Introduction

Abstract

Chapter 1 of Library Technology Reports *(vol. 50, no. 5) "3-D Printers for Libraries" explains the mechanical process of a 3-D printer. Author Jason Griffey raises a few library-specific issues and makes an argument for libraries to implement 3-D printing.*

O ver the last two to three years, there has been an explosion of interest in 3-D printing in libraries. This has been driven by the falling cost of the technology and the rise in interest in interactive, creative spaces inside libraries (makerspaces or tinkerlabs). 3-D printing as a technology isn't new; it's been available commercially for decades. But only in the last five years or so has the price for deposition printers, driven by dedicated hobbyists and the company MakerBot Industries, dropped to the point where they are within the reach of the average individual.

There are a number of reasons that libraries should be looking at 3-D printing as an addition to their technology services. The first is that libraries, especially public libraries, have often been a technological leveler for their communities. Libraries were the first place where many people came to print their résumés on a laser printer. (It's easy to forget how transformative high-quality printing was in the late 1980s.) They were also the first place where many people had an experience with the Internet, especially with the World Wide Web, in the mid-1990s. Going back to pre-computer technologies, the local public library was the place where someone could go and use a typewriter that was freely available. So libraries have a well-worn history of being places where new technologies can be seen and interacted with for the first time. 3-D printers are at the point now where the personal computer was in 1984; they are mostly a hobbyist pursuit, but they have a clear future.

That future is as varied as the objects these printers can create. There are a number of traditional mechanisms for creating things in plastic, ranging from machining and milling (subtractive manufacturing) to molding and vacuum forming. In most cases, these are optimized for creating a high volume of identical plastic parts, such as tens of thousands of action figures or hundreds of thousands of appliance parts. They are almost impossible to use cost-effectively if you want just one of something, and that's where 3-D printing shines. With a 3-D printer, you can create unlimited numbers of unique objects for the same price. Need a replacement part for a toy? No problem. And then when you need a doorstop or a speaker frame or something totally other, that's not a problem either. If you're making ten thousand copies of a thing, there are more cost-effective options. But if you need just one, there is no better option than printing it.

This flexibility is key to the uptake of the technology, especially in libraries. Each patron can design and create his or her own particular object. Kids can print new additions to the toys that they love and can create just about anything that they can imagine.

What Is 3-D Printing?

The simplest way to imagine a 3-D printer is that it's a machine that makes bigger things out of smaller blocks. In some cases, the "blocks" are a powder; in others, they are melted plastic; and in yet others, they are an ultraviolet light–sensitive resin, but in every case it's just a matter of large things being made from smaller substrates. A 3-D printer is a simple sort of robot that

understands how to manipulate the raw material it's working with in three dimensions rather than just two, as an ink-jet or laser printer does. This type of manufacturing is also called *additive manufacturing*, as opposed to more traditional subtractive manufacturing where material is removed from a larger sample to create custom shapes in a process like milling, lathing, or CNC (computing numerical control) machines.

Imagine that you take an ink-jet printer, and instead of printing ink, it extrudes hot plastic that cools quickly. Think of it like a hot glue gun, where the plastic is solid, then gets heated to a liquid state, and then cools again into a solid. If it printed this plastic onto a piece of paper, you'd end up with a slightly raised design being "drawn" on the paper by the printhead moving back and forth across the paper (the X dimension) and the paper being moved through the print area (the Y dimension). Those of us old enough to remember the days when color printing was very expensive might have memories of hot-wax printers that did basically this.

With a 3-D printer, you add the last of the spatial dimensions, height, by moving the printhead and printing surface (usually called the *build platform* in this case) apart from each other. In our ink-jet analogy, imagine that you put the printhead on an elevator that could move it closer and farther away from the paper. If you do that while the printhead is putting down plastic, you can just keep moving them farther and farther apart, layer after layer, in the Z dimension. Over time, you end up with an object made of very thin layers of this plastic. That's what most 3-D printing is like.

This is the basis for almost all of the 3-D printing that you have seen in the media over the last few years and almost all of the 3-D printing that libraries have been involved with. As we'll learn in chapter 2, this isn't the only type of 3-D printing—it's just the most affordable.

Library-Specific Issues

Anyone who has talked with people about 3-D printing has probably heard the question, "So can you print a gun with it?" This is by far the most common question I get asked when I'm showing off a 3-D printer, whether it's to students or adults. It's good to have a standard answer to this question, as it's definitely going to come up. Mine is usually, "Maybe, but it would easier and cheaper to make one in a machine shop." This sort of question can also come from people like your friends group or your board, and for that, you might want to have a slightly more nuanced answer that includes things like, "Not really, and it's really not any more dangerous than having chemistry textbooks on the shelves."

Other objections to having a 3-D printer in the library include the overall cost of the consumable filament, which is easily recouped by charging just a few pennies per ounce for prints. The staff skills necessary are a concern, as 3-D printing really is at the level of hobbyist at this point. I often tell people that running a 3-D printer is like driving a classic car. You can do it even if you don't know anything, but it'll be a whole lot cheaper if you can change the oil yourself. For a 3-D printer, that might include regular cleaning, bed leveling, and occasionally swapping out a part if necessary.

Other skills that are useful but not necessary would include having someone who is at least aware of the types of modeling programs and could troubleshoot basic things like, "That won't print because of X reason." Libraries might also want to provide their patrons with resources for learning more, so it's a good idea to purchase materials about 3-D printing, modeling, and the like in case you have a patron who wants to deep-dive into the topic.

The Case for 3-D Printing in Libraries

The question that comes up most often, after the gun question, when I talk to librarians about 3-D printing is the very practical "Why?" Why 3-D printing in libraries? Why should libraries spend money and time on providing these services to the public?

There are a variety of ways to answer this question, but I think that the most straightforward is, "We've always done this sort of thing." Libraries are, at their core, an engine of democratization of knowledge and information. The library as a concept acts as a collective resource for the individuals of a community, and while we are best known for the resource of information, that's never been all we are. Libraries were often the first place in a community where someone could go to touch a computer and were one of the places where most Americans first saw the Internet. Those of us who were around technology in the 1990s remember how amazing something as omnipresent as a laser printer was in its early days. The library was often the place where patrons would go to print their résumés in the early 1990s because they didn't have a printer at home and the laser printer looked so much more professional than the more common dot-matrix printers. Even further back than the computer, the library was the place where members of the community could use a typewriter.

The point is that the library has a long, long history of providing technology for its patrons. It is still admittedly early in the life of 3-D printing, but the basic technology is affordable at this point. The future of additive manufacturing is likely to be stranger and more wonderful than I can imagine, but given the ways

that even these very rough first steps are being used (in health care to print organs, in food prep to make unique foodstuffs, in art to make impossible objects), I think it's fair to say that some amazing things will come from this technology.

To give you some idea of the sorts of things that are possible with 3-D printing technology, there are hundreds of inspiring stories around the web—some that are barely believable. Here are just a few:

- 3-D printed tissues and structures have already been implanted successfully into humans, and the potential for printing entire replacement organs is on the horizon.[1]
- People are using 3-D printers to provide custom, cheaper, and more comfortable prostheses for amputees and children, providing them with hugely better living conditions.[2]
- The same technique used in FDM printing (fused deposition modeling, discussed in chapter 2) is being used to build experimental housing and could revolutionize low-cost housing, including replacement housing after natural disasters.[3]

I also believe strongly that it would benefit libraries themselves to have 3-D printers available for any number of reasons. While it's great to provide the technology to patrons, don't forget that libraries and librarians could benefit from it as well. Need a shelf bracket? Want to have a custom sign for your new books shelf? How about a custom sign for every month? Need to repair a random broken plastic thing? Once you have the power to create arbitrary things, the benefit is that you can create anything you can think of.

Give access to a 3-D printer to your public services department, to your circulation department; see what they can imagine that would make their jobs easier. Then share that thing for other libraries to print. If libraries started iterating things that improve librarians' daily tasks, everyone could benefit. And 3-D printers help enable that kind of thinking—the ability to see a thing in the world and want to make it better. That's what I want to see libraries and librarians working toward.

Conclusion

The ultimate promise of this technology is the Replicator from *Star Trek*, a machine capable of taking the raw building blocks of matter at the atomic level and recombining them into anything you can imagine. That is obviously not happening soon, but this is how we get there, by building the simple machines that help illuminate the way.

Libraries have always been a place for their communities to discover new things. As technologies become increasingly important for accessing information and interacting with the world, libraries have become a place where people can go to see The New. 3-D printing is one of many technologies that are going to help to define the future in many ways, from fundamentally changing aspects of medicine to reworking the way we think about manufacturing.

Note that I am not saying that every library needs to immediately run out and purchase a 3-D printer. Many already have, and more have plans to, either through staff interest or through actual patron demand. I think that 3-D printers, in one form or another, will eventually become as commonplace as laser printers. Not everyone will have one at home, but most people will have access to one if they need it. And a lot of that access may come through their public library.

As the technology becomes more fully featured, as the 3-D printers become capable of printing more and more complicated objects, and as the prices continue to drop, more and more people will see that these devices may fill a need in their lives: not necessarily owning a printer, but being aware of their capabilities and able to imagine using one. That is also an opportunity for some public libraries, to be ready for that potential by understanding the current state of the 3-D printing landscape. It's always easier to be ready for the future when you prepare for it in the present.

Notes

1. Anthony Atala, "Lungs on a Chip, 3-D Printed Hearts: The Shape of Medicine to Come," Vital Signs, CNN Opinion, March 13, 2014, www.cnn.com/2014/03/12/opinion/lungs-chip-3-D-print-organs; Susan Young Rojahn, "Artificial Organs May Finally Get a Blood Supply," *MIT Technology Review*, March 6, 2014, www.technologyreview.com/news/525161/artificial-organs-may-finally-get-a-blood-supply.
2. Marcus Wohlsen, "The Next Big Thing You Missed: 3-D Printing Promises Better Bionic Limbs for the War-Wounded," *Wired*, March 18, 2014, www.wired.com/2014/03/next-big-thing-missed-bionic-limbs-3D-printed-worlds-war-wounded; Mará Rose Williams, "Kansas Teen Uses 3-D Printer to Make Hand for Boy," *Kansas City Star*, January 31, 2014, www.kansascity.com/2014/01/31/3261314/kansas-teen-uses-3d-printer-to.html.
3. Michael Franco, "Giant 3D Printer Starts Spitting Out a House," CNET, March 14, 2014, www.cnet.com/news/giant-3D-printer-starts-spitting-out-a-house; Kathleen Miles, "This 3D Printer, Capable of Building a House in a Day, Could Change Construction Forever," Impact X, Huffington Post, January 21, 2014, www.huffingtonpost.com/2014/01/21/3D-printer-house-mars-slums_n_4639046.html.