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The Emerging Technology Collection at Carleton University Library: Supporting Experiential Learning in the University Curriculum

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Abstract

The Emerging Technology Collection at Carleton University is a successful collaboration between three units on campus: the Library, the Discovery Centre for Undergraduate Research and Engagement, and Information Technology Services. The Emerging Technology Collection began as a pilot project in January 2015 to circulate Raspberry Pis and Arduinos at the request of faculty in the Engineering Department. Due to the success of the pilot project, the collection now provides access to over 70 pieces of technology equipment for loan to support experiential learning for students. Development and implementation of the Collection is discussed. The Emerging Technology Collection has provided a number of academic benefits, such as innovative student projects, outreach and faculty engagement, and community engagement. There have also been benefits for the Library including promotion of the Library collection, continuing education for Library staff, and significant usage of the Emerging Technology Collection. Some of the challenges faced during the development of this collection are analyzed, including the need to register certain products, maintenance and upkeep of the collection, damage and replacement costs, and promoting the use of emerging technology across disciplines. This successful project underscores the value of a shared space where different units on campus can work together to develop and deliver an innovative new service. Finally, this project demonstrates the value of innovation in academic libraries that are responsive to new developments and deliver useful services.

Incorporating innovation into the organizational culture of academic libraries can be a challenge, but it is possible when Library leadership actively supports new ideas and services.

Keywords

Academic libraries, emerging technology, collection development, creative spaces, experiential learning, staff development

Introduction

Access to Emerging Technology at Academic Libraries: Makerspace vs. Specialized Library Collection?

In recent years, a great deal has been written about libraries implementing makerspaces. As noted in Fourie and Meyer (2015), much of the literature focuses on the physical space and the equipment, but a number of important topics remain underdeveloped including specific learning objectives and the information-related involvement of libraries (Fourie & Meyer, 2015, p. 520). While there are useful similarities and ideas which can be taken from the literature on makerspaces, there is little published on technology lending in academic libraries. There are however, a number of excellent examples in practice, see, for example, North Carolina State University Libraries' [Technology Lending](#) which serves as useful model and source of ideas for academic libraries setting up a similar service. The Emerging Technology Collection at Carleton University Library is a specialized, non-traditional Library collection which supports teaching and research on campus. While there is a tendency to conflate access to emerging technology and makerspaces, from the outset the project was intended not to be a makerspace due a strong preference among faculty that students use the existing labs on campus for projects since they have the appropriate equipment (such as soldering tools, wire cutters, strippers, and clamps) as well as health and safety stations.

For academic libraries, the link to research and curriculum drives our mission and mandate. Hence, a trend which underlies technology lending programs is the increasing number of university courses which incorporate experiential learning, especially in engineering and technology. This approach to teaching includes hands-on exercises and projects where students develop skills and problem solving. Students synthesize and apply knowledge they have learned in order to design, construct, and complete a project. At the same time, students are also building related skills in teamwork, project management and budgeting. Experiential learning enhances classroom instruction and enables students to acquire practical skills which are valuable in the employment market. This approach to teaching is especially important at Carleton University where experiential learning and student engagement are mentioned as core values in the current University strategic plan (Carleton University, 2013, p. 4). Thus, there is great value in academic libraries doing what they can to support developments in pedagogy and student centred learning.

The Emerging Technology Collection at Carleton University

The Emerging Technology Collection at Carleton University is a successful collaboration between three units on campus: the Library, the Discovery Centre for Undergraduate Research, and Engagement, and Information Technology Services. The Emerging Technology Collection began as a pilot project in January 2015 to circulate Raspberry Pis and Arduinos at the request of faculty in the Engineering Department. Due to the success of the pilot project, the Emerging Technology Collection was granted ongoing funding in the Library's collections budget in May 2015 with an annual budget of \$6,500 plus occasional donations of equipment. Replacement costs, which will be discussed later, have been minimal and come out of the main collections budget. Information Technology Services (ITS) circulates and maintains the collection through the Library ITS Help desk. The Discovery Centre for Undergraduate Research and Engagement co-ordinates the space, develops infrastructure, and supports the experiential model of learning with services such as 3D printers and a gaming lab.

The collaboration between the three units was initiated for the Emerging Technology Collection pilot project as a new service to support student learning and engagement. The collaboration is consistent with the Library's 2015-2018 strategic plan, especially goal 1-1 "to improve the relevance of our collections to the academic programs of the University". Regular meetings, especially between the Library and ITS maintain communication about the collection and facilitate co-operation on issues such as training for ITS help desk staff. Significant issues regarding the Emerging Technology Collection are also discussed by the Library Collections Committee which includes representation from across the Library. The collection is intended to be cross-disciplinary and the Library actively seeks purchase suggestions from faculty in all disciplines. The collection now provides quick and easy access to over 70 pieces of technology equipment available for loan.

The Emerging Technology Collection at Carleton University Library has two main objectives: to support student course work, projects, and research; secondly, to give all students, faculty and staff the opportunity to use and experiment with emerging technology.

Implementation

In order to keep the collection as accessible as possible, loan rules are simple: all items are available for two-week loan with a valid student / faculty / staff card. As discussed earlier, the collection is not a makerspace and the fact that equipment can be borrowed gives students the time and space to experiment with technology at home or in a lab at their convenience. All items are fully catalogued and records include links to online user manuals, quick start pages, project ideas and tutorials. Borrowers sign a user agreement which is standard for this type of collection (Moorefield-Lang, 2015) and outlines the conditions for borrowing items from the collection including liability for loss or damage.

The borrowing for the Emerging Technology Collection has been efficiently implemented as it has “piggy-backed” onto the existing laptop loan program. For example, the user agreement for the Emerging Technology Collection has been merged into the user agreement for the laptop loan program which has saved time for staff who work at the ITS help desk who are already familiar with the document. Similarly, the Library’s laptop loan program requires ITS help desk staff to carefully check equipment when it is signed back in and this important procedure continues with the Emerging Technology Collection. Academic libraries need to be responsive to new ideas often within the context of budget and staffing constraints. Efficiencies can be achieved by expanding an existing service rather than implementing something entirely new.

Analysis: Benefits

The Emerging Technology Collection was launched in January 2015 and has provided a number of benefits and opportunities for the academic community that Carleton University Library serves, as well as for the library.

Academic Benefits

Innovative Student Projects

In the process of building the Emerging Technology Collection, the Library has enjoyed fruitful collaborations with a number of Carleton faculty members including Cheryl Schramm in the Department of Systems and Computer Engineering and Alan Steele in the Department of Electronics and Director of Discovery Centre for Undergraduate Research and Engagement. Dr. Steele was recently awarded a 3M National Teaching Fellowship and is a strong proponent of project based learning for students (Bowness, 2017). Steele is enthusiastic about the practical aspects of engineering such as designing and constructing circuits. Students “learn a lot better than me just telling them ... it builds confidence, it builds ability, it builds an understanding in ways you can’t often convey in a classroom” (Bowness, 2017).

The Emerging Technology Collection is well used by students for coursework and project courses in particular the fourth year capstone project. Open-ended project courses are lab based and students work in teams to propose, develop, design and build a project. Projects include a budget and the Emerging Technology Collection permits students to experiment with equipment before they include it in their project, or equipment which is outside their budget. Cheryl Schramm believes that access to the Emerging Technology Collection is key for students to experiment and often provokes new ideas which they can incorporate into projects. This open environment provides a good incubator for ideas and innovation. One example is a student project in Systems and Computer Engineering (SYSC 3010) Computer Systems Project Development where a team of students constructed a prototype smart house using a Raspberry Pi and a doll house.

Figure 1. Prototype smart house. Photo credit: Cheryl Schramm.

Outreach and Faculty Engagement

In May 2016, project partners organized a workshop at the Carleton University Teaching and Learning Symposium. The workshop included an overview of the Emerging Technology Collection and a demonstration of a fourth year student project from the Systems and Computer Engineering Department where students constructed an automated ringette coach using an Arduino from the Emerging Technology Collection. During the demonstration, students explained that the day before their project presentation was due, the Arduino they were using malfunctioned. In a panic, they were able to rescue their presentation by borrowing an Arduino from the Library collection. The workshop also provided hands-on time with 360 video, a Makey Makey banana piano, and a pencil stylus for iPads. The session was well attended and sparked a number of interesting conversations with faculty. As a result of the workshop, a faculty member from the Physics Department donated a new telescope to the collection. The faculty member is a member of [#popscope](#), “an urban movement that aims to reconnect communities to the night sky—and to each other—by hosting free, “pop-up” astronomy nights in public spaces”. While the size of the telescope and accompanying material initially presented some challenges, the Library came up with an innovative and uniquely Canadian solution. The Library purchased a hockey bag to keep the telescope and all the accompanying equipment together. The telescope was also bubble wrapped to prevent damage.

Figure 2. Telescope kit. Photo credit: Ryan Tucci

The faculty member is delighted that the telescope can be made accessible through the Library and it has been a runaway success. When first added to the collection in February 2017, it was immediately borrowed and eight holds were placed within the first week. The faculty member also included a solar system imager MP camera and his contact information in the hope that borrowers will take astrophotography and video of the night sky and post the images online on a site such as AstroBin.

Community Engagement

The Emerging Technology Collection has provided a number of opportunities for outreach and building connections with the local Ottawa community. Collaboration and community partnerships are mentioned as a core value in the University strategic plan.

As a modern university, Carleton is an active partner with communities, business, industry, government, institutions and organizations, providing research, education opportunities and solutions to the challenges of society and the economy (Carleton University, 2013, p. 4).

Through the Emerging Technology Collection, the Library has been able to align with the University's strategic objectives in this area and establish connections with the local community based on education and technology. For example, in February 2016, the Library received a request from a local teacher to borrow the Makey Makey for her grade 5 class. Borrowing from the Emerging Technology Collection is limited to Carleton students, faculty and staff. However, this case provided a welcome opportunity to connect with local schools and future Carleton students and requests from external borrowers continue to be accommodated on a case-by-case basis.

Carleton students have also used the Emerging Technology Collection for outreach activities. For example, students in the System and Computer Engineer Society (SCESoc) organize outreach events for students once a semester to demonstrate the use of equipment from the Emerging Technology Collection. Events include a variety of stations each with a different piece of equipment. The sessions usually last about four hours, are held in the Library, and attract approximately 50-60 students. Engineering students also participate in Virtual Ventures which is a Carleton University science, technology, engineering, and mathematics (STEM) camp for local children. The camps incorporate some of the equipment from the Emerging Technology Collection, especially the Ototo banana piano which is consistently popular. Sarah Garlough from the System and Computer Engineer Society (SCESoc) says these workshops are valuable for children because "they make STEM less scary, they bring humor into STEM and make these subjects more approachable." In addition, an undergraduate student in Information Technology used E-Z robots, LittleBits, and Makey Makey for tutoring sessions with students in grades 6 and 7. This kind of student-led initiative develops valuable connections with the local community and provides opportunity to engage in experiential learning for Carleton students which helps them to develop leadership skills.

In addition, the Emerging Technology Collection has also been used in a workshop for the Library and Information Technician (LIT) program at Algonquin College in Ottawa. For example, in Spring 2017 Library staff organized and taught a workshop for 24 LIT students. The half-day session provided an overview of the development and operation of the Emerging Technology Collection, introduction to Raspberry Pi with Library related project ideas, and hands-on time with Raspberry Pi, 360 video, the Makey Makey fruit piano, and VR with the Oculus rift headset. This type of session is valuable for Library technician students who may be required to work in a makerspace or organize technology related events at schools or public libraries. To this end, the workshop also provided an overview of resources for self-training for key technology, which could prove useful in the employment market. Carleton University also has the [Bachelor of Information Technology - Information Resource Management \(BIT-IRM\)](#). This unique 4-year program was launched in Fall 2016 and enables students to graduate with both a Bachelor of Information Technology degree from Carleton University and a Library and Information Technician diploma from Algonquin College. The blended university – college curriculum combines a strong theoretical education with practical experience. The program incorporates experiential learning with practicums, a year-long fourth year project, and co-op opportunities. It is anticipated that BIT-IRM students will make

significant use of the Emerging Technology Collection as a rich area for course work, projects and student research.

Finally, the Emerging Technology Collection was used in a conference presentation at the Ontario Association of Library Technicians / Association des bibliotechniciens de l'Ontario annual conference in May 2017 (Cross, Tucci & Whitney, 2017). The conference session included a presentation and hands-on time with selected equipment from the Emerging Technology Collection.

Benefits to the Library

Promoting the Library and the Collection

The Emerging Technology Collection has generated positive publicity for the Library and also served as a means to promote use of the existing Library collection relating to technology. For example, the Library subscribes to Safari Books online and Springer e-book packages which have significant content relating to the practical use of technology and computer programming.

Some examples of Library news items which promoted both the Emerging Technology Collection and the Library's existing e-book collection include the following:

- [GoPro Hero 5 camera added to the Emerging Technology Collection](#)
- [New items for Emerging Technology Collection](#)
- [Smartphone VR viewers at the Library](#)
- [Leap motion controllers @ the Library](#)
- [Raspberry Pi and Arduino @ the Library](#)

This approach of promoting the Emerging Technology Collection with a connection to the Library e-book collection develops a point made by Fourie and Meyer (2015, p. 521). Using this approach, the Library moves beyond providing equipment to also providing information resources to support the collection and student centred learning. Marketing in this way also demonstrates that the Library collection remains useful and relevant and includes materials which people might not be aware of. This type of marketing also promotes the Library as forward thinking and in touch with technological developments.

Continuing Education for Library Staff

An interesting development of the Emerging Technology Collection is the enthusiastic use of the equipment by Library staff. The use of makerspace technology for Library staff development and continuing education is also discussed in Purpur, Radniecki Colegrove. and Klenke (2016), who discusses the benefits of a "pop-up" technology event for Library staff at the University of Nevada, DeLaMare Science and Engineering

Library. The event provided a forum for staff to keep up to date with technology trends and hands-on learning with colleagues in an informal and fun environment (Purpur, Radniecki, Colegrove, & Klenke, 2016, p. 132, 139). Similar events have been held at Carleton University Library. For example, hands-on technology and continuing education event was held in conjunction with Ontario Library Association webinar “Arduino and Raspberry Pi for the uninitiated” presented by Tim Ribaric, Digital Services Librarian at Brock University which was viewed at the Carleton Library on December 2, 2014. The presentation covered the basic features of Raspberry Pi and Arduino, examples of Library related projects and tools, and resources for future learning. After the webinar, Arduinos and Raspberry Pi units were made available for staff. These items were, at that time, brand new to the Library and the webinar provided a welcome opportunity to discuss the development of an emerging technology collection at the Library.

The use of specialized Library collections for staff development is also supported by earlier work done with the Carleton University Library game collection (Cross, Mould & Smith, 2015). Library staff enthusiastically embraced the board game collection by creating a library gaming club. The group, which met regularly, gave staff an opportunity to learn about new board games and spend time together in an informal and fun social atmosphere (p. 136). In 2016, a similar group was formed around the exploration of the video game collection. In the video game group, staff explore games purchased by the library through the library’s Steam accounts. With the high level of interest in the library’s special collections, staff have also expressed interest in developing a library group around the exploration of the Emerging Technology Collection. Benefits of having a staff group would be similar to those of the library gaming groups: learning about new emerging technology, as well as spending time together in an informal and fun atmosphere.

Usage of the Emerging Technology Collection

Borrowing statistics for the collection indicate that a number of key items are heavily used. By far the most popular items are Raspberry Pis and Arduinos. As of May 8, 2017, the Library’s nine Raspberry Pis have circulated a total of 97 times and renewed a total of 63 times. The Library’s six Arduinos have circulated 56 times and been renewed a total of 32 times. Other items which have been well used are: Smartphone VR viewers by Dodocase (the five cardboard units have circulated a total of 36 times and been renewed 17 times); the Leap motion controllers (the two units have circulated a total of 24 times and been renewed a total of 26 times, and have also been used in a project for a second year course in the Bachelor of Information Technology - Interactive Multimedia and Design Course); the 360 degree camera (circulated 23 times and renewed a total of 17 times) and the Pencil bluetooth stylus by FiftyThree, Inc. (four units have circulated a total of 18 times). Other notable popular items include the electronic circuit games: Makey Makey and littleBits. The Myo gesture control armband and the Reveal thermal imaging camera have also been well used [See table 1].

The high number of total renewals for popular items also seems to indicate that once borrowed, students generally want more than two weeks to become familiar with the

equipment. This does appear to support the rationale behind technology lending so equipment can be borrowed to give students adequate time to experiment and complete projects.

Table 1			
<i>Top ten circulating emerging technology items (Dec. 5, 2014 to May 8, 2017)</i>			
<u>Technology</u>	<u>Number of Copies in the Collection</u>	<u>Total Checkouts</u>	<u>Total Renewals</u>
Raspberry Pi*	9	97	63
Arduino**	6	56	32
Smartphone VR viewer / Dodocase	5	36	17
Leap Motion controller	2	24	26
Ricoh Theta S 360 degree camera	1	23	17
Pencil Bluetooth Stylus	4	18	0
Makey Makey	2	17	8
Myo gesture control armband	2	16	14
littleBits Premium kit	2	13	3
Reveal thermal imaging camera and high performance light	1	11	13
<i>Notes.</i>			
<i>Statistics cover the period Dec. 5, 2014 to May 8, 2017.</i>			
<i>* Raspberry Pi includes all Raspberry Pi models (Raspberry Pi B+, Raspberry Pi, Raspberry Pi 3, CanaKit Raspberry Pi 3, and Raspberry Pi Zero)</i>			
<i>**Arduino includes all Arduino models (Arduino mega 2560, Uno rev 3)</i>			

Review of circulation statistics is helpful to guide future purchases for the collection. Based on usage patterns, the Library will continue to purchase Raspberry Pis and Arduinos. They are ideal for the collection as they are reasonably priced, robust, and can be used for a wide range of projects at different levels of ability. The popularity of the Raspberry Pi has also prompted the recent purchase of new accessories including PiFace Digital, Raspberry Pi Sense hat and Gertboard to further expand the range of equipment available to students. The Library has also recently purchased more smartphone VR headsets as the Library's cardboard models have provided excellent value for money but are starting to show some wear and tear. Recent additions to the collection include the Samsung Gear VR, Google Daydream, and the BOBOVR Z4. An additional future purchase is another 360 camera based on the popularity of the Ricoh Theta.

However, circulation statistics don't tell the whole story. The collection includes some specialist equipment which does not have high circulation rates but is nonetheless valuable to the faculty and students who use it. For example the Infragram plant cam for

analyzing plant health using “near-infrared” imagery. The Library will continue to add specialist equipment to the collection upon request by faculty even if they may not be the highest circulated items.

Finally, circulation statistics also show that usage is not distributed evenly through the collection. For example, aside from the Raspberry Pi and the Arduino, the Library’s other development boards such as Intel Edison, Intel Galileo, Beaglebone, MSP430 LaunchPad (Texas Instruments) and UDOO have far lower circulation statistics. Changes have been made to the [Emerging Technology Collection webpage](#) to better describe the full range of equipment available and hopefully to improve circulation for all items in the collection.

Analysis: Challenges

Collecting and maintaining emerging technology comes with a number of challenges to libraries. Emerging technology is wide-ranging and constantly changing. It is important to recognize and address the various issues surrounding these products in order to allow better integration into the library collection. Some of the more challenging emerging technologies require product registration, maintenance, upkeep, cleaning, and consumable components. Furthermore, developing a connection with departments outside STEM departments can be difficult but are ultimately necessary for an emerging technology collection to be successful and meet the needs of the institution’s learning objectives.

Registration of Products

Technology that requires product registration can be problematic because it is not always a clearly stated requirement when the product is purchased. If the first borrower checks out the technology and registers it on a personal email address, this can cause headaches for future users. The BKON A1 product is just such an example, as it requires registration before a user can operate it. Beacons are typically palm-sized devices that emit Bluetooth signals to nearby cellular devices. When the mobile devices receive the signal they act accordingly. Often this technology is used in retail to push location-based notifications to the user depending on their proximity to the beacon (Moody, 2015, p. 60). The BKON requires a user to create an account which is then used to manage the beacon and its content. Although the setup is not time-consuming or difficult, it proves challenging to libraries because of the detail required. First, an account needs to be setup using a unique code provided on the BKON. The account needs to be associated with an email address. The company then sends a verification link to the email address and asks the user to create a password. It is important to store the email address and password with the device when it is loaned out, since projects can be stored on the account. Borrowers will need the username and password to create new projects.

Product registration can be difficult for libraries to manage. An idea being considered for the Carleton Emerging Technology Collection is a centralized management system for storing registration information with a dedicated email address. As more technology

requires registration, it will be important for this information to be stored in a centralized location. A number of free, open source options are available to record and store this information. KeePass Password Safe is one such software which allows storage of multiple usernames, passwords, and URLs in one database. The database is locked using one master key so only one master password is needed to unlock the whole database. The databases are encrypted using secure encryption algorithms, Advanced Encryption Standard (AES) and Twofish (KeePass, n.d.). It is also a good idea to have a troubleshooting email address for people to contact if they require passwords to be sent to them.

Maintenance and Upkeep of the Collection

Another challenge of emerging technology becomes the maintenance and upkeep of the collection. For example, the electronic circuit boards Makey Makey and Ototo encourage users to attach components of the device, such as alligator clips, to various electrical conducting materials, creating touchpads out of random, everyday items. The technology encourages creativity and experimentation, but cleanliness can become an issue if maintenance schedules are not adhered to or if they are ignored completely. For example, Makey Makey encourages people to “[t]urn everyday objects like bananas into touchpads!” (Makey Makey, n.d.) and similarly, the Ototo, to “build a piano out of vegetables” (Ototo, n.d.). If the components of the device are not cleaned, debris can accumulate on the metal conductors. Not only unsanitary, the conductivity of the attachments degrades the performance and responsiveness of the electrical signals transmitted to the board. Staff at the Library ITS Help desk clean returned equipment as necessary.

Similar attention is required for digital cameras, although digital cameras pose different challenges if the collection is not properly maintained. While many digital cameras require an SD card to store photographs on the device, some cameras include built-in digital storage. This is the case with the popular Ricoh Theta S 360 camera and the Flip UltraHD video camera. Both of these devices contain eight gigabytes of internal storage for photographs and videos. If returned to the library without deleting the photographs, those photos can be passed on to the next borrower. Similar challenges are associated with iPad loaning programs. When an iPad is returned to the library, oftentimes the iPad has all the content wiped off the machine, including files, logins, or browsing history left by the previous borrower. The iPad is then restored using iTunes, reverting the changes back to the library configuration (Thompson, 2011, p. 213).

In many cases, items loaned out from the Emerging Technology Collection come with additional parts such as cords, adapters, memory cards, and manuals. When loaning material from the Emerging Technology Collection, staff at the Library ITS Help desk are prompted by a message in the library system to check that all the parts are present when the item is checked out. Similarly, when the item is checked in, staff are prompted to check that all parts have been returned and are free from visible damage. It is not possible to check the contents for items with a large number of small pieces such as LEGO. These items are loaned on trust and the Library relies on patrons to report

problems. However, as discussed earlier, damage to the collection has been minimal and is not an ongoing concern.

Ongoing Financial Investments

The development of an Emerging Technology Collection does represent an ongoing financial investment. At the outset, the Collection was intended to be intensively used by students so the Library was concerned about the possibility of damage and replacement costs. However this has proved to be less of a challenge than initially thought. At the time of writing this article, since January 2015 only two items from the Emerging Technology Collection have been withdrawn from circulation due to damage or malfunction: the E-Z robot broke after a technology outreach session at a local school, and patrons have reported clogging problems with the LIX 3D printing pen. Both items are currently under review and it may be the case that these items are delicate and not really suitable for the rigors of Library circulation. In addition, one Raspberry Pi has been replaced as it was returned without an SD card. All development boards and cameras now have a special note to check for the SD card when the items are returned. Reminders are also sent periodically for ITS help desk staff.

New technology can also be difficult to manage since it can have additional ongoing financial investments associated with it. This can include consumable parts, such as filaments, which are used with 3D printers, or premium plans offered by the company for support or added features. In the case of the LIX 3D printing pen, the pen came with approximately 40 rods of filament used to print. In this case, a decision needs to be made for how to distribute the filament and for what happens when the filament runs out. This becomes a challenge for libraries as it becomes difficult to continuously ensure that filament is available to loan with the pen. It also becomes difficult for users who want to borrow the 3D printing pen. Will the users purchase their own filament? Will the filament purchased be compatible with the pen? Will users read the instructions about switching between Acrylonitrile Butadiene Styrene (ABS) and Polylactic Acid (PLA)? According to the pen's after sale support, "since the pen has been preloaded with ABS, it is mandatory to use ABS mode until one inch (~3cm) of filament is remaining outside the back of the pen. In this moment all the ABS plastic has been extruded and you can switch to PLA mode" (LIX Pen, n.d.). People who want to use the traditional 3D printer in the library pay a fee for printing (based on a combination of time and filament used) and submit a printing request. Oversight of the operation of the device is placed on the library staff, who are trained and knowledgeable about the product. However, by loaning a 3D printing device more onus is placed on the user and expertise is not guaranteed.

Emerging Technology Used Across Disciplines

As already discussed, the impetus to start the Emerging Technology Collection started with the Engineering Department and it is faculty members in STEM disciplines who frequently request this type of service (Fourie & Meyer, 2015, p. 521). At the time, the collection was being developed to support classroom learning so workshops were not thought to be necessary. However, when the collection received permanent funding in May 2015, Library management stipulated that the collection had to be developed for all

disciplines and it would be advantageous for the Library to initiate outreach to other departments. Efforts have been made to purchase equipment which can be used by different disciplines, for example, the Korg synthesizer for the Music Department; the cameras which can be used by all disciplines, and LEGO Architecture Studio for students in architecture and industrial design. LEGO kits can also be used for pop-up making spaces and outreach (Lotts, 2016).

The Library may consider a future project, including a survey, to gather more information on the challenges for non-STEM disciplines to use emerging technology. In the meantime, the Library is examining two other strategies to make the Emerging Technology Collection useful and accessible for students in all disciplines. Firstly, faculty champions in multiple disciplinary fields who are both interested in and are using emerging technology in the classroom. Having faculty support is valuable for libraries and their collections. According to Weber and Flatley (2006),

[i]f a professor champions the library and uses the library resources, it is much more likely that his or her students will have a good initial impression of the library and be encouraged to use it. In short, a faculty member serves as a vital intermediary by directing students to the library and its services. (p. 1)

This is no different in special library collections. However, it is not enough to just work in collaboration with faculty to build collections. Instead libraries should seek to embed their activities within academic programs and not simply align with them (Rodwell & Fairbairn, 2008, p. 117). Emerging technology provides an opportunity to embed the library collection within academic programs. The potential for emerging technology in non-traditional, technology-using disciplines is there: we as library staff just need to know where to look. For example, the Microsoft Hololens can be used with Art History students to build a virtual exhibit in real spaces, and the Ricoh Theta S 360 camera, when paired with virtual reality technology like the Oculus Rift or Google Cardboard, can provide architecture students with a new perspective on buildings around the world without having to leave their classrooms. Finding faculty champions to try new technologies in their classroom is both a challenge and an exciting opportunity.

Secondly, the Library is developing introductory technology workshops to make the collection accessible for students and faculty in all disciplines. At Carleton, the Library is taking the approach of developing in-house expertise so that librarians and library staff can develop and teach technology workshops. This strategy has been adopted as efforts to recruit faculty members to teach workshops proved to be time consuming and ultimately unsuccessful. This approach has great potential to empower librarians and staff to develop technology skills and increase the profile of the Library as a champion of technology. As mentioned earlier, the workshop for the Algonquin LIT students in March 2017 is the first technology workshop developed and taught exclusively by librarians and library staff, and more are planned for the future. Future introductory technology workshops will likely start with Raspberry Pis and Arduinos which are, by far, the most popular items in the collection.

While there are many unique requirements for loaning emerging technology in libraries, these challenges should not deter them from doing so. Instead, it is important to understand the issues associated with emerging technology and what can arise when loaning it. The best way for libraries and their staff to face the challenges presented with these new technologies is to better familiarize themselves with new products through hands-on interactions and to seek out feedback from the technology users.

Conclusion

In conclusion, this successful project underscores the value of shared space where different units on campus can work together to develop and deliver innovative new services. The value of so-called Library innovation space has been examined in the literature, see for example Colegrove (2015) and Bieraugel and Neill (2017). At Carleton University, the Discovery Centre for Undergraduate Research and Engagement is a shared space with Information Technology Services on the fourth floor of the Library which has facilitated just this type of collaboration. Librarians and library staff have the opportunity to intermingle with people in other departments on a regular basis and discuss shared interests and new ideas. The Emerging Technology Collection is a successful collaboration as each of the partners recognizes the value of collection to support student learning and engagement. Working together in a shared space facilitates communication and problem solving. Having a dedicated space in the Library for student engagement also sparks ideas and suggestions from librarians and library staff to support learning and student success.

The Emerging Technology Collection has been developed to support changes in the way university courses are being taught with an increased emphasis on experiential learning. Based on circulation statistics, we know the collection is popular with students:

Carleton's emerging technology collection is an incredibly valuable resource for students. The ease of access and borrowing of otherwise expensive and hard to acquire equipment really allows students to expand on and put into practice what they've learned in the classroom. I think knowing that this technology can be easily obtained also helps to foster creativity and a desire to test out new ideas. Whether students want to "test drive" a particular piece of equipment or simply need immediate access to equipment for a short period of time, the collection facilitates both of these. From our project, the speed and access to the technology was a tremendous benefit. It allowed us to develop aspects of the project in parallel without having to buy extra hardware (and wait for it to be shipped).—Jonathan From, 2016 graduate, Bachelor of Computer Systems Engineering program, Carleton University.

Finally, this project also demonstrates the necessity of innovation in academic libraries to be responsive to new developments and deliver useful services. For example, Yeh and Walter (2016) examine the determinants of service innovation in academic libraries. Incorporating innovation into the established and often conservative culture and structure of academic libraries can be challenge. Despite organizational barriers to innovation such as lack of money, fear of failure, and reluctance to take risks,

management can utilize strategies to fast-track interesting ideas and avoid cumbersome implementation processes (Bieraugel, 2015, p. 354). Ideally, discussing and fast-tracking innovation in accordance with institutional priorities can be key part of an effective strategic planning process in academic libraries (Saunders, 2015). Thus, innovation in academic libraries is possible when Library leadership is actively supportive of new ideas and services.

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Technology Lending at Academic Libraries: A Selected List

- Carnegie Mellon University Libraries. (n.d.) [Technology lending](#).
- Columbia University Libraries. (n.d.) [Technology lending: equipment list](#).
- Concordia University Library. (n.d.) [Technology sandbox](#).
- North Carolina State University Libraries. (n.d.) [Technology lending](#).
- Ryerson University Library & Archives. (n.d.) [RULA DME Technology Equipment Lending Policy](#).
- University of Arizona Library. (n.d.) [Borrow technology](#).
- University of California, San Diego Library. (n.d.) [Tech lending program \(TPL\)](#).
- University of Central Florida Libraries. (2017). [Technology lending](#).
- University of Toronto Scarborough Library. (n.d.) [Technology lending service](#).

References

- Bieraugel, M. & Neill, S. (2017). [Ascending Bloom's pyramid: Fostering student creativity and innovation in academic library spaces](#). *College & Research Libraries*, 78(1), 35-52.
- Bieraugel, M. (2015). [Managing library innovation using the lean startup method](#). *Library Management*, 36(4/5), 351-361.
- Bowness, S. (2017). [Inspiring instructor: Carleton's Alan Steele wins 3M teaching award](#).
- Carleton University. (2017). [Bachelor of Information Technology - Information Resource Management](#).
- Carleton University. (2013). [Collaboration, leadership and resilience. Sustainable communities - global prosperity. The Carleton University Strategic Integrated Plan 2013-2018](#).
- Carleton University Library. (2017). [Emerging Technology Collection](#).
- Carleton University Library. (n.d.). [Strategic plan 2013-2018](#).
- Carnegie Mellon University Libraries. (n.d.) Technology lending.
- Colegrove, T. (2015). [Rise of the innovation commons](#). *Information Technology and Libraries*, 34(3), 2-5.
- Columbia University Libraries. (n.d.) Technology lending: equipment list.
- Concordia University Library. (n.d.). [Technology sandbox](#).
- Cross, E. (2017, February). [The Emerging Technology Collection at Carleton University Library: Supporting experiential learning in the university curriculum](#). Poster presented at the Ontario Library Association Super Conference 2017, Toronto, Ontario.
- Cross, E., Mould, D., & Smith, R. (2015). [The protean challenge of game collections at academic libraries](#). *New Review of Academic Librarianship*, 21(2), 129-145.
- Cross, E., Schramm, C., Skerlak, S., & Tucci, R. (2016, May). [Carleton University emerging technology lending library](#). Presentation at the Carleton Teaching and Learning Symposium, Carleton University, Ottawa, Ontario.
- Cross, E., Tucci, R. & Whitney, J. (2017, May). [Setting up a technology lending library: experience from Carleton University](#). Presentation at the Ontario Association of Library Technicians / Association des bibliotechniciens de l'Ontario annual conference in Ottawa, Ontario.

- Fourie, I., & Meyer, A. (2015). [What to make of makerspaces: Tools and DIY only or is there an interconnected information resources space](#). *Library Hi Tech*, 33(4), 519-525.
- KeePass. (n.d.). [KeePass Password Safe](#).
- LIX Pen. (n.d.). [LIX PEN help center](#).
- Lotts, M. (2016a). [Playing with Lego, learning about the Library and "Making" campus connections: The Rutgers University Art Library Lego playing station, part one](#). *Journal of Library Administration*, 56(4), 359-380.
- Lotts, M. (2016b). [On the road, playing with Legos and learning about the Library: The Rutgers University Art Library Lego playing station, part two](#). *Journal of Library Administration*, 56(5), 499-525.
- Makey Makey. (2017). [Makey Makey](#).
- Moody, M. (2015). [Analysis of promising beacon technology for consumers](#). *Elon Journal of Undergraduate Research in Communications*, 6(1), 59-68.
- Moorefield-Lang, H. M. (2015). [User agreements and makerspaces: A content analysis](#). *New Library World*, 116(7/8), 358-368.
- Moorefield-Lang, H. M. (2014). [Makers in the library: Case studies of 3D printers and maker spaces in library settings](#). *Library Hi Tech*, 32(4), 583-593.
- North Carolina State University Libraries. (n.d.). [Technology lending](#).
- Ototo. (n.d.). Ototo: Make music from anything.
- Physics Department, Carleton University. (2017). [Carleton University Observatory](#).
- Popscope. (n.d.). [#popscope: A telescope for every neighbourhood](#).
- Purpur, E., Radniecki, T., Colegrove, P. T., & Klenke, C. (2016). [Refocusing mobile makerspace outreach efforts internally as professional development](#). *Library Hi Tech*, 34(1), 130-142.
- Rodwell, J., & Fairbairn, L. (2008). [Dangerous liaisons? Defining the faculty liaison librarian service model, its effectiveness and sustainability](#). *Library Management*, 29(1-2), 116-124.
- Ryerson University Library & Archives. (n.d.). RULA DME Technology Equipment Lending Policy.
- Saunders, L. (2015). [Academic libraries' strategic plans: Top trends and under-recognized areas](#). *Journal of Academic Librarianship*, 41(3), 285-291.

- Thompson, S. Q. (2011). [Setting up a library iPad program: Guidelines for success.](#) *College & Research Libraries News*, 72(4), 212-236.
- University of Arizona Library. (n.d.). Borrow technology.
- University of California, San Diego Library. (n.d.). Tech lending program (TPL).
- University of Central Florida Libraries. (2017). [Technology lending.](#)
- University of Toronto Scarborough Library. (n.d.). [Technology lending service.](#)
- Weber, M. A., & Flatley, R. (2006). [What do faculty want?: A focus group study of faculty at a mid-sized public university.](#) *Library Philosophy and Practice*, 9(1), 1-8.
- Yeh, S. T. and Walter Z. (2016). [Determinants of service innovation in academic libraries through the lens of disruptive innovation.](#) *College & Research Libraries*, 77(6), 795-804.