Digital Fabrication Technology in the Library: Where We Are and Where We Are Going
by Stephanie C. Prato and Lauren Britton

EDITOR’S SUMMARY
Makerspaces are environments where crafters and techies can come together to create, share and learn. Many libraries support the maker movement by providing access to a variety of technologies from sewing machines and looms to recording equipment and production tools, an expansion of services that is in line with promoting literacy, community and lifelong learning. About one third of makerspaces charged a fee or required membership in 2013, though some, including libraries and museums, are supported by major funding agencies. Digital fabrication technology or 3D printers are increasingly available through library-based makerspaces and extend opportunities for STEM education, but libraries face challenges from high initial and ongoing costs, user training and even encouraging users in 3D thinking and design. 3D printers can be a powerful stimulus for creativity, learning and sharing, even promoting jobs and community development.

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outed as havens for techies, artists and entrepreneurs, makerspaces are being developed at an astounding rate, both domestically and internationally. Creative, do-it-yourself spaces where people can gather to create, invent and learn, makerspaces are perceived as powerful learning environments, supporting project-based learning, design learning and experiential learning. The maker movement creates a hybrid of digital and face-to-face community interaction and has been cited as a means to empower individuals by creating access to tools and technology that democratize the means of production. Makerspaces in libraries often have 3D printers, software, electronics, craft and hardware supplies and tools and more. The promise is that these spaces enable communities, including those facing social and economic challenges, to create jobs, innovate and grow small businesses. It’s an open question, though, to what extent this growth is occurring and when and where it is successful.

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This article explores issues around the use of digital fabrication technologies in public library makerspaces in order to examine the incorporation of these technologies into library services and to suggest opportunities for future research.

Background

Makerspaces are operating as independent entities in schools, as well as in legacy institutions such as libraries and museums. While frequently described as community centers, most makerspaces are operating as independent entities and are membership-based. In 2013 over 30% of makerspaces required membership or a daily usage fee. Costs of membership at makerspaces can range anywhere from $30-$200 per month, and the more expensive memberships usually come with increased levels of access, such as a building key for 24/7 access to the space. However, major funding agencies, including the Institute for Museum and Library Services (IMLS), National Science Foundation (NSF) and Defense Advanced Research Projects Agency (DARPA) have funded grants to support and develop maker initiatives in more publically accessible spaces, particularly libraries and museums.

Making in libraries has been a popular topic of discussion for several years. The maker movement embraces innovation and creative problem solving through tinkering and hands-on exploration. Often it incorporates the use of emerging technologies and has been closely linked to 3D printing since the movement’s inception. Today, the American Library Association estimates that there are over 250 library makerspaces across the United States; this expansion is clearly more than a fleeting trend. In addition to services like 3D digital fabrication, libraries are providing access to hardware, like laser cutters, vinyl cutters and milling machines, and to software that enables web design, video editing and audio creation. Whether in a dedicated space or not, libraries are increasingly committed to providing access to a diverse set of tools and learning opportunities. Makerspaces offer libraries a new way to provide access to tools, content, technology and community, bringing people together to share ideas. They support 21st century literacy skills, such as digital literacy and STEM (science, technology, engineering, mathematics) literacy, but perhaps most importantly, makerspaces foster a read/write culture and enable community members to imagine what can be – with the potential to remake our world, for the better.

Since 2011, library makerspaces have grown both in numbers, as evidenced above, and in diversity. In addition to the increasingly ubiquitous 3D printer, these spaces have developed niche collections and services that fit the specific interests of their local communities. For example, some libraries have invested in looms, jewelry making tools, musical instruments, recording equipment, green screens and much more. Additionally, sewing machines are becoming more common, used by a range of community members from teens to small business owners. Libraries are also incorporating laser cutters, computer numerical control (CNC) mills and other computerized cutting technology that enables detailed and precise fabrication. On the low-tech side of the spectrum, libraries also provide access to hand tools like hammers, screwdrivers, saws, soldering irons and more. These items, while common in most households, encourage people to come together in the public space to work on projects they might otherwise do at home and to learn from others in the community as a result. Making these technologies available to the public not only allows people to experience and explore the equipment, but it also helps them to build new skill sets.

Libraries facilitate programs on 3D design, woodworking, jewelry making, sewing, computer coding, robotics, web development, recording and cinematography, just to name a few. And while these programs and services might seem like a radical departure from the so-called traditional library, they are merely a new twist on the age-old intent to foster lifelong learning. Educational institutions, like libraries, strive to create a savvy and knowledgeable public who can participate fully in modern life. Students and professionals are increasingly required to have advanced skill sets like analytical thinking and iterative problem solving, in addition to technical requirements like coding and 3D design. Makerspaces in libraries are well positioned to become the catalyst for this kind of personal, academic and commercial growth in the community. Perhaps this desire to be a catalyst is
why many library makerspaces and fab labs center their spaces on the newest and perhaps most disruptive technology of our time: 3D printing.

It’s not hard to understand why this particular technology has captured the imagination of so many. The idea of printing a tangible object, of seemingly creating something ex nihilo, is nothing short of amazing. Many have talked about how potentially revolutionary this technology could be. Popular television shows depict doctors printing in human tissue to create organs for patients in need, and across the globe engineers in China have begun to print concrete houses. The implications for medicine, manufacturing and consumerism are staggering. As libraries are becoming better known for providing access to this kind of technology, fewer people are questioning the importance of the service or the appropriateness of the library as a platform. In some respects, the library community has been so successful in this messaging that generous community members have donated funds or the 3D printers themselves to their local libraries, and therein lies a problem.

Challenges
There are specific challenges that go hand-in-hand with the opportunity provided by 3D printing technologies. First, the cost of purchasing a 3D printer may be prohibitive for some libraries, and even after the initial investment the product of the printer (plastic, in most cases) is a consumable that must be replaced at a cost. Most libraries get around this hurdle by simply charging the cost of the plastic so as to break even on this budget line. Yet, even barring the financial investment, offering access to these technologies requires additional investments in the form of staff time and training. It is not enough to put a 3D printer in a public room and to call that access. 3D printers have come a long way in improving usability for the average person. Gone are the days where you had to buy the parts, assemble it and tinker with both the hardware of the machine and the software settings to achieve a usable plastic model. Today it is often as simple as plugging in the machine, downloading a pre-made 3D design file and hitting print.

In some ways, this simplicity is wonderful, as it allows for more users than ever before. Training simply becomes a matter of familiarizing people with the software, the parts of the machine and the basic concept of printing by extruding layers of plastic. Training the public to use the 3D printer is a wonderful first step; however it isn’t really achieving the promise that this technology holds. One goal of the maker movement is to increase innovation through tinkering and through creation, potentially reversing the slide into pure consumption. This activity also creates challenges around intellectual property and copyright.

In order to achieve true innovation, we must train people in 3D design, which is considerably harder. This process requires critical thinking, analysis and a lot of creativity. It’s no wonder people sometimes look at these machines and think, what would I use that for? This is where we hear stories of printers that sit and collect dust, because there is no one trained to use them, or because people lack the skills to imagine how 3D printing might be relevant in their lives. Examples of where 3D printing has been most successfully integrated into library services center around the overlapping areas of broad access, in-depth training and community engagement.

What’s Happening Now?
If one of the goals of providing access to 3D printing is to foster a culture of innovation, to empower our community to create and not just consume, libraries must train the public. This mission means that anyone, from a child to an adult, an entrepreneur to a hobbyist should have equal access to the equipment and the training. The next step is to provide broad access to 3D design training. Some libraries are providing this access through subscriptions to online databases and video tutorials like Lynda or Treehouse. Others are reaching out to community experts who can teach classes on Solidworks or work with individuals on specific issues they are having with a project. For beginner adults and kids, there are free, web-based programs like Tinkercad or Blender, which have a less steep learning curve and make it easier to get started with creating unique designs.

When all of these elements are combined, the results are nothing short of amazing. Libraries are providing a platform for prototyping new products. One 12-year-old entrepreneur designed and created a display board for cloth badges out of cardboard. He used the library’s laser cutter to
produce the displays, which were so successful a major company for large-scale manufacturing purchased the design.

In addition to providing access to tools and technology, library spaces help provide people with access to other people. Because library makerspaces are public places for generating ideas and products, people often come together in unexpected but serendipitous ways. One man who spent many hours in the lab perfecting his prototype happened to start chatting with another man who was a copyright lawyer able to give him advice on patenting his design. In a space buzzing with activity, with people printing, cutting, sewing, crafting and more, all kinds of connections are made, which spark ideas and connections that could never be achieved alone.

But 3D printers support more than just entrepreneurial activities; they are also utilized by people who seek to repair something (a light fixture, a water fountain, an iPad mount, etc.) by printing a new part as opposed to buying a whole new product. Lastly, they are a great tool of the hobbyist and the artist. A woman prints beautiful 3D designed beads for her jewelry company. From the plastic model, she is able to create molds into which she pours the resin to make more beads to sell. Libraries should also encourage school-aged students who want to tinker and play with no practical purpose in mind, but they should encourage them to engage in the creative process, to dream up and make something that does not yet exist. It’s not enough to just download and print something.

**Conclusion**

The discourse surrounding the maker movement, particularly in the political spectrum, focuses heavily on STEM education, manufacturing and job creation. It is the technology and tools that are ushering in what some have called the new industrial revolution. Through democratizing access to these tools, communities facing social and economic challenges might be given the opportunity to create jobs, grow small businesses and provide unique platforms to learn 21st century skills. While identification with the term *maker* is not limited to those engaged with digital fabrication tools, most of the power and opportunity purported to emerge from making practices is strongly focused on STEM education and the tools of production.

Making has become a popular focus of study in the field of information science, particularly in the computer-supported cooperative work (CSCW) community. However, very little scholarly work has examined public library makerspaces and community use of digital fabrication technologies. As the incorporation of digital fabrication technologies moves beyond the public library to academic and special libraries, engagement with these technologies in library spaces has become an exciting and largely untapped topic for scholarly exploration. The following are among possible research directions:

- How are library patrons incorporating access to these technologies into their library use?
- What obstacles might librarians encounter while working with this technology?
- What obstacles might community members encounter while working with this technology?
- How do we assess the impact of creating access to these technologies?
- Does engaging with these technologies in libraries change community perceptions about the role of the library in the 21st century?
- How does use of digital fabrication technology in informal learning environments affect STEM learning outcomes in traditional academic settings?

As libraries invest significant financial and professional resources in digital fabrication technologies it becomes increasingly important to understand how they are being used and what makes access to these technologies meaningful to our users.