattoni, 2016). The ecological metaphor, for example, is often used in education research and studies of the digital activities of youth to explore how learning environments can span various physical and digital spaces (Caldwell, Bilandzic, & Foth, 2012; Herr-Stephenson, Rhoten, Perkel, & Sims, 2011; Ito et al., 2010; Ito et al. 2013). In

media studies, Neil Postman is often associated with popularizing the ecological metaphor (Stephens, 2014) through his assertions that “technological change is not additive; it is ecological” (Postman, 1998, p. 4). Postman thereby suggests that the influence or effect of new technologies can be felt throughout society. For this reason, Postman (1998) calls on scholars to be attentive to—and often wary of—technological innovation because the resultant changes are “vast,” “unpredictable,” and “largely irreversible” (p. 4).

Scholars of ICTs for development, meanwhile, have applied a “communicative ecology” framework to try and understand technological changes on a local level (Altheide, 1994; Foth & Hearn, 2007; Hearn, Tacchi, Foth, & Lennie, 2009). The “communicative ecologies” perspective is not as centered on media effects as the media ecology metaphor of Postman because it aims to “extend the meaning of media ecologies as used in the medium theory approach in order to include the structure and context of media uses” (Treré & Mattoni, 2016, p. 294). A communicative ecologies framework allows for the examination of how various technologies and social relationships are navigated in a local context and thus this study will take a “communicative ecologies” approach to capture the dynamics of these makerspace initiatives.

A “communicative ecology” involves three, interrelated layers: a technological layer, a social layer, and a discursive layer (Foth & Hearn, 2007, p. 9). According to Foth and Hearn (2007) the *technological layer* involves the communicative infrastructures and media that enable interaction; the *social layer* involves the association or organization of individuals—their social networks, both formal and informal; and the *discursive layer* is what ideas are communicated in that ecology. The “communicative

ecology” framework is useful for exploring the efficacy of media- and technology-based initiatives in local contexts because it is highly contextualized and offers a more holistic view of the opportunities and challenges faced in those locales:

The concept of communicative ecologies places ICTs in the context of all the ways of communicating that are significant locally, including face to face interaction. It is recognised that any ‘new’ connections and networks (social and technical) that develop as a result of the introduction of individual ICTs will be far more effective if they are somehow interconnected with existing, locally appropriate systems and structures. (Tacchi, 2006, p. 5)

The communicative ecology approach has been used to explore the relationships between ICTs and poverty (Tacchi, 2006), social networks in an inner-city apartment building (Foth & Hearn, 2007), urban food systems (Hearn, Collie, Lyle, Choi, & Foth, 2014), an urban renewal project (Klaebe, Adkins, Foth, & Hearn, 2010), and has been paired with the “boundary objects” concept to explore a mobile makerspace initiative in Australia (Foth, Lankester, and Hughes, 2016).

Framework for Studying the Communicative Ecology of Intermediaries

A communicative ecologies approach which focuses on adult technological literacy practices in makerspaces offers a more holistic account of how meta-level discourses about inclusion and innovation are adopted and adapted at the meso-level by local communities. Adult technological literacy is here conceived of as situated practice. Offering an a priori definition with attributes classifying an individual as “literate” is not appropriate nor the aim. Instead, literacy initiatives should be designed to attend to the various resources an individual needs to engage with new texts and technologies. For example, Luke and Freebody’s (1999) Four Resources Model remains a useful framework for identifying the various “roles” individuals enact during literacy practices such as reading, or in this case, “making.” *Text User*, describes the act of using texts

“functionally by traversing and negotiating the labor and social relations around them” (p. 5). Examples of the Text User role in making include prototyping designs on a 3D printer or documenting software development. The role of *Text Critic* describes the act of “critically analyz[ing] and transform[ing] texts by acting on knowledge that texts are not ideologically natural or neutral” (p. 5). Examples of the Text Critic role in making include choosing software based upon its governance structure (e.g. OSS) or participating in adaptive design for the creation of accessible technologies. The role of *Code Breaker* describes “recognizing and using fundamental features and architecture” of a text (p. 5). Examples of Code Breaker role in making includes using the interface of a design program or understanding the elements of a device’s code. The role of *Meaning Maker* describes “participat[ing] in understanding and composing meaningful written, visual, and spoken texts” (p. 5). Examples of how this applies to making include translating between representational modes (e.g. 2D to 3D renderings) and deconstructing and recombining existing representations to make something new.

Conclusion

The innovation divide literature has largely focused on STEM skills for employment and R&D to increase the global economic standing of the U.S. from a decidedly neo-liberal standpoint. However, the innovation divide literature also raises questions of ownership and technological governance. The social production literature offers insights into grassroots production practices and governance alternatives such as open source, creative commons, and the like that deserve more attention. By focusing on these aspects of innovation, the innovation divide literature could enter conversation with the digital divide literature and its concern with inclusion. The digital divide literature

offers a long history of research on initiatives that address demand-side concerns such as social support systems and literacy initiatives that encourage sustainable adoption of new technologies. Approaching makerspaces as a contemporary example of such initiatives will extend current understandings of how various stakeholders and communities negotiate concerns with innovation and inclusion.

As a boundary concept, makerspaces have attracted the attention of various fields though few studies of the phenomenon offer a communication perspective. Insights from the emerging body of literature on makerspaces call attention to social differentiation around technology practices and forms of expertise, the varied ethics of these spaces of creative exchange, and the constitutive role of pedagogical models in structuring even “informal” learning activities. Furthermore, communication and media theory are integral to the project of extending the notion of media and technological literacy from content creation and use to also include technological logics, design, and medium literacy (Meyrowitz, 1998).

To explore these boundary crossing areas of exchange, a communicative ecology approach offers the appropriate amount of flexibility. It allows for in-depth study of a particular locale without compartmentalizing the focus of analysis (e.g. production or consumption) or assigning strict roles to actors (e.g. producers or consumers). Instead, the entire system of localized interaction is understood as connected. Studying these communicative ecologies requires similarly flexible yet robust methodological approach.

CHAPTER 3

METHODS

This dissertation charts the development of makerspaces in Massachusetts using an ethnographic approach which included participant observation, semi-structured and ethnographic interviews, and document and artifact analysis. In addition to explorations of larger institutional trends in the state, the dissertation offers an in-depth analysis of three public access makerspace initiatives; one supported by an economic/community development project, one organized by a public library, and one imbedded in a public access media center. The chapter begins with an explanation of my research participation including a detailed overview of my entry to the field and the development of the current study's focus. Next, I explain the epistemology of the methodology. The chapter then concludes with a discussion of the data gathering and data analysis practices employed.

Research Participation

This dissertation emerged from participation in “maker” communities beginning in February 2014 and continuing through December 2018. Over this nearly five-year period, I volunteered in three community organizations as they designed and refined their makerspace initiatives: a community media center, an economic/community development project, and a public library. My engagement with maker communities, however, took me beyond the confines of these physical makerspace sites and included visits to spaces of creative exchange throughout the state of Massachusetts, engagement with online resources and communities, and participation in maker-branded events such as the National Maker Faire, World Maker Faire, and Barnes and Noble Mini Maker Faires. My position in the field was constantly in flux due to the “crosscutting and contradictory

personal commitments” that multi-sited ethnographic work inevitably entails (Marcus, 1995, p. 113). Furthermore, due to the inductive, ethnographic approach I took to researching the makerspace phenomenon, my research questions and, resultantly, my research trajectory, evolved significantly over this time. This research trajectory can best be described as a movement through three stages of research: (1) A *preliminary fieldwork* stage consisting of a short-term exploration of the maker phenomenon as understood in one local context, (2) a phase of *refining the research focus* through deep engagement with varied makerspace initiatives and events, and (3) a *data collection and analysis* phase consisting of ethnographic fieldwork to understand the contours of the communicative ecologies of the makerspaces selected for in-depth study (See Table 1).

Table 1. Research Stages

Stage	Sites	Activities
Preliminary Fieldwork February 2014- May 2014	Makerspaces - Community Media Center	- Participant Observation - Focus Group - Document Analysis
Refining the Research Focus May 2014-December 2017	Makerspaces - Community Media Center Project (2014- present) - Economic/Community Development Project (2016- present) - Library Project (2016-present) Outside Events - World Maker Faire in New York - National Maker Faire in Washington DC - Regional Developer Conference - Civic Hackathon	- Space Monitoring - Workshop and Program Facilitation - Event Coordination - Event and Workshop Attendance - Secondary Research

	<ul style="list-style-type: none"> - Community Media Conference - Barnes & Noble Mini Maker Faire <p>Online Spaces</p> <ul style="list-style-type: none"> - Public Lab - Instructables - Sparkfun - Adafruit 	
<p>Data Collection & Analysis for Current Study January 2018- January 2019</p>	<p>Makerspaces</p> <ul style="list-style-type: none"> - Community Media Center Project - Economic/Community Development Project - Library Project - Industry Makerspace - University Makerspace - Community Center for the Arts - Crafts and Arts Center <p>Outside Events</p> <ul style="list-style-type: none"> - Barnes & Noble Maker Event - Regional Developer Conference - University Extension Program's Community Brainstorm Session <p>Online Spaces</p> <ul style="list-style-type: none"> - Public Lab - Instructables - Sparkfun - Adafruit - Thingiverse 	<ul style="list-style-type: none"> - Participant Observation - Semi-structured Interviews - Ethnographic Interviews - Document Analysis - Community Feedback Session as Participant Checks - Space Monitoring - Workshop Facilitation - Event Coordination

Preliminary Fieldwork

Initially, I was interested in the potential of makerspaces to promote digital literacies among youth through media production and thus began observing the activities

of a group of scholars, teachers, local college students and community media producers as they designed a space for the community to explore do-it-yourself (DIY) STEAM (Science, Technology, Engineering, Arts and Design, and Mathematics) activities at a local community media center. After four months of fieldwork from February 2014- May 2014, I continued as an ongoing volunteer at the space, staffing drop-in hours and helping organize workshops. I became the central organizer and a paid facilitator for an after-school program that ran from 2014- 2016 as a partnership between the community media center makerspace and a local middle school. As a participant and volunteer with the group, I represented the community media center's initiative at various community events such as family nights at the local middle school, informational fairs at the local university, and civic hackathons and developer conferences. I also attended the World Makerfaire in 2014 with K-12 and college students who had been working with the initiative and staffed informational tables at the National Makerfaire in 2015 and Barnes and Noble Mini Makerfares in 2015 and 2017.

Refining the Research Focus

My preliminary research and involvement with the maker scene through this community media center encouraged me to explore the larger Massachusetts makerspace network. In the spring of 2016, a faculty member with the extension program of the local university approached the organizers of the Community Media Center Makerspace to consult on ideas for beginning a "pop-up" makerspace in an older industrial city in Massachusetts. This makerspace was initially conceived of as a one-month temporary project in partnership with MassDevelopment but went on to become a permanent initiative. I assisted in designing and facilitating some of the first workshops held in the

Economic/Community Development Project's makerspace in June of 2016 and continued as an occasional workshop host and participant at the space through December 2018.

Through these experiences as a volunteer and participant I learned that adult interest in these spaces was often overlooked or underemphasized in favor of narratives related to the educational potential of making for youth. These impressions were corroborated by Ames and Rosner's (2014) ethnographic study of "Young Maker" repair clinic events in the San Francisco Bay area conducted during the same period. There, the authors found that despite being a youth-focused initiative, only one child attended the Fixit Clinic they observed. Instead, adult volunteers, retirees, and the elderly were the most active participants. My immersion in the maker communities coupled with secondary research regarding the emerging "maker" literature at the time therefore redirected my research focus. My original research questions related to youth, digital literacies, and media production evolved into considerations of how community organization and learning institutions served adult populations through makerspace initiatives.

Data Collection and Data Analysis

Due to this change in research focus, I began to seek out other sites of public access with makerspace initiatives currently in operation. This search led me to a makerspace supported by a public library in the suburbs of Boston which was operating out of a storefront in an indoor mall. In December of 2016, I joined the volunteer team of this initiative and continued to serve as an occasional volunteer space monitor, program facilitator, and workshop participant until December 2018. Originally, I intended to conduct in-depth case studies of four sites: The Community Media Center Makerspace,

the Community Development Makerspace, the Library Makerspace, and an Industry Makerspace in a consumer electronics company. The Industry Makerspace was a unique example of an informal learning space for adults. It was open to employees from any department in the company and offered free use of advanced equipment for their own, personal projects. Unfortunately, access to the Industry Makerspace was much more restrictive than I was aware of during the design of the study. To visit the makerspace, I always had to be accompanied by an employee as there were company activities and projects occurring in, and adjacent to, the makerspace. While my contact at the Industry Makerspace was a lead member of the development team of the makerspace, he was firstly an employee of the company. After my first visit and tour, it was clear that on-going visits to this space would not be feasible as it would burden the employees who would be tasked with accompanying me during observations. The data collection and analysis thus included only three of the original four sites: The Community Media Center Makerspace, the Community Development Makerspace, and the Library Makerspace.

Data collection for the current study began after obtaining clearance from the University of Massachusetts Institutional Review Board's Human Subjects Research Review in January, 2018. The specific makerspace sites have been anonymized to protect the anonymity of the organizational leaders I interviewed. Interview participants were asked to provide a pseudonym, or I would provide one for them. They could also elect to use their own names.

Methodology

Foundationally, this dissertation takes a critical sociocultural approach that theorizes communication as a way of producing the social and which must necessarily

contend with questions of power in order to understand social inclusion/exclusion (Craig, 1999). This dissertation takes a “segmented institutionalist approach” to the analysis of uses of technology (Kling, 1980, p. 63). Although Kling’s (1980) early review of the literature focused more narrowly on the social consequences of computing in organizations and public life, his overview of this approach remains highly applicable to the contemporary project:

Rather than assume a consensus on important goals and values, segmented institutionalists assume that intergroup conflict is as likely as cooperation unless the contrary is empirically demonstrated. They identify as dominant values the sovereignty of individuals and groups over critical aspects of their lives, the integrity of individuals, and social equity; economic or organizational efficiency is subservient to these values. They typically identify settings of computer use as broad in scope, and they are likely to emphasize parties other than the computer user (e.g., clients, regulators, suppliers, competitors, or controllers of critical resources). (Kling, 1980, p. 65)

For this study, the “segmented institutionalist approach” has much to offer how I both conceptualized and experienced organizational policy change during my role as participant observer. As the segmented institutionalist approach suggests, research regarding organizational policy should not assume that there are shared goals among all stakeholders or that all technologies and infrastructures work toward a common, efficient realization of those goals. Across makerspace case studies, I witnessed conflicting goals between participants and organizers, between institutional leadership and coordinators, and between the larger “maker” scene and its local instantiations. The goals and policies of many of the makerspaces also changed significantly over time. Studying organizational policy in practice, over time, means confronting change and conflict. This reality is a methodological *problem* when it is assumed a study should offer a clear map of the efficient processes an organization can adopt for success (and that there is a

consensus on what success means). This reality is a methodological *asset* when a study intends to offer an understanding of the contingencies of policies and practices for organizations aiming to be sustainable during times of conflict and change. When I was asked by organizations and individuals what I found to be successful examples of makerspaces or the “best” ways to run a workshop, I answered by way of offering the trade-offs I had witnessed. This study offers a similar answer: A catalog of the tensions experienced by those with varied goals when an organizational model like a makerspace is introduced. The methodology is thereby designed to address aspects of the communicative ecology at all three levels—technical, social, and discursive (Foth & Hearn, 2007).

Methods: Multiple Case Study Approach

This study employs an ethnographic multiple case study approach. Makerspaces are incredibly varied due to differences in funding sources, institutional missions, community needs, and the kinds of activities offered. Fieldwork with multiple sites associated with different institutions makes for a more robust exploration of this variation. Indeed, Sheridan et al.’s(2014) study of makerspaces as learning environments also employed a multiple case study approach to three different makerspaces. They borrowed from Stake (2008) to argue that “building theory from diverse instances can be a powerful way to develop inclusive accounts” (Sheridan et al., 2014, p. 510). A case study approach is appropriate for how and why questions in relation to present day phenomenon when behaviors cannot be controlled (Yin, 2013). An ethnographic case study approach is also commensurate with the media ecologies framework as it allows for the integration of diverse data sources to craft an in-depth understanding of how a

makerspace model fits in the “context of all the ways of communicating that are significant locally” (Tacchi, 2006, p.5).

Data gathering techniques included participant observation, interviews, and document analysis within the makerspaces and with other organizations and stakeholders related to the development of makerspace initiatives throughout the state. The activities of the makerspace cases under study dictated the bounds of the case and, as such, the bounds for different cases varied. Participant observation was limited to events in the makerspaces or explicitly hosted by the makerspaces. The selection of interview participants, meanwhile, depended upon the specifics of the communicative ecology of the spaces. For example, the Community Media Center initiative was an attempt at a town-gown collaborative between local schools, universities, and community organizations. Thus, the dynamics of affiliations with partnering organizations were integral to understanding the potential and challenges of the initiative. Interviews were therefore conducted with members of a local high school, the local library, and stakeholders from the university. The library project, however, was self-sustaining through funding and grants obtained by the public library. The affiliations of individual volunteers were more crucial to understanding the potential and challenges of the library case. Interviews were therefore conducted with organizations that volunteers also worked at such as a local arts center and a public university. Through fieldwork at these varied sites, the dissertation interrogated the potential of such makerspace initiatives to sustain inclusive, collaborative innovation and technological literacy by exploring their motivations, practices, and organizational structures.

Research Questions and Analytical Framework

This dissertation explores the following research question:

How might adoption of Makerspace models by different public access institutions support (or undermine) digital inclusion through promotion of digital and technological literacies?

Here, digital inclusion is aligned with the capability approach which focuses on freedoms or “the expansion of the ‘capabilities’ of persons to live the kind of lives they value” (2001, p. 18). By extension, I use digital inclusion to reference the project of expanding opportunities for all to increase capabilities related to media and technology in ways that enable individuals to achieve what they value. Digital inclusion thereby requires the public to understand available media and technology options and benefits, to have access to those options, and to have opportunities for participation and decision-making regarding the role those media and technologies have in their lives. Promotion of digital and technological literacies are foundational to this effort. The conceptualization of digital and technological literacies used here borrows and builds on Luke and Freebody’s (1999) Four Resources Model for textual literacy to show how the literacies related to emerging technologies include the integration of a repertoire of literacy practices. In summary, this study is concerned with understanding how the specific practices and policies of local makerspaces contribute to expanding capabilities and cultivating a repertoire of literacies.

To address this overarching question, the following questions were designed based on the literature reviewed in Chapter 2 to capture the dynamics of the local cases:

- 1) What are the institutional motives, organizational policies, and organizational structures that support makerspace development?
- 2) What are the perceived outcomes of makerspace involvement for adult users? What motivates adult participants to visit the makerspace?

- 3) What are the values and ethics of the makerspace?
- 4) What are the implications of the above findings for future organizational policies?

The following framework is proposed to capture these dynamics:

Table 2. Framework to Explore the Communicative Ecology of Makerspaces

<p><i>Technological Layer</i></p> <p>The communicative infrastructures and media that enable interaction.</p>	<p><i>Accessibility</i> Physical Accessibility External Communication and Advertising Media</p>
	<p><i>Technologies Available</i> Physical Set Up Internal Communication Channels</p>
	<p><i>Pedagogical Models</i> Teaching Philosophies Assumed Outcomes</p>
	<p><i>Organizational Policies</i> Rules and Guidelines Funding Sources</p>
<p><i>Social Layer</i></p> <p>The association or organization of individuals—their social networks, both formal and informal.</p>	<p><i>Social Networks</i> Associations of Attendees Associations of Organizers</p>
	<p><i>Labor Force</i> Associations of Personnel Forms of Expertise/Credentials</p>
<p><i>Discursive Layer</i></p> <p>The ideas communicated in the ecology.</p>	<p><i>Activities</i> Topics of classes Uses of Space</p>
	<p><i>Issues of Concern</i> Governance/ Ownership Discussions Outcomes of Participation</p>

Data Collection

Fieldwork consisted of on-site observation of workshops, drop-in hours, organizational meetings, and community events organized by the makerspaces; document and artifact analysis of promotional materials, volunteer training manuals, and

makerspace creations; as well as ethnographic and semi-structured interviews with organizational stakeholders, makerspace staff and volunteers, and visitors to the spaces.

Fieldwork consisted of tours of makerspaces as well as on-site observation of workshops, drop-in hours, organizational meetings, and community events organized by the makerspaces. In 2018, the one-year period of the current data collection, over 70 hours of participant observation were conducted across sites. Participant observation allowed for analysis of routines, motivations, and constraints on participants (Lindlof & Taylor, 2011). My position in the field varied during these observations. I often occupied the role of learner as a participant in workshops, at other times I was a volunteer cleaning or supervising the spaces, while on other occasions I was the workshop or event leader. My role(s) in each space are reviewed in the case studies but the overall approach was focused on active participation. In her research with technology cultures, Dunbar-Hester (2014) explained the value of such an approach:

[S]ince tinkering activities like the workshop presented here were purportedly about imparting skills, there was merit in doing this as an active participant, rather than trying to reconstruct these dynamics through interviews or observation. (p. 30)

It is important to acknowledge, however, that I did have a privileged position in many of the spaces as an organizer, workshop leader, or space monitor. While this provided me with access to spaces of decision-making, it also influenced my critical distance.

Interviews and document analysis helped to address this issue somewhat but it is important to acknowledge it as a reality of an ethnographic study such as this.

In addition to observation of practices in the space, document and artifact analysis of promotional materials, volunteer training manuals, and makerspace creations were used to understand the values espoused by the spaces as well as the policies that enabled

and constrained participants and volunteers. Examples of these materials include, but were not limited to, the television series on making produced by the community media center, the monthly email blasts from the library project, and a promotional documentary video produced by the economic development project. The promotional materials and media produced by these makerspaces as well as the websites on which they host their design documentation were analyzed to better understand how and why the makerspaces choose to make their activities visible and were used to help triangulate data from observations and interviews.

Twenty-four semi-structured interviews with organizational stakeholders, makerspace staff and volunteers, and visitors to the space were also conducted. These interviews lasted an average of 45 minutes. Interviews were crucial as they allowed for inquiry about the past and the evolution of these spaces and provided insight into institutional practices that shaped the initiatives but may not be visible through observation alone. Semi-structured interviews were conducted with the leadership of each initiative and with contacts and collaborators at the partnered institutions. Interview participants were identified by previous knowledge of their role as an organizer in the initiative, recommendations from organizers and contacts at each of the makerspaces, in-person meetings at workshops, and through email solicitations for participants sent to the listservs of the various organizations. Semi-structured interviews were recorded and transcribed if the participant consented. Only two semi-structured interviews were not recorded. For these interviews, detailed notes were taken.

Two different interview protocols were designed to address organizational personnel and makerspace participants, respectively. Both protocols asked about the

participant's history of involvement with the makerspace and how they felt the space compared to other similar local offerings or spaces. Organizational personnel were asked to explain what they felt the goals of the makerspace were as well as the role of technology in those goals. The organizational personnel were also asked about challenges the initiative has faced and was likely to face in the future. Participants, meanwhile, were asked about their own goals for involvement and how the makerspace supports those goals, their everyday uses of technologies like those in the space, and what they found most rewarding about involvement. In the course of data collection, it became clear some participants blurred these categorizations as they had move between roles. In these cases, a blended protocol was used to address both their position as visitor and as a volunteer/organizer.

Informal, ethnographic interviews were also conducted during workshops and drop-in hours. These informal conversations were intended to capture the participant's motivations for visiting, their everyday engagements with technology, other organizations they visited to do similar activities, and their hopes for the future of the space (See Appendix A). These interviews were not recorded but detailed in field notes during participant observations.

Data Analysis

While the inductive nature of ethnography allowed for issues and themes to emerge over the course of the course of the study, the Framework for Exploring the Communicative Ecology of Makerspaces (Table 2) as proposed in the previous chapter and Luke and Freebody's (1999) Four Resources Model of literacy are used to guide the analysis of the data gathered from these three case study sites. This data was maintained

and analyzed using the software NViVo to explore emergent themes through thematic textual analysis using the constant comparison method (Glaser & Strauss, 2009). Coding for emergent themes in the data was guided by the communicative ecology framework which considers the technical, social, or discursive elements of the activities or organization of the makerspaces. First, I coded the transcripts, fieldnotes, and documents pertaining to the case study at the broad level of “Technical,” “Social,” and “Discursive” to align with the appropriate layers of the Framework for Studying the Communicative Ecologies of Makerspaces (Table 2). For example, the following experience, outlined in fieldnotes, was coded as “Technological”:

Field Notes: Community Development Makerspace (March 31, 2018)

He also suggested we try Onshape if we were ready to move onto more advanced modelling that was not possible in Tinkercad. I struggled with it because, once I had the objects, I could not figure out how to edit them. The facilitator suggested I just add onto the design to cover parts of it that I did not like...

Next, I coded the content within each layer along the dimensions outlined in the framework from Chapter 2 (Table 2). The above excerpt was coded at “technologies available” and “pedagogical models” because it both detailed the tools we used as well as the approach to facilitation. This framework is intended for holistic analysis, so it was common for a particular interview excerpt or field note experience to be coded at two layers simultaneously. The following excerpt from an ethnographic interview was given both the “Discourse” and “Social” codes:

Fieldnotes: Community Media Center (March 28, 2018)

She was looking for professional development. Currently consulting on policy was not sustainable so she is networking and looking for work. She was most interested in the media opportunities at the space. She currently does a radio show on feminism at [the local university] and was visiting to see what people were working on. Said she was “not a hacker” and “not into arts and crafts” scenes.

The “Social” code was further refined to the code “Networks.” This contributed to the analysis by illustrating the prominence of associations to the university among visitors to the space. The “Discourse” code was further refined to “Outcomes of Participation”. This contributed to the analysis by illustrating how a visitor articulated some of the different sub-groups within the larger maker discourse of the creative economy where she differentiated between media work, hacking, and arts and crafts.

The initial coding was highly structured to allow for the various case studies to be put into conversation with one another. However, the constant comparison of excerpts coded within these categories allowed for patterns unique to that case to emerge. For example, codes related to the Technology and Discourse layers at the Community Media Center Makerspace foregrounded open source software while similar codes at the Library Makerspace foregrounded free (as in cost) software.

Rigor and quality of the research depended on a commitment to faithfulness of accounts and careful consideration of the contingencies of claims made (Eubanks, 2011). This dissertation was designed with consideration of the “trade-offs” inherent in defining field sites and data gathering approaches (Markham & Baym, 2009). For example, a study of local contexts of makerspace, although varied in their intuitional approaches, is intended to offer findings useful in its comparability and not in its generalizability to other contexts. Furthermore, by studying practices and organizational structures at a meso-level, questions about micro-level learning/literacies fall outside the scope of the study.

Conclusion

The data analyzed for Chapter 4's study of how "access" is conceived in makerspace initiatives spanned all interviews and included mission statements from makerspaces operational in Massachusetts in 2019 when the data analysis was conducted for this chapter. Chapter 4 employed an exploratory qualitative textual analysis to identify emergent themes across sites of the maker scene. Chapters 5, 6, and 7, meanwhile, draw from the ethnographic data collected from the local ecologies under study. These materials were analyzed using the Framework for Exploring Communicative Ecology of Makerspaces outlined in Chapter 2. Each chapter will offer additional detail regarding the specific data collection and analysis practices. Furthermore, specific challenges to the methodology will be addressed within each case study chapter. Namely, Chapter 5 will explore the difficulties of "observation" in production spaces, Chapter 6 will discuss the "interrupted interview" as a challenging but productive experience in these spaces of creative exchange, and finally Chapter 7 will discuss how this long-term methodological engagement was witness to vast changes in organizational focus.

CHAPTER 4

MAKERSPACES AND THE EVOLUTION OF PUBLIC ACCESS

Introduction

For Communication scholars, *public access* commonly refers to equitable access to ICTs and communication channels. In Library and Information Science, *public access* is invoked in discussions of how knowledge and information is curated and disseminated. The IS field, for example, offers a useful tripartite framework for informational access which differentiates between physical access, intellectual access, and social access: “the ability to reach or obtain the information (physical access) and then understand and use that information (intellectual access), but also to access and use information without barriers created by social context (social access)” (Thompson et al., 2014, p. 10). While this framework helps address the complexity of media and technology access concerns, it only captures the interaction at the individual level. An expansive conceptualization of *public access* includes access to the networks that create and sustain media and technology, not merely the media and technologies themselves. Such a conceptualization relies not only on *public access* to technology, information, spaces, and infrastructure but also on *public participation* in creation activities and *public engagement* between communities and the institutional stakeholders, specialists, and researchers working on relevant technology and information initiatives. Public access thereby includes opportunities for a more direct role for the public in the creation and decision-making processes related to the technologies and information that impact their lives. These interrelated public access, public participation, and public engagement concerns depend

upon the availability of local assets to deliver the necessary infrastructure, services, expertise, and training to keep pace with changing technology.

The institutions which serve as these local assets are crucial to understanding contemporary approaches to public access. Anchor institutions such as libraries and schools, public access television stations, community centers, and faith-based organizations have historically been crucial sites of both public access and public participation. Public engagement, meanwhile, is a term largely used by universities, some private companies, and museums to bolster their claims to supporting the public good. Communication and media studies has much to offer explorations of this system and the institutions that support it. With the proliferation of networked ICTS in the 1990's, communication scholars began raising new questions about media that were not focused on effects and reception but rather participation: "a new model of communication that ensures public access defined as voice rather than as availability" (Rakow, 1999, p. 75). This new line of inquiry requires more than merely a shift from consumer to producer. For example, Deuze (2009) builds on Jenkins' (2006) convergence culture concept to explore the extensive ways media, technology, and society are intertwined:

Media convergence must also be seen as having a cultural logic of its own, blurring the lines between economics (work) and culture (meaning); between production and consumption; between the competition and cooperation ('coopetition') implied in creativity, commerce, content and connectivity; between making media and using media; and between active or passive spectatorship of mediated culture. (p. 475-476)

Institutions like libraries play an important role in "redistributing" the technologies and infrastructures, skills and knowledge, and practices and opportunities related to these convergences (Wyatt, Mcquire, & Butt, 2018). Using an ethnographic approach spanning educational institutions, non-profit organizations, and industry, this chapter illustrates

how makerspaces fit into the evolution of conceptualizations of public access to emergent technology in the U.S. context.

Evolution of Public Access Spaces in the United States

Concern with equitable public access to emergent technologies spans various fields and involves stakeholders from diverse civic and cultural institutions. Public access to the production and distribution of television programs, for example, became a policy concern in the 1970s in the United States. The first U.S. television access initiative, the Dale City Television channel in Virginia, operated from 1968 to 1970 and provided the community with access to a television channel (Janes, 1987). A year later, filmmakers George Stoney and Red Burns built on their successes in community television in Canada by founding the Alternative Media Center at New York University. This center would go on to become the “hub of the public access television movement in the United States” (Linder, 1999, p. 5).

The Federal Communications Commission (FCC) historically allowed municipalities to require cable companies to set aside public access channels dedicated to Public, Educational, and Governmental (PEG) content and to use a percentage of their revenue to support these channels. A 2019 FCC vote proposed by Chairman Ajit Pai, however, put this funding mechanism in jeopardy by limiting franchise fees by allowing cable companies to deduct “in kind services” from those fees. On their small—and now shrinking—budget, community media centers, often run by non-profits or cable operators, provide space and equipment for the public to use to create local television content. As such, public access television is important not only for the content it circulates but also for its “ability to bring community members together in time and space

for the purposes of education, deliberation, networking, community building, and of course, media production” (Ali, 2012, p. 1120). Thus, many of the “public access television stations” have rebranded themselves as “community media centers” to capture the varied activities and resources available there (Ali, 2012, p. 1127).

The advent of the internet required new approaches to public access to communication services. In 1996 the E-rate program was established by the FCC to provide discounted telecommunication services to public schools and libraries. Eligible libraries and schools must still pay for electricity, devices, and professional training but are able to submit a request for bids on services such as broadband that are discounted between 20 and 90 percent. The evolution of conceptualizations of public access to the internet can be illustrated by tracing the trajectory of research and policy related to so-called digital divides. In 2001, FCC Chairman Michael Powell made the now infamous comment, “I think there is a Mercedes divide” when questioned about the digital divide in the U.S. (“New FCC Chairman Meet-and-Greet”). By equating Internet access to a luxury vehicle, Chairman Powell suggested the digital divide was an issue for the market to solve. The digital divide literature reveals a move from this simplistic distributive understanding of the digital divide to reconceptualizations that render digital inequality a more complex and multi-faceted phenomenon (Fuentes-Bautista & Olson, 2018). Research into broadband adoption, for example, has identified “infrastructure; content and services; and effective use” as “vital layers” (Notley & Foth, 2008, p. 5). Infrastructure or “supply-side” demands are often foregrounded as they are the most easily identified and addressed. Meanwhile, demand-side issues such as culturally

relevant content, support services, training initiatives, and effective use of new technologies have largely been a secondary concern.

In the U.S., the American Library Association (ALA) established itself as a leader in the push for equitable public access to the internet. For adults, libraries are one of the few free public internet access points. This reliance on libraries for public access can be a heavy burden for librarians. The FCC “has called public libraries the cornerstone of digital literacy and inclusion in the nation—and at the same time has reprimanded them for not doing enough in these area, threatening to take away federal funding” (Thompson et al., 2014, p.3). The ALA contends, “Equity extends beyond equality—fairness and universal access—to deliberate and intentional efforts to create service delivery models that will make sure that community members have the resources they need” (ALA, 2015). For example, to support community-wide digital inclusion, the Institute of Museum and Library Services offered a framework that included access, adoption, and application principles (Clark & Perry, 2015).

As the internet became more commonplace, funding was cut to digital inclusion efforts such as the Technology Opportunities Program (TOP), which provided grants to make digital network technologies more readily available, and the Community Technology Center (CTC) program, which created access and training points for these new technologies. President Bush “cut the TOP program from \$42.5 million in 2001 to \$15 million in 2002 and the CTC program from \$65 million in 2001 to \$32.5 million in 2002” (Davies et al., 2003, p. 9). Both programs ended in 2004 though the TOP program was replaced by the Broadband Technology Opportunities Program (BTOP) to support broadband infrastructure in 2009. In 2019, there were still persistent gaps in access

(Anderson & Kumar, 2019). However, with home broadband penetration at 73% and smartphone ownership at 81% (Anderson, 2019), public access institutions were tasked with defending the relevance of their media and technology initiatives. Cafés and other public spaces are increasingly offering free access to Wi-Fi hotspots for users who have their own mobile devices. While these hotspots are expedient for freelance workers (Forlano, 2009, 2013) this approach to public access may not serve disadvantaged groups (Fuentes-Bautista & Inagaki 2006). Moreover, while Wi-Fi hotspots may address public access concerns, they do not support public participation and public engagement in meaningful ways.

While not common in the U.S. context, globally, cybercafés or Internet cafés have been important public spaces which provide public access to ICTs for a fee. In relation to Internet cafés in Ghana, LeBlanc and Schrum (2017) outline the two prevailing perspectives on physical spaces of public access to the internet: The “inclusionary perspective” that argues that “Internet cafés are public digital spaces that afford less-advantaged populations the benefits of connectivity as well as the potential for digital citizenship in the global era” and the “transitional perspective” that suggests such spaces may have been useful when connectivity was scarce but are now obsolete given the diffusion of ICTs (p. 89). While many libraries continue to emphasize an “inclusionary perspective” in their technology initiatives, CTCs in the U.S. largely fell prey to the “transitional perspective” which deemed them obsolete. As the latest attempt to address access concerns, makerspaces offer important insights into the evolution of these perspectives.

This analysis reviews how makerspaces fit into the historical and theoretical evolution of the concept of public access by exploring how organizers and participants discuss dimensions of “access” regarding makerspaces. While their survivability depends upon adapting to constant technology advancements, and their missions often highlight community inclusion goals, makerspaces do not neatly fit into the transitional or inclusionary perspectives offered by LeBlanc and Schrum (2017). Indeed, makerspaces may best be explained by a third perspective on physical sites of technology access, an *exhibitory* perspective. Long-term engagement with the makerspace scene in Massachusetts suggests makerspaces can be best likened to a theater. For organizations, these theaters are flexible “catch alls” which they can stage in different ways to meet complex and ever-changing access concerns. Makerspaces can be dressed to suit different needs, they allow participants to embody different roles, and they provide audience to creative pursuits. This performativity is important for the institutions and spaces they are associated with as it helps align them with discourses of revitalization and innovation at a time when their relevance is being questioned.

Data

Data for this chapter was drawn from participant observation, online “about us,” “FAQs” and mission statements for 18 makerspaces in Massachusetts, and in-depth interviews with 21 organizers and participants in makerspace initiatives throughout Massachusetts from January 2018- May 2019. While many of these spaces were opened during the surge of makerspace popularity spurred on by the Obama administration’s policy support for making, the interviews and analysis were conducted after Obama left office. The online mission statements and online “about us” information for makerspaces

in Massachusetts offered brief overviews of the intentions of the spaces and their emphases (e.g. artisan production, hacking communities, business incubators, etc.)(See Table 3). During interviews, participants and organizers were asked about what they hoped the spaces would do for participants and some of the challenges to achieving those goals. Additionally, the in-depth interviews and ethnographic interviews during participant observation aimed to elicit narratives about activities and projects that the participants and organizers were most proud or excited about. Their responses offered insights into the possible impacts of makerspaces as well as the opportunities they perceived to be in the purview of the makerspace.

Table 3. Massachusetts Makerspace Information

Makerspace	Mission Statement URL (last accessed September 7, 2019)
Artisan’s Asylum	http://artisansasylum.com/
Boston Makers	https://www.bostonmakers.org/
BUILDS	https://builds.cc/about/
Cambridge Hackerspace	https://www.cambridgehackspace.com/
CreatorPult	https://www.creatorpult.com/
Empowlabs	https://empowlabs.com/
Framingham Makerspace	http://www.framinghammakerspace.org/about
Hatch	https://www.watertownlib.org/hatch
LaunchSpace	https://www.launchspace-orange.com/frequently-asked-questions/
Lowell Makes	https://lowellmakes.com/
Make it Springfield	https://www.makeitspringfield.org/ourvalues
Makers at Amherst Media	https://amherstmedia.org/makers
Makersworkshop	http://makersworkshop.com/about-us/
Makeshift	https://makeshiftboston.org/
Possible Project	https://www.possibleproject.org/program-components/
Technocopia	http://technocopia.org/
UMass Boston MakerSpace	https://www.umb.edu/makerspace/about_us
Worshop	https://www.theworshop.com/facilities.html

Analysis

Using my knowledge of the literature in this area and experience in the field, I conducted a thematic qualitative textual analysis of the data using constant comparison (Glaser, 1965). As analysis proceeded, new data could revise properties of previous categories or add new categories. Thirty-four preliminary categories relating to access themes emerged during open coding of mission statements, transcripts, and field notes. These codes were reviewed, compared, and further refined into 13 themes. The data was then reviewed again with selective coding for the 13 identified themes. Throughout the coding process, analytic memos were written to explore connections between themes. In so doing, themes were found to either discuss what aspects of makerspaces were likely to support or hinder access (i.e. access antecedents) or discuss what makerspaces provide access to (i.e. access types). Brief descriptions of these themes are reported below, beginning with the access types. Together these themes suggest an “exhibitory perspective” as a consequence of the ways makerspaces are discussed and enacted.

Table 4. Access Themes

Theme	Properties	Example from data
ACCESS TO:		
Physical Space	Workspace, event space, and storage space are important resources and should be both accessible and flexible to fit the needs of the community.	“What attracted me right away to the word makerspace is that space is open ended as an idea. It something people occupy. And they make the space, they claim the space for what they want to do with it. And um, that has a sense of being democratic. It could be any space. It could be a factory building, it could be whatever people choose.” – Interview, Fiber Artist
Tools	Makerspaces are valued as storehouses for	“It’s a place where anyone with existing skills can go to work on

	materials and tools that are cumbersome, expensive, or not yet domesticated.	projects that require more space than they have at home, or tools that they don't normally have access to due to space or budget issues.”- LaunchSpace Mission Statement
Lifelong Learning	The policies and practices of makerspaces encourage cooperative learning encouraging all to act as teachers and learners.	”At Lowell Makes we believe that collaboration is a truly effective form of learning. To that end, our members and volunteers teach classes, hold unique educational events and collaborate on cool projects.” – Lowell Makes Mission Statement
Community	Makerspace communities offer creative support, intellectual support, and social support for participants. These activities support local revitalization efforts for the larger community.	“Make-It Springfield is a community incubator and workshop space for local makers, artists, entrepreneurs, programmers, students and enthusiasts to make, create & share their skills and tools. Make-It provides a platform for community members of all backgrounds to learn new skills, build relationships, launch businesses & inspire one another.” – Make-It Springfield Mission Statement
Business Opportunities	Makerspaces can serve as incubators, accelerators, or entrepreneurial launch pads.	The WorcShop intends to be a major force in the revitalization of Worcester as an entrepreneurial center for New England. We'll accomplish this by promoting artistic/engineering endeavors, non-traditional educational initiatives, and technological research and development, while simultaneously securing Worcester's place at the leading edge of the new "Innovation Economy.”- Worcshop Mission Statement
DUE TO:		
Affordability	Makerspace initiatives should be careful not to create monetary restrictions.	“For that reason, the MakerSpace's services are free for any project you are working on; we don't charge for materials, equipment time, or

		consultation.” – MakerSpace at UMass Boston Mission Statement
Forward Thinking Approach	Makerspaces aim to be on the cutting edge of technology and business developments.	“Our focus is to provide opportunities for learning, professional development, and peer networking in the areas of virtual, augmented, and mixed reality technologies, 3D design and modeling, robotics, wearable technology, sensors, IoT (Internet of Things) and human-machine interfaces – areas that hold significant potential for future career opportunities but are difficult fields to start learning because of the cost of equipment and lack of opportunities to be mentored.” – Empowlabs Mission Statement
Cooperative Decision- Making Roles	Makerspaces offer opportunities for leadership and decision making.	“We would get a larger pool of people that would be functionally a steering committee people that were engaged enough that they were willing to be aware of what was happening, make decisions about what was happening, propose activities, and run the activities and that never really happened...” – Interview, Makerspace Organizer
Integration of Varied Perspectives/Domains	Makerspaces bring together people from various disciplines and social networks.	“Anyone and everyone is welcome. Whether your thing is software, electronics, woodwork, or knitting, we provide a space where you can meet fellow makers, to learn, and be inspired. We hold workshops every month so you can learn new skills.”- Cambridge Hackspace Mission Statement
DESPITE:		
Overextended Populations	Makerspace participants and potential volunteers have many competing demands on their time, often holding multiple jobs.	“It’s difficult to say because I would say that it is probably different in Boston than it is here. So it is more parochial here and also feel that people are, let’s say the college population, is probably even over-extended. There is so

		much offered here in the valley” – Interview, Makerspace participant
Jargon	“Makerspace” is an unfamiliar term to many and the specialist activities that occur there employ jargon that may be incomprehensible to a lay person.	“So when we started there wasn't anything at all I mean people didn't know what a Makerspace was you'd get a kind of Golden Retriever look when you said Makerspace and then all of a sudden everybody had a Makerspace” – Interview, Makerspace Organizer
Difficulty Evaluating Access	Organizers often struggled to understand why their space was not attracting new participants and were not able to do an evaluation of their initiatives.	“Actually that's something that we are really struggling to document because we want to be very careful not to assume so and are having a hard time. We actually have a survey out right now. One of the aspects of the survey is trying to gather some demographic information, especially because a lot of the grants that we applied for require that kind of stuff.” – Interview, Arts Organization Leader
The Mess	Messiness and orderliness are at constant odds in makerspaces.	“What is great about their makerspace is “OCD in full force” as they are able to have salaried management of the space. Community spaces, alternatively, are “frat houses”, which is not a bad thing but rather people’s heads are so lost in their projects that they don’t keep it organized and managed.” – Paraphrased Interview, Industry Makerspace User

Physical Space

The value of access to physical spaces was a prominent theme in interviews and makerspace mission statements. As evidenced in the excerpts below, makerspace mission statements frequently referenced their workspaces, spaces to meet or hold events, and spaces to store projects or materials.

Mission Statement: LaunchSpace

It's a workshop, providing tools and equipment for members, along with storage space for larger projects.

Mission Statement: Cambridge Hackspace

We have a 1200sqft workshop catering to enthusiastic makers, and hold weekly meetings where we get together and make things.

Mission Statement: Technocopia

Our 11,000 sq. ft. facility offers common work space, rental bays, and a variety of tools for artisans to create and work with.

This emphasis on space is warranted as space was discussed as a scarce resource and an asset by many interviewees as well.

Interview: Library Director (5/7/2018)

We live in a city that you don't have a lot of space for a workshop in the backyard so it's really about breaking down barriers and giving people opportunities to explore with certain types of education or certain types of thinking or entertainment that isn't always accessible.

Interview: Makerspace Participant (5/16/2018)

Space! You gotta have space to do this. And like in the gallery, sitting here, this is, I don't know how many square feet...Maybe a 1000, I don't know. But it's a lot of space. And you could do a lot here if it were realized by the people of Leveret Craft and Arts, to dedicate this space a whole month into a makerspace. I would love to see that.

Interview: Economic Development Makerspace Organizer (5/23/2018)

A lot of it was space-related really. Physical space to do some creative project and maybe they were doing it at home or some of them are teachers and they did it in the classroom but they had no dedicated place where they could actually do this and have a messy project.

Given this emphasis on space, organizers were particularly concerned about how the space could best serve the diverse groups who come to work in it.

The Economic Development Makerspace is an excellent example of a makerspace that is used for very diverse activities including bike repair, 3D printing, painting, dance, and poetry readings. One workshop leader there suggested that the makerspace needed a

clearer focus and target demographic to make best use of the limited space. In particular, he felt the space should be physically bifurcated to better serve youth and adults. As of writing, organizers are looking at other spaces in the city to expand to meet increasing demands on the space.

While expansion is one solution, other organizers discussed how a flexible single space is ideal as it ensures the space would always be in use. One makerspace open to the employees of a consumer electronics company, for example, had tables users could reserve for their activities and different areas dedicated to various technologies (e.g. Water Jet, Laser Cutter, 3D printer). Facilities built or renovated with a makerspace in mind can create such flexible workspaces. For organizations that do not have the resources of a large company, however, a shared, convertible space may be the solution.

Inflexible architecture poses a challenge for makerspaces housed in existing organizations like libraries. Many of the libraries I spoke with discussed having a cart or “corner” where they switched out activities and tools for use by visitors. One librarian described an on-going “fight” against the building:

Interview: Librarian (9/26/2018)

And I think in general we are constantly fighting this building, this building is beautiful, and it was last renovated in 1991 right on the cusp of the like the computer internet revolution, and that becoming such an intrinsic part of library service, so in every part of this building you can see where we've had to kind of shoe horn it in. Like we've more public computers that are in the next room. We don't have good oversight of them because the infrastructure for them wasn't designed in the last renovation. I always have problems with them. The same thing, in the reference department here we have wonderful computers but we just don't have the space to have a lot more that we would be interested in having like a focused regular maker lab. What we are able to offer people here for technology, it's just sort of [inaudible] but it's functional and a little bit less cutting edge.

Finding space or creating new makerspaces in existing facilities is often a challenge. The Library Makerspace that serves as a case study in Chapter 6, for example, is in a separate building from the library.

Interview: Library Makerspace Coordinator (6/8/2018)

We are the library but we're not in the same building. Right. It's really tough. Um, and not that we really want to be in the same building. We probably make way too much noise for the library, but you'd like it to be right next to us.

The location of these physical spaces was also an accessibility concern due to transportation needs. The lack of reliable or close public transportation was a concern for organizers and participants alike.

Tools

The tools or equipment a makerspace offers are a defining feature that depend, in part, on the features of the physical space. In many cases, makerspaces promoted the technologies they made available to users that are not practical to have in one's own home due to size or expense. The mission statement for LaunchSpace, for example, highlights these issues:

Mission Statement: LaunchSpace

It's a place where anyone with existing skills can go to work on projects that require more space than they have at home, or tools that they don't normally have access to due to space or budget issues.

Similarly, for universities, makerspaces could house equipment that individual departments did not have the interest or funds to upkeep on their own. One university makerspace in Boston, for example, hosted classes from various departments to teach them about applications of 3D printing and virtual reality. By functioning as a central repository for this equipment, the equipment was accessible more frequently by more students and faculty:

Interview, University Makerspace Coordinator (10/31/2018)

The Engineering professor had their own Makerspace, it was specifically for engineering students. Had a couple 3D printers. It was smaller than this, and specifically it wasn't able to be open, they didn't have coverage to support it for that many hours per day, so they were interested to have a place that could be open for more hours, even if it wasn't just for engineering students anymore, so they donated some 3D printers.

In other cases, makerspaces were a transitional space for equipment that had not yet been domesticated. Tools that were considered cumbersome, too expensive, or too new for people to want to make the investment in purchasing for their own home are housed in makerspaces for the community to access. One visitor to the Community Media Center Makerspace explained his interest in makerspaces:

Interview: Makerspace Participant (8/17/2018)

So yeah basically a home-based lab is my current stage of things and if I need anything more than that I look around for enterprises which have these things to share or to rent such as makerspaces. You know almost every makerspace has some computer boards a few have things like 3D printers or laser cutters and more expensive equipment. It's harder for an individual to come by. 3D printers aren't so bad the cheapest one I've seen these days is around a hundred and fifty bucks. That's getting quite affordable for an individual. Laser cutters are still pretty pricey, they're in the 4 to 5 thousand dollar range so makerspaces are alive and well and are going to stay that way for a while I think. They're always going to be two steps ahead of the curve.

Given the history of ICT access concerns for many of the organizations working on makerspace initiatives (e.g. libraries, community development programs, etc.), ICTs were often conspicuously absent in these discussions. There seemed to be an assumption that ICTs were easily accessible, so makerspaces were needed for other kinds of technology. For example, a workshop organizer at the Economic Development Makerspace said, "You can go to the library for a computer lab but the makerspace is where you would go for a table saw." When I specifically asked the Library Makerspace coordinator about computer use, she explained that the old laptops they had were not in

demand. New laptops, however, were expected to be more appealing to the makerspace users:

Interview: Library Makerspace Coordinator (6/8/2018)

Our laptops are definitely a bunch of dinosaurs and uh, people do come in and there's like a handful of people who do that. It's not frequent. I know the computers, the library much nicer. We actually do have new laptops that are here now and the new it company is configuring them for us and then we should get them, hopefully, I'm hoping in the next couple of weeks they are gonna be the hot ticket. I think people will come into use them once they realize we have these new laptops.

Because many of these spaces are known for the specialized technologies that they offer, they are forced to update or be considered obsolete. For example, one middle school teacher who brought together different resources to create maker opportunities for his students explained how he needed to find something new to engage his students as many were coming to class already familiar and bored with the LEGO Mindstorm robots.

Lifelong Learning

While space and tools were the dominant themes discussed related to access, learning was also frequently invoked in mission statements as evidenced in the excerpts below.

Mission Statement: Lowell Makes

We are an organized group of local artists, engineers, makers, and thinkers who work together to provide tools and learning resources to the public.

Mission Statement: WorcShop

We also recognized that the Artisan and Maker Movement offers a new way to reengage our youth as active learners -- motivating students to learn about art, science, and technology as well as to gain valuable practical experience developing creative and innovative projects. As artists/makers, children will see themselves as producers, not just consumers and develop as self-directed learners.

Mission Statement: Artisan's Asylum

A non-profit makerspace devoted to the teaching, learning and practice of fabrication.

Additionally, makerspaces were lauded as forwarding progressive and collaborative forms of learning that are not easy to find in more formal learning environments.

Tinkering, as discussed by the Library Makerspace director quoted below, was a common way to describe the exploratory learning model in makerspaces.

Interview: Library Director (5/7/2018)

For me and for us it's trying to break down the barrier to a type of learning and a type of thinking that isn't always within reach for a lot of people whether it's because they go to school and it has a kind of very rigid curriculum or they don't have the income to tinker with some of the equipment and materials that we have. Because it's expensive!

One workshop leader from the Economic Development Makerspace described how “doing” is central to the makerspace movement and that his classes “have almost no methodology on purpose”. Similarly, a librarian’s discussion of educational experiences for young people positioned tinkering as a learning “pathway”:

Interview: Librarian (9/26/2018)

We got a grant called mind in the making, it was about having a developmentally appropriate play resources in the library and using play and tinkering as a, you know, a real pathway for learning, social emotional things and that grant was geared at ages 0-six, so magnet tiles, alphabet blocks in different languages and things like that.

Makerspaces in more formal learning environments were also discussed as providing new approaches and opportunities for instructors. One makerspace coordinator from a Boston university explained how the makerspace was intended as a new form of educational technology:

Interview: University Makerspace Coordinator (10/31/2018)

When my boss was starting the makerspace, it seemed like a good fit for me to help out with, basically we wanted anyone to be able to use this, anyone on campus to be able to use it. But the main thing we want people to use it for is to improve their courses and how they're teaching and how the students are learning. So having someone who could help faculty with technology and using it for their classes is a good fit.

Community

Both meso- and micro-level conceptualizations of the ever-loaded term “community” were found in the discourses about Massachusetts makerspaces. The economic development imperative that underpins much of the optimistic rhetoric of The Maker Movement from the Obama era means that many makerspaces invoke geographic understandings of the term “community” in promotional materials to emphasize the importance of the initiative for local economies. The mission statements, for example, referenced “community” as a geographic location when touting the promise of “rejuvenation” and “revitalization” of the local areas home to makerspace initiatives:

Mission Statement: Creatorpult Makerspace

We offer space, tools, equipment, classes, and event hosting. Join us and help the exciting revitalization effort that is currently underway in our downtown area.

Mission Statement: WorcShop

The WorcShop promotes creativity, and will also play a significant role in developing an ecosystem that contributes to the economic and cultural life of Worcester.

On a more micro-level, makerspaces are idealized as collaborative spaces where individuals enact “community” through shared practices and values. The makerspace model depends upon a sense of community as space and tools are shared and learning is cooperative. The dynamics of “community” vary widely, however. While community was frequently invoked in mission statements, three sub-themes emerged from my analysis which add specificity to this slippery concept: A creative community, an intellectual community, and a social community.

Creative Community Support

In mission statements, makerspaces were discussed as providing access to a community of others who value creativity. As part of this group, one could inspire others and be encouraged to create.

Mission Statement: Creatorpult

Creatorpult Makerspace offers Haverhill's creative community a place to be around other creatives and to bring their ideas to life.

Mission Statement: Make Shift

Make Shift Boston is a cooperative coworking space of diverse working artists, activists, and creative people from across disciplines.

Mission Statement: LaunchSpace

At its core, a makerspace is a place where creative people can gather and work on projects.

Intellectual Community Support

Community was also conceptualized as a knowledge network related to their object(s) of practice. The expertise and knowledge offered by others in the space was described as a resource one could lean on for support in some of the mission statements as evidenced below.

Mission Statement: Makersworkshop

Our mission is to provide students and adults with access to specialized equipment, as well as the necessary knowledge-base support to pursue their creative and academic pursuits.

Mission Statement: Cambridge Hackspace

We've started the Cambridge Hackspace to provide a physical space where people can gather and work on their projects, have access to larger or expensive tools (like the 3D printers, and laser cutter), and provide a place where the community can share their knowledge.

Participant also discussed this intellectual support as a motivation for coming to makerspaces. One makerspace participant described his attempts to reenter the high-tech workforce after many years away. He explained that he was seeking other "brains":

Interview: Makerspace Participant (8/17/2018)

And looking for resources shared resources or just brains to pick too. That's always useful. There's plenty of those around. I think it's fortunate that Massachusetts is such an academic state, plenty of knowledgeable people to pick brains from.

Social Community Support

A third form of community found in mission statements and interviews was related to social support networks based on friendship and mutual respect:

Mission Statement: Framingham Makerspace

Our dream is to create a place which provides community, shared tools and a work space which encourages and enables members to build their dreams. Exploring art and technology in a welcoming, respectful, community oriented space while also being a resource to the community at large.

Mission Statement: BUILDS

Come join our community, hang out, and be in good company!

Some makerspaces were more explicit regarding the policies to create a welcoming and respectful community space. Make Shift, for example, had a long list of values posted on their website which outlined what social support looks like in the space:

Mission Statement: Make Shift

- Offering our creativity and solidarity towards a better world for all people
- Valuing one another's lived experiences, recognizing our privilege, working for just and fair relationships with each other and with our communities
- Consideration and care for each other as people and as workers and artists
- Open and respectful lines of communication
- Encouraging collaboration among members
- Being an active and contributing member of the South End community
- Creating a safe and welcoming space for people of all races, classes, faiths, genders, sexualities, abilities, and places of origin.
- Respect for our members' well-being and health
- Respect for our environment in the immediate, local, and global sense
- Not taking ourselves too seriously
- Camaraderie, friendliness and mutual support

Participants also referenced the social feel of the spaces as a motivation for returning. One makerspace participant described how the open-door policy and social environment of a makerspace created an atmosphere that she enjoyed:

Interview: Community Media Center Makerspace Participant (5/16/2018)

And I also felt that everyone there was welcoming. Friendly. And I felt I wasn't judged. Because there are a lot of, in the art world, who can be looking down their noses if it's not their medium, they don't have the time of day to ask any questions about what floats anybody else's boat. And that receptivity to what happens to be my medium, was really refreshing. Still is.

Business Opportunities

The learning and community offered by makerspaces could also provide access to mentorship networks to support entrepreneurial efforts. In addition to advice and networking opportunities, these spaces offered physical resources to support small businesses. Mission statements often referenced this as a central or related goal of their makerspace:

Mission Statement: Launch Space

Launchspace's mission extends beyond the traditional definition of a makerspace. We are also committed to helping makers who want to start their own business and those interested in learning technical skills that could be used in real-world jobs.

Mission Statement: Make-It Springfield

Make-It Springfield is a community incubator and workshop space for local makers, artists, entrepreneurs, programmers, students and enthusiasts to make, create & share their skills and tools. Make-It provides a platform for community members of all backgrounds to learn new skills, build relationships, launch businesses & inspire one another.

Mission Statement: Workshop

On the Studio side we incubate several businesses including Eternity Ironworks, Steve Cornie Enterprises, Singularity Computers, Ancient Arts, Void's Creations, and True Life Photography.

The manufacturing opportunities provided by new desktop tools in makerspaces were also helpful in launching businesses or bringing product ideas to life. The university makerspace in Boston had been used to create prototypes of student product ideas, for example. The coordinator of the university makerspace explained prototyping as a valuable aspect of the university model:

Interview: University Makerspace Coordinator (10/31/2018)

Yeah, when I do my introductory workshop I talk about how, in the old days you'd have to go to China and send them your plans, and they would ship you back and it would be a long process and it would be expensive, where now you can make a prototype, 3D print it, if something's wrong, the next day you print a new copy of it. We had a student who, she was intern at a fashion design company in Boston and she brought her boss in and they were very excited about fashion uses of 3D printing so they ended up doing some fashion show where they had 3D printed accessories.

The makerspace housed in a consumer electronics company, meanwhile, created a “soft manufacturing” area for small production runs. This area was set up like a miniature assembly line and was meant to be used by participants to produce their own products.

The producer could invite a small number of people in, train them on the construction of the product, and have them help build it as a community effort.

Affordability

Keeping costs low and participation affordable for visitors was a predominant theme across mission statements and interviews with organizers. Spaces desired to be free to use or, if that was not possible, to provide some free opportunities. Some organizations were steadfast in their dedication to free services:

Interview: Library Makerspace Coordinator (6/8/2018)

Where we differ is pretty big, we're part of library and we offer things for free. We don't, one of our major goals is accessibility. And that's a goal of most makerspaces is this, you know, you want people to do the things, but for us it's a little bit broader and that we want anybody, any ability level, any income level to be able to do these things. Uh, we're not for profit. We don't intend, we hope that we will never have to charge people.

Having organizations that offered these activities for free is very important because the dominant hobbyist forms of “making” requires many resources and tools. One organizer described how hobbyist cultures are increasingly difficult to sustain in the current economy:

Interview: Community Media Center Makerspace Organizer (5/24/2018)

Ordinary people have less and less disposable income. It's not clear how people sustain this hobby anymore... You know you don't hear about people building giant model train sets anymore but maybe that's before your time. When I was a kid that was one of the big quirky hobbies that people would have was to build a giant model train set with scale trains that would cover a huge table in their basement and they spent hours and hours playing the track and wiring it all up and adding crossing signals and little scale trees and buildings but to do that sort of thing was fantastically expensive and I think that there's a smaller and smaller number of people that have that kind of disposable income or time so many people are having to work multiple jobs to make ends meet and you have to have a two income family to even imagine raising children these days so it's pretty discouraging.

Indeed, during my observations, many people told me about makerspaces or makerspace ideas that failed or were in financial trouble because they were unable to find funding models to sustain them.

Forward Thinking Approach

Makerspaces were expected to be on the cutting edge of technology developments and social trends. For the spaces that emphasized technology, a makerspace was a way to realize the “potential” of emerging technology:

Mission Statement: Empowlabs

Our focus is to provide opportunities for learning, professional development, and peer networking in the areas of virtual, augmented, and mixed reality technologies, 3D design and modeling, robotics, wearable technology, sensors, IoT (Internet of Things) and human-machine interfaces – areas that hold significant potential for future career opportunities but are difficult fields to start learning because of the cost of equipment and lack of opportunities to be mentored.

There was an expectation that technology be used to improve other aspects of life. For example, the coordinator of a university makerspace explained how that space aimed to “improve” teaching with new technology:

Interview: University Makerspace Coordinator (10/31/2018)

And I think we think that and we found that it's not like specific to one thing like just, it's more for engineering or more for art, really we've found that anything can

work with 3D printing when you sit down with them, with professors, and try to figure out what they're teaching, how that could be improved with 3D printing or the VR.

Even spaces which deemphasized technology underscored innovation through creativity.

The mission statement for Workshop, for instance, listed several forward-thinking initiatives with innovation as the ultimate goal:

Mission Statement: Workshop

We'll accomplish this by promoting artistic/engineering endeavors, non-traditional educational initiatives, and technological research and development, while simultaneously securing Worcester's place at the leading edge of the new "Innovation Economy."

This focus on the future was also articulated by some participants. When discussing what made the makerspace attractive, one fiber artist discussed how she had a "sense of adventurism" and explained that she enjoyed, "brainstorming together and going the road less traveled. That appeals to me. Being a pioneer in something."

Cooperative Decision-Making Roles

Many makerspaces throughout Massachusetts rely, in part, on volunteer labor.

Often workshops are staffed by volunteers, some spaces have designated volunteers who mentor others on specialized equipment, and other spaces invite the users to be part of the decision-making process. Participants I spoke with were often hoping for such opportunities to take leadership roles, particularly regarding teaching workshops or sharing their skills. One makerspace coordinator explained that this cooperation was ideal theoretically but had been incredibly difficult to sustain in practice:

Interview: Community Media Center Makerspace Coordinator (5/24/2018)

There were like 12 to 13 people who came to this meet up at the spoke and similarly there were a bunch of people that were interested... They had 15 or 20 people who are coming to meetings and there did seem to be people that were interested in doing this stuff, at least they were interested to come into a place to

talk about how much they were interested in doing the stuff, but then translating that into actually coming in to do the stuff is harder.

Additionally, some spaces were beginning to recognize volunteering as labor. For example, the makerspace in a consumer electronics company was struggling to figure out how to staff the space on off-hours:

Interview: Workplace Makerspace Organizer (5/2/2018)

So we're going to try and see, the most motivated users of it, who would plan on being there anyway on nights and weekends to see if they may use it. Establishing targets for staffing, except for the fact they're there to use it so are they really there to help others? And we're going to find out how much tension there is between, look I'm here on a Saturday so that you can be here cuz we have a system but I wanna work on my project. So if you're constantly asking me how do I use this, how do I use this, it takes a special kind of empathy and a patient, and giving soul to say, I'll put my project to the side. And do we have to compensate them for that?

Integration of Varied Domains

Makerspaces are used for a breadth of activities. The mission statements for these spaces often highlighted the variety visitors could expect in the space:

Mission Statement: Cambridge Hackspace

Anyone and everyone is welcome. Whether your thing is software, electronics, woodwork, or knitting, we provide a space where you can meet fellow makers, to learn, and be inspired. We hold workshops every month so you can learn new skills.

Mission Statement: Makers Workshop

Makers Workshop combines scientific and STEM based curriculum with a heavy emphasis on aesthetics and art. Our specialized educational programs and workshops offer a fun exploration of form versus function while allowing the students to gain a better understanding of how technology can improve and add to their creative process.

This variety of activities offered more learning opportunities. The library makerspace coordinator described how learning from diverse groups of people happened organically in the space:

Interview: Library Makerspace Coordinator (6/8/2018)

I think also just by listening to people you know there's so much especially if you go to [the makerspace] you can meet you know five or six people in one night that'll have these different experiences that come from different industries but their intersecting somehow and you hear of all this different cool stuff that happens so I think that if you're observant you know you can pick up on different things that are out there that are really cool.

Similarly, the university makerspace was intended to serve individuals throughout campus and led to creative combinations of different domains.

Interview: University Makerspace Coordinator (10/31/2018)

From fields, which departments, we've had many, many, different ones. A lot of STEM stuff, so the class coming today is Biology. We had Engineering, but we also had the Art Department, where they were doing, it's a video production class and they were doing stop-motion videos and so they printed things and they used them in their thing. We had a Creative Writing class, which is kind of unique. I didn't work on that project, but they're doing something around metaphor and literature and finding things to print based on what they were reading.

Overextended Populations

Participants frequently discussed how time was an important resource and that to have a cooperative and collaborative space is difficult when people have so many other responsibilities. Particularly, interviewees made references to the economic pressures on people who did not have traditional employment. For example, artists who depended on gig work had to combine various jobs to support themselves. In discussing her work as a sculpture artist, the library coordinator explained how she was “always supplementing it with something else.” Another makerspace participant talked about how even those who were working in more stable employment often also had a “side hustle.”

For the Community Media Center Makerspace Initiative, sustaining volunteers and participants was challenging. The organizers and participants themselves noted that over extension may be part of the problem:

Interview: Community Media Center Makerspace Coordinator

In general I think people are too busy. I think people are having to work too much I think there are many competing demands on people's time but if I knew the answer to that problem I think [the makerspace] would have different challenges than the ones that it has.

Interview: Community Media Center Makerspace Participant

So it is more parochial here and also feel that people are, let's say the college population, is probably even over-extended. There is so much offered here in the valley.

Jargon

Interviewees were divided as to whether the term makerspace was useful, esoteric, or passé. The term makerspace was preferred by the Community Media Center Makerspace as it was flexible and not as value laden as the term "hackerspace." One librarian admitted she disliked the term makerspace as it was specific to the scene and may not be inviting to new participants who were unfamiliar with it:

Interview: Library Makerspace Director (5/7/2018)

What is a Makerspace? Which I always regret that we call it a Makerspace. I wish that we referred to it differently because I always explain it as a public workshop and I kind of wish we had kind of branded it that way just because Makerspace, for people within the library world or within the maker World they understand it, but a lot of people don't always understand it-but that's an aside.

The Community Development Makerspace, however, felt the term was already outdated and not as attractive as the trendier term "Collaborative Workspace":

Interview: Community Development Makerspace Coordinator (5/23/2018)

And in fact, this may be something you'd be interested, in we don't always even call it a makerspace anymore. We call it a collaborative workspace sometimes. And in fact our grant calls it a collaborative workspace because the city or the state and planners in general and economic development people when they talk about revitalizing downtowns and cities they see the collaborative economy as a piece of that.

Difficulty Evaluating Access

Many of the organizers I spoke with did not describe a concerted and long-term planning effort for the makerspaces they were coordinating. The Community Development Makerspace that is the case study in Chapter 7 was meant as a one month pop up in an empty storefront but was soon adopted by the local community. The makerspace in the consumer electronics company was described as having an extended, ad-hoc, “duct-tape phase” as people donated random equipment to outfit the space. Without clear targets and goals, these spaces often did not have any evaluation in place regarding who was accessing the space. Those that did, described collecting some basic visitor statistics and having trouble analyzing them:

Interview: Library Makerspace Coordinator (6/8/2018)

And I was like, well, you know, we've been tracking it since I came in and a little bit better. We don't know who exactly, you know, but it's everyone, there's, there's retirees, there's young kids, there is kids in school who aren't from here. There's, there's moms who are sewing dance costumes. There's uh, people between jobs. So like software engineers who just want to like bounce some ideas off someone else. It is such a huge range of people.

Interview: Arts Initiative Coordinator (10/29/2018)

Actually that's something that we are really struggling to document because we want to be very careful not to assume so and are having a hard time. We actually have a survey out right now. One of the aspects of the survey is trying to gather some demographic information, especially because a lot of the grants that we applied for require that kind of stuff. That's actually been a bit of a stumbling block among various members of our staff, that had different perspectives. But we, we have a lot of mixed ethnicity families that we serve. Partially just due to where we're located. Partially because of the work we do and because serving a diverse public is part of what we do so.

The Mess

Because these spaces were largely improvising their design and policies at the start, or switching course while in operation, they were often slightly dis-organized. The coordinator at the commercial electronics company makerspace said that one of his goals

was to keep the space organized as the community spaces he was used to using were more like “frat houses.” The participants I spoke with at the Library Makerspace were similarly in favor of an orderly space. They were particularly excited about the hiring of a new coordinator as she was tasked with making the space neater:

Interview: Library Makerspace Coordinator (6/8/2018)

I understood that that space, it's pretty ad hoc. Like we, everything just sort of happened in this weird amorphous way and the space wasn't clearly defined. We can have like stations, we sort of had stations because saying that we didn't really have stations for things is a lot of clutter. And so I understood that one of my big challenges would be to organize the space in a way that was clear and consistent and easier for people to navigate it because one of the reasons [the makerspace] was formed was to be accessible to people, to make things that are very hard to understand, or expensive, accessible and um, so understanding that as part of the mission made it pretty clear that organization was a big part of this job.

Organization as a marker of accessibility was a contested idea, however. For the spaces that deemphasized technology, messiness was discussed as a necessity and something that made people feel like they had ownership over the space. The Community Development Makerspace, for example, described how the messiness of even the organizational structure was valuable as it gave the space a more relaxed and open feel:

Interview: Community Development Makerspace Coordinator (5/23/2018)

I think another virtue of this makerspace as sloppy as this kind of structure is, there is no dominant really, in some ways maybe the art gets a lot of traction but there is no real dominant thing.

Given the unstructured forms of learning that these spaces forwarded, many discussed how seemingly dis-orderly workshops were ideal. Participants were encouraged to test, try, and experiment with new technologies or materials. One makerspace coordinator admitted that others may be attracted by a simple or “safe” step-by-step learning experience even though he found those workshops less enriching:

Interview: Community Media Center Makerspace Coordinator (5/24/2018)

People like those things because they're safe and somebody just tells you what to do and I think also that a lot of times people want projects to be a little too serious and that it's worth taking on projects that are fun or idiosyncratic because it doesn't matter so much the stakes are lower if it ends up not working out or there could be a lot of flexibility in terms of the results actually missing what the scope was.

Discussion

For individuals, *public access* to the spaces and tools of making is impeded by physical accessibility of spaces. Participants across sites highlighted the lack of reliable public transportation and/or parking. Additionally, for individuals, understanding the focus of activities in these spaces may be difficult. In attempting to fit all needs, their guiding missions may be unclear to audiences. They do, however, offer access to tools and resources that are impractical or unaffordable for many to have in their own home. For the institutions or organizations attempting to start makerspaces, the public access concerns were largely related to not understanding their audiences and/or being unable to reach audiences. Many of these spaces were still operating from a framework where demographic usage was the main measure of accessibility and those demographics were difficult to attain. No evaluations were being routinely conducted and the demands on staff were too great to require additional data gathering. Additionally, naming or advertising the space and its activities proved challenging for many of the initiatives. The terminology is jargon heavy and the activities were hard to describe to non-specialist audiences.

Public participation for individuals was impeded by the resource-heavy demand of these activities. In addition to the materials and time required to participate in creation, they require both solitary and group participation to work. Making supports public participation by emphasizing mentorship networks and providing channels for individuals

to prototype their own designs. Organizations encourage public participation by offering makerspace opportunities at no cost and by attempting to integrate various activities and interests. The architecture of these spaces, however, may not be conducive to varied and on-going production activities. Prior studies have similarly found that “bricks and mortar” space concerns are paramount for some access institutions (Clark & Perry, 2015, p. 6).

Individuals can interface with organizational leaders and experts at makerspaces by way of *public engagement*. The volunteer model common to these spaces provides more people opportunities for leadership and decision-making. Simultaneously, however, the broad breadth of activities in makerspaces may impede the depth of engagement.

Conclusion

Together these themes suggest makerspaces are expected to be affordable, forward thinking initiatives with a cooperative leadership structure that values varied perspectives and activities. The analysis found the following aspects of accessibility that point to an evolution in expectations regarding public access:

- Makerspaces are useful for those searching for space, tools, learning and business opportunities, and social support.
- Often the spaces begin with a very broad focus during their “duct tape phase” which can lead to muddled missions and contradictory goals. This may offer more opportunities for public participation and engagement because members take part in shaping the direction of the initiative. However, if inclusion is not an explicit mission or goal, marginalized individuals may not be or feel welcomed.

- Attracting new or busy potential audiences is difficult as makerspaces may seem muddled to outsiders due to various forms of “messiness” and scene-specific jargon.
- On top of the instrumental needs makerspaces serve (e.g. providing technology), they also are expected to serve representational needs. For example, the focus on cooperation and community learning assures the learning and creativity are always visible to others. In other words, there is a built-in audience for the activities of these spaces.
- Makerspaces are fundamentally exhibitory spaces. This exhibitory function is useful for existing access institutions as it allows them to make public claims regarding their relevance.
- The exhibitory nature of these spaces means that audience is a necessity. They are less robust and enriching without a critical mass of users.

The following chapters will explore how this exhibitory perspective on access has shaped three different makerspace initiatives in varied institutions. Through a detailed exploration of the specific successes and challenges of these spaces, these case studies will explore how technological literacy is enacted in these local theaters of making.

CHAPTER 5

COMMUNITY MEDIA CENTER CASE STUDY

Introduction

[A]n effort to provide a physical space where a community of people with an interest in Science, Technology, Engineering, Art and Math (STEAM) can meet up, work on projects, and learn through “Doing It Yourself” or “Doing It Together.” It is also a place where Makers of all ages can come together and help and learn from one another. (Excerpt from Community Media Center Mission Statement)

The community media center is the public, educational, and government access television station for a town with two colleges and a university. The university is the largest employer in the town and these three colleges bring in over 25,000 students when school is in session. The colleges and the town share an uneasy relationship. Employees, local businesses, and real estate depend on the influx of students each fall. However, residents often raise concerns about rowdy parties and the university has experienced student riots after high-profile sporting events. The community media center sits at a unique intersection between the colleges, university, and town. While dedicated to local town news and government, they employ student interns and have programming hosted by experts from the local colleges.

The town is part of a region rich with educational, environmental, and artistic initiatives. In speaking with the planning group, it was clear that the local groups which offer similar DIY opportunities were important to shaping the understanding of the makerspace and defining where there is still a need. When I joined the initiative in 2014, similar spaces for adults included a technologically focused makerspace which catered to the engineering students at the local university, a crafting-focused space open to the general public, an ecological farm-focused makerspace which was membership

based, and a local academic consortium makerspace which was taking form at one college and was searching for a more permanent location. The local library was also holding occasional makerspace programs for youth. When asked about how the Community Makerspace fit within the local scene, organizers highlighted the community-based, environmental focus.

The media center occupies the bottom floor of a standalone brick building a few blocks from a small, liberal arts college. During the months when colleges were in session, a local student intern would greet guests as they entered and direct them to the computer labs, conference room, or studio. The computer labs had six computers in each where visitors could come to use the internet and production software. The studio was the physical and metaphorical center of the space so when there were shoots, the space buzzed with the energy of production interns, staff members, and those involved in the show. On afternoons when no shoots were scheduled in the studio, the space was quiet, with only a handful of staff and community members working on computers in offices and the shared lab spaces. There was no dedicated “makerspace,” so the makerspace volunteers and visitors found space in the media center for their gatherings. Most often, the group met in the conference room at a long table that afforded the space to spread laptops, prototype boards, fabric, and crafting supplies. During events when larger numbers gathered, volunteers set up folding tables in the studio. For the makerspace coordinators, this arrangement provided a dedicated meeting space that was already a trusted community resource. For the media center, the makerspace activities demonstrated why the center needed a new, more centrally located building to better serve the community.

The media center entered a town-gown collaborative (i.e. a partnership between the town and the gown, or academics, in the area) in 2013. A Public Service Endowment Grant (PSEG) from a large public university provided initial funding to buy equipment and pay student interns to help support programming for the makerspace. The initial emphases in this space were STEAM literacies and educational programming related to environmental sensing technologies such as water and air sensors. The initiative began in 2013 with three programming models that operated simultaneously, a college open-science course, an after-school program for middle schoolers, and occasional weekend workshops. All these activities were housed in the media center. Organizers hoped that these three activities would bring more people into the social center of the initiative, maker drop-in hours. These “drop-ins” were held weekly for approximately two hours, staffed by volunteers and student interns, and offered a space for anyone in the community to meet up and work on projects together. Staff of the media center also helped the group produce a television program that cataloged local “maker” projects or activities.

The structure evolved over time alongside funding, staffing, and scheduling changes. At the end of fieldwork in 2018, only the workshops, drop-in, and television program remained housed in the media center. Maker courses were on-going at the university, but the students no longer traveled to the media center. Since the PSEG grant funding period ended, the initiative has not secured any additional funding and much of the fundraising efforts have focused on the need for a new building. The group has since offered a variety of workshops focused primarily on open source hardware and software. In what follows, a communicative ecology framework (Hearn, Tacchi, Foth, & Lennie,

2009) is used to analyze the evolution of the media center's initiative in order to explore the potentials and constraints of this initiative's approach to social production. More specifically, the analysis follows the Framework to Explore the Communicative Ecology of Makerspaces offered in Chapter 3 (See Table 2).

Analysis

The media center is in a college town within Western Massachusetts, a region that boasts many colleges and universities. The U.S. Census Bureau lists the population of the town where the media center is located at approximately 38,000 as of the 2010 census. According to the 2018 American Community Survey, 70.3% of the town is white, not Hispanic or Latino, 12.9% are Asian alone, 6.9% are Hispanic or Latino, 6.1% are Black or African-American alone, and 4.5% are two or more races. In the town, 90.9% of households have a broadband internet connection and this figure does not include the students living in dorms. Two-thirds of those over age 25 have a bachelor's degree or higher. (U.S. Census Bureau)

Data for this case study comes from fieldwork conducted with the media center from February of 2014 to December of 2018. Research participation varied over this period as I moved between roles as a researcher, participant, paid program organizer, and volunteer steering committee member. I entered the field by conducting a pilot study from February to May 2014 as plans for a makerspace were drafted. After this period, my role evolved, and I became the central organizer and a paid facilitator for an after-school program that ran from 2014- 2016 as a partnership between the makerspace and a local middle school. I also became a member of the makerspace steering committee at this time, a volunteer position I held until I moved from the area in 2018.

Fieldwork

Given the diverse activities of the makerspace initiative, fieldwork included various forms of participation. In addition to periodic meetings with stakeholders from the university, media center, and local schools, I joined weekly makerspace drop-in sessions which were open to the community and included a mix of planning discussions and making activities. I also helped to organize workshops and took part in various social and marketing activities such as attending community events and bringing students to the National Makerfaire in Washington, D.C., and the World Makerfaire in New York. To explore stakeholder and participant visions of the space, motivations for joining, and their understanding of the complexities of this site, I conducted in-depth interviews in 2018. To help provide a fuller picture of the evolution and vision of the space, these in-person discussions were supplemented by analysis of the media produced by the initiative such as its social media presence, a television program hosted by the group, various mission statement drafts, and the public access media center's website. Finally, I held an open meeting at the media center in September of 2018 to present some of my initial findings as a member check which was attended by six people.

Interviews

During the pilot study in 2014, a preliminary focus group was conducted with three members of the steering committee, two from the university and one from the media center. A focus group was useful as it provided a nuanced institutional history while also allowing for organizers to reflect upon the common and diverging motivations for forming the makerspace. The remaining interview data is from in-depth interviews conducted in 2018 as part of the current research study. These in-depth interviews

included questions similar to the initial pilot study in order to explore how the initiative evolved over time. In-depth interviews also provided a chance for participants to expand on how and why they valued the media center, the maker initiative, and/or the maker phenomenon more generally. Table 5 lists the interviews which were relevant to the media center case study. All names are pseudonyms unless the participant elected to be identified in accordance with the IRB protocol.

Table 5. Community Media Center Interview Data

Type	Participant	Affiliation
Preliminary Focus Group	Chris, Tom, Rich	Stakeholders of University & Media Center
In-Depth Interview	Jim	Stakeholder of Media Center
In-Depth Interview	Chris	Stakeholder of University
In-Depth Interview	Michael	Stakeholder of University
In- Depth Interview	Tom	Stakeholder of University
In-Depth Interview	David	Participant
In-Depth Working Interview	Leonore	Participant
In- Depth Interview	Craig	Participant
In-Depth Interview	Rachel	Stakeholder Local Library
In-Depth Interview	Ian	Stakeholder Local High School

Document Analysis

To understand the initiative’s position in the local media ecology, I reviewed the social media presence. This included a Twitter account, a Google Group, and a Flickr account. Meetup was also used briefly in the fall of 2017 as an attempt to grow the membership base. The initiative’s website hosted the event invites, news stories about the makerspace activities, and the television series. The television series included 11 episodes. Three episodes were opportunities for the university makerspace to show the projects students had worked on the previous semester. Five episodes were guest appearances by individual makers. Two were interviews with organizers to describe the

initiative. Finally, one episode was a recording of a panel from a community access conference where I spoke about the makerspace initiative.

Technological Layer

Accessibility

Physical Accessibility

While makerspaces are often known for cutting-edge ICTs, robotics, and fabrication equipment, observations and interviews have consistently revealed that space and infrastructure are the most important technological factors shaping these initiatives. The media center is a single floor with wheelchair accessible bathrooms. The space is rather compact, however, and when someone comes in with a wheelchair, tables sometimes need to be moved to accommodate. Different areas of the station are used for different events and there is no single dedicated makerspace area. The computer lab has six large iMac computers which make collaboration between people difficult as you cannot see around or over the screens. While there is a large studio and a conference room that can be used for collaborative activities, there are no portable laptop computers. In my observations, this led to drop-in activities being bifurcated with youth working on digital media activities in the computer lab while adults worked on hardware projects in the conference room. For those who could not bring their own devices to drop-in, this was a challenge. Leonore explained, for instance, how important it was to have access to the iMac computers during drop in to look up information and purchase materials but that it left little room to work on the e-textile projects she was crafting. During one Inkscape workshop, Chris and I set up the room when we arrived around 9:20am. We wanted a space where everyone could work together and Chris could project his computer screen

for others to follow along. We decided to use the conference room and ended up bringing in two of the desktop computers from the lab. Two visitors did not bring laptops with them so we set up the Mac desktops for them to use.

A librarian admitted that staff at the local library just up the street from the media center were “constantly fighting this building” to offer technological literacy programs and that the library’s technological offerings are “bare-bones functional” rather than “cutting edge” (Interview, 2018). While the media center and library faced similar challenges, the library remained an important and accessible community resource because of its location in the center of town, on bus lines and close to local schools. The media center, meanwhile, has struggled with both of these spatial and infrastructural concerns and was also difficult to access geographically.

The current location of the media center is too far from the local schools for youth to walk there. While there is a town bus line, there is no stop close to the media center. Most visitors drove and parked in the small parking lot next to the media center. The discontinuation of the after-school program and university course at the makerspace were both partially the result of transportation issues. The after-school program struggled to fund and schedule buses to the media center as it was not in walking distance from the school. For college students, the trip off-campus without a close bus stop made it prohibitively difficult to hold class there:

Interview: Tom (6/15/2018)

For instance, just the challenges of having ... students meet off campus. Is a real challenge and we gave it a go with it but I think I’ve realized after several attempts that especially with students that are in programs like engineering, it may seem like a small thing to go off campus and take a half hour to get there and a half hour to get back. But I don’t think it’s a small thing. I think students see that as a real difficult thing to do.

These transportation issues extend beyond the organized programs and to the other makerspace offerings at the media center. For example, one participant arrived over an hour late to a workshop because it had taken him three hours on public transportation to reach the media center.

The media center makerspace is inspired by the desire to bridge a town-gown divide participants fear will widen if the local colleges and universities continue to have insular activities, resources, and programs that serve their discrete campuses. These spatial discourses about “local” places, the disruption of “silos,” and spanning “divides,” are more than simply metaphors, however; they are shaping the very architecture of a new media center. In 2018, the media center was in the process of fundraising for the construction of a new building to house its programs and production spaces. At the time of writing, the media center is still in the process of receiving final building approval. The media center staff hopes its new building will be an embodiment of the bridge between secondary schools, local colleges and universities, local business, and the community-at-large.

External Communication and Advertising Media

The media center is uniquely positioned to provide opportunities for external communication. The makerspace, for example, had its own show on the local cable station. Eleven episodes were recorded and aired between 2014 and 2017. Guest could come in and discuss projects in the works and organizers of the makerspace could explain the goals of the space to the local community. Other external advertising channels were often underutilized, however. For example, there were major changes to the media

center's website underway when the space began. Once the website was available, the content on it remained unchanged.

Despite the availability of various broadcast technologies and ICTs, the space struggled to keep advertisements and scheduling for the space up to date. The space primarily used a Google Group email list to circulate updates and information and a Twitter page to communicate with the public. Early in the development of the space and again in 2017, Meetup.com was used to advertise the space, schedule events, and grow the participant base. Unfortunately, once a certain number of participants join a group on Meetup.com, the group organizers must begin to pay to maintain the page. Without funding, these costs were too high to sustain. Additionally, no paid staff is available at the space to help oversee the advertising channels for the makerspace. One member of the steering committee explained his frustrations with the arrangements:

Interview: Chris (5/24/2018)

I felt as though we haven't had very many people that are able to come in and actually take ownership of pieces and carry it forward and so, as I've gotten busy, trying to do everything, trying to come up with ideas for workshops, trying to write the copy for the announcement, trying to get the sign up sheet built...that kind of responsibility to do all of the pieces to make a workshop or something come off has—we don't have a large enough people pool for that to be viable.

The labor involved in the upkeep of the initiative's media presence has been a continual roadblock and one that can best be explored through the lens of the social layer of this communicative ecology.

Technologies Available

Physical Set Up

ICTs and emerging technologies are central to the activities of the media center's makerspace. As an access center, the space includes technologies for recording, editing, and broadcasting video. There are also two computer labs outfitted with iMac computers.

In the early years of the initiative, middle school students would use drop-in hours to record “Let’s Play” videos of Minecraft for YouTube. During my observations in 2018, a few visitors were interested in the possibility of classes or software to do podcasts. Some participants came to the makerspace expecting a focus on these digital media technologies and were surprised to find participants hacking hardware and creating e-textiles.

A grant from the university helped the makerspace purchase small prototyping boards called Arduinos that allow for the creation of interactive electronic devices. These Arduinos were followed up by the purchase of Lily pads which are based on the same technology but allow for the creation of responsive textiles. Some participants who visited expected fabrication technologies such as 3D printers and laser cutters as these are commonly associated with the larger maker scene.

These media and computational technologies were used synergistically in the space. For example, the director described how programming that used the Arduino devices could be coupled with video production. Some of the programming with youth, for instance, included training on both the emergent technologies and the video recording technologies so they could record themselves explaining the work they were doing. Indeed, this space had the unique opportunity to record and broadcast “maker” activities as evidenced by the 11 episode maker series.

ICTs were also integral to the process of making most anything we worked on in the space because they were used to seek out information, expertise, and advice. During one drop-in, for example, I was working with Leonore with fiber optic filament. We had ordered the filament online the week before during drop-in and we decided to experiment

with it together. I had already made a string of LEDs sewn into fabric that we could use as a prototype for an e-textile wall hanging. We put black tubing that I found in the closet over the LEDs then strung some of the filament into the tubing. At first, the light was only shown at the end of the filaments. One of the videos we watched on YouTube the previous week said that you could scuff or scratch the filaments to make the light shine through other parts. I went to the closet and found some sandpaper to use. Once we scuffed it, light came through the whole strand. The goal of the final project was to make a wall hanging e-textile for display and education. This anecdotal example of one drop-in experience is a good exemplar of what “making” often entails: Planning, gathering materials, gathering expertise on and offline, prototyping, testing, and sharing what was learned.

Internal Communication Channels

Internally, the group conversed over email through a Google group. Only those already signed up to the group would receive these messages. Since the start of the initiative in 2014, members of the group started 137 email threads. While the early threads included various topics from a breadth of members, during the year of fieldwork in 2018, threads were primarily advertising specific events and notifications regarding cancelled drop-in sessions. The organizers worked for the university and the media center, so email was a common method of internal communication. The central organizing group was very small, so this method was simple to maintain.

Pedagogical Models

Teaching Philosophies

Two primary pedagogical models were used at the access center. Firstly, there were drop-in activities. During drop-in, participants were free to work on any project they brought. All visitors were thereby both learners and teachers as they helped develop projects and troubleshoot issues. At periodic workshops, meanwhile, a leader would provide a basic introduction to the tools and technologies and then the participants could work freely on what they wanted. Often these workshops ended in a show and tell, or an opportunity for participants to share what they created.

While not located in the media center, associated maker courses and events were held at the university and local K-12 schools. On-going courses and afterschool offerings have built in expectations of continued participation but introduce different challenges regarding expectations of expertise. For example, Ian, a teacher from the local high school, described himself as a generalist leading to anxiety about an upcoming robotics club meeting where he may not be able to personally provide the guidance students expect:

Interview: Ian (9/26/2018)

There is a certain level of fear, apprehension- like tomorrow we're going to have the first meeting of the engineering club...we're going to open up the floor and say to the kids, "What do you want to do?" And then that then opens the flood gates for all these crazy ideas which we probably can't do or we can't support or it's not relevant or not applicable to school or appropriate or something. But I know I am going to get somebody who comes up with something that makes me go. Oh! That might not be a bad idea. And then we have to find a way to make that. To make that work. What skills do we have, what machines do we have, what equipment and materials do we have that we can actually do that? Can we do that here? Do we have to bring in somebody else? Do we have to go somewhere else?

In outlining the tenets of the university-level maker course, Tom also described how successful projects emerged through the ad hoc coordination of various resources. In particular, Tom described one of the “key” elements as finding other faculty mentors for students that had the applicable expertise for their projects. In both these cases, there is less control over the direction of knowledge production, but the institutional legitimacy helps to coordinate the allocation of resources.

Assumed Outcomes

The media center discusses the makerspace as a logical extension of what their organization is already known for providing. The director, for example, described the makerspace as a natural fit given the organization’s role “which historically has always been there to introduce people to technology”:

Interview: Jim (5/3/2018)

Originally it was television technology, equipment or technology for people to be making their own shows, producing their own shows, editing their own shows then distributing their own shows. So that, historically, has been giving access—both financial access and training—to people for free or near free for the community since ’75. Once I heard of makerspaces, I thought it was a natural—to me it was a continuation of the new technology that we should be supporting. There’s been for years—how to make cable access television relevant today? Obviously with handheld computers, telephones that are cells, that are distributors, that are production. Why does a child or why does an adult need to come to us?

Rich expressed a similar perspective during the preliminary focus group in 2013, emphasizing how this access is crucial for expression:

Focus Group: Rich (4/2014)

I’ve been working in community media in one form or another for about 15 years and getting people to realize that their interaction with their environment isn’t just passive and that you really can engage in the process of your creation and of the fabrication and structure of your existence. And sometimes that’s technical and sometimes it’s very much not. You know, lets learn how to use a microphone, lets learn how to use a camera, lets learn how to make a light that blinks and you know, it’s all sort of a continuation of that. I think this fits well with the mission

of community media spaces, of connecting people with the technology that allows them to express themselves and engage in other people's expression.

The director described the various ways the organization had attempted to keep up-to-date in a changing technological environment such as becoming a certified Apple training center and changing the organization's name to reference "media" rather than "TV".

Training or instruction remains a central focus of the organization's mission regarding making. The Director, for example, was interested in having the makerspace be a place for "training the trainers." In other words, a space where college students could learn to work with community members in productive and respectful ways.

Organizational Policies

Rules and Guidelines

Specific rules and guidelines were not set for the space though they were discussed on a few occasions. For example, there was some discussion about whether children should have to be accompanied by an adult when they are left in the space.

Funding Sources

The space was originally envisioned as opening possibilities for "Active collaborations among academic, business, artist, migrant, immigrant, veteran, low-income, and elderly communities" according to an early mission statement. During the pilot fieldwork period, however, events focused on youth and their families. This focus is partly because many of the organizers are educators dedicated to fostering interest in STEM or media production among youth. Additionally, the availability of grants and the goals of the ICT center's outreach to local schools are more aligned with support for youth initiatives. Drop-ins in the early years focused on drafting these grants and we have found that the realities of funding, the interests of our organizers, and the ICT center's

mission of networking with local schools led to a focus on youth-centered activities. During the fieldwork period in 2018, fundraising efforts were focused on the larger project of the media center's new building. Without a budget to work with, and desiring to keep workshops free, the makerspace focused primarily on textile and open-source software workshops. These activities attracted a primarily adult crowd.

Social Layer

Social Networks

Associations of Attendees & Organizers

While this initiative is focused on technology, it is, at its core, a social enterprise. When questioned about motivations for participating in the makerspace, nearly everyone began with a story or comment about people in their lives or their desire for socialization. Chris, Tom, and Craig told stories about their children and how they were inspired to learn more about making to work with or support their children's interests. Parents have always been an important target population for the group. An early goal of the initiative was to connect with parents from underserved populations in the town:

Interview: Jim (5/3/2018)

We wanted to tie into the family center. Coming from my own background in starting family literacy programs...parents don't have the skills to help children with homework at times...So if a child brings home an Arduino, the parents have seen one, knows what it is, and they might get excited about it

Additionally, the initiative offered opportunities to meet new people. David explained the value of the community of a makerspace:

Interview: David (8/17/2018)

Well you know there are multiple reasons for using a Makerspace so there's no one single reason that would be the all-qualifying reason for using it. One is just camaraderie or moral support. You know having like-minded people to talk to and brainstorm with.

Leonore, an older adult living far from her family, also emphasized the social element in her explanation for her initial attraction to makerspaces:

Interview: Leonore (5/16/2018)

It could be any space. It could be a factory building. It could be whatever people choose. Whatever they want and congregate at... it's a people thing.

When asked about why she visited the media center specifically she said:

Interview: Leonore (5/16/2018)

It's not [the media center] it is you and [Chris], it is the personas. Without you that space of the maker and making wouldn't happen. And your loyalty to that. Showing up every week with few exceptions when you have a bigger thing on your agenda. That is just remarkable. But if it weren't for you. I wouldn't be there. That is really the truth.

While the social element is central, participants frequently discussed the rarity of being able to find others with shared interests to work with in person.

Because makerspaces are place-based, it is not easy for those interested in the scene to join. Some of the makerspaces in the area are housed on college campuses which are not open to those outside the campus community. Chris referred to these as academic “silos” at the community meeting in 2018 and Michael echoed this suggesting that, even when we have good intentions, “we build silos from the start.” To confront the insular nature of the makerspace scene, participants discussed the need to reach out to prospective or dormant members and encourage collaborations among organizations. That collaboration, however, is labor intensive and it requires someone “who wants to be that conduit between the university and the school systems and the non-profit” (Tom, Interview 2018).

Labor Force

Associations of Personnel

Though many participants suggested in interviews that they have interest in teaching and hosting workshops, the primary organizers for the makerspace included professors and students from the local university. While a unique resource for a media center, the organizers explained that the participation from colleges can introduce new challenges for community organizations. Professors are often overburdened with research and teaching demands and these forms of outreach, while encouraged, are not rewarded for faculty:

Interview: Michael (5/23/2018)

I mean, my faculty annual faculty review, I'd maybe note under service and outreach that I was doing that, taking credit for it, and it wasn't like my department would say oh, you shouldn't be doing that, but it really is kind of not something that in the formal evaluations of faculty, it's encouraged but it's not something as encouraged as standard teaching and standard research. So, you know, it makes it a little harder from a faculty motivation standpoint to keep it going.

Student participation is often short-lived even if they have a more formalized position such as an internship:

Interview: Chris (5/24/2018)

[Students] come in for a relatively short amount of time, they're engaged while there, while it's part of their formal duties, but then it doesn't translate into anything beyond that once the particular semester ends or once they graduate, they go away.

Forms of Expertise and Credentials

The Director explained that college students are not always prepared to work with the community:

Interview: Jim (5/3/2018)

Students need training before especially they work with inner city youth or low-income youth. That was our target. Originally we wanted to find a way to connect

with those families, connect with those students... Students needed some sensitivity training and training on how to work with youth.

The local librarian described a similar scenario in her work with an outside group who came to the library to teach an engineering program. While the engineers were excellent at explaining the work process, it was the librarians who had to step in to deal with the “emotional fall out” when youth became frustrated or cried. As these challenges demonstrate, some of the most important labor concerns for sustainable, inclusive technological initiatives are the forms of labor that are often elided by discourses that focus on technical expertise or entrepreneurship—In particular the logistical and emotional labor.

Discursive Layer

Activities

Topics of classes

Organizers use the term “makerspace” for the ICT center’s initiative to connect it to an emerging culture of community-focused, DIY technology tinkering. From a cloud statue that changes color to reflect online weather reports, to sweatshirts with functioning lights sewn in for cyclists to signal their turns in the dark, to pollution monitors the size of a cellphone that can be thrown into lakes and rivers, the projects discussed by the media center’s makerspace developers vary widely, likewise the definitions of making and hacking that underpin them. One of the organizers of the media center initiative bristled when I mentioned the term “maker movement,” explaining why the term did not feel applicable:

Interview: Chris (5/24/2018)

The maker movement I think makes it sound too much like a group that actually shares common ideas and is moving forward in the same direction. I would say

that making is more of a phenomenon, it has a whole lot of different people all moving in different directions amorphously.

The workshops and drop-ins were primarily organized around open-source technologies and software. For example, Arduino workshops introduced participants to responsive technologies through the use of prototyping boards while Blender and Inkscape workshops introduced participants to open source digital design technologies. There was always an educational bend to the space due to its ties to the university, goals of working with local schools, and the mission of the access center itself. The issues of concern were related to open science. How can more young people get involved in science and how could the makerspace support these efforts? The drop-ins tended toward broader goals of involving people in varied forms of open source making. The outcomes of participation were often focused then on learning and community building.

Uses of space

Because the “makerspace” was a meeting of makers rather than a physical room, the space was only open for use during planned activities such as drop-in and workshops. At all other times, the space was used for the activities of the public access media center.

Issues of concern

Governance/ Ownership Discussions

The position of a makerspace as outside of, or in contrast to, more formal institutions emerged in some of the interviews. For example, when discussing other activities she participates in locally, Leonore explained why she does not align the activities of a fiber arts group she is a part of with that of a “makerspace”:

Interview: Leonore (5/16/2018)

[The fiber arts space] is not exactly a makerspace but it is a community meeting space. I wouldn't regard it a makerspace because they have really a topic. It's not

so, ad hoc, not so open and there are teachers that are instructors. It's less interactive. It's hierarchical, the women learn basic skills in a structured way.

Leonore further mentioned that she was drawn to the media center's initiative's status as outside of a formal educational environment:

Interview: Leonore (5/16/2018)

A walk-in educational place without having to sign up for an institution and this open door culture that I sensed appealed to me very much.

For another participant, David, online maker communities and resources were the most accessible and were again marked in contrast to more formal educational opportunities:

Interview: David (8/17/2018)

I haven't been doing much in the way of local on-campus learning. That exist but because of my transportation difficulties and my budget limitations at the moment, I've tended to stay away from that so far. I'm finding so far that's not very limiting. It's just there's a phenomenal amount of information out there for people who know how to dig for it.

Similar to Powell's (2015) findings on open source hardware licensing, these comments show how a makerspace, as a boundary concept, becomes a site where the institutional legitimacy of formal educational models and the adaptiveness of emergent, ad hoc communities of practice meet.

Open source cultures were also a prominent discourse the space often aligned itself with in my interviews and observations. As the drop-in activities and discussions I witnessed often attested to, those dedicated to the makerspace engage in very laborious processes of coding and creating so that all products remain open-source. The ICT center, for example, is a dedicated member of a community-access-media group that collaborates with stations across the U.S. through the use of the open-source content management software, Drupal. Furthermore, the steering committee members I interviewed from the university are interested in open source science instrumentation and dedicated to

promoting knowledge commons through their pedagogy. For example, in one workshop on the open source illustration software, Inkscape, Chris dedicated part of the time to a discussion of Creative Commons licensing and the best choices for hosting images so they remained in the commons.

Outcomes of Participation

Cavalcanti (2013, May 22) of Make Magazine provided an outline to define and differentiate a few of the most common terms for these creative, informal production spaces. He first provides a differentiation between a hackerspace and a makerspace, the two most common terms:

To me, ‘hacking’ and ‘hacker’ are fundamentally exclusionary; whether they refer to the traditional act of programming to defeat or circumvent existing systems, or the act of working with physical parts, there’s a basic understanding that ‘hacking’ refers to a specific subset of activities that involve making existing objects do something unexpected. (Cavalcanti, 2013 May 22)

When I questioned the group on the validity of that distinction in the initial focus group, Tom suggested an alternative conceptualization: “I’m much more likely to think about making as working with things in the real world and hacking as working with stuff in the virtual world” (Focus group, 2014). This distinction was not purely an online/offline divide, however. Instead, hacking was described as inventing something unexpected by combining and remixing. Rich, for example, viewed it as a difference between incorporation and creation: “So on the hacking front its really about taking things and incorporating them into a new process whereas the making is about the main process” (Focus group, 2014). In an interview, makerspace participant Leonore explained she does not conceive of skill sharing workshops as “making”: “I associate the word making more with utility, I mean, even if it’s high-tech. You develop something together or individually” (Interview, 2018). Hacking is therefore more aligned with the imagination

while making is creative but more concrete. The planning participants were careful, however, not to discount hacking. Rich wanted to emphasize that hacking is not a delinquent behavior:

Focus Group: Rich (4/2014)

I mean I think that there's definitely a group or a number of people who are intently using hack in a positive way to rupture it from that negative connotation... Yeah, I like that... I like the defiance of that. This was positive to begin with and it will always be a positive term and we're going to keep using it to make sure it is.

Nevertheless, Tom confessed that in speaking with those outside the scene the terminology is still crucial: "I have to admit part of the reason for calling it a makerspace rather than a hackerspace is because make doesn't have the negative connotation" (Focus group, 2014). Michael, meanwhile, suggested that in 2018, the term "making" was losing its purchase among regional planners who found it "passé" (Interview, 2018). These discussions reveal how the space must negotiate within the scene while remaining cognizant of how those outside (including prospective makers) will view the openness of the space. The space must be legible to those outside to achieve its goal of open participation but also work to maintain its autonomy or distance from the activities or institutions that it defines itself alongside.

Social cohesion was the most discussed reason for the creation of this space. There was hope that the space would heal town and university divides. Additionally, the space initially envisioned creating connections between the local schools, the access center, and the university. By way of mentoring, it was hoped the young people would aspire to do work like the college students they met. A few participants seemed to share that outcome goal. They discussed the importance of a welcoming group that was willing

to engage with their interests. This cultivation of community connection was a central mission.

Conclusion

The media center desires to disrupt existing academic and community silos through accessible, collaborative learning opportunities involving open source hardware and software. In the resultant “town-gown collaborative,” the media center’s makerspace has become a productive “boundary object” (Star, 2002) that allows for people who are more interested in a structured, orderly, space where knowledge/expertise can be transmitted to interface with those who are interested in the risk and messiness of the emergent construction of knowledge. In attempting to be neutral ground between various silos, it occupies a liminal space between a structured institution and an emergent collective. The potentials and challenges of this position were explored through the lens of its discursive, technical, and social communicative ecology (Hearn, Tacchi, Foth, & Lennie, 2009). For the Community Media Center, larger technological changes were shaping their role in the community. The Director described the various ways the organization had attempted to keep up-to-date in a changing technological environment such as becoming a certified Apple training center and changing the organization’s name to reference “media” rather than “TV”. Training or instruction remains a central focus of the organization’s mission regarding making. The Director, for example, was interested in having the makerspace be a place for “training the trainers.” In other words, a space where college students could learn to work with community members in productive and respectful ways.

CHAPTER 6

LIBRARY MAKERSPACE CASE STUDY

Introduction

We want to give everyone in [town] the opportunity to become a maker. We want neighbors to share skills with each other. We want to see you learning from and teaching to each other. Becoming a maker is not about talent - it's about collaboration, creative problem solving, and the development of a curious and tenacious spirit. (Excerpt from Library Makerspace Mission Statement)

The Library Makerspace is associated with, though not housed in, a city's public library. The library is an important educational and cultural hub for the community. The library itself was renovated and expanded in 2006 to be ADA compliant and their Long Range Plan (FY2017-FY2022) reported that in 2015 the library had over 398,000 visitors. The library makerspace was initially located about two miles from the town library in a mid-size mall. Through the glass storefront windows, visitors to the mall could see a small room with three 3-D printers, and a small worktable. The walls were covered in flyers for community events, projects made by visitors, and signs explaining the space's connection to the local library. Volunteers greeted guests and could tour them around the space which included a back room, not visible from the mall concourse. The backroom had more worktables, a tool cabinet, resource bins full of crafting supplies, and sewing machines. Visitors who went even further into the backroom area of the space would find a laser cutter station, a small bathroom area, and a door to the back of the mall. This mall storefront was offered to the initiative for free in 2015 while they were in the process of renovating the retail area. After a long process of searching for a new location, the Library Makerspace moved to another "temporary" location in August 2017. The new location was only about a third of a mile, or a 7-minute walk from the library

itself. It was in a storefront in a town center under an assisted living facility. Visible through the large glass window from the street, the makerspace was a single room, approximately 2,000 square feet. Sewing machines, Lego Mindstorms parts, and Little Bits circled a large worktable at one end of the space. At the other end of the space, a laser cutter, tool cabinet, and 3D printers lined the walls around another set of worktables. A large mural of butterflies covered the wall above the 3D printers while the rest of the space was decorated in brightly colored paint, DIY instruments, laser-cut creations, and other arts and crafts. In the center of the space, wheelchair-accessible rest rooms stood next to a small alcove that served as a makeshift storage closet for all manner of parts and pieces used by the makers.

The library makerspace began in 2015 when the discourses of the Maker Movement were at their height and many libraries were expanding into the area of offering desktop manufacturing and robotics technologies alongside their traditional ICT offerings. The space offered periodic workshops run by volunteers on a variety of “maker” activities including 3D printing, vinyl cutting, Inkscape, Arduinos, basic tool use and wood working, and sewing. As a permanent, volunteer-run facility, the makerspace is open weekdays in the afternoon and evening, and on weekends in the afternoon. Some volunteers have more depth of expertise in certain topics, so visitors were often encouraged to visit on certain days when those volunteers were in if they needed help with a specific technology or project. Additionally, there were blocks of time set aside certain days of the week for those interested in areas such as sewing, mechatronics, or electronic music to gather.

This overall structure has remained consistent though changes to the offerings have evolved as the library moved the makerspace to a new building and hired a dedicated makerspace coordinator in 2017. The space was initially funded by donations from a community foundation. The mall storefront was free to the initiative as the mall was looking to integrate community offerings during its renovation. Additional donations from community organizations and Best Buy supported the initiative during the move to the downtown storefront location in 2017. The makerspace became a line item on the library budget during my observations in 2018. The space is still in operation at the downtown storefront during the time of writing, though they are working on securing a larger, more fitting space in a former police station close to the library. In what follows, a communicative ecology framework (Hearn, Tacchi, Foth, & Lennie, 2009) is used to analyze the evolution of the library initiative in order to explore the potentials and constraints of this initiative's approach to social production. More specifically, the analysis follows the Framework to Explore the Communicative Ecology of Makerspaces offered in Chapter 3 (See Table 2).

Analysis

The library is in a suburb of Boston, placing it squarely within a regional technology hub. The U.S. Census Bureau lists the population of the town where the library is located at approximately 34,000 as of the 2010 census. According to the 2018 American Community Survey, 77.4% of the town is white, not Hispanic or Latino, 9.7% are Hispanic or Latino, 8.5% are Asian alone, 2.1% are two or more races, and 2.0% are Black or African American alone. In the town, 89.5% of household have a broadband

internet connection. Of those over age 25, 63.9% have a bachelor's degree or higher.
(U.S. Census Bureau)

Data for this case study comes from research participation at the library makerspace from 2016 to December 2018. I visited the mall location on a few occasions in 2016 and was approved as a volunteer after a background check and training on January 9th, 2017. In addition to visits to the makerspace, I visited a university makerspace and an arts center after volunteers mentioned their affiliations with those spaces.

Fieldwork

Fieldwork for the library makerspace ecology occurred in the makerspaces, at a local university makerspace, and at an arts center. I made my position in the space as a researcher clear from the initial volunteer meeting, and my observations occurred during volunteer shifts and while participating in training workshops. I took a volunteer training, a laser cutter training, and a vinyl cutter training during the 2018 observation period for this study. I was living over two hours from the space during this period, so my volunteer hours were rather sporadic. During volunteer shifts, I was responsible for welcoming the community, monitoring use of the tools, and helping visitors with projects where and when I could. I took scratch notes during my visits and wrote up more detailed field notes following the visits using the structure outlined in Appendix B. I also conducted ethnographic interviews during these periods and used my notebook to record written notes on our conversations.

Interviews

As a project envisioned and carried out by the local library, the library makerspace was more consolidated than the public access media center initiative. As such, there were fewer organizational stakeholders with which to conduct semi-structured interviews. Instead, the bulk of semi-structured interviews were conducted with volunteers and ethnographic interviews were conducted with visitors and volunteers. At the time of observations, the volunteer list was approximately 40 individuals. I put a call out for interviews on the organization’s Slack channel. The volunteers who agreed to participate asked to conduct the interviews in makerspaces.

Table 6. Library Makerspace Interview Data

Type	Participant	Affiliation
In-Depth Interview	Cindy	Affiliated Arts Center
In-Depth Interview	Sarah	Library Director
In-Depth Interview	Emma	Makerspace Coordinator
In-Depth Interview	Leo	University Makerspace Coordinator/Volunteer
In-Depth Interview	Melissa	Volunteer
In-Depth Interview	Gloria	Volunteer
In-Depth Interview	Dante Mann	Volunteer
In-Depth Interview	Mark	Volunteer

This initiative offered a unique methodological challenge and opportunity related to interviews. Many of the interview participants for semi-structure interviews desired to interview while working. While this occurred in other spaces as well, it was particularly common at the library makerspace. As the study was focused on perceptions and experiences of the initiative, and not intimate personal details, this did not pose privacy concerns. This arrangement led to several “interrupted interviews” which offered unexpected insights into these sites of creative exchange. During interviews, other people in the space would occasionally stop by and join the conversation, the participant would

ask for a hand in what they were making, decide to show me something elsewhere in the space, or the participant would pull others into the interview by addressing them. These unexpected moments encouraged me to revisit Bird's (1995) work on reception studies in communication. She describes how the “ethnographic encounter” is “an act of communication that is inseparable from the existing gender and/or class-based circumstances of which it is part” (n.p.). She stresses the value of “encouraging of the informant to define the terms of the encounter” (n.p.). Occasionally, these interviews became more akin to group interviews which can evoke a “spontaneity of viewpoints”: “group interviewing celebrates individuality by gathering people together and encouraging participants to talk about (even debate) their divergent and convergent thoughts or ideas (Roller & Lavrakas, 2015, p. 105). For example, some of the interviews were conducted while the interview participant was leading a workshop or working on a personal project. Rather than asking them about their pedagogical approach, I was able to witness it in action and ask more specific questions. These interviews could be likened to active or “walking” interviews. Ratzenböck (2016) used the “walking interview” in the homes of study participants to explore ICT use and understanding in everyday contexts. At the library makerspace, one participant asked that I visit the workshop he was conducting and interview him as he worked. Before we began, I addressed everyone in the space to explain my study and allow them to opt out of me taking any notes on their activities or comments. My self-introduction prompted the participants to discuss what they considered to be the “technology” of the space. One woman who was there with her daughter said that she considered this side of the room technology but not the other side—gesturing to the hand tools, 3D printers, and laser cutter as technology, and to the

sewing machines as not technology. One of the other visitors mentioned that the instruments they were making could be considered technology and discussed how fretted instruments were a technology of antiquity. According to Ratzenböck (2016), the benefits of this interview style that are relevant to the current study include, more participation from those who may be less flexible in terms of location, allowing for “different ways of expressing experiences,” and changing the power dynamics as interviewees “lead” in a more familiar form of interaction than a typical sit-down interview (p. 56).

Document Analysis

The experiences in the space were supplemented with analysis of various documents and artifacts. I used emails for the volunteers, monthly email blasts, promotional videos, the makerspace’s Facebook page, and news articles to triangulate and fill out some of the institutional history provided by volunteers. I also explored the Slack channel to understand the communication resources used by volunteers.

Technological Layer

Accessibility

Physical Accessibility

During my fieldwork in 2018, the library makerspace was in a downtown area which made it easier for the community to stumble upon it. This site also offered unique access for members of a local elder care facility. The makerspace shared a building with an assisted living community and there were occasional activities coordinated between the two spaces. In an email sent out to volunteers before the downtown storefront was found, the library director made a list of requirements for the new space:

- Has to be within [town] city limits

- 1500 square feet (our current space is just about 1,000)
- Electricity
- Bathroom
- Some sort of wet area with sink outside of a bathroom
- Preferably free, but paying rent isn't off the table. I don't have a number of what we could pay, just know that having to pay rent isn't a deal breaker [Personal Communication, 1/25/2017]

While the current storefront fits most of these requirements, the physical space bars the makers from certain activities. In his interview, Mark mentioned that there are certain tools they cannot have in the space because they generate a lot of dust. The building owners also asked that they do not work outside on the sidewalk. Finally, there is no slop sink to use to clean paintbrushes or for screen printing. The space constraints are also a financial burden. During the laser cutter workshop, we were reminded that the filters are consumables and cost \$400-500 each. Unfortunately, they are consumed rather quickly as there is no way to vent the laser cutter to the outside of the building.

While the volunteers and organizers I spoke to were interested in moving to a more fitting space closer to the actual library, they admitted that the library itself, much like the mall before, was not a practical space for these kinds of activities. One visitor I spoke to said it did not make much sense “bringing a glue gun into a library,” and the makerspace coordinator admitted they would make too much noise if they shared a space.

There is another way that the building and space set up may be physically inaccessible: disorganization. Gloria admitted that she was so pleased with the new makerspace coordinator hire because she was prioritizing organization. The coordinator, Emma, explained:

Interview: Emma (6/8/2018)

I think I actually had a really good idea about what to expect coming into this. I understood that that space, it's pretty ad hoc. Like we, everything just sort of happened in this weird amorphous way and the space wasn't clearly defined. We can have like stations, we sort of had stations because saying that we didn't really

have stations for things is a lot of clutter. And so I understood that one of my big challenges would be to organize the space in a way that was clear and consistent and easier for people to navigate it because one of the reasons [the makerspace] was formed was to be accessible to people, to make things that are very hard to understand, or expensive, accessible and so understanding that as part of the mission made it pretty clear that organization was a big part of this job.

External Communication and Advertising Media

The primary form of external communication and advertising was through the library: its website, calendar, and email listservs. The site has a well-maintained Facebook page as well. There was also a Meetup site for the makerspace but the Meetup site was discontinued in August 2019. One of the major responsibilities of the makerspace coordinator role was to manage the external communication:

Interview: Emma (6/8/2018)

Even though we have a community engagement specialist at the library who I can send things to, I have access to the [makerspace] portion of the library website. I have access to all of our online accounts through her. So rarely do I actually put things through her unless I needed to go to a huge, huge audience. Like try to get in the full library newsletter. We send out our own newsletter. So I do all of our marketing. I do all of, I do all of our scheduling.

Technologies Available

Physical Set Up

Desktop fabrication tools are central to the offerings at the library makerspace. The Assistant Director of the library explained that the choices of technology were guided both by expectations on a “makerspace” as well as by what the community asks for access to:

Interview: Sarah (5/7/2018)

You know we knew we would have a 3D printer because that was the big sexy thing at the time. That has never been my favorite thing. I've always liked the laser cutter...We had some things that were kind of like hot button type of high interest items that we knew people wanted to see but a lot of it was driven by volunteers and their interests and what kind of made them spark.

As a result, the technologies at the space are very varied. They have robotics kits, sewing machines, a vinyl cutter, hand tools for wood working, a drill press, and laptops available for use.

As the space is one room, it is easy to move about the different tools and tables. The space is very flexible in that the chairs and tables can be easily rearranged. There are extension cords and outlets easily accessible throughout the room, including some which dangle from the ceiling over the worktable.

Internal Communication Channels

The volunteers and organizers converse primarily over the discussion application, Slack. There are also email blasts that are sent out to the volunteers periodically. Slack is very active and organized around specific topics. It has “channels” which volunteers can post to which keeps the conversations on-topic and allows for other users to opt in or out of notifications for certain discussions on a mobile device. As many of the volunteers are in the tech field where Slack is a common application, this tool has been a strong way to keep the community connected. Makers share events, questions, and resources on Slack frequently. The makerspace coordinator is also able to quickly update the volunteers when there is a problem, or someone needs to cover a shift in the space.

Pedagogical Models

Teaching Philosophies

Volunteers design and teach workshops in the space. In speaking with these volunteers, many explained that they prepared by doing research through online tutorials. Gloria, an older adult who was the resident fiber artist, was frequently on Pinterest looking up ideas. When I mentioned to Dante Mann that I was planning to work with EL wire for the first

time in the media center makerspace, he said that he “cribbed Adafruit tutorials” to design his workshop on the topic.

A difficult pedagogical aspect of the making process that was revealed in my observations of workshops was related to streamlining the process. As the volunteers I spoke to admitted, their own learning and making experience came from research, purchasing/finding materials, crafting elements, trial and error, and discussions with other makers. Condensing that process down to a short workshop necessarily lessens the experience. For example, in a ukulele building workshop, Mark had already gathered and/or crafted the basic pieces the group would need to construct the instrument. For the laser cutter workshop I attended, the facilitator explained that the longest part of the process is always the design. We started after the “design” phase as he had a design for us to print. Another librarian, not associated with this makerspace, explained this challenge well:

Interview: Rachel, Librarian (9/26/2018)

And I think also just because of time constraints and because we want kids to have like outcomes, it's natural for teachers or people who are facilitating these workshops to do a lot of that work beforehand. This is what you've gotta do for step one, and this is what you gotta do for step two, or even just having the materials that I think we're to use for this process, but when you include kids a little bit more in that beginning kind of things, it just opens up a whole new way of thinking. I should also say I think that was probably the pitfall of the engineering program that we did is that we didn't spend so much time on that. The engineers were going away every night and doing the actual soldering of motherboards and, like they spent so much time helping us they were amazing but like that's probably good to have a program that includes both aspects of that.

In Mark’s ukulele workshop, he explained that one of the changes made between the first and second workshop was to make some of the choices beforehand. Nevertheless, he still encouraged flexibility and supported their agency as the participants crafted their instruments. Mark reiterated that the goal was to walk out with a playable instrument and

that they can make it “fancy” later. When he was asked questions about whether or how to do something, he would use the language of choice: “That would be your first choice” or “that would be your second choice.” When asked what to do next, Mark would say, “my instincts are that next we should...”

Assumed Outcomes

Completed projects were emphasized in workshops. Even if the workshop was about teaching a skill like how to use the vinyl cutter, the goal was for everyone to walk away with a finished physical or digital object. The space, however, was often conceived of as a sandbox to tinker and play alongside others who had varying expertise. Connection was therefore frequently invoked in discussions of the primarily educational mission of the space. A promotional video from 2016 included a few examples of this emphasis:

Promotional Video: Volunteer (2016)

I work in the public school so I have access to a number of students and I'm always promoting [the makerspace] to them as a place to go and to work on projects and ideas. They can shine here in ways that they don't shine at school, but they come here and they're able to take their creative minds and do amazing things. It's easy to see how engaged they are once they're here... You see, it's not like school where we put everybody the same age in the same grade. People at all ages are learning from each other.

Promotional Video: Volunteer (2016)

We want to connect people to people, to ideas, to technology, to what interests them, and [the makerspace] gives us a very clear opportunity to do so.

Organizational Policies

Rules and Guidelines

Among the three fieldwork sites, this space has the most explicit organizational policies governing participation. While the space is open to visitors to use for free, volunteers get the additional benefit of being able to use the space during off-hours. They have a formal

process for applying to be a volunteer, volunteer training workshops, and a volunteer handbook. During my observations in 2018, some new policies for visitors and volunteers were implemented. The coordinator changed the entrance area to include a computer where you sign in and sign a waiver. Previously, you would simply sign a paper sheet if it were your first time there. There was also a new laptop sign out system.

Advanced technologies like the laser cutter are governed by a training system. For example, visitors must take an hour-long training and then be assisted in using the laser cutter three times before they are considered certified to use it independently. As volunteers, we were asked not to give out the password for the laser cutter to patrons so that we can regulate its use.

The creation and sustainability of such policies has been the responsibility of the coordinator of the space. Gloria welcomed all these policy changes as she preferred a space that was “managed”. She contrasted the library makerspace with other spaces she does fiber-arts work. In those spaces “techno geeks” in their 20s and 30s preferred “technology as the manager” and thus cleanliness and rule following often broke down. [Participant Observation, 4/8/2018]

Funding Sources

According to a local news article, a community foundation contributed \$12,500, the library’s fundraising group contributed \$11,000, and Best Buy provided \$10,000. The makerspaces have enjoyed rent-free accommodations at both sites. In 2018, the makerspace became a line-item in the library’s budget. The library makerspace relies on these donations to continue providing all the materials and activities for free at the space.

Keeping the activities free, while a driving goal of the initiative, has made partnerships difficult. The organizer I spoke to at an affiliated arts space explained the long relationship they had with the library makerspace and many of its volunteers.

Nevertheless, they had yet to conduct joint programming at the time of the interview:

Interview: Cindy, Arts Program (10/29/2018)

Well, and that's been one of the kind of tension points where you've been working with [the makerspace] is because of [the makerspace's] mission and being a part of the library, all of their programming has to be free when we don't have that ability. So, it's, it's a little difficult to partner with them and not violate their mission but still work within the structure that we already have existing. So that's very challenging. We actually, while we have been trying to program with [the makerspace] we have yet to successfully have a program, um, which is baffling to me.

Social Layer

Social Networks

Associations of Attendees & Organizers

Much like a public library itself, the library makerspace was visited by a public diverse in age and occupation:

Interview: Emma, Coordinator (6/8/2018)

We don't know who exactly, you know, but it's everyone, there's, there's retirees, there's young kids, there is kids in school who aren't from here. There's, there's moms who are sewing dance costumes. There's uh, people between jobs. So like software engineers who just want to like bounce some ideas off someone else. It is such a huge range of people. And I can't say there's particularly one demographic we serve the most where I think that we really, the only way we serve an elderly communities because we are in an elder care facility and then retail space on the ground floor that, um, and I think in that we're actually really lucky because otherwise we wouldn't really get to serve that community as much.

These older adults were the only marginalized community directly engaged through tailored events. While one of the participants I spoke with during observations mentioned that many people misconstrue the space as intended for kids (Fieldnotes: Library

Makerspace (April 9, 2019)), it was well attended by adults. The design of the library makerspace was intended to address an existing gap in library usage among young adults:

Interview: Sarah, Assistant Director (5/7/2018)

We were hoping for young adults...young professionals, people out of college but who are getting jobs. That's typically the age where we see a lot of drop off in libraries for various reasons. To try and bring some of that crowd in, but we didn't think it would only be for that crowd, we just thought it might be a draw. But definitely we were looking more toward the adult side of things than the child side of things because we do a lot of programming that's geared towards children and a lot of it is in the STEM biosphere so we're not- so we wanted to kind of reach out to other people who did not have the same kinds of dedicated programming already. So, multigenerational with a little bit of focus on the young adult-professionals.

Another group the makerspace is developing programming for is the library staff.

The coordinator solicited ideas for a professional development series that will move between the library and the makerspace every other week to encourage skills sharing between the two spaces. As the Assistant Director explained,

Interview: Sarah, Assistant Director (5/7/2018)

There is also need or education for Library staff to understand better what's going on over there. I would say the things that have highly specialized skill sets go over to [the makerspace] because we don't have the staffing to teach people how to do Inkscape or different coding languages.

Gloria was asked to help think of some programming related to e-textiles and she explained that, while she has plenty of simple e-textile projects for kids (e.g. key chains, stuffed animals with light up eyes), she doesn't know what would be practical for adults. She says she always wants to do practical projects and that her mind always goes to the practical constraints. [Participant Observation, 4/8/2018]

Labor Force

Associations of Personnel

The makerspace has one paid coordinator who is a sculpture artist with a background in managing studios. In my interview with the coordinator, it was clear why a strictly volunteer model is not sustainable. While volunteers staff the space and donate their time to run periodic workshops, there are many other labor-intensive responsibilities required to manage a makerspace:

Interview: Emma, Coordinator (6/8/2018)

I've managed a roster of about 40 volunteers. Um, I do maintenance in this space. I coordinate budget with [Sarah], all those things. So I figured out what we need and I've tried to make sure it happens in a timely way. Uh, it, it ends up being a lot of tasks. Then when people are here, I often, I have to put the computer aside, I have to not be doing those things and I have to help people who are here. I don't have to, I'm trying to do things simultaneously. It doesn't always work out. But as you saw it, you know, it's 3D printing. We're finding materials, teaching [Name of guest we helped] how to use the Jig saw and all these things are happening simultaneously.

The volunteers at the space are largely retirees or professionals in technology and/or arts. Some of the most active volunteers were unemployed or retired. Gloria, who volunteered 7 hours a week, explained that she found this space during a moment of “desperation” after the museum she was volunteering in closed:

Interview: Gloria (10/27/2018)

And I was desperate because, um, I'm years out of the job market. I don't have any, not that I have no marketable skills, but I have no up to date technological skills. I wouldn't be an attractive employee.

There are also engineers, software developers, and fabric artists who volunteer and visit after work. Some of the volunteers are also associated with other makerspaces. I interviewed one volunteer who coordinated the makerspace at a public university to ask him why he also worked at the library makerspace:

Interview: Leo (10/31/2018)

Yeah, I ran across something I saw that they did, basically a volunteer run, and I thought it was, would be an interesting way to get more experience in another makerspace. I've never even been to another makerspace besides ours before that. And it's, just to like see what other Makerspaces do, what services they offer, as a way for us to think about what we might have here. So they have a lot more like, tools and even like a sewing corner, which is an interesting thing that we might do here someday.

Forms of Expertise and Credentials

There were volunteers known for their expertise in certain areas. Volunteers wore handmade lanyards with their names to indicate they were someone you could go to for assistance. Certain volunteers were the go-to person for fabrication technologies, others for design technologies, and still others for some of the coding challenges people faced. Across makerspace sites, many individuals had foundational knowledge in a technical or manufacturing field and were bringing together online and community resources to either update their skill set or keep themselves engaged after leaving the workforce. In my interview with Dante Mann, a volunteer at the library makerspace who was known for his skills with electronics and e-textile work, he relayed a similar trajectory. He previously worked in IT, but retired when there was a “paradigm shift” to cloud computing in his professional life and, in his personal life, he was experiencing the onset of Parkinson’s. He described how he would run workshops with information he had learned from his own research online but realized that he knew more than he thought he did on the topic:

Interview: Dante Mann (10/24/2018)

Me: Where did you learn to do electroluminescence? Or how, maybe not where?

Dante Mann: Online, you know, YouTube videos, Adafruit.com and Instructables, you know, and I had some basic knowledge of electricity and electronics, which I sort of thought was kind of nothing until I actually started teaching like electro luminous wire and people were asking, what's AC? What's DC? Why is this AC? What? Oh, okay. Okay. I guess I know a little more than I think I do.

During observations, I encountered many visitors and volunteers discussing the lack expertise among individuals (particularly youth) with hands-on technologies. There seemed to be a universal concern with the lack of skills regarding how to, for example, use a screwdriver or fix a bike. One volunteer who helped me work with an Arduino explained that he had come from Europe where “the person who touches the thing is considered a technician” and that is considered a lowly profession in comparison to engineers who are about the ideas and who are considered more prestigious. He was hoping that that divide could be broken. He also works as a Boy Scout leader and admitted they are still having a lot of trouble getting the scouts interested in doing technology-related hands-on projects. It was not a problem of lack of interest in technology. In fact, he had many problems with the students on their phones or using headphones rather than socializing with one another. Getting them interested in problem solving with technology was a challenge, however.

Discursive Layer

Activities

Topics of Classes

While desktop fabrication was a strength of this space, I observed visitors and volunteers involved in many diverse activities. Skills training was one area of focus as workshops included tool and software training on all the available technologies. There were also monthly PechaKucha nights for community members to do short visual presentations on topics or projects of interest to them. Overall, the broad base of volunteers and visitors meant this space had very varied activities. While the community was supportive of one another, there was no single identifiable ethos or collective mission.

One minor discourse that arose during my observations and interviews was related to aligning the makerspace with initiatives for adaptive design for persons with disabilities:

Interview: Sarah, Assistant Director (5/7/2018)

We're talking right now about adaptive technology and stuff and I'd love to see that kind of incorporated a little bit more so that not only are people just learning it as a hobby but to show how this whole culture can be part of making improvements to people's lives.

Uses of Space

Because the space was a well-staffed, dedicated makerspace, it frequently had various visitors working on vastly different projects. I witnessed utilitarian making as visitors came to hem clothing and repurpose old textiles. Hobbyists such as cosplayers would use the fabrication tools to create their costumes and props. Young people came to finish class projects. Robotics team mentors came to discuss the challenges their teams were having. Some visitors were working on product prototypes for their own entrepreneurial pursuits or simply finishing up some coding on a work project.

Issues of Concern

Governance/Ownerships Discussions

Governance discourses were largely absent from the space. Free software was introduced and encouraged in the space primarily because of the goals of financial accessibility.

Outcomes of Participation

The makerspace was not approached as a specialist space with virtuoso hackers nor like a business incubator focused on networking and entrepreneurship. Instead, it was considered by the library assistant director as a “public workshop”. Sarah was concerned

that the title “makerspace” could be inherently exclusionary. She explained how she would prefer the space to be aligned with a more general concept of a workshop:

Interview: Sarah, Assistant Director (5/7/2018)

I always regret that we call it a Makerspace. I wish that we referred to it differently because I always explain it as a public workshop and I kind of wish we had kind of branded it that way just because Makerspace—for people within the library world or within the maker world they understand it—but a lot of people don't always understand.

The makerspace coordinator explained the intended outcomes of participation as a learning resource or springboard:

Interview: Emma, Makerspace Coordinator (6/8/2018)

I actually really think of this as like a learning incubator. This is where you get your intro level into these things. If you need to go beyond that level, you might go to a different space. You might be paying someone for a service, you might be investing in equipment on your own at that point. This is the place to get started. So that's really how I think about [the makerspace]. It's you're hatching and then they can go do your adolescence somewhere else.

Conclusion

The library is working to extend the resources available to the community in arts and technology. The multi-faceted space is staffed by volunteers from varied fields and age cohorts making it a productive “boundary object” (Star, 2002) for redefining collaborative activities. The volunteers bring the vibrancy to the space and the existing organizational structures and funding sources that have historically supported the library’s mission, offer support to this initiative as well. Using the lens of its discursive, technical, and social communicative ecology (Hearn, Tacchi, Foth, & Lennie, 2009), it is clear this space is an organizational model well-suited to the community it attracts. Together, the analysis of the technical, social, and discursive layers of the ecology demonstrate how the tools and topics align with the larger Maker Movement discourse of democratization of participation in creative culture. This space focuses on production of

material culture primarily through workshops on advancing digital fabrication tools and technologies, textile work, and robotics. A liberal discourse related to greater access and choice was used in discussions of who was encouraged to be part of the makerspace community. Situated in a regional tech hub, workers in STEM fields visit, often with their families. Many of these same STEM professionals donate their time as volunteers. The space also was attractive to retired and unemployed members of the community who were able to share their many talents with visitors outside a formalized work or school context.

CHAPTER 7

COMMUNITY DEVELOPMENT MAKERSPACE CASE STUDY

Introduction

[A] community workshop space for local makers, artists, entrepreneurs, programmers, students and enthusiasts to make, create & share their skills and tools...a platform for community members of all backgrounds to learn new skills, build relationships, launch businesses & inspire one another.(Excerpt from Mission Statement 2018)

[A] community incubator and workshop space for everyone to make, create & share their skills and tools... a platform for community members of all backgrounds to learn new skills, build relationships, launch businesses & inspire one another. (Excerpt from Mission Statement 2020)

The community development makerspace is located on a side street in a city center. It is a storefront, like the library makerspace, so visitors are greeted by a large glass window that reveals a brightly painted single room. The aesthetics of the space have certainly improved over the course of the initiative. In 2016, the makerspace was merely a group of individuals using a vacant building for a “pop-up” cultural development event. The walls were white, the space was empty, and there was not even consistent power or Wi-Fi. During participation in 2018, the space was bright, and cozily cluttered. The area in front of the large window was used to display some of the products for sale by local makers such as bowties, jewelry, and soap. Upon entering the space’s wooden door, you faced a wall with the events calendar and various community notices. What you found inside the space, depended on the day. Some afternoons you could barely enter for the number of teens and adults working on repairing bikes on and between tables. Other afternoons, worktables would be set up in circles throughout the room with visitors drawing, painting, eating, and drinking. There was a backroom where a photographer set up a small studio space and where makers could purchase storage space. For a time, the

corner of the space had a mediation station with neatly arranged pillows. Most striking, were always the walls. They were decorated with paintings, drawing, and mixed media pieces that included sneakers, fabric, or photography. Unlike the media center makerspace which packed its activities and projects away in a closet, leaving little trace, or the library makerspace that reset the work area for each new day, the activities and creations by visitors to the community development makerspace made lasting impressions on the space.

The community development makerspace began in the summer of 2016 when a member of a regional university received \$500 to run a few weeks of creative programming to “activate” a vacant storefront in an older industrial city. The professor visited the media center makerspace (Chapter 5) in the spring to ask about “making” activities that might fit the project. The professors and students in that space, myself included, agreed to partner for the events of the first week of what came to be known as a pop-up makerspace. The initiative has grown in unexpected ways since 2016. Largely led by the community of local volunteers that supported the space, and grant money from the university and MassDevelopment, the space has continued well past the initial 30 day planned “pop up.” At the time of writing, the community development makerspace has just hired a new executive director and is in the process of expanding to a new location.

More so than the other sites included in this study, the community development project is interested in the idea of a makerspace for community revitalization and business incubation. In 2018, a photography studio, community bike shop, and STEM educational services startup operated out of the makerspace. Popular programming included bike repair drop-ins, art clubs, and poetry and comedy open-mic nights. While

there was Wi-Fi access during 2018, there were no ICT devices available. There was a 3D printer, but users were asked to consult one of the volunteer organizers who was incubating a STEM education business before use. The space was open when there were workshops or events. These workshops and events were led by local volunteers.

In what follows, a communicative ecology framework (Hearn, Tacchi, Foth, & Lennie, 2009) is used to analyze the evolution of the community development initiative in order to explore the potentials and constraints of this initiative's approach to social production. More specifically, the analysis follows the Framework to Explore the Communicative Ecology of Makerspaces offered in Chapter 3 (See Table 2).

Analysis

The community development makerspace is in the downtown "Transformative Development Initiative District" of an older industrial city. The U.S. Census Bureau lists the population of the city where the community development initiative is located at approximately 153,000 as of the 2010 census. According to the 2018 American Community Survey, 44.7% are Hispanic or Latino, 31.7% are white, not Hispanic or Latino, 20.9% are Black or African-American alone, 4.6% are two or more races, and 2.2% are Asian alone. In the city, 69% of household have a broadband internet connection. Of those over age 25, 18.6% have a bachelor's degree or higher. (U.S. Census Bureau)

Data for this case study comes from research participation at the community development makerspace from June 2016 to December 2018. I assisted with the pop-up makerspace in 2016 and visited the space as a workshop host for 4-H youth programs on a few occasions in 2016 and 2017. During 2018, I attended workshops led by volunteers

on bike repair and 3D printing, group leadership meetings, and clean up days. In addition to visits to the makerspace, I visited the nearby university extension center, and attended a community-wide feedback session about the space.

Fieldwork

Fieldwork for the community development ecology occurred primarily in the makerspace and at the local university extension center, a short walk from the space. While the organizers knew I was studying makerspaces since our initial meeting in 2016, I reintroduced the direction of my study in 2018 before the participation and interview period for this study began. My observations occurred during membership meetings where anyone was invited to attend to contribute ideas for the initiative. One of these meetings was a Make It Clean event where we worked together to clean the space. I also visited the makerspace during bike repair workshops and 3D printer workshops.

This space posed a few methodological challenges. Firstly, as an initiative of a university with a partnership with MassDevelopment, various researchers and stakeholders were doing research and evaluation. In 2018, the initiative was completing its own study to better meet the needs of the community. Issues of study fatigue discouraged me from replicating some of the activities already underway by the organizational team. Additionally, during my long-term engagement with the space, the focus gradually evolved from the design, citizen-science, and STEAM literacies of the pop-up event to more of an arts focus. The space is again adding STEAM programming but there were not many related offerings during the observations in 2018.

Interview Data

The fieldwork for this case study relied more on participation and observation than semi-structured interviews. I did, however, interview the co-director of the space, the director of the university extension building, one of the arts programming organizers, the professor from the media center makerspace who partnered at the space, and the volunteer who facilitated the 3D printing workshops.

Table 7. Community Development Makerspace Interview Data

Type	Participant	Affiliation
In-Depth Interview	Darrell	Incubating STEAM Business
In-Depth Interview	Michael	Co-Creator
In-Depth Interview	Joseph	University Stakeholder
In-Depth Interview	Deborah	Arts Programming Organizer
In-Depth Interview	Tom	University Stakeholder/ Media Center Makerspace Coordinator

Document Analysis

The makerspace visits were supplemented with analysis of promotional videos, meeting minutes from the makerspace leadership meetings, email blasts, the makerspace’s webpage, the makerspace’s Facebook page, and the makerspace’s Eventbrite page.

Technological Layer

Accessibility

Physical Accessibility

The makerspace was initially intended to revitalize a downtown area that did not see much community or tourist use. A development initiative has been underway in this “Transformative Development Initiative District” but many people still felt the space was rather out of the way. Only on-street, metered parking was available. It still offered

increased accessibility to the community as most similar initiatives were housed in the local colleges and were not open to the public:

Interview Notes: Darrell (4/5/2018)

Access to maker-type spaces is often limited to college students and community college students.

External Communication and Advertising Media

While the practices in the space are not focused on the use of technology or ICTs, technology does organize the activities. Michael, for example, described how important social media was to the initial success of the space and how the other co-creator designed a platform for scheduling and advertising events using Eventbrite, Facebook, and a website landing page.

Interview: Michael, Co-Creator (5/23/2018)

Then that one Saturday, I don't even remember the day but it was in June, we had a pretty good turnout for that first event and then really the power of social media, not for that event but really for everything that came later, would not have been possible. When I think about why this thing worked, it worked because of variety of reasons, but one of the important things is we could quickly get the word out and people could see what we were doing and then they could even start offering their own kind of workshops. So, in some ways I guess that was kind of a model. You know, people came together it was kind of with the organization of the University, or under the auspices somewhat of us University folks, but it quickly started turning into a community thing.

Maintaining this online presence is labor-intensive, however, and without a member dedicated to overseeing the scheduling, the listings are not always accurate. For example, during one workshop I observed, the photographer who uses the space as her studio was troubled to find there was a workshop scheduled that day as it was not listed online. As the volunteer base grew and the community began to take over the direction of the initiative, there was still a challenge of who would be responsible for this advertising and management labor.

Technologies Available

Physical Set Up

ICTs are not a central feature of this makerspace. An ongoing problem in the space during my participation was connectivity issues to the Wi-Fi network, and unfortunately there is no dedicated technical support staff to assist when problems arise. There are no computers available to visitors and workshops often rely on participants to bring their own or for workshop organizers to borrow devices. Fortunately, the university's extension program office is nearby, and workshop leaders can arrange to borrow laptops if necessary.

Emergent computational technologies like 3D printers and drones have been used in workshops at the space. However, the co-creator of the space has said that technology is “not the driving force”:

Interview: Michael, Co-Creator (5/23/2018)

Our space, initially, I thought it was going to be heavily technology driven because that was going to be the link to the university because the university is the creator or the promoter of technology that is kind of like cutting edge. But, I rethought that, so yes, in some ways, we do have a 3D printing and yes that would be great but, when I think about the equity component, and the creative component, I do wonder how much role technology needs to play... Unfortunately, the kind of technology we might be familiar with on campus isn't always a good fit for entry-level people. So that is kind of my hunch. It would be intimidating.

Instead of activities that center on the use of computing technologies, practices in the space are usually related to the arts (e.g., drawing, painting, poetry, etc.).

While not a central focus, some of the organizers explained what technologies they hoped the space would adopt in the future. The STEAM volunteer organizer explained that a makerspace should be like a gym where you can access the tools and technologies that are not available easily elsewhere:

Interview Notes: Darrell (4/5/2018)

You can go to the library for a computer lab but the makerspace is where you would go for a table saw.

The arts network coordinator explained that there were tools, technologies, and infrastructure that a makerspace could include to better support the professionalization of artists as well:

Interview: Deborah, Arts Network Coordinator (12/18/2018)

You could have equipment, like shared equipment there, like scanners and printers and the artists would use, you know, and the same as other makerspaces have, shared office space or shared water coolers or shared printers.

Internal Communication Channels

Several offline and face-to-face elements serve as communicative infrastructure. For instance, the makerspace holds monthly meetings for anyone interested in the future of the makerspace. These meetings are for community members to raise concerns and suggest solutions to help collaboratively manage the space. The physical maker meetings were important moments for the volunteers and interested community members to connect. Collaborative Google Docs were also shared among the volunteers and organizers to assist with planning and transparency.

Pedagogical Models

Teaching Philosophies

Many of the events in the space are themed workspace times. The bike workshops, for example, function more like public clinics. People would bring in bikes to fix or tune up. Anyone and everyone was invited to help during these clinics. During my first bike repair workshop I helped a mother with the training wheels on her daughter's bike and replaced the batteries in another visitor's bike light. Among the workshops where a skill or process

is taught, there is still a rather open structure. The STEAM program volunteer who facilitates the 3D printing workshops explained that:

Interview Notes: Darrell (4/5/2018)

His classes “have almost no methodology on purpose.” Having an open person for the workshop means people can learn and some students may get interested enough to go to the next, intermediary step. Those classes would be more structured and follow a more standard teaching approach. Less theoretical and always about a physical object. Creating a manifestation of an idea. This is central to the “makerspace movement.”

Regarding 3D printing more specifically, Darrell explained to me during one of the workshops how he focuses participants on design first because it allows them to be more creative in their thinking. He explained that if he starts by telling people about some of the limitations of the printers, sometimes their ideas are constrained. Later, we can learn how to optimize for the printer by trying out different prints.

Organizational Policies

Rules and Guidelines

Community “ground rules” also have a role in structuring the makerspace environment. The co-creator, for instance, referenced these flexible rules when discussing how the space encouraged “messy” projects:

Interview: Michael, Co-Creator (5/23/2018)

This space, because it was so basic and we didn't have many ground rules, you could do anything in there. People felt very comfortable.

At the same time, however, the “ground rules” that did exist were a useful tool to help workshop organizers control the space. For example, at one of the monthly meetings, a young woman described the difficulty she had with an unruly visitor during a late-night workshop. After a discussion about safety, and ways to protect the young woman during late night workshops, one of the co-creators reminded everyone they could point to the

community ground rules posted at the door if they needed to ask someone to change their behavior or leave.

Funding Sources

The space was also dedicated to free or cheap programming. The bike repair workshop organizer described how he “pitches” the space in one promotional video:

Promotional Video: Bike Repair Leader (2018)

I pitch it as a free way to gain skills and knowledge... Cheap or free access to skills, information, and teaching and learning that isn't something you necessarily see in school.

To keep the activities free for visitors, the space relied on grants, donations, and the fees for makers who choose to have a permanent storage space.

Initial funding for the pop-up space came from the university and Mass Development. The space boasts \$50,000 in grant funding as of 2019. In 2017, for example, the space received a \$25,000 grant from the state's Collaborative Workspace Program.

Social Layer

Social Networks

Associations of Attendees

Several different social networks intersect at this makerspace. As an initiative of the university, professors and students often run workshops and participate in activities in the space. Due to its role as a business incubator, the space attracts members of a local non-profit entrepreneurship group. Additionally, a group of artists has established a stake in the leadership by attending all the monthly meetings and running workshops. When asked about who this space was intended for, the co-creator responded that “there needs to be space for everybody”:

Interview: Michael, Co-Creator (5/23/2018)

In the spirit of openness and accessibility I think we feel that the makerspace needs to always address the needs of a wide range of people.

The STEAM organizer acknowledged some of the challenges of this vast variety of interests with stakes in the space. He explained that most makerspaces could be depicted as an inverted triangle. It begins at the top with a broad idea and then specializes or narrows. He argues you need to start with a mission in mind. It should be an upright triangle where you begin at the top and branch out from your mission as you progress. He suggests the common model “leads to polarization” because if you “start out wanting to serve all,” inevitably you start to become known for one thing if you work with an organization that has a need or specialization. [Darrell, Paraphrased Interview, 2018]

Associations of Organizers

The organizational model has undergone changes over the course of the initiative. Initially, the space was organized and administered by members of the public university and affiliates working on economic and cultural development initiatives in the area. As the space attracted attention, other organizers who had gone through leadership and planning training programs in the region, and an entrepreneurial mentorship program were connected to the space. Over time, some of the initial visitors and volunteers from the community began to take on leadership roles and the advisory board of approximately a dozen people now includes members from all these various stakeholder groups.

Labor Force

Associations of Personnel

Organizers and personnel are an overlapping category in this makerspace. In 2018, the space was primarily volunteer run with co-founders taking on much of the managerial labor.

Forms of Expertise and Credentials

Expertise is complicated in the community development makerspace. There are credentialed forms of expertise like that of members of the local university with urban planning experience or graduate students from engineering. There are also those with professionalized forms of expertise such as the seamstress who runs workshops on sewing. There are also small business owners using the space as an incubator. They may share their expertise with the community through workshops while at the same time seeking out mentors and network connections to support their own entrepreneurial efforts. There are also visitors who are casual or hobbyist users of the space.

The connections provided by participation in the community network may help some build expertise or even support the move into professional networks in their area of interest. The arts network coordinator described how these spaces can offer more than what one thinks of as traditional business “networking” by providing guidance and an audience of peers for novice artists:

Interview: Deborah, Arts Network Coordinator (12/18/2018)

Besides the networking, there's, you know, where do we go to do this? Where do we go to do printing? Which printers should I use? Which, you know, who knows how to do this? There's also critiquing and growing as an artist and being able to share your work with other artists and get feedback not from an audience but from other artists learning, um, building portfolios, putting yourself out there, writing grants, knowing the schedule of applying for shows, knowing which shows, how to keep up with the shows that are available to apply for... How do you manage

all that? You know, there's, there's a lot of different things that sort of to keep moving as an artist if you want to be seen.

Discursive Layer

Activities

Topics of Classes

Community programming of all types happened in the space. The makerspace's Eventbrite page lists technology-aided classes such as 3D printing and design thinking and prototyping; performance classes such as open mic comedy night and introduction to Bomba; professional development classes such as Facebook for business and crafting a creative business; community classes such as a Tanzanian youth diaspora conversation and an introduction to Italian language and culture; and many arts and media classes.

Uses of Space

Interviews with the organizers and stakeholders all began with histories of how the projects developed. The community development project, for example, was repeatedly described by the co-creator as “ad hoc”. He explained that he had been given the charge to develop a vacant store front in a downtown urban area to assist with the overall urban renewal initiatives going on in the city:

Interview: Michael, Co-Creator (5/23/2018)

The main reason to even be there was to take over a vacant space and the purpose for what that vacant space was going to be used for was really secondary.

According to one of the stakeholders who is using the space as a business incubator, this is leading to tensions over cultures and values. He described how there are so many interests involved at the makerspace (e.g. business, altruistic, non-profit) that it is hard to get everyone focused in planning meetings.

Complicating the identity of the space further, the discourse with which organizers align the space varies depending upon audience. For example, the co-creator explained how they often try to use the language common to development and urban planning for grants:

Interview: Michael, Co-Creator (5/23/2018)

We don't always even call it a makerspace anymore. We call it a collaborative workspace sometimes. And in fact, our grant calls it a collaborative workspace because the city or the state and planners in general and economic development people when they talk about revitalizing downtowns and cities they see the collaborative economy as a piece of that.

Issues of Concern

Governance/Ownerships Discussions

At the organizational level, the evolution of the space and its leadership structure shows a direct engagement with governance and ownership discussions. The advisory group has largely assumed ownership of the initiative. In workshops and conversations, there is clearly a call for recognition of the assets offered by the community and region. For example, the arts network coordinator explained that artists in the area are often overlooked or outright exploited. She told me a story of an artist she met who had his work stolen:

Interview: Deborah, Arts Network Coordinator (12/18/2018)

Somebody else took a picture of his painted t-shirt, a tee shirt that was on display as an artwork. They took a picture of it and then started [inaudible] claimed it as their own photograph and then printed it on their own cards with their own name on it. And were selling the card for \$7 at a street there.

Outcomes of Participation

The community development makerspace is often described as simultaneously offering individuals a space to meet and connect, and infusing some vitality into a district that was largely abandoned:

News Article Excerpt: Melody, Co-Creator (2016)

We are thrilled to offer a space for local makers, creators, artisans, nonprofits and entrepreneurs to share their skill sets and connect with local community members. We hope this project brings new life and energy to a previously vacant downtown storefront and has lasting ripple effects on the streetscape and the neighborhood.

Sharing and collaboration dominates the discourse of what the outcomes are of a space like this one. Michael explained that regional planners and urban development professionals are committed to this notion of sharing to bolster the creative economy:

Interview: Michael, Co-Creator (5/23/2018)

We don't always even call it a makerspace anymore. We call it a collaborative workspace sometimes. And in fact our grant calls it a collaborative workspace because the city or the state and planners in general and economic development people when they talk about revitalizing downtowns and cities they see the collaborative economy as a piece of that. They probably see a makerspace as a piece of that but they seem to talk more about the collaborative economy, people that have shared work spaces, shared art spaces, just share things in general among the group. They see that as having both business benefits like sharing of skills but they also see it as a signifier, like a trendy coffee shop, as something that younger people expect to see in a city. They see it as an indicator of a more thriving downtown if you have several of these.

Conclusion

The community development project aimed to connect community members to one another, recognize the assets in the community, and contribute to a revitalization of the downtown district. While the language used by the organizers and promotional information seem to align the initiative with “creative economy” and entrepreneurial discourses tied to economic concerns, the activities in the space speak to a local and social enterprise. The potentials and challenges of this tension were explored through the lens of its discursive, technical, and social communicative ecology (Hearn, Tacchi, Foth, & Lennie, 2009). For the community development project, sustainability was secured by encouraging the visitors to dictate the direction of the initiative while the co-founders managed recognition in the institutional arena by aligning the space with economic

development discourses to funding bodies. While the evolution of the space moved it away from a focus on media and technological literacies, programs in these topic areas were still offered to provide the community with a wide range of resources.

CHAPTER 8

ANALYSIS

Introduction

The case studies reveal that organizational models and technology use varies drastically between different makerspaces and from day to day in the same space. However, observation of local patterns in organizational and technological practices was possible thanks to the long-term ethnographic method and the communicative ecologies framework (Foth & Hearn, 2007). This cross-case analysis first synthesizes insights from the local communicative ecologies presented in the previous case studies to offer a model for how the organization of activities varied between and within makerspaces. Next, the analysis offers a conceptualization of maker-technology practices. Finally, the analysis concludes with a review of the literacies cultivated by maker-technology practices. Together these three components suggest what possibilities for digital inclusion are opened and foreclosed by varying approaches to communal, placed-based technology activities.

Structure of Activities

There are many dimensions which could be used to chart the activities of makerspaces. Educational scholar, Tonia Dousay (2017) proposed one framework which included four dimensions: The openness of access, the staffing model, the technologies offered, and whether the space was mobile or permanent. According to Dousay (2017), “Each line represents a spectrum along which a space may operate, either by initial setup and design or through evolving changes. The spiral that swirls around the axis represents

a multidimensional nature” (p. 71). This framework only presents the organizational decisions, however, and largely leaves out how participant agency shapes the space.

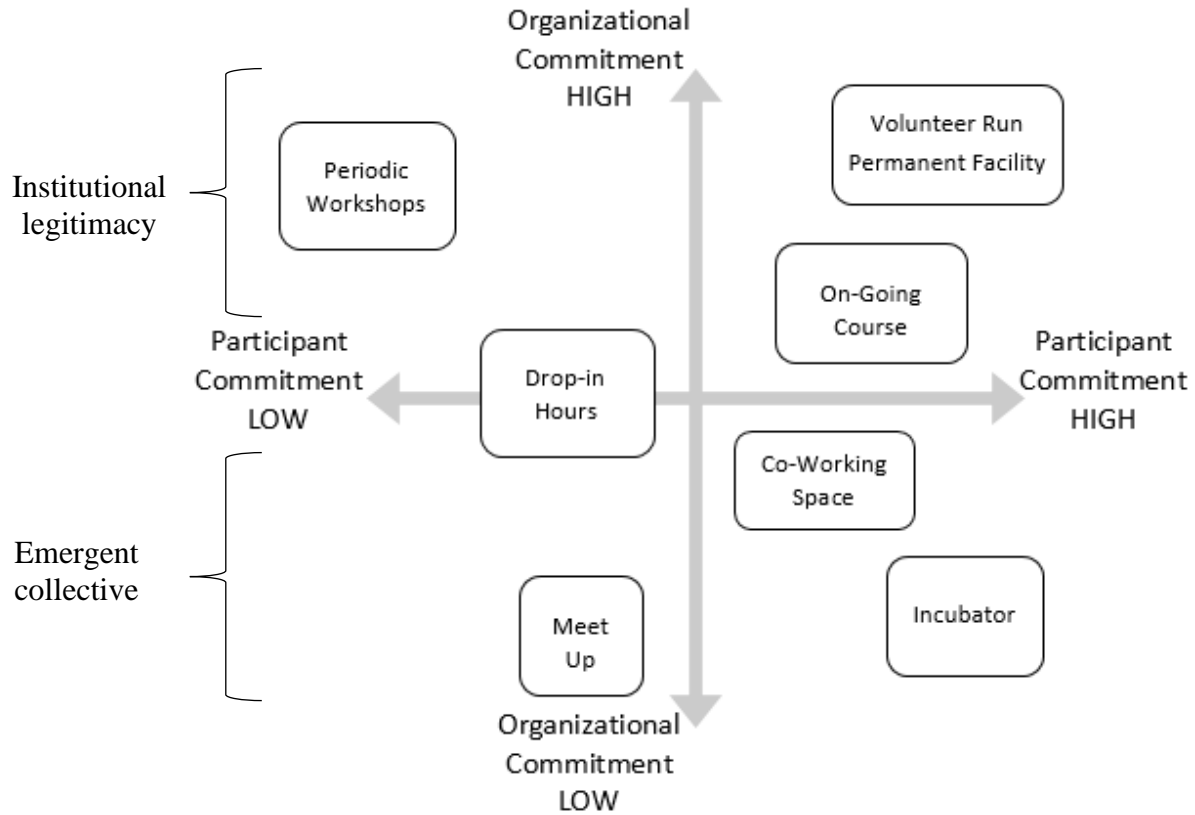
The Differentiating In-Person Makerspace Models chart (Figure 3), meanwhile, was designed in response to observations and interviews across makerspaces in Massachusetts. Unlike the multi-faceted framework from Dousay (2017) that explains how a makerspace may compare to other makerspaces, Figure 3 captures the variety of activity models possible *within* a makerspace. Each of the boxes represents an activity that was either discussed or implemented as part of the observed initiatives. Those activities are as follows:

- (a) *Periodic Workshops* were structured events to teach participants a skill, process, or tool.
- (b) *On-Going Courses* included structured instruction but unlike periodic workshops, participants met consistently and repeatedly over a period.
- (c) *Drop-in Hours* were set times that the public could meet other members of the community and use the space and its tools. Drop-in Hours could be open or have a theme related to a practice (e.g. sewing) or tool (e.g. LEGO Mindstorms).
- (d) *Meet ups* were set times that the public could meet other members of an interest community. Unlike *Drop-in Hours*, *Meet ups* did not have a dedicated location and were instead held wherever a community could find meeting space. Meet ups could also occur prior to establishing a physical makerspace.

- (e) *Volunteer Run Permanent Facilities* allowed members to meet and use a space and its tools for projects. These spaces were open during the day to the public and offered after-hours access for volunteers or members.
- (f) *Co-Working Spaces* allowed participants to use the space as a kind of communal office or workshop. Unlike a *Volunteer Run Permanent Facility*, *Co-Working Spaces* were not likely to include specialized equipment and participants were expected to bring their own supplies and technologies.
- (g) *Incubators* were a kind of communal office or workshop that startups or organizations could use. They focused on supporting the launching of businesses or initiatives.

These different organizational models were charted in reference to the commitment required from the organization and commitment required from participants to sustain the activity. Commitment here refers both to investments—of capital, labor (paid and unpaid), and time—as well as intrinsic motivations such as social bonds and dedication to a common mission.

Figure 3. Differentiating In-person Maker Models



The activities with the highest organizational commitment also tended to have the most institutional legitimacy. These activities had established structures and practices. *Periodic Workshops*, for example, were designed and facilitated to teach skills or introduce new technologies. The needed resources were secured by the organization ahead of the activities. It required low participant commitment as visitors could stay as long as they wanted and there were no expectations for continued attendance at events. These *Periodic Workshops* brought in a variety of new participants, but these participants did not necessarily take part in other kinds of activities at the space such as open drop-in hours. A *Volunteer Run Permanent Facility*, meanwhile, required steep investment by the organization in facility cost, upkeep, and equipment purchases. As permanent facilities

required on-going staffing, volunteer models were often used. These volunteer models also required high commitment from the community of participants to sustain operations.

On-going Courses and *Drop-in Hours* were described by organizers and participants as both rewarding and challenging. This is likely due to their proximity at the nexus of institutional legitimacy and emergent collective. *Drop-in Hours* require space and staffing and thus a commitment by the organization. However, the activities are dependent on the desires, needs, and projects brought in by participants. Additionally, these *Drop-In Hours* rely on the varied expertise of the collective participants. If few participants show, there are fewer sources of expertise. Thus, a critical mass of participants is needed to sustain commitment. *On-Going Courses* have built in expectations of continued participation but introduce different challenges regarding expectations of expertise. Projects for *On-Going Courses* either need to be designed to meet the available expertise of the organization or the organization must have a model in place to link participants with mentors or content area experts for their projects.

The activities that align more with emergent collective models such as *Meet ups*, *Co-Working Spaces*, and *Incubators* are primarily driven by the needs and activities of participants. Aside from providing space or communication infrastructure, they require little from organizations. This lack of structure from established organizations can also mean fewer mechanisms for bringing in new participants, thus leading to rather insular and potentially exclusionary working groups.

This chart offers several insights into how these spaces can better support digital inclusion efforts. Offering activities that fall at various points along the participant commitment axis provides flexibility as participants can choose what capabilities or

literacy repertoires they wish to prioritize. Organizations such as the Library, Community Television Access Center, and the Economic Development Initiative studied here play a crucial role in supporting that flexibility. Indeed, the activities which demand the lowest participant commitment (e.g. Periodic Workshops) and highest participant commitment (e.g. Volunteer Run Permanent Facility) both require high investment and support from organizations to purchase equipment, publicize, and staff activities.

Digital Inclusion: Maker-technologies

Looking across cases and the larger makerspace ecosystem, a typology of maker-technologies emerged. As the communicative ecology approach dictates, these maker-technologies are conceptualized broadly to include the varied analog and digital technologies that mediate communication and connect individuals and communities. To capture the dynamics of the technological, social, and discursive layers of these ecologies, the typology is practice—as opposed to tool—dependent. In other words, a specific technology could fall into a different maker-technology type if it is used as part of a different practice.

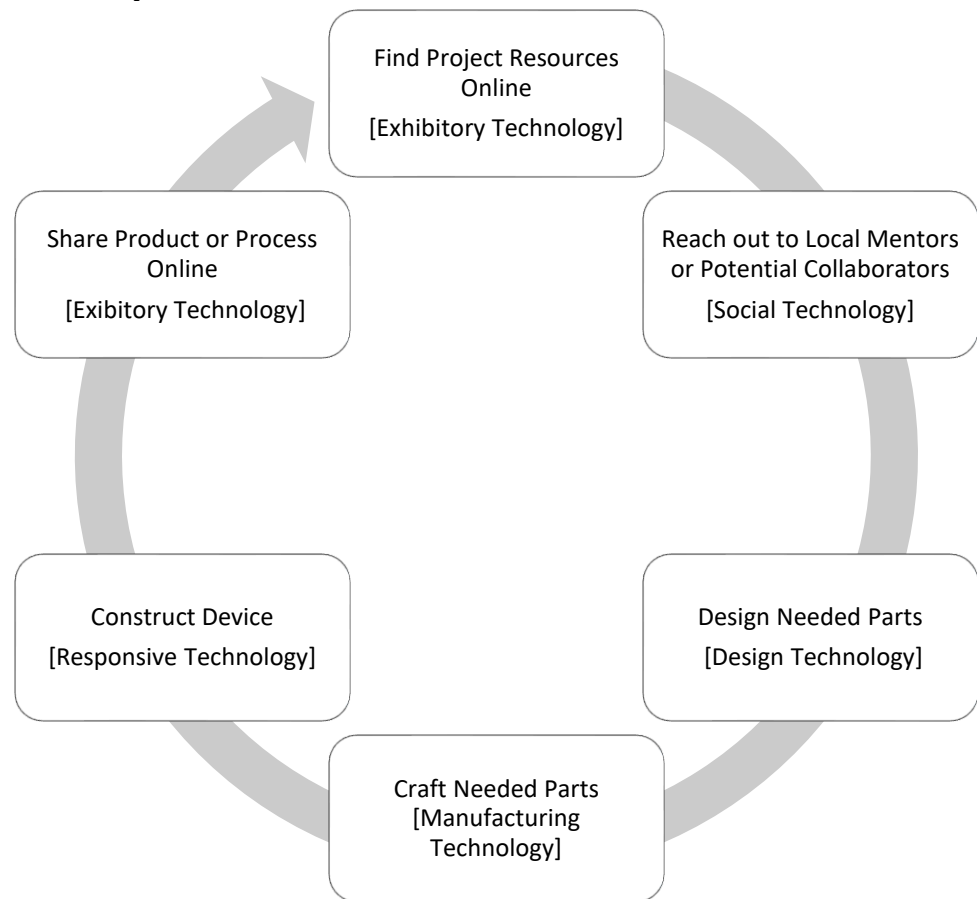
Table 8. Maker-technology Types

Maker-technology Type	Description	Examples
Exhibitory Technology	Associated with practices of sharing and circulating. Through these technologies, individuals make their plans, process, or product visible to audiences large and small.	<ul style="list-style-type: none"> • Websites: Instructables.com • Artifacts: Bulletin Boards • Products: Art Displays • Governance: Creative Commons
Social Technology	Associated with practices of socialization and information exchange between individuals. Through these technologies	<ul style="list-style-type: none"> • Websites: Meetup.com • Applications: Slack

	individuals coordinate events, raise issues of collective concern, and create bonds with others.	<ul style="list-style-type: none"> Listservs Governance: Steering-Committee
Design Technology	Associated with creation of symbolic artifacts. Through these technologies, individuals craft digital media of various forms.	<ul style="list-style-type: none"> Websites: Tinkercad.com Applications: Blender Devices: Video Cameras Governance: Open Source Software
Manufacturing Technology	Associated with the creation of physical artifacts. Through these technologies, individuals craft objects and media that occupy physical space.	<ul style="list-style-type: none"> Devices: 3D Printer Tools: Power Drill Governance: Open Source Hardware
Responsive Technology	Associated with practices of systematic interactivity. These technologies are crafted by individuals to respond in predetermined ways to digital or analog inputs.	<ul style="list-style-type: none"> Devices: Prototyping boards (e.g. Arduino) Artifacts: Musical Instruments Governance: Data collection protocols

The following diagram shows how these varied technologies might integrate into makerspace activities more generally (See Figure 4). This process is iterative and not every individual will follow this process precisely as their goals will differ. Nevertheless, the process is useful as a general explanation of how individuals and collaborative groups often navigate maker activities.

Figure 4. Maker-activity Process



Makerspace workshops are excellent exemplars of this process in action. For example, the library makerspace held a two-day workshop on how to construct a ukulele out of a cigar box [Library Makerspace 10/20/2018-10/21/2018]. At the suggestion of the Makerspace Director, the workshop leader found the idea to craft ukuleles out of cigar boxes online [Exhibitory Technology]. He had experience crafting other instruments out of found materials, so he was a local expert on the process. He organized a formal workshop and asked the makerspace coordinator to publicize the event through their event hosting sites—the library’s online calendar and Meetup.com [Social Technology]. The ukulele was built using cigar boxes that the workshop leader prepared ahead of the workshop. He designed sound holes on the ukulele using Inkscape

[Design Technology] then cut them out using the laser cutter [Manufacturing Technology]. During the workshop, the participants used woodworking tools to create the fret board and connect all the parts of the ukulele [Manufacturing Technology]. After the two days, participants had a functioning instrument [Responsive Technology]. Participants could then show off their creation and the workshop leader could display the product on the wall of the makerspace and post the best practices learned from leading the workshop online [Exhibitory Technology].

These maker-technology types and this maker-activity process offer two central insights. Firstly, they can reveal how and why a makerspace may be falling short in supporting the capabilities of their local community. According to O’Donovan and Smith (2020) makerspace specific capabilities include:

- (1) The capability to skilfully [sic] make and do
- (2) The capability to assume and perform a valued maker identity
- (3) The capability to establish and maintain maker community
- (4) The capability to sustain livelihood
- (5) The capability to modify one’s place in the world
- (6) The capability to participate in material culture. (p. 70)

Across case studies, social technology practices were often a stumbling block. This created a barrier to “maintain[ing] maker community” as it was difficult to forge new participant connections and maintain consistent connections among existing participants (O’Donovan & Smith, 2020, p. 70). Exhibitory technologies, however, offered avenues to “perform a valued maker identity” (O’Donovan & Smith, 2020, p. 70). In addition to clarifying the processes that support the capabilities of participants, these maker-technology types and the maker-activity process offer the grounded specificity needed to outline the media and technological literacies cultivated in the space. These literacies have the potential to apply to practices outside the makerspace context as well.

Cross-case Analysis of Maker-technologies

The library makerspace remains in successful operation at the time of writing. During the fieldwork period the site had frequent visitors, a robust volunteer staff, and a safe and accessible space. The library makerspace's strengths included all the maker-technology types. Their exhibitory technology included display boards and shelves throughout the space, a central whiteboard, and, perhaps most importantly, a connection with the local library which promoted their activities and successes widely. Their internal social technology was the chat application Slack. Slack was incredibly active and organized around different topics. It also allowed the coordinator the ability to connect with all volunteers easily. Externally, the space could again rely on publicity through the library channels but it also had a Meetup site. Thanks to the availability of laptops in the space, the design technology was also strong. Visitors had access to open source design software such as Inkscape on the laptops. The space was also well-outfitted with desktop manufacturing technologies such as 3D printers, vinyl cutters, and a laser cutter. The woodworking equipment and tool cabinet was used frequently as were the sewing machines. Finally, the space had responsive technology available in the form of Arduinos, Lego Mindstorms, and Little Bits. While their consistent funding and location in a technological hub of the state were crucial to the on-going success of the initiative, their strengths across the maker-technology activity types likely contributed as well.

The community media center also had a technology focus but did not have the resources or desire to support all the maker-technology types. While the first few years of the initiative attracted many new visitors and offered programming to local youth and college students thanks to grant funding from a local university, the group did not sustain

its activities at the same level by the end of the fieldwork period. At the time of writing, the group has no planned events or consistent activities. The exhibitory technology was strong thanks to the connection with the local media center and university. The television program was a unique asset, for example. The website and various social media feeds also exhibited the activities of makers in the space. They were also thoughtful about governance regarding exhibitory technology and demonstrated commitment to commons-based production and sharing. Social technology was an unfortunate weakness for this initiative. The organizers had many demands on their time and no dedicated staff to maintaining the social sites. Additionally, the internal communication was through email which was not the most transparent communication channel and the information overload on email made it common for organizers or participants to miss messages. The design technology was another strength of the Community Media Center Makerspace. Thanks to their media studio and lab, media production and editing technology was readily available. Workshops were held on other open source design technologies as well such as Inkscape and Blender. The space did not, however, focus on manufacturing technologies. As this was such a central component of the larger Maker Movement at the time, some visitors were hoping for more manufacturing technology. Finally, another strength of the Community Media Center Makerspace was its collection of responsive technology components. Prototyping devices such as Arduino and Lilypad were available for tinkering along with a supply of varied sensor devices. While the Community Media Center Makerspace had many unique strengths, it likely suffered because it was not as closely aligned with the mainstream Maker Movement focus on manufacturing and struggled to build a consistent community of makers.

The community development initiative is a unique case as it organically moved away from a focus on maker-technologies and into the realm of art and culture. At the time of writing, the space has received funding from the state to expand into a larger site and is expanding its paid organizing staff. The exhibitory technology was the space itself. It functioned as a kind of community art gallery with visitor creations covering the walls and surfaces. There was even a small store front selling some the products made by community members. The external social technology was primarily Facebook while organizers communicated through email. Design technology was not common as the space did not offer laptops for public use. Workshops on 3D printing occurred occasionally and lead guests through the use of design technology like TinkerCAD. Manufacturing technology was limited to a 3D printer and sewing machines. Finally, responsive technology was not a focus, so it was only available during specific and infrequent workshops.

Technological Literacies

Because the rhetoric surrounding “innovation” is so strongly biased toward positive and producerly activities, many literacy practices that occur in makerspaces are overlooked. Godin (2017) suggested some “innovation” practices that would not typically be categorized as such in the introduction to his edited volume: adaption, withdrawal, imitation, maintenance of existing innovation, learning from failure, alteration of the innovation and unintended consequences. A conceptualization that includes these “non-innovative” practices is crucial to a robust approach to media and technological literacy. For example, Masterman’s (1985) “critical autonomy” concept from the media literacy literature allows for negative reactions, critiques, and rejection of an instructor’s analysis.

Similarly, Virginia Eubanks' (2011) work on technological literacy programs among adult women suggested that rejection of technologies was not indicative of a failure on the individual's part but instead was a signal of incipient critique—a positive outcome from a literacy perspective.

Literacies are understood here from a practice framework that suggests literacy “involves shaping and mastering the repertoire of capabilities called into play when managing texts in ways appropriate to various contexts” (Luke & Freebody, 1999, p. 4). Looking at the practices related to the various maker-technology groupings reveals how these activities can contribute to the “flexibility of practice” that Luke and Freebody (1999) referenced regarding their Four Resources Model. The model suggests that individuals and communities “break the code” of texts, “participate in understanding and composing” texts, “use texts functionally”, and “critically analyze and transform texts by acting on knowledge that texts are not ideologically natural or neutral” (p. 5). While this Four Resources Model was developed for written and oral texts, it can be adapted to explore the group of literacy practices observed in the makerspaces.

Exhibitory Technology Literacies

How participants understood and used exhibitory technology revealed a breadth of literacy practices. Use of online exhibitory technology began with search practices. Participants scoured YouTube and Pinterest for project ideas and how-to guides. They also used more niche sites such as Instructables and Thingiverse. These activities involved participants “breaking the code” by navigating the architecture of the sites such as how one would download an STL file for 3D printing from Thingiverse or “pin” an interesting idea to one's board on Pinterest. Beyond functional use, these activities

involved “understanding and composing meaningful texts” as participants had to sift through huge catalogues of information on these sites to find applicable, well-designed, and achievable projects. Often, participants did not want to merely re-create a project but were looking for help on how to craft something they had imagined themselves. Others wanted to create an open-source or low-cost version of a commercial tool or technology. In such cases, participants practiced bricolage as they copied code from a site like GitHub, a wiring diagram from a site like Instructables, and searched on Google for answers to any issues that arose. Such activities involved using “texts functionally” as participants learned about the different types of information available on different sites and what kinds of contributions would be welcome in these different spaces. Finally, workshops were a space for critical discussions about available exhibitory technology. The Community Media Center Makerspace, for example, encouraged the use of exhibitory websites for open-source science such as PublicLab and websites which allowed for Creative Commons licensing of photos such as Flickr. Offline exhibitory technology such as the whiteboards, bulletins, and displayed media similarly called on participants to consider the functional uses of the available space and the transformative potential of art or displays.

Social Technology Literacies

The management of many of the social media and event sites for the makerspaces was limited to makerspace organizers. When participants became volunteers or regular visitors, they were often added to an internal communication tool. The library makerspace, for example, used Slack to communicate among volunteers while the Community Media Center Makerspace used a Google Group that allowed anyone who

was part of the group to start an email thread. Due to this arrangement, there were restricted opportunities for guests to showcase or build their “repertoire of capabilities” (Luke & Freebody, 1999, p. 4) related to social technology.

Social technology practices included learning the basic function of platforms such as Slack and how to negotiate what is appropriate for a group message, email, and face to face discussions. During workshops, guests discussed their more critical opinions on the social technology options available. One participant at a workshop for the Library Makerspace admitted she had a fake Facebook account so she could learn about community events. She did not want her personal information on Facebook but many organizations use the site, so she felt she was “forced” to use it as well [Library Makerspace 10/21/2018].

Design Technology Literacies

Design Technologies were often a new addition to participants’ literacy repertoires as evidenced by the number of workshops specifically dedicated to exploring design technologies. All three of the makerspaces offered guided workshops on the use of design software such as Inkscape for illustration, TinkerCAD for basic 3D design, or Blender for 3D computer graphics. Unlike some of the other maker-technologies where “breaking the code” of the architecture was taken-for-granted or intuitive for those with digital technology experience, the interfaces of these design technologies were more difficult to master.

Designing with these tools was often a necessary first step for using some of the manufacturing technologies such as the 3D printer or laser cutter. Knowing the future use of the design was therefore crucial as participants had to consider how to “use [the] texts

functionally”. For example, the 3D printers printed in layers on a glass base from the bottom up. Users had to be mindful of how they were crafting their designs so there would always be a solid base of existing material for the plastic to print onto. Design software also involved creative composition practices such as when participants transformed photographs of their line drawings into digital illustrations on Inkscape [Community Media Center Makerspace 1/27/2018].

Manufacturing Technology Literacies

Desktop manufacturing or digital fabrication technologies such as 3D printers and laser cutters were a defining feature of the mainstream Maker Movement. As these technologies had not quite been domesticated yet, they were alluring to participants who wanted to learn more about them. However, these technologies were often the most expensive and the most likely to malfunction or break if used improperly. As such, use of the digital manufacturing technologies was more restricted and often had to be overseen by trained volunteers. These spaces also had analog manufacturing technologies such as woodworking tools, bike repair kits, and sewing machines. All the spaces which had these manufacturing technologies offered tutorials and workshops for participants to learn how to understand the components, work the machinery, and compose texts appropriate to those tools.

The technology specific literacies were most likely to be cultivated through direct instruction. For example, the Library Makerspace instituted a credentialing system for use of the laser cutter that involved attending a workshop and then successfully completing three uses of the machine while under observation by a trained volunteer. At the Community Development Makerspace, meanwhile, the weekly bike repair workshops

had a more ad hoc and communal approach to learning about the bike repair tools and best practices for bike tune-ups. There were a few volunteers with expertise in the room, a few teens who were trained to help, and community members who shared any knowledge they could.

These technologies also offered opportunities for participation in material culture which fostered literacies related to specific products. Indeed, the manufacturing technologies led to many critical and transformational making practices. Participants discussed how the 3D printers were used to prototype improved breast pump parts and toys to help with attention disorders. One participant at the Library Makerspace created braille signs on the 3D printer to label the floors at her child's school. Another visitor to the Community Media Center Makerspace explained how he used a laser cutter from a different makerspace to make his business cards. These business cards were etched onto scraps from cereal boxes and other recycled materials. Similar sustainability efforts were observed at the Community Development Makerspace where sewing machines were used to repurpose fabric and old t-shirts into quilts and bags.

Responsive Technology Literacies

A common entry point into working with responsive technologies was through music. Musical instruments such as DIY ukuleles and hand pianos decorated a wall of the Library Makerspace. As “analog” forms of responsive technology, instruments could be used to explain the basic premise of digital responsive technologies: An input (i.e. key press), results in an output (i.e. a sound). The initial project tutorials included with many Arduino kits offer step by step instructions on how to create music with buzzers and a popular introductory use of the Makey Makey board is to create a piano out of bananas.

Makerspaces are thus playful spaces for individuals and communities to learn more about the logic and architecture of the computational technologies in their lives.

Responsive technology literacies are needed to address the rising investment in the Internet of Things (IOT) and proliferation of smart devices. To assist in cultivating literacies related to “break[ing] the code” (Luke & Freebody, 1999), makerspaces have devices and materials that aim to open the “black box” of these digital responsive technologies. Often, such devices and materials encourage tinkering and play. For example, Chibitronics are stickers that include LEDs and sensors. They can be used to create functional and responsive circuits on various surfaces to help users understand the architecture of electronics. Similarly, LEGO Mindstorms are robotic devices built out of LEGO parts which are controlled by programming a series of commands into the intelligent brick. LEGO Mindstorms thus encourage computational thinking through experimentation with algorithms.

In addition to tinkering, workshops about low-cost prototyping board such as the Arduino or LilyPad were held in the makerspaces. These boards provide opportunities for individuals to create functional devices and learn how to program them to respond to their environment or collect data. Much like the manufacturing technologies, the products created using these responsive technologies offer opportunities to participate in material culture in critical and transformative ways. The Community Media Center, for example, promoted the use of Arduinos for citizen science projects such as air and water quality monitors. Additionally, many of these devices are open-source and thus encourage participation in the open-source ecology or, at the very least, introduce users to the existence of alternative IP structures.

Conclusion

Makerspaces are multi-faceted and are unique to the communities who build and sustain them. There are, however, patterns in how activities in these spaces are organized. This analysis suggested a framework to conceptualize how organizational investment and participant investment are negotiated in different makerspace activity models. Some of these organizational models are foreclosed to organizations or institutions which have constraints on their ability to invest in makerspace initiatives. Some makerspace practices also ask for steep or ongoing investment from participants and this may lead to further social differentiation or exclusion.

The organizational models adopted by various institutions are only one of the factors that shape inclusion in making. This study also identified five families of maker-technology practices: Exhibitory Technology, Social Technology, Design Technology, Manufacturing Technology, and Responsive Technology. These maker-technologies reveal the strength of an ecological approach to emergent technology. Each of these families of maker-technology practices connects specific technologies, to particular social uses and relevant discourses. This holistic approach avoids emphasizing only the technology, use, or meaning making of the observed practices.

Using this maker-technology typology, the analysis concluded by presenting a more expansive conceptualization of media and technological literacies in makerspaces. The variety of literacy practices observed emphasizes the potential to expand an individual or communities' capabilities using makerspace models. However, to be truly transformative, critical and “non-innovative” activities must be recognized as valuable literacy practices.

CHAPTER 9

DISCUSSION

Emerging technologies, political changes, and global crises like the 2020 COVID-19 pandemic will continually reorganize and influence priorities for organizations with social inclusion goals. This analysis aimed to explore how the organizational policies and actual practices in makerspaces both enabled and constrained how these three makerspaces negotiated competing demands of innovation and inclusion in changing times.

Preliminary conclusions suggest that the needs of innovation and inclusion compete and that these are not merely abstract tensions but tensions which can have material consequences for the organizations. As Willet's (2016) has warned regarding discourses encouraging library adoption of makerspaces, the expectations of constantly adopting new trends and technologies could make the libraries less relevant for the actual communities they serve:

Librarians might argue that their existing programming of more vernacular kinds of projects are meeting the needs of makers in their community; further, libraries might have limited social, technical, or economic resources for establishing maker programs. Within current rhetoric about makerspaces, we might ask whether there is a risk of these libraries being characterized as out of date and irrelevant for the changing needs of society. (p. 321)

The organizations studied here seem to be faced with a similar struggle. For example, for the Community Development Makerspace, the goal of including innovative technology had to be revisited as it did not seem to fit the needs or desires of the community. For the Community Media Center, the changing technology landscape puts pressure on them to constantly defend their relevance. In what follows, I respond to the study's research questions by briefly summarizing tensions these three spaces faced.

Elements of Organizational Policy

The first research question asked what institutional motives, organizational policies, and organizational structures supported makerspace development. Each space was motivated by different, though related community development goals: The Community Media Center Makerspace was motivated by a desire to bridge a town-gown divide and train users on emergent open-source technologies, the Library Makerspace was motivated by a desire to expand the cultural impact of library offerings, and the Community Development Makerspace was motivated by a desire to revitalize a downtown area and provide creative production activities as part of a cultural development project.

Each of these makerspace serves as a kind of “boundary object” (Star, 2002) for the varied interests that invest in or visit the spaces. For the Library Makerspace, the open workspace model meant that multiple creative and technical activities were occurring side by side, physically negotiating priorities in the space. For the Community Access Media Center Makerspace and the Community Development Makerspace, the university affiliations of the organizers needed to be negotiated with the desires and realities of the local communities. These collaborations were meant to help disband the “silos” reinforced by institutional norms which primarily reward individual achievement and emphasize efficiency. While these partnerships have brought in crucial sources of funding and labor, they have simultaneously introduced policy and structural challenges related to transportation, marketing, and labor.

The case studies explored here largely operated under the “procrastination principle” common to technology initiatives which “gives license for the idea’s technical

and social blueprints to be incomplete” at the start (Zittrain, 2008, p. 240). The Library Makerspace described how the purchase of equipment or materials was based on recommendations and requests from visitors, while the Community Development Makerspace was largely guided by the participants at monthly meetings. While this allows for innovation, flexibility, and for the voices of the community to have a role in defining the uses of the space, waiting to “hear” or “see” the needs of the disenfranchised or excluded may mean their concerns are never recognized. More targeted interventions could be useful if inclusion remains a primary goal. The Library Makerspace interest in disability and adaptive design sounds like one promising avenue. Additionally, the conscious effort to include communications and programming in languages other than English can help address this oversight.

Elements of Discourses

The second research question concerned user outcomes and motivations for visiting. Unsurprisingly, how organizers explained the space and how participants relayed their reasons for visiting varied widely and were highly individualized. This is partly due to the “fuzzy” nature of the makerspace concept. For some who were attracted by the early discourses surrounding the revolutionary potential of The Maker Movement more generally, participants visited to see what kinds of technologies were offered. Adult interviewees particularly highlighted the desire to engage the interest of their children or students, socialize with other adults around their interests, get an opportunity to teach or share their knowledge, and get or stay up-to-date for their employment prospects.

Maker participation is not only active but includes an implicit commitment to others in the local makerspace and the maker scene more generally. A term that

continually surfaced during drop-in meetings when I first visited the Community Media Center was a desire to “pay it forward.” Chris highlighted paying it forward as his main reason for being involved in the creation of a makerspace: “I’m trying to foster community, the same kind of community that I found useful in the past. I would like to have that kind of community be available for other people.” (Focus Group, 2014). This community operates on both a local level and globally online. However, the dedication to the “local” is more complex than it seems on the surface. Local politics and the value and constraints of physical spaces shape how the makerspace articulates its goals as part of the maker scene. Furthermore, the local is not inseparable from larger discourses and priorities, as funding sources often focus on youth initiatives and affiliations with local universities and schools have a part in shaping an initiative.

Elements of Value

The third research question asks about the values and ethics of the makerspace. The values and ethics of each space are made visible in the partnerships they cultivate, the programming options offered, and the discourses that circulate during events.

The Community Media Center’s partnership with a local school-based initiative for supporting families of school-aged children, and the desire to create training opportunities for college students who would like to work with marginalized populations are evidence of a desire to democratize self-expression. The expertise among the steering committee members, however, foregrounds a different ethic of democratization. The perspectives, largely from the university, infuse the space with discussions and efforts towards open-source and knowledge commons to democratize knowledge structures. This

is evidenced not only in the hardware and software tools offered but is also made explicit in the courses and programs offered by the space.

The Library Makerspace was most aligned with the mainstream maker ethos related to desktop production, wood working, robotics, and arts and crafts. The space could be described as a hobbyist sandbox. While there was a diversity of activities and events, the space largely aligned with the project of democratizing participation in material culture.

The Community Development Makerspace migrated the farthest from media and technology concerns over the course of the project. The arts and entrepreneurial discourses of the Creative Economy were most notable in this space. The association with the cultural development project as well as the space's role as an incubator for a few local artisans and educators indicated a push towards professionalization. This did lead to some clashes over identity as many of the activities in the spaces were amateur community arts programming, however.

Elements of Ecology

The final research question concerned the implications of the findings for future organizational policies. This question is a reminder that changing technology landscapes and economic discourses are experienced in material ways by place-based communities. The communicative ecology framework keeps a study like this one tethered to the local experience. The lessons of these spaces, while not generalizable, provide insights into the types of changes and tensions we should be sensitized to in future initiatives.

Place and space are infrastructures for communication and must be part of the conversations regarding media and technology ecologies. Throughout the study, it was

striking how often complaints from organizers and participants alike related to the physical buildings and locations. For the Community Media Center Makerspace, the physical space was a contentious issue as the landlord of the building that houses the Community Media Center terminated the center's lease before I began my study in 2014 and it only recently had its building plans approved at a new site in 2020. The Library Makerspace, meanwhile, has moved from one temporary space to another, awaiting a space in a location closer to the library that suits their needs.

The most prominent theme in all the data gathered to date is the importance of the social support element. In line with previous research on initiatives aimed at supporting digital and technological inclusion (Park, 2014; Powell, Byrne, and Dailey, 2010; Rhinesmith, 2012), organizers in all three makerspaces emphasized the social over the technical when discussing the opportunities and barriers they were facing. As the data revealed, there needs to be more support for overseeing and organizing the day to operations of the space including advertisements and scheduling. While the Library Makerspace created a paid coordinator position, the other two spaces still had volunteers or those with other jobs within the organizations taking on this labor during the analysis in 2019. Moreover, when there are technical problems such as the Wi-fi connectivity issues in the Community Development Makerspace, there should be dedicated technical support. Finally, as discussions with the Director of the Media Center Makerspace emphasized, there should be more attention paid to training in productive and equitable pedagogy for those who work on such initiatives.

Participants across the spaces highlighted the desire to teach and the Community Media Center organizers were originally interested in the space becoming a training

facility. Creating a mechanism such as an online form for organizing “guest” hosts that would be a possible first step. Improvements in pedagogy are beneficial to all involved and will begin to address the need for technological literacy programming for adults.

CHAPTER 10

CONCLUSIONS

The act of researching and writing a dissertation on a topic that is dynamically changing over five years presents several challenges. I have consistently maintained my overarching theoretical purpose to situate this inquiry within the framework of Critical Media Literacy. However, the evolving rhetoric surrounding the “Maker Movement” and “DIY” philosophies and practices necessitated refinement of my investigative framework over the course of the research process.

In the Study Rationale (starting on p. 12), I outlined my theoretical background as framed within the discourse of the “digital divide,” and guided by questions of social mobility and well-being through the expansion of individual and community capabilities (Sen, 2001). By interrogating the debates surrounding the transformative potential of emerging trends in public access institutions and industry related to multidisciplinary social production spaces, I sought to foster approaches to lifelong media and technology education that would be sustainable and inclusive. As I defined my research questions, I incorporated the Communicative Ecology Approach (p. 55) which provided an epistemological foundation and helped to refine the ethnographic methods. Therefore, while using a methodology that incorporated participant observation, semi-structured and ethnographic interviews, and document and artifact analysis, I decided to narrow my research questions by examining a technological layer, social layer, and discursive layer (p. 63).

The study was framed to address the broad question: “How might adoption of Makerspace models by different public access institutions support (or undermine) digital inclusion through promotion of digital and technological literacies” (p. 69). In presenting the data, I incorporated a “segmented institutionalist approach” (p. 66) and addressed these issues through case studies. This allowed me to analyze my data with the four specific research questions in mind that were specifically germane to the issues of local production sites (pp 69-70):

- 1) What are the institutional motives, organizational policies, and organizational structures that support makerspace development?
- 2) What are the perceived outcomes of makerspace involvement for adult users?
What motivates adult participants to visit the makerspace?
- 3) What are the values and ethics of the makerspace?
- 4) What are the implications of the above findings for future organizational policies?

These research questions allowed me to identify and contextualize the following conclusions.

Previous research has identified the importance of intermediaries such as community centers and libraries in supporting digital inclusion for adults while also acknowledging that emphasizing technological innovation and adoption at the expense of social concerns can lead to further marginalization and exclusion (Eubanks, 2011; Kvasny & Keil, 2006; Rhinesmith, 2016). By taking a holistic view of the communicative ecologies (Hearn, Tacchi, Foth, & Lennie, 2009) that surround three organizations that have adopted makerspace models, this study questioned if makerspace initiatives could

reconcile competing targets of inclusion and innovation through their organizational policies and approaches to media and technological literacy.

Observations and interviews across the three ethnographic case studies suggested the makerspace model is a productive “boundary concept” (Star, 2002) when adopted and adapted by community intermediaries. Two unique aspects of this model that can support digital inclusion through the promotion of digital and technological literacies include (1) an emphasis on sociality and skill sharing and (2) the exhibitory nature of making.

Firstly, the emphasis on sociality and skill sharing can help individuals broaden their repertoire of literacies by connecting individuals with diverse interests, thus expanding their knowledge of the possibilities of emergent technologies and informational resources. Indeed, interviews and mission statements from across makerspaces in Massachusetts emphasized the value of these spaces for fostering creative, intellectual, and social support networks. Kvasny and Kiel’s (2006) early work on initiatives to ameliorate digital divides suggested the social relationships built through opportunities to share skills and learn collectively were important. The social nature of making and the varied activities happening in the spaces allowed for this collective sharing. All the case study makerspaces also had opportunities for volunteers to lead workshops or facilitate drop-ins. However, as highlighted by Sims’ (2014) work on school-based digital literacy, certain practices related to technology and digital media are legitimized or delegitimized through local social practices, and this can lead to further social differentiation. To foster the diversity of skills and perspectives circulated in these spaces, makerspace initiatives should not only offer, but also promote activities aligned with the assets of the local community, even if they are not directly in service of popular

understandings of media and technology literacies. Successful examples of this variety include the Community Development Makerspace’s popular bike repair sessions and the Library Makerspace’s fiber arts programming. Offering opportunities for the community to join in planning and decision-making can help to identify these assets and interests.

The collective learning and creation processes in makerspaces encourage—and are encouraged by—the exhibitory nature of making. As various interests and activities intersect in these spaces, they offer new audiences for activities that are often siloed. The mainstream “maker” discourse, forwarded by Maker Media, encouraged this understanding of making through their “show and tell” Makerfares and the various on- and offline publications where designs and products could be widely circulated. While I did not observe participants in the spaces creating this kind of public documentation, they frequently referenced these resources in their own making practices. For individuals working in the sites I visited, acts of creation were almost always visible to others participating in the space. During workshops, leaders often described or demonstrated how their expertise came from trial and error, making the process of learning transparent. For the more formalized classes, sharing completed or nearly completed projects was the culminating activity. This visibility and transparency can contribute to digital inclusion goals on both a micro and meso level. Organizers for the Community Media Makerspace, for example, frequently discussed the value of having younger participants see the projects and activities of older college students so they could better understand the possibilities of new technologies and design practices. At the meso-level, these spaces make community assets more visible and can create connections between diverse organizations and publics. When established within existing community intermediaries

like libraries and media centers, this increased visibility can help support the intermediary's relevance in changing media and information ecologies. However, offering a coherent message to engage new, outside audiences can be difficult given the diversity of interests and the ad hoc approach to development within the makerspaces I visited.

To realize the benefits of the social and exhibitory aspect of the makerspace model for digital inclusion, initiatives should prioritize creating pathways toward continued use, establishing dedicated staff support positions, and adopting a *critical technological literacies* orientation. Previous research on technological literacy programs has highlighted the importance of “opportunities for continued use” (Kvasny & Kiel, 2006, p. 50). While the makerspaces did offer some one-off workshops, they also encouraged continued learning and use through drop-in hours and opportunities to join others in collective projects. Nevertheless, some of the organizers of the makerspaces did acknowledge that the activities were more amateur in these spaces and were to serve as a kind of introduction and sandbox for individuals. While tinkering and experimenting in a social space is invaluable, opportunities for engaging in more advanced aspects of social production requires more resources. These intermediaries could work to build connections to opportunities and resources like university labs, galleries, or apprenticeships. The work of building those connection is laborious and therefore dedicated staff positions should be created to ensure sustainability of these spaces. Even for spaces that can rely on consistent volunteer staffing, a dedicated coordinator is crucial for the often-overlooked labor of maintaining these spaces, building network connections, and upkeeping public-facing communication channels. While grant funding will often

support equipment purchases, it is difficult to find funding to support operational budgets. This is a crucial aspect of the future of these initiatives and will take reorienting the makerspace discourse toward the social rather than the technological. A similar reorientation is needed in understanding the literacies cultivated in these spaces if they are to foster inclusive visions of innovative practices.

The study took a practice-based approach to conceptualizing the media and technological literacies fostered by making activities. A typology of Maker-technology types emerged from the analysis of practices across the varied sites (See Table 8). These Maker-technology practices are interrelated but do have differentiating characteristics:

- **Exhibitory Technology Literacies-** These literacies involved making one's contributions visible beyond the immediate context of making.
- **Social Technology Literacies-** These literacies involved practices of informational exchange and relationship building among individuals.
- **Design Technology Literacies-** These literacies involved symbolic creations.
- **Manufacturing Technology Literacies-** These literacies involved material creations.
- **Responsive Technology Literacies-** These literacies involved computational thinking and data use.

If intermediaries interrogate how their makerspace initiatives allow for community members to engage in practices across this spectrum of literacies, they can better contribute to “the expansion of the ‘capabilities’ of persons to live the kind of lives they value” (Sen, 2001, p. 18). While important for the design of makerspace initiatives specifically, these Maker-technology Types also provide important insights for the future

of literacy initiatives concerned with digital inequalities. Together, these literacy practices highlight how media and technology are increasingly intertwined with possibilities for voice and recognition, interpersonal exchange and social networking, digital and material production, and the circulation and use of data through computational activities across varied domains of social production. They encourage attention to technology-aided activities as well as symbolic practices more commonly aligned with media and communication.

To ensure these literacies do not foreground innovation concerns at the expense of inclusion concerns, this study borrows from the long history of scholarship on digital inequalities and the applied lessons from the critical media literacy field to forward a call for social production spaces and public access intermediaries like the ones studied here to attend to *critical technological literacies*. While technological literacies are often conceptualized as concerning the creative, responsible, and effective use of technologies for various endeavors, *critical technological literacies*, as forwarded here, link on-going analysis with use. Critical media literacy scholars Alverman and Hagood (2000) described a similar mission regarding visual media. They aimed to support their students' media engagement while "simultaneously uncovering the codes and practices that work to silence or disempower them as readers, viewers, and learners in general" (p. 194). Building on media literacy frameworks (Center for Media Literacy, 2009), *critical technological literacies*, then, begin with questioning the codes and rules of a technology or technology-aided practice, attend to the varied experiences of that technology or practice, interrogate the imbedded values, and finally identify the motives behind its creation and use in context. Effective use, then, requires a fuller understanding of context

to re-envision, reinvent, or refuse media and technology to meet local needs. I observed examples of this critical orientation in the Maker-technology literacy practices outlined above such as creative commons licensing of images, the negotiation of privacy concerns when choosing to engage on Facebook, and discussions of the ecological impact of 3D printing materials. To foster these crucial critical technological literacies and link inclusion and innovation, future initiatives must attend to their pedagogical approach.

Summary of Contributions

Contributions to the field:

- **The analytical framework demonstrated the strength of a communicative ecology approach to expand beyond ICT-related development initiatives to include more expansive understandings of the experiences of media and technology in local contexts.** Low-cost, open source technologies create possibilities for individuals to participate in material culture in new ways while computational technologies are being used to monitor and filter our experiences on and offline. Communication scholars should attend to these experiences of the contemporary media ecology.
- **The literature review brought the development literature concerns with innovation into conversation with the social inclusion concerns from the digital divide literature.** The literature review highlighted some of the neo-liberal bias in innovation policy and supply-side bias of the digital divide literature. Bringing the innovation divide and digital divide literature into conversation encourages renewed attention to grassroots production activities, ownership, and governance alternatives like open source and creative commons.
- **In the contemporary media and technology ecology, an “exhibitory” approach to access is crucial where discourses emphasizing creativity and innovation converge with stratification of opportunity.** While availability and cost of media and technology are persistent concerns, mission statements and interviews also highlighted the value of community connections, business opportunity, and learning related to emergent technologies. Access, then, requires exhibitory mechanisms that make visible the connections between networks, between skills and meaningful use, and between different opportunities for the communities served.

Contributions to future media and technology literacy initiatives:

- **Makerspaces can serve as intermediaries for their local communicative ecologies.** Makerspaces serve the dual role of being sites of *access* to media, technology, and design practices as well as sites of *recognition* for members who can connect to larger organizations, grow their social networks, and take on leadership roles.
- **Offering varied models that allow for different levels of participant commitment supports digital inclusion by providing flexibility for participants to choose what capabilities or literacy repertoires they wish to prioritize.** Makerspace activities were primarily organized as periodic workshops, on-going courses, drop-in hours, meet ups, volunteer run permanent facilities, co-working spaces, and incubators.
- **These possibilities for participation are not the same as actual opportunities.** One element of digital inclusion as conceived here was the need for individuals and communities to understand the benefits of media and technology practices. While the spaces I studied made genuine efforts to remove barriers related to cost, expertise, and affiliation (e.g. to an institution like a college), targeted interventions are needed to create opportunity for individuals to connect the practices of makerspaces with capabilities they value.
- **Makerspaces are jargon heavy.** More attention should be paid to external communication strategies to clarify what opportunities are offered. Resources and advertising in languages other than English is an important step.
- **The fieldwork data led to the identification of related practices that I grouped into five Maker-technology Types: Exhibitory Technologies, Social Technologies, Design Technologies, Manufacturing Technologies, and Responsive Technologies.** These types are useful for local makerspaces who may want to evaluate their own activities to better understand the strengths and potential weaknesses of initiatives.
- **Using the five Maker-technology Types, I enumerated potential maker literacies, or repertoires of literacy practices observable in the makerspaces.** I argued that to be truly transformative, critical and “non-innovative” activities must be recognized as valuable literacy practices.

Methodological Considerations:

- **Studying organizational policy in practice, over time, means confronting change and conflict.** This reality is a methodological *problem* when it is assumed a study should offer a clear map of the efficient processes an organization can adopt for success (and that there is a consensus on what success means). This reality is a methodological *asset* when a study intends to offer an understanding of

the contingencies of policies and practices for organizations aiming to be sustainable during times of conflict and change.

- **The participant observer role in collaborative learning spaces foregrounded the character of expertise related to emerging technology.** During fieldwork, I consistently moved between novice and expert roles. This sharpened my focus on limits of personal knowledge/skills and emphasized the importance of collaborative knowledge networks both on and offline.
- **The participant observer role obscured my view of emerging community needs in favor of institutional priorities.** My role at each space was different but all included access to leadership discussions due to my position (e.g. steering committee member, workshop leader, space monitor) and my seniority (e.g. by the time of the current study I had been working with these spaces for years). While I had privileged access to the decision-making processes and organizational discussions/conflicts, I had less critical distance to anticipate changing desires and needs of potential new members.

Limitations & Future Research:

- **There are, of course, “trade-offs” regarding an ethnographic approach and how this study defines field sites (Markham & Baym, 2009).** The case study approach applied here is useful for comparability but is not intended to suggest generalizability to other contexts. Additionally, the diversity of cases allows for consideration of varied institutions, but necessarily limits the depth of nuance for each individual case. Future studies should foreground the experiences of users/participants to better capture micro-level experiences of media and technology initiatives.
- **As interview participants were recruited from the space or listservs operated by the initiatives, the study did not capture experiences of non-users or marginalized populations who may be routinely excluded from participation due to structural factors.** As previously highlighted, initiatives need clearer mechanisms by which individuals could connect the repertoires of literacies to the activities they value. To understand what those are, a future study would need more in-depth interviews with participants that spanned various contexts rather than just the makerspace.
- **The changes I observed over the 5-year period of this study as attention shifted from “makerspaces” to “coworking spaces” suggests we will see (1) increased demand for less defined and more flexible activity spaces and (2) a move away from practices of play and transgression to production and professionalization.** Research into the communicative ecologies and practices of coworking spaces is necessary to further explore whether coworking spaces should be considered an evolution or alternative to makerspaces.

APPENDICES

APPENDIX A

INTERVIEW PROTOCOLS

Interview Protocol: Makerspace Personnel (i.e. organizers, workshop leaders)

1. How did you first get involved with [Name of Makerspace]?
 - Has your participation changed over time?
2. Who do you hope will participate in the activities here?
3. What do you hope to see this Makerspace do for its participants?
 - What do you hope the participants will do for the makerspace?
4. What do you imagine your role to be?
 - Verbally walk me through the [last workshop, organization meeting, etc.] and what participation was like for you.
5. What role does technology play in the activities here?
 - How do you think people best learn about technology?
6. What do you think makes [Name of makerspace] different from or similar to other community spaces in the area?
7. What have been the biggest challenges in designing this Makerspace?
 - Do you anticipate any new challenges?
 - Has there been any recent tension or uncertainty about the future of the Makerspace?

Interview Protocol: Participants (i.e. visitors to the makerspace)

1. Tell me a bit about yourself and how you first got involved with [Name of Makerspace]?
 - Has your participation changed over time?
2. What do you hope to see this Makerspace do for the people who come here?
 - Can you think of any changes the Makerspace could make to better support visitors in that regard?
3. Verbally walk me through the [last workshop, organization meeting, etc.] and what participation was like for you.
4. What role does technology play in the activities here?
 - What kind of technology do you use in your daily life?
 - Where do you go to learn more about technology?
 - How do you think people best learn about technology?
5. What do you think makes [Name of makerspace] different from or similar to other community spaces in the area?
6. What have been the most rewarding aspects of participating in activities here at the Makerspace?
 - Tell me a bit about any recent projects that you enjoyed.

Interview Protocol: Ethnographic Interviews

Motivation: What are their reasons for visiting?

Everyday Engagement with Technology: What kind of technology do you use in your daily life? Where do you go to learn more about technology?

Other Orgs: Have they visited any other local spaces that do similar activities?
How is this space similar or different?

Hopes for the Future: What other activities/offerings would you like to see here?

APPENDIX B

FIELDWORK NOTES

The following outline was used to structure my fieldnotes and prompt me to address questions related to the study. This structure was inspired by Virginia Eubanks' (2011) fieldnote structure.

Date

Organization Name

Duration

Participants

What did we do?

What is one significant interaction with technology I witnessed?

What did people say about technological literacy?

What did I learn?

How did I feel?

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