Lending a Hand: Supporting the Maker Movement in Academic Libraries

Adam Rogers, North Carolina State University Libraries

Adam Rogers is an innovative and user-focused librarian who works at the intersection of public services and new technologies. In his role as Emerging Technology Services Librarian based at NCSU's new James B. Hunt Jr. Library, he planned for, launched, and currently manages the Hunt Library Makerspace which makes 3D printing, 3D scanning, laser cutting, and electronics prototyping tools accessible to all at NC State. He is also leading the development of a second, larger Makerspace, set to open in D.H. Hill Library this spring.

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Ben Leduc-Mills is a researcher in the education department at SparkFun Electronics where he investigates strategies to infuse learning spaces with more hands-on activities. He received his Ph.D. in Computer Science from the University of Colorado, Boulder, where he worked in the Craft Technology Lab building toys aimed at getting children involved in designing objects for 3D printing. Prior to Colorado Ben spent time in New York City, working at Eyebeam, a premier art and technology center, and earning his Master's degree from NYU's Interactive Telecommunications Program (ITP), a hotbed of the DIY and maker movements. Ben has taught, presented, and published at numerous academic conferences, Maker Faires, hackerspaces, universities, and other informal learning spaces on building and teaching emerging technology to children and incorporating it into learning spaces of all shapes and sizes.

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Mr. Brian Huang, Sparkfun Electronics

Brian Huang is an Education Engineer for SparkFun Electronics, a cutting edge open-source hardware and electronics education company. Brian started his career in engineering with wireless transport technologies for ADC Telecommunications in Minneapolis, MN. While working at ADC, Brian volunteered at the Science Museum of Minnesota and quickly discovered a passion for teaching and working with students - especially in an environment that fostered and supported the "wow" factor associated with inquiry and discovery. In 2007, Brian left the world of engineering to pursue a career in education. For the past 5 years, Brian has taught various levels of high school physics, mathematics, applied technology, and robotics.

Brian joined Sparkfun Electronics to help integrate "tinkering," electronics, and computational thinking into the classroom. One of his goals is to help teachers to de-mystify how household consumer electronics work. With a few simple tools, classrooms can excite and encourage students to explore the possibilities of microcontrollers, electronics, and physical computing.

Brian Huang has a Bachelor's of Science in Electrical Engineering from the University of Illinois, Urbana-Champaign and a Masters in Education from the University of Colorado, Boulder.

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Abstract

Many libraries are embracing the Maker movement as an exciting new community to welcome into their doors by creating new spaces, adding new services and technologies, and offering new types of programming. At the North Carolina State University Libraries, we have been inspired by the Maker world, with its enthusiasm for creativity and interest-driven learning and its focus on Open Source, easy-to-learn, and powerfully flexible technology platforms. We have formed a Makerspace program, with two dedicated spaces and a variety of technologies available for our users to borrow. The NCSU Libraries and SparkFun Electronics, Inc. have partnered to explore challenges and creative solutions to integrating Maker technologies into libraries as well as ways to support student learning goals with both library-led workshops and course integrations. The purpose of this paper is to share the lessons we learned by reflecting upon our experiences with technology lending and teaching workshops while examining data from checkout information and personal surveys to draw conclusions about best practices and the impact we have on the campus community.

Technology Lending

Libraries have very robust systems for lending books to their users, and often use these systems to loan non-book items. At North Carolina State University Libraries, we have loaned a variety of technology items (such as laptops and cameras) for over a decade through our Technology Lending Service. Using the existing infrastructure, adding a new type of item requires only a small amount of policy decision-making and staff training. For example, in 2010 we made thirty iPads available for lending during the first week iPad was released to the public.

The NCSU Libraries launched a Makerspace program in January 2013, with a small space offering 3D printing and laser cutting services. We also added electronics kits to Technology Lending for the first time: the SparkFun (Arduino) Inventor's Kit, a Raspberry Pi kit from Adafruit Industries, and the MaKey MaKey, also manufactured by SparkFun. At first, we offered these in a "beta" mode, with little support and no related events in the libraries. However, the Inventor's Kit in particular includes an excellent print guide that makes the kit accessible and easy to get started with. We started with ten Arduino kits, four Raspberry Pi kits, and four MaKey MaKeys; each can be borrowed for one week at a time, with renewals allowed if the kit is brought to the library to do so. We have since added more kits and extended the service to a second library.

Challenges in Lending Electronics Kits

We have identified and tried to address a number of challenges with lending electronics kits at the NCSU Libraries. First, their numerous components mean there is a great potential they will be checked out or returned missing a part, and will be sidelined until parts are replaced. To mitigate this we have put a visual parts list in each kit that both library staff and our users can refer to when the kits change hands. In addition to the regular checkups by library staff when the kits go out and come back, we assign a student worker with strong electronics skills to do a full inventory after each semester. SparkFun helpfully offers a 'Parts Refill Pack' for the Inventor's Kit, which we use to replace less-expensive parts such as resistors and LEDs when they go missing, thus keeping the kits circulating rather than waiting on parts to be ordered and shipped.

Most of our staff, including those performing checkouts as mentioned above, had little experience with electronics. We have tried to address this by organizing staff-only workshops and even hack-a-thons where we address staff-identified library problems and use Arduino and other tools to prototype solutions. In addition, we have hired stellar students from our university's engineering departments, requiring the strong customer service and interpersonal skills we do for all user-facing library jobs. These students have augmented our Makerspace program by providing technology consultations for the kits, helping develop curriculum and support materials, and teaching workshops.

Library Workshops and Faculty Collaborations

We identified another issue with lending electronics kits when we decided to offer our first "Introduction to Arduino and MaKey MaKey" workshops in February 2014: we needed to pull most of the kits out of circulation in order to teach a hands-on workshop with a kit for each student. Prioritizing the workshop as a high-value learning experience and engagement with the libraries, we did this despite the extra effort. SparkFun has since helped resolve this issue by donating a teaching set of Inventor's Kits, along with other electronics and tools, to the NCSU Libraries.

The focus of the NCSU Libraries Makerspace program has been to expand access to the tools and technologies of the Maker movement, and as such our Arduino workshops have been specifically designed for beginners. We see Arduino as a general tool for creativity and problem solving, which would be useful for students of any discipline or background to learn. Also, it's a great entry point to the domains of electronics and code, of design and engineering–which can lead to interdisciplinary approaches and collaborations.

Our Arduino workshop has been developed iteratively, incorporating user feedback and the contributions of multiple instructors, including both librarians and student workers from our

Electrical Engineering and Textile Engineering programs. (New instructors will attend the workshop once, then assist the main instructor once before teaching it themselves.) Over time, we have settled on a few primary objectives:

- A conceptual understanding of the Arduino platform,
- Hands-on experience with the SparkFun Inventor's Kit,
- Completion of a simple circuit (e.g., blinking an LED),
- Some open-ended exploration/tinkering, and
- A clear path to learning more after the workshop.

These workshops have often been completely filled with twenty attendees and even a wait list. This is actually rare for library workshops, and shows that we are meeting a community need. We have had undergraduates, graduate students, and faculty in these workshops, from a variety of disciplines, with engineering strongly represented. Attendees will often check out a kit afterwards, and in several instances we have also begun collaborations with faculty who attend.

In our first Arduino workshops, we also included a section on the MaKey MaKey at the end. It was a good fit, as the MaKey MaKey is based on the Arduino platform, but we soon realized it was difficult to cover both platforms effectively with sufficient time for open-ended exploration. As of January 2015, we have removed the MaKey MaKey section, and we hope to develop a separate workshop or activity on prototyping physical interfaces with the MaKey MaKey. In the fall of 2014, we offered an additional Arduino workshop, "Spooky Sounds with Arduino" (the week of Halloween), to build on the introductory workshop.

In addition to our library-led workshops, which are optional for students, our librarians have collaborated with faculty at NC State University to integrate Maker technologies into their classes. We have worked with instructors in a variety of disciplines, but have found particularly strong partners in the humanities, with Digital Humanities scholars. We have integrated 3D scanning of artifacts into a history class, as well as constructing telegraphs using basic electronic components into a course called Victorian Media Studies. In these cases, the library serves the interesting role of 'gap-bridger', bringing these more engineering-friendly tools into practice in the humanities.

The low barrier to entry of the MaKey MaKey (which is essentially 'plug-and-play') combined with library support, enabled a Communications faculty member, Nicholas Taylor, to develop a class assignment using MaKey MaKey in collaboration with a librarian, Brendan O'Connell, for his Communications and Technology course. Students produced videos in which they built physical representations of intellectual concepts from the course using MaKey MaKey. They used the MaKey MaKey as an experimental communications medium, learning about both self-expression and electronics prototyping in novel ways.

With the library as partner, faculty members are relieved from performing the heavy lifting of learning a new technology and spending valuable class time teaching it, freeing them up to experiment and push the envelope in ways that would otherwise be impossible.

Learning from Usage Data

We have been collecting rough usage data since the beginning of February 2013 for the electronics kits that are checked-out from our libraries. Due to privacy restrictions we cannot collect information that identifies specific users, but we are able to track the number of check-outs, check-ins, and renewals, academic department (if specified), user role (e.g., undergraduate or faculty), as well as the kit type and which library the kit was checked out from. From February 1, 2013 to December 29, 2014 we recorded 1462 transactions, consisting of 695 check-ins, 697 checkouts, and 70 renewals. Presumably the discrepancy from checkouts to check-ins represents two kits that were on loan at the time the data was collected.
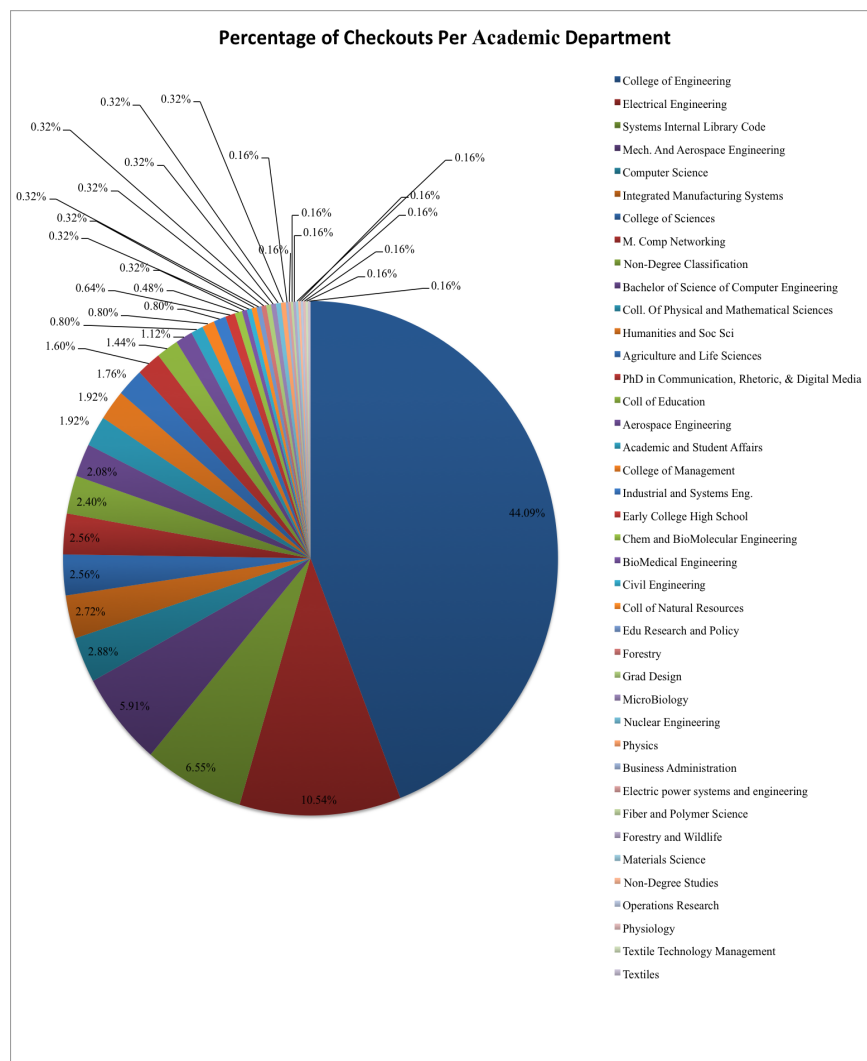

Figure 1: Distribution of Checkouts by Academic Department

Both of our main libraries saw strong usage, although James B. Hunt Jr. Library saw significantly more activity than D.H. Hill Library, 1237 to 225. We suspect this is due to that Hunt Library is the main library for the colleges of engineering, textiles, and other science disciplines, who are the heaviest users of the Technology Lending Program. As displayed in Figure 1, we registered technology checkouts for 40 different academic departments across campus - a far greater diversity than one might expect, with disciplines ranging from agriculture and forestry to business management and physiology. Departmental information was attributable in 626 of the 697 checkouts (some codes were specific to staff and faculty members). However, the distribution relative to department is more in-line with what one might expect given the nature of the kits being lent. Figure 1 shows all 40 of the departments we registered and the relative percentage of checkouts attributable to them.

The College of Engineering was by far the most frequent visitor, with 276 (44.09%) of the total check-outs recorded, followed by Electrical Engineering with 66 (10.54%), Library Staff with 41 (6.55%), Mechanical and Aerospace Engineering with 37 (5.91%), and Computer Science with 18 (2.88%). Unsurprisingly, of the 40 departments recorded, the vast majority are engineering or hard science disciplines. However, we were encouraged by some significant numbers from non-traditional fields. Humanities and Social Science had 12 checkouts, Agriculture and Life Sciences had 11, and the Ph.D. program in Communication, Rhetoric, and Digital Media had 10 checkouts. While we are uncertain whether these checkout numbers represent one or two devoted individuals or a broader cohort within the particular department, either scenario represents meaningful involvement from sectors that the library may not have been aware of without this data.

We were also able to determine (to some degree) what sections of the academic population were checking-out the technology kits. The raw checkout data provided six different classifications: undergraduate students, Honors undergraduate students, graduate students, faculty (including post-doctorates), systems (library staff), and staff (non-faculty university employees). This data includes the number of checkouts as well as the number of renewals.

We can see in Figure 2 that the distribution roughly correlates to a typical university population as a whole. Undergraduates were the most frequent patrons, with 322 (42%) check-outs and renewals, followed by graduate students with 217 (28%), faculty with 109 (14%), Honors undergraduates with 49 (7%), Library Staff/Systems with 41 (5%), and Staff with 28 (4%). While not particularly unexpected, the data shows participation across all sectors of the university community, indicating that the campus as a whole knows about the technology lending program and can (at least occasionally) make use of it.
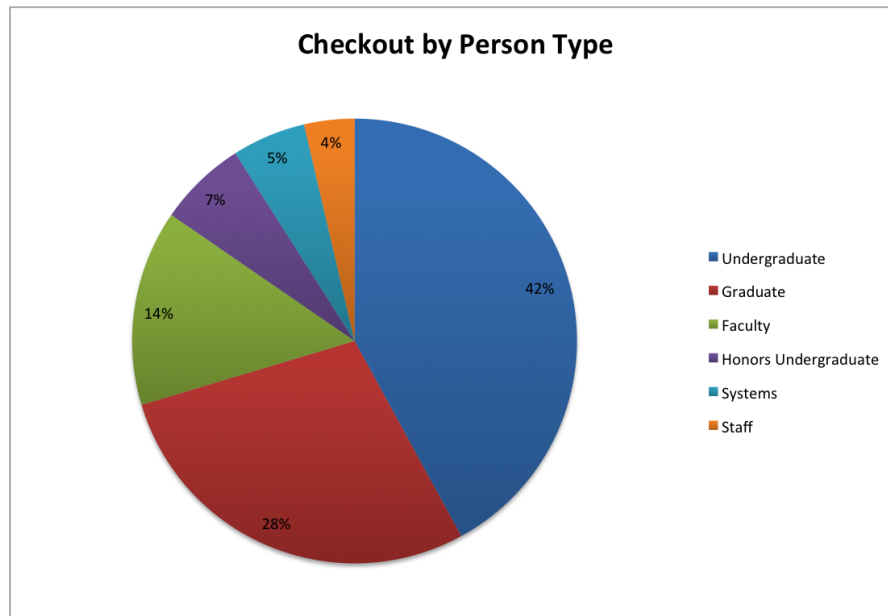
Checkout by Person Type

Figure 2: Distribution of Checkouts by Role

We also collected data for five different technology items: the SparkFun Arduino Inventor's Kit, the MaKey MaKey, the Raspberry Pi, an Arduino Wifi shield, and an Arduino Ethernet shield. To give a brief account of each of these items: the SparkFun Inventor's Kit (SIK) contains a selection of simple electronics parts (e.g. LED lights, resistors, light sensors, motors) as well as an Arduino microcontroller and an experiment guide, which details a sequence of 15 circuits that can be built and customized with the parts included in the kit. The MaKey MaKey is a circuit board that senses capacitive touch and acts as a USB keyboard when plugged into a computer. Thus, any capacitive object (such as a banana) may be used as an input to the computer (e.g. as the space bar to help control a video game). The Raspberry Pi is a simple computer, that runs a version of the Linux operating system and has ports for connecting basic input/output components as well as audio, video, and USB input. The Arduino Wifi and Ethernet shields are called 'shields' because they fit on top of an existing Arduino microcontroller with the purpose of adding specific functionality; in this case, adding Wifi or Ethernet capabilities to the Arduino.

Of the 695 recorded check-outs, 422 (61%) were for the Arduino Inventor's Kit, 164 (23%) were for the Raspberry Pi, 95 (14%) were for the MaKey MaKey, and the Wifi Shield and Ethernet Shield were both checked-out 7 times (1%). The low numbers for the two shields are not terribly surprising; the shields are, by their very nature, more advanced than the Arduino and are built for specific purposes, unlike the general SparkFun Arduino kit, Raspberry Pi, or MaKey MaKey. The remaining kits are somewhat influenced by the total kits available (between the two libraries we had 23 SparkFun Inventor's Kits, 9 Raspberry Pi Kits, and 18 MaKey MaKey kits) but more likely the checkout numbers are simply reflective of the popularity and utility of the various devices. The MaKey MaKey is a wonderful introductory tool, but not as versatile as the Arduino, and not as powerful as the Raspberry Pi.
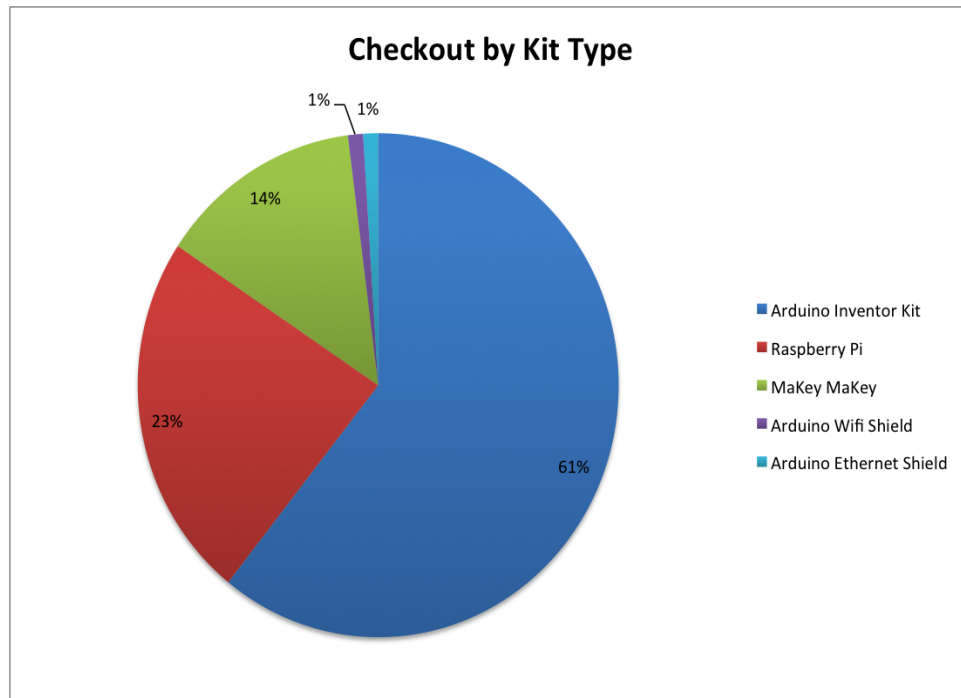
Figure 3: Checkouts by Kit Type

Going forward, we can use this data to direct outreach into new programs and departments, dictate the in-house workshops and trainings offered by the libraries, and more generally serve the campus community more effectively.

Learning from a User Survey

In addition to the checkout data discussed above, we also conducted a small survey asking users about their experiences with the technology lending program in order to gain more insight into who our users were and what their user experience was like with the library. We deployed the survey in mid-October of 2014 by e-mailing a campus listserv for the library Makerspace, as well as putting a card in certain technology kits with a link to an online survey. IRB approval was obtained before deployment of the survey, and informed consent was obtained via an online form before the participant was allowed to participate in the survey.

(User)	Total	1	2	3	4	5	6	7	8	9	10
Course-Related	2	x	x								
Personal/Hobby	7		x	x		x	x	x	x		x
Professional/Research	2				x			x			
Entrepreneurship	2			x						x	

Table 1: User Survey Results for "What was your purpose for checking out the kit?"

To date, 18 participants have started the survey, but only 10 had completed the entire 14-question survey, so for the purposes of this paper we shall only report findings from the 10 complete surveys. Of the 10 responses, five were from the Electrical and Computer Engineering department, two were from Computer Engineering, and one each from Physics, Communication, Rhetoric, & Digital Media, and 'Engineering'. Seven of the respondents checked-out the SparkFun Inventor's Kit, and three checked-out the MaKey MaKey kit. Four of the participants had checked out their kit once before (i.e., this was their second time), while the other six were checking out their kit for the first time.

Table 1 displays how users answered the question, 'What was your purpose for checking out the kit?' Multiple selections were allowed (course-related, personal/hobby, professional/research, entrepreneurship) as well as open-text answer, although none of the users availed themselves of it. Our goal was a coarse break-down, as these are only a few general areas we believed to be relevant; the lack thus far of any alternate answers via the open-text box does not necessarily confirm our category selection.

Interestingly, most of the participants were checking out kits for extracurricular activities: either their own personal hobbies, their professional lives, or for entrepreneurial pursuits. These answers may indicate that the library tech-lending program is supporting the personal hobbies and interests of the campus community more effectively than course-related projects. This is most likely a reflection of the relative newness of both the technology and the lending program, as many instructors may have been unclear how to use things like an Arduino or MaKey MaKey or how to incorporate them into a course.

The observation that most kits were used for extra-curricular activities is reflected in users' answers as to what sorts of projects they were working on with the kits. Some example responses include simulating a pump-based communication system, using a MaKey MaKey to control a computer through a mobile phone interface, a motion-sensitive musical instrument, a heart-rate sensor, and the director of an on-campus a cappella group searching for new inspirations to bring to his group. The variety and creativity displayed in just this small sample of respondents was outstanding, and underscores the importance of making these types of technologies available to the campus population and supporting them with proper staff and appropriate spaces within the library for working on hands-on 'maker-type' projects.

Conclusion

The research and data analysis outlined here have informed our lending practice, the way we frame our services, and our goals for improving and expanding our Makerspace program--but there are certainly gaps in the knowledge we have. We would like to know more about our users' projects, their processes in developing them, and the impact our kits have had on them at those levels as well as in their broader understanding of electronics, prototyping, and engineering.

We have found that our libraries are a natural fit for the Maker ethos, its tools, and its technologies. Through a focus on accessibility, we are working to broaden participation in this movement by lowering barriers to entry, providing free access to the tools and entry-level learning experiences that are open to all. We think that many other academic libraries could make an impact on their campuses in this way, depending of course on their own context and their users' needs. If they do want to support making, lending Maker-friendly technologies such as electronics kits is a productive and affordable way to start. It leverages libraries' existing strengths and infrastructure, and can be a small effort that is added to over time. Supplementing a technology lending program with workshops can be more difficult, but for us this has been an essential outreach tool, facilitating collaborations and pushing access further.

By embracing the Maker movement, academic libraries can support engineering education by offering tools and learning experiences to engineering students, who do not always have easy access to these, especially in the first years of their university education. These offerings can both supplement a formal engineering education, and provide informal learning experiences to both engineers and non-engineers. Libraries and museums have long known the importance of learning outside of the classroom; we think this extends beyond K-12 to university education as well.

As we extend the NCSU Libraries Makerspace program in the coming years, we see both opportunities and challenges in continuing to broaden access to the Maker movement and its technologies, and in integrating new types of tools such as wearable and electronic-textiles (which present unique challenges for lending). Perhaps most importantly, we see great promise in leveraging on-campus expertise to strengthen our workshop program, and in connecting makers more thoroughly in a community of practice that furthers collaboration and knowledge-sharing. The impact of adopting a maker-friendly atmosphere has been overwhelmingly positive; we serve real community needs, we help foster creativity across many disciplines, and while there is some effort in training and implementation, we are planning to continue expanding our maker programs for the foreseeable future.

Resources

1. Askey, Dale, et al. "Perspectives on Supporting and Administering Maker Culture and Programs in Libraries." (2014).

2. Bowler, Leanne. "Creativity through "Maker" experiences and design thinking in the education of librarians." *Knowledge Quest* 42.5 (2014): 58-61.

3. Brady, Tara, et al. "MakeAbility: Creating Accessible Makerspace Events in a Public Library." *Public Library Quarterly* 33.4 (2014): 330-347.

4. Colegrove, Patrick. "Editorial board thoughts: libraries as makerspace?."*Information Technology and Libraries* 32.1 (2013): 2-5.

5. Halverson, Erica Rosenfeld, and Kimberly M. Sheridan. "The Maker Movement in Education." *Harvard Educational Review* 84.4 (2014): 495-504.

6. Hutzel, Martha M., and Janice A. Black. "We Had a "Maker Festival" and So Can You! Central Rappahannock Regional Library Celebrates Resurgency in Do-It-Yourself Movement." (2014).

7. Lippincott, Joan, Anu Vedantham, and Kim Duckett. "Libraries as Enablers of Pedagogical and Curricular Change." *Educause Review Online* (2014).

8. Michele Moorefield-Lang, Heather. "Makers in the library: case studies of 3D printers and maker spaces in library settings." *Library Hi Tech* 32.4 (2014): 583-593.

9. Peltonen, Marjukka, and Mikaela Wickström. "3D-prints and Robots Play a Part in My Story. Participatory Learning Action and Content Creation in a Library Maker Space." (2014).

10. Peppler, Kylie, and Sophia Bender. "Maker movement spreads innovation one project at a time." *Phi Delta Kappan* 95.3 (2013): 22-27.

11. Phetteplace, Eric, Nicole Dixon, and Michael Ward. "The Maker Movement and the Louisville Free Public Library." *Reference & User Services Quarterly* 54.1 (2014): 17-19.

12. Scalfani, Vincent F., and Josh Sahib. "A model for managing 3D printing services in academic libraries." *Issues in Science & Technology Librarianship* 72 (2013): 1-1.

13. Slatter, Diane, and Zaana Howard. "A place to make, hack, and learn: makerspaces in Australian public libraries." *The Australian Library Journal* 62.4 (2013): 272-284.