SURVEY RESULTS

EXECUTIVE SUMMARY

Introduction

Rapid fabrication technologies, or "3-D Printing," to use the less accurate but more familiar term, have undergone rapid evolution and are now used for medical implants, prosthetics, teaching aids, information visualization, research on rare/fragile objects, architecture, art, and advanced manufacturing. These technologies are rapidly lowering a number of different barriers faced by researchers and others, barriers that had previously made it prohibitively difficult for most individuals, researchers, and organizations to manufacture objects without significant investment of time and money in training and equipment. Because of these advances, the complexity and range of objects that may now be manufactured has increased precipitously, including easily customized items or precisely replicated physical objects, while the process by which these may be manufactured has flattened, allowing on-site or local manufacture and reducing lead time (in some cases permitting even just-in-time manufacturing processes).

These technologies produce intellectual assets—sensor and digitization data, as well as models and methods—that are potentially valuable to other researchers for future reuse and replication. Moreover, these technologies offer the opportunity to create spaces ("makerspaces") that facilitate research, collaboration, information discovery and management, and a form of technical and information literacy.

Strategic Relevance to Libraries

In the last several years, the interest of libraries in this space has been growing rapidly. Fabrication technologies and makerspaces are strategically relevant to research libraries for at least three reasons.

First, makerspaces represent a unique use of library space. The assessment and renovation of libraries' use of space has been recognized as a current strategic issue for libraries in general. As Joan Lippincott notes in *Research Library Issues*[1], it is essential that library space assessment be informed by campus priorities related to teaching and learning, expanding beyond library-centric thinking to design proactive spaces that engage with student learning more broadly. Makerspaces offer a key potential opportunity for such engagement, while creating spaces that align with the library mission, synergize with other services, and integrate staff competencies like information management.

Second, libraries are increasingly engaging with data management. Digitization and fabrication technologies both make use of and produce research data—data describing objects, models, and the sensor information collected from them. Makerspaces offer a clearly scoped locus for the integration of data management with other services and resources.

Third, we are now seeing fabrication figure increasingly throughout the various stages of the research lifecycle, and there is a clear trend towards adoption in higher education generally.[2] These technologies may be used early on as part of prototyping for research interventions or to embed sensors for research data collection, or later on as part of analysis or research collaboration (e.g., by materializing models for examination and sharing).

Further, libraries have a number of core competencies that are complementary to fabrication:

- Fabrication extends the information lifecycle. Fabrication technologies make information

material and, conversely, help make material objects into information.

- Libraries support the research process. Use of fabrication technologies requires a core set of skills and knowledge (such as databases of models) outside of specific research domains and requires skills and knowledge that are not in the sole domain of any one discipline.
- Libraries promote literacy broadly. Use of fabrication technologies promotes design, science, technology, engineering, art, and mathematics.
- Libraries are responsible for maintaining the scholarly record. The data, digitizations, designs, and models produced as part of rapid fabrication approaches can constitute unique and valuable parts of the scholarly record.
- Libraries provide commonly accessible physical spaces designed for research and learning. Successful makerspaces bring together accessible locations, thoughtfully designed space, curated hardware and software, skilled staff, local information management, and global "reference" knowledge.

Survey Highlights

The goal of this survey was to gather information for senior library staff to support decisions related to engagement with 3-D printing, rapid fabrication and digitization technologies, and makerspaces, in general, and in particular to inform decisions regarding the types of service offerings libraries can provide, resources needed, and evaluation of the service. These results are based on 64 responses from the 124 ARL member libraries (52%) by the deadline of June 12, 2015.

Service Offerings

Makerspaces appear to be of significant interest to ARL libraries. A substantial majority of the responding libraries (41, or 64%) are currently engaged with makerspace service deployment (providing, piloting, or planning the service). Another 11 (17%) plan to investigate these services in the future. Only 12 respondents have no plans to enter this domain (Q1). The respondents that are currently engaged with makerspace service deployment were asked to complete the survey. The others were directed to a question on futurecasting.

Of those libraries engaged in makerspaces, the majority offer, or plan to offer, a combination of core services including reference, training, hardware, scanning, and model repository, while a substantial minority are also engaged in collection development around 3-D models (Q5). In addition to these core services, almost all of these libraries offer, or plan to offer, use of 3-D printers. More than four-fifths support 3-D design and conversion software, and more than three-quarters provide 3-D scanners (Q13, Q15).

While only a minority of these libraries offer additional hardware and services beyond 3-D printers and scanners, the breadth of technologies being explored is impressive (Q5, Q13, Q15). The responding libraries support a wide range of CAD, visualization, animation, drawing, and audio production software, as well as software specific to scanning and printing systems. They provide an even wider range of hardware, including hand tools (carpentry tools, sewing tools, soldering irons, and 3-D pens); electronics (microcontrollers, electronic kits, motors, wearable/soft circuits, and sensors); visualization equipment (digital globes, virtual reality goggles, digital surfaces, and visualization walls); subtractive fabrication (laser cutters and CNCs); large mechanical tools (drill presses, and industrial sewing machines); large format printers and scanners; and drones.

These hardware and software offerings are supported with online resources, reference services, and training sessions. Almost all of the responding libraries offer, or plan to offer, in-person technology training and skill-building sessions. Approximately three-quarters use LibGuides or other resources, supply documentation, or provide reference services (focusing on design, models, and software) to support hardware and software use (Q17, Q18, Q19, Q22).

Implementation and Resources

Libraries investigate makerspaces for a variety of reasons, most commonly because library staff or administration recommended developing these services, or because they were identified as a priority during strategic, space, or renovation planning (Q2). While direct user requests and user need evaluations were a

less common motivator (cited by approximately a third of respondents), almost all libraries expect substantial service use from undergraduates, with four-fifths and half of libraries expecting substantial use from graduate students and faculty respectively (Q2, Q3, Q26).

The responding libraries are funding makerspaces using existing resources. Almost four-fifths fund their makerspaces from their general budget, and 85% use only existing staff to support these services. Fewer than a third of libraries currently charge any kind of fee for the service (Q14, Q30, Q33, Q35).

Offering makerspace services typically requires allocating staff time, purchasing hardware and software, and preparing space. Staffing was most commonly (modally) named as the largest single expense, although substantial clusters of respondents named equipment or materials (respectively) as the largest expense (Q32, Q36).

The median library makerspace service involves three staff members, contributing portions of their time (Q32). Staff are drawn from across the library. Those roles contributing at least 20% FTE to library makerspaces and services include: lab assistant, student technician, lab manager, design architect, digital fabrication specialist, digital media mentor, developer, graduate research assistant, multimedia specialist, arts librarian, science librarian, and even head of circulation (Q33). (The significant staff requirements may explain why most libraries offer limited hours for makerspace services—see Q29.)

Planning also requires a significant investment of staff time. Of those libraries that fielded a service, most reported spending several months or more developing the service, while some libraries reported spending up to a year (Q4, Q6).

Although most respondents did not identify the construction, renovation, or preparation of space as a dominant expense, there were large variations in the reported space required. While the average amount of space used is approximately 310 square feet, the upper range reported was 9000 square feet (Q11).

Evaluation

Libraries' formal evaluations of their engagement with makerspaces were quite positive. Forty percent of the libraries (15 of 38) have conducted some formal assessment, most by collecting usage data, observing of users, and user satisfaction surveys (Q40, Q41). As a result of these assessments, approximately half of the libraries identified the need for altered or expanded services, and none identified the need to eliminate or reduce services (Q43).

Frequently reported challenges clustered around the dual themes of resources and maintenance. Funding and staff time are a recurring challenge, especially because the hardware requires training, adjustment, and maintenance (Q50, Q52). These challenges are manageable—no horror stories were reported, and many respondents encouraged experimentation, patron outreach, and keeping an entrepreneurial perspective. This was articulated well in a number of respondent comments, which note that hardware is not a "turnkey" solution and requires a "DIY [do-it-yourself] ethos" (Q54).

Overall, respondent comments about the role of the makerspace in their libraries are overwhelmingly positive (Q53). They said that makerspaces are "a catalyst for innovation," "a component of scholarly communication," "hubs for participatory and collaborative learning," the "next steps for active learning and presentation of scholarship,"and that they "foster creativity." One respondent crisply articulated a general theme touched on in many of the comments: "A central department-free place on campus for this technology is key, since the applications are so broad… Having a library service solves this problem and opens up the technology to the entire community." There was, however, a note of caution sounded, as well—a number of respondents emphasized that the core competitive advantage of the library is not in providing hardware or simple physical space but in creating an environment that combines service, space, and expertise to foster individual and collaborative "investigation, interrogation, and learn[ing] through doing."

A Rapidly Changing and Challenging Area

As the survey results reveal, many research libraries are engaging with making and makerspaces. This area remains both exciting and challenging. These technologies are rapidly evolving, which presents a challenge to the libraries that need to buy and maintain

them. For example, within roughly the last eighteen months, there have been a raft of 3-D printers and scanners introduced into the market at all price points from hobby-level, through consumer, business, and manufacturing grade. Although consumer-level 3-D printers require relatively little capital investment, more advanced rapid fabrication technology can be expensive, requiring extensive setup and maintenance, as well as dedicated space. Some hardware even requires specialized plumbing, HVAC, or access control.

This technology shift has some advantages. Prices are dropping, and technologies in development have the potential to dramatically improve the capabilities of consumer- and professional-grade equipment—in the speed of printing, ease of use, cost of maintenance, and range of materials. Some of the benefits of these advances may be huge. For example, the ability to use multi-material printing technologies could allow the integration of working electrical circuits in printed objects, which greatly expands the potential types of objects that can be designed, as well as the potential range of applications.

The expertise and skills needed to support makerspaces and services is also complex. Library patrons will need support to determine whether rapid fabrication will be of use to them, discover existing models and design solutions (using specialized databases and collections), alter models or scan or design new ones (using specialized software), select service bureaus, and use locally hosted fabrication tools. They will also need support in managing the data (models) they produce, and in sharing or archiving them. Expertise is also needed to set up and maintain the makerspace tools and infrastructure.

Some of this support involves discovery, data management, and reference interview expertise that is within the traditional training of librarians. However, making also draws on skills and expertise from multiple disciplines, including design, engineering, electronics, and architecture. Moreover, some experience with tool use is highly device-specific and requires tactile feedback; as such, it can be gained only by using the appropriate physical tools. Further complicating matters is the fact that there is little formal guidance available for libraries that wish to engage in the development of a makerspace or services, and there are few established sets of best practices, training, or reference publications that may be used to guide selection and development of these practices.

Finally, the rapid change in technology also impacts both the cost and attractiveness of makerspace service offerings. In the last eighteen months, major retailers, such as Staples, UPS, and Office Depot, have entered into the market both as retailers and as print-on-demand service providers, while former niche leader Makerbot has experienced a substantial contraction. This is likely to have the effect of creating new opportunities for reference and design support, while reducing the attractiveness of services that offer only low-end, consumer-grade printing—that is, those that are already increasingly available to the public.

In sum, while libraries can field small pilot services or experiments in 3-D printing with relatively few resources, support for advanced making can require substantial investment—and investments in hardware involves heightened risk because of the rapid changes in technology. Because of this technological instability, libraries creating makerspaces and services should thoughtfully consider how investments can be made in staff, focusing more, perhaps, on developing expertise and service rather than on providing extensive hardware and facilities.

Discussion

Library Interest is Steady and Substantial

This is the first comprehensive survey of ARL member libraries in this area, so trends are challenging to gauge. Only two other recent surveys have been conducted,[3] and these have substantial limitations in design and coverage. A convenience sample survey of libraries in all classes was conducted in 2013, which found that 41% of libraries sampled had some form of fabrication or maker service while another 36% were planning such services.[4] The results from this SPEC survey indicate that 27% of the responding libraries (17 of 64) are engaged with services in this area and 37% are in the investigation and planning stages. While this is insufficient to establish a statistical trend, it suggests that interest in rapid fabrication/makerspace services is steady and substantial.

Formal Guidance is Limited

The libraries that responded to this survey have constructed guides and tutorials for clients and have identified online books, articles, video tutorials, software, and collections of models that are useful to a broader audience. Nevertheless, existing resources in this area remain sparse. Survey respondents and our own literature reviews revealed that relatively little information is available online or in print that can be used to guide patrons in determining whether rapid fabrication will be useful to them, to help them discover and alter existing models, or to teach them to scan or design new ones, or to support the fabrication of an object from these models. Nor are there established best practices or off-the-shelf solutions for libraries in this area.

We were able to identify some useful online resources, which are listed in the bibliography. However, we would recommend that libraries engaging in this area also participate in maker events—such as conferences and "faires"—to learn directly about emerging uses, trends, and to gain hands-on experience.

Respondents, while reporting generally positive experiences with these services, cautioned that manufacturer service and support is often uneven and that even recent mass-market products require tinkering and maintenance. Running a makerspace requires a willingness to do-it-yourself.

The Audience is Broad

It is, perhaps, unsurprising that we've encountered a wide variety of applications in our interviews with students, staff, and faculty at MIT over the past year. Some use rapid fabrication technologies in medical engineering, while others employ the technologies for such diverse projects as prototyping robotics, supporting collaborative design of a satellite, visualizing information, and even developing new fashions. Meanwhile, other MIT researchers have developed new methods for printing everything from houses, to solar cells, to artificial bones and skin. The ARL survey results, however, make clear that the broad appeal of these technologies extends beyond technology-focused universities, such as MIT. As one respondent put it, "During our pilot phase, we gauged interest from anyone we could talk to, and it became clear that the applications for this technology are so broad that any department could use it."

Outlook

While no trend data is yet available regarding ARL member libraries' engagement with 3-D printing and similar technologies, it is evident from the survey data that considerable effort is going toward mapping and forecasting community needs and developing appropriate library services and resources. Unsurprisingly, resource allocation is a primary concern, given that most respondents report funding makerspaces and attendant costs from existing operating budgets. The rapid advancement of technologies, as well as the increase in readily accessible consumer-level printing services, complicate libraries' ability to invest in and maintain equipment that will serve their communities into the mid-term—on the flip side, however, the novelty of the technology and the rapid expansion of possible applications are characteristics that generate enthusiasm and make the makerspace an opportunity for vibrant community outreach and collaboration.

The center of balance between these potential risks and rewards will vary depending on institutional context—in some cases, individual schools, departments, or labs may provide access to rapid fabrication equipment, and so, in addition to consulting peer institutions regarding the latter's makerspace experiences, it is critical to map existing institutional services (including who can access them) and identify gaps which may be productively addressed by the libraries, whether independently or collaboratively. In order to develop a sustainable model, the rapidity with which technology is changing should be factored into service models realistically, as should the costs of equipment maintenance, staff time related to makerspace supervision, and staff time related to instruction and outreach. Models should also include regular assessments in order to identify areas for improvement and expansion and to ensure responsiveness to user needs in a shifting environment. Finally, the purpose of the makerspace service should be clearly articulated and closely tied to the library's and institution's respective missions to ensure continued relevance.

Certainly, responding institutions appear to recognize that the nature of the technology dovetails with the function of academic research libraries, offering a novel means of engaging students, faculty, and affiliated researchers that intersects with both emerging library roles like data management and traditional functions related to information access and preservation—and, as researchers increasingly incorporate the technology throughout the research lifecycle across disciplines, it will become more and more necessary for libraries to provide expertise and other forms of support in this area.

Endnotes

1 Joan Lippincott and Kim Duckett, "Library Space Assessment: Focusing on Learning," *Research Library Issues*, no. 284 (2013): 12–21, http://publications.arl.org/rli284/12

2 Larry Johnson, et al., "The NMC Horizon Report: 2013 Higher Education Edition." (2014): 1–40, http://www.nmc.org/publication/nmc-horizon-report-2013-higher-education-edition/

3 Gary Price, "Results From 'Makerspaces in Libraries' Study Released," *Library Journal* (Infodocket). (December 16, 2013) http://www.infodocket.com/2013/12/16/results-of-makerspaces-in-libraries-study-released/; PRG, "Survey of 3D Printing in the Library," Primary Research Group (2014)

4 Gary Price, "Results From 'Makerspaces in Libraries' Study Released," *Library Journal* (Infodocket). (December 16, 2013) http://www.infodocket.com/2013/12/16/results-of-makerspaces-in-libraries-study-released/

SURVEY QUESTIONS AND RESPONSES

The SPEC Survey on Rapid Fabrication/Makerspace Services was designed by **Dr. Micah Altman**, Director of Research and Head/Scientist, Program on Information Science for the MIT Libraries; **Matthew Bernhardt**, Web Developer for the MIT Libraries Digital Library Application Development team; **Lisa R. Horowitz**, Assessment & Linguistics Librarian; **Wenqing Lu**, research intern in the MIT Libraries Program on Information Science; and **Randi Shapiro**, assistant to the MIT Libraries Director and the MIT Libraries Program on Information Science. These results are based on 64 responses from the 124 ARL member libraries (52%) by the deadline of June 12, 2015. The survey's introductory text and questions are reproduced below, followed by the response data and selected comments from the respondents.

Rapid fabrication technologies, or "3-D printing," to use the less accurate but more familiar term, have undergone rapid evolution and are now used for medical implants, prosthetics, teaching aids, information visualization, research on rare/fragile objects, architecture, art, and advanced manufacturing. These technologies are rapidly lowering a number of different barriers faced by researchers (and others), barriers that had previously made it prohibitively difficult for most individuals, researchers, or organizations to manufacture objects without substantial investment in obtaining manufacturing skills and equipment, to manufacture complex objects, to offer a wide variety of different objects, to easily customize and individualize manufacturing, to manufacture objects locally or onsite, to manufacture objects with little lead time (or just-in-time), or to easily and precisely replicate physical objects.

These technologies produce intellectual assets—sensor and digitization data, as well as models and methods that are potentially valuable to other researchers for future reuse and replication. Moreover, these technologies offer the opportunity to create spaces ("makerspaces") that facilitate research, collaboration, information discovery and management, and a form of technical and information literacy.

The goal of this survey is to provide information to senior library staff that will support decisions related to engagement with 3-D printing, rapid fabrication and digitization technologies, and makerspaces in general. And in particular to inform decisions regarding the types of service offerings libraries can provide, level of service, level of resource commitment, potential clientele needs, and evaluation of the service. The specific objectives of the survey are to provide systematic, well-structured, baseline information on ARL member libraries' policies, services, investments in, and experiences with supporting fabrication services and makerspaces.

BACKGROUND

1. Which of the following statements best describes your library's current status regarding fabrication/makerspace services? N=64

We provide such services on an ongoing basis	17	27%
We are piloting/testing these services	9	14%
We are actively investigating these services	15	23%
We plan to investigate these services in the future	11	17%
We have no plans to provide such services at this time	12	19%

Comments N=16

We provide such services on an ongoing basis N=6

We have been offering 3-D printing services since Fall 2013.

We have offered 3-D printing to the university since 2003, and 3-D scanning starting in 2005.

We just began piloting the service in late 2014 and are continually testing, but we plan on offering the service as an ongoing program.

We offer mediated 3-D printing and we are in the process of creating a dedicated makerspace for student use.

We only provide a 3-D printing service.

We started a small makerspace in our Hunt Library when it opened in January 2013, outfitted with a laser cutter, 3-D printers, and 3-D scanners—being the first place on campus to offer access to these technologies to any student or faculty member. This makerspace has largely been oriented around providing a printing service for all students and faculty. In June 2015, we will be opening a new space in our D. H. Hill Library. This space will focus on giving hands-on access to the emerging technologies of making, and thus on affordable consumer-level equipment. This space will enable many more students and faculty to directly work with 3-D printing, 3-D scanning, electronics prototyping, and other maker tools. With a program of beginner workshops and easy-to-use tools, we will show that these tools aren't just for engineers and designers, but can have an impact in every discipline. We will partner with faculty to integrate 3-D tools into their curriculum, while also supporting students' interest-driven informal education.

We are piloting/testing these services N=3

The Science & Engineering Library (SEL) is currently providing course-related project prints for students, as well as test prints of other material types for various purposes. At the same time, we are planning more extensive makerspace services as part of our new Digital Scholarship Center.

We are piloting/testing services in the Norlin Commons, and are investigating these services in the Gemmill Library (Engineering, Mathematics, and Physics).

We purchased a single Makerbot Replicator last year to test. We've come up with a plan for implementing a library service based on these devices and are currently seeking support/funding.

We are actively investigating these services N=5

> We are in the midst of preliminary discussions with a campus partner who recently developed a faculty-specific makerspace for students. They have equipment and some staffing, and have expressed interest in expanding. We have space in the libraries that could be re-purposed should a partnership proceed. We didn't have specific plans to provide makerspace services prior to this opportunity arising, so haven't done much research. As a result, I haven't answered any other questions.
>
> We have a design studio created in partnership with the schools of mechanical engineering and industrial design. The studio is a pilot for one piece of a potential multidisciplinary design commons that might include fabrication services.
>
> We have a Scholarly Commons unit and are building the Grainger Engineering Library Informatics, Design, and Data Visualization Center (GLID2).
>
> We have developed a service plan, and purchased initial equipment for testing (with library IT), and hope to implement a 3-D printing service within a year.
>
> We were going to be a host site for a third party 3-D printing operation in Summer 2014 but their business model failed during their pilot.

We have no plans to provide such services at this time N=2

> At this time we have no plans to implement 3-D printing.
>
> There are at least two other active rapid fabrication/makerspace services on campus, one of which is in a building adjacent to the Libraries on campus. Duplication of this service within the Libraries does not appear to be needed or prudent at this time.

If your library is currently providing fabrication/makerspace services, please complete the survey.

If your library is currently pilot testing or actively investigating whether to provide fabrication/makerspace services, please answer as many of the survey questions as possible at this time. Some survey questions are asked in the past tense. Please answer them as if they were asked in the present or future tense if that better applies to your situation.

If your library plans to investigate these services in the future or has no plans to offer such services, you will skip to a question on future casting.

PRE-IMPLEMENTATION

2. What motivated your library to investigate the development of fabrication/makerspace services at your library? Check all that apply. N=40

Library staff recommended developing these services	27	69%
These services were identified as a priority during a strategic (or other) planning process	19	48%
A library renovation project provided an opportunity to develop a space and services	18	45%
Library administration recommended developing these services	18	45%
Library users requested these services	13	33%
A donor wanted to help develop a space and services	4	10%
Other motivation	16	40%

Please briefly describe the other motivation. N=16

A call for volunteers to set up the service was put out and I volunteered to propose a service model and help manage it on an ongoing basis.

A competitive grant was provided by LibraryLinkNJ.

An existing makerspace on campus is looking for a new home and approached the library.

Differs by location. The director of Educational Technology Services approached the Libraries in creating a 3-D printing lab in its Media Commons @ the Knowledge Commons.

Environmental scanning of similar libraries

Interest from faculty, opportunity to centralize services and products of makerspaces being developed

One major source of motivation was Educause's Horizon Report, which has listed 3-D printing and makerspaces in recent years.

Our graduate school wanted to establish makerspace opportunities.

Part of the library's mission is to expose our community to emerging technologies.

Pilot a teaching studio for multidisciplinary design education.

Project in conjunction with Engineering Department.

The library is very interested in digital scholarship centers. The campus is actively pursuing several initiatives in design learning, including building out a network of design learning nodes across campus. We are interested in the library's role in these campus-wide endeavors.

These technologies were available in other schools at our institution, but not in the College of Arts & Sciences. We thought that once humanists and others were exposed to the possibilities, in a low-stress, sandbox environment, changes to research interrogations would follow.

University 3-D printing club expressed interest.

We knew of one other school on campus offering 3-D printing, but this was for program -pecific outcomes. We purchased our first 3-D printer using funds provided by student government. Our first 3-D printing was a class gift to the library.

We noticed the service trend in other libraries. We recognized our patrons were pursuing these services elsewhere on campus. We thought it was a service our library could provide, that it was consistent with our mission and would provide benefits including increasing our knowledge and support of patron projects and research.

3. What type of information did your library gather before deciding whether to test or implement fabrication/makerspace services? Check all that apply. N=40

Investigated equipment, maintenance, cost, etc. of fabrication/makerspace services	39	98%
Collected information from other libraries that provide fabrication/makerspace services	35	88%
Observed other departments that might be affected by digital fabrication services, for example, technology department, printing service department, innovation department, etc.	27	68%
Collected library users' requirements on fabrication/makerspace services	13	33%
Gathered other type of information	12	30%

Please briefly describe the other type of information. N=12

Collected information from institutions that have labs containing 30 or more 3-D printers—Florida Polytechnic Institute and SUNY–New Paltz. Consulted, and visited, MakerBot headquarters.

Collected information from teaching faculty in departments that might rely on fabrication services.

Conducted a literature review.

Due to when we first considered 3-D printing, our focus was placed on the technology and its capabilities.

Investigated other research-oriented fabrication spaces at other institutions. Bought inexpensive equipment and encouraged staff to test it, address their own scholarly questions, prior to launching it for the public.

Looked at local (community) makerspaces and their offerings.

We also looked to other non-library makerspaces including museums, academic departments, and for-profit makerspaces.

We also spoke with Loans Services and the finance office about accepting payment for 3-D printing services. We spoke to various local 3-D printing experts about equipment and critical making.

We are fortunate to have faculty that have provided detailed breakdowns of how the machines would be utilized in their classes. We hosted a "3-D Printing Expo" to bring together interested parties and survey attendees.

We did an extensive literature review for more than a year before deciding to pilot this service ourselves.

We purchased a very low cost printer just to pilot the service. We used that printer to understand the technology, gauge time and service commitments, and patron interest.

We visited several academic institutions that offer digital scholarship services, including NCSU, Duke, Indiana, and Michigan and spoke with Brown, Georgia State, and Calgary.

4. Please briefly describe how much time and effort your library spent on gathering data and planning the development of fabrication/makerspace services (for example, number of months to plan, or number of staff weeks allocated to the project). N=38

We provide such services on an ongoing basis N=16

1+ year to assemble, test, and teach the technologies, plus 6 months to renovate and organize the space.

3 months to plan between myself and my collaborator, the manager of a mobile development lab, who had agreed to host the 3-D printing equipment. We started an environmental scan in May, got the equipment in August, and launched the service in October 2014.

4–6 months with 2 librarian staff members (part-time)

6 months

A working group was formed that produced an interim and final report with recommendations.

About two months planning and grant writing. Following the award of the grant we spent about two months simultaneously waiting for the 3-D printer to arrive and preparing the area.

From conception to implementation, it took us about 6 months to implement 3-D printing as a service.

Gathering data and consulting with other institutions: six months; planning and development of services: three months

It took approximately 2 months to gather data and other information about 3-D printing in libraries, train on the use of the 3-D printer, and develop a policy for the library about the 3-D printer.

Once our IT department felt comfortable servicing the printer, we offered it to the public on a trial basis. Printing was free at first in exchange for completing a survey about what the patron would use printing for, how often they would use it, and how much they would be willing to pay. This only lasted a couple of months. We then bought a prosumer-level printer and continued our trial for a year. We now offer the service on an ongoing basis.

One staff member spent approximately 10 hours a month for one year doing research/literature review, an environmental scan, and talking to staff at other libraries and museums. The department head in our New Media Center took a sabbatical to visit 20 academic and public libraries, five of which offered makerspaces or 3-D printing. She discussed the services with their staff to better understand how we could implement them ourselves.

The Makerspace plan was developed over approximately 10 months at the end of which we implemented our first prototyping services. Since then (7 months), we have been offering these services while continuing planning and implementation of other aspects of the plan with most aspects to be realized by September 2015. Total time from introduction of the plan to implementation: 22 months.

We spent ~40 person hours on the project.

We spent about 100 hrs gathering data and planning the development of the makerspace services. Although this process from our point of view is an ongoing thing.

We spent several months researching other makerspaces and 3-D printing services before receiving funding from the university's undergraduate student government to purchase our first 3-D printer. One staff member was allocated to the project, but received guidance and assistance from library administration.

When we first entered this market, due to the technology being quite new there was little understanding/interest on campus. As such much of our interest came from within the organization resulting in only ~1 month of staff time to acquire funding and implement the system. Moving forward we had a shared interest and multiple staff members stepped in to help support its continued use.

We are piloting/testing these services N=8

A couple of months were devoted to planning/developing a proposal for offering makerspace support through the libraries. Existing services on campus were consulted to determine their scope, audience, and what niches remained that would logically reside in the library. Cost, and business models were similarly investigated, and focus groups conducted with undergraduate and graduate students to elicit the highest priority equipment they would like to have available.

Approximately six months for the Norlin Commons data and planning phase.

Fabrication/makerspace services are provided at a branch library (Science/Engineering) as well as planned for Digital Scholarship Center. Planning process has ranged from three months for branch library to longer term for Digital Scholarship Center, as fabrication will be a pilot service until needs and demands are assessed further.

It took us three months to plan our 3-D printing pilot service.

Not possible to answer this question.

Spent about nine months gathering information, purchasing equipment, and hiring staff.

This has been in some form of active development since about March 2014 for ETS. We had discussed 3-D printing before that, but it wasn't until we began exploring the 36-printer option that we were talking about a true makerspace service in the library.

We have been seriously looking into 3-D printing since Spring 2014. It is primarily me and another colleague that have been doing the testing and outreach (because the printer is in our office), and there are four of us that have drafted a plan for creating a large library service. So, we have been planning for over one year at this point. Since it is just a proposal, no staff time has been allocated, but the proposal calls for a whole new FTE position.

We are actively investigating these services N=14

1–2 weeks of product research, roughly one month of testing in conjunction with other projects. Approximately two months of man hours.

20 hrs total so far

6 months planning

A staff interest group was formed. That group met bi-weekly for a semester. An external grant proposal was developed that took two staff members 10 hours a week for three months. Two internal grants were developed and several (5) staff members devoted 25 hours per week for two months.

Approximately 2–3 weeks spent investigating technologies and meeting with potential third party vendor.

Four months of planning before opening studio, and now ongoing assessment (over three years) as more services are considered.

Ongoing, one staff week

Our systems librarian conducted a feasibility study over the course of a month, reviewing literature, contacting other libraries with makerspaces and connecting with faculties to determine where there may be existing services in place on campus and to gauge the need for a service in the library.

Research continues/is in progress.

Roughly 6 FTE months, over one year.

The GLID2 project has been in planning for approximately one year.

Very difficult to estimate. Probably 100s of staff hours. Have been considering this to one degree or another, with considerable research and assessment, for roughly seven years. Plan to implement within the next year. Exact service details yet to be determined.

We are still in the information gathering stage, and are allotting two months to data gathering and planning prior to piloting/testing.

We've been informally investigating this for 1–2 years, and actively investigating for several months. Library IT also actively investigated this with us during this same period. We plan to continue investigation over the next several months, as both IT and the Learning Spaces Program test a new 3-D printer being purchased.

STATUS OF FABRICATION/MAKERSPACE SERVICES

5. Please indicate the current status for each of the services listed below (in planning stage, in pilot testing, in production, tried but discontinued, or has not been considered). Please make one selection per row. N=40

Services	Planning	In Pilot	In Production	Discontinued	Not Considered	N
Reference services for fabrication (e.g., desk reference, consultations, LibGuides on rapid fabrication, or other online resources	18	2	15	0	5	40
Training services (e.g., workshops and classes)	18	5	13	0	4	40
Hardware (providing and maintaining fabrication and scanning hardware)	13	7	18	0	2	40
3-D scanning support	20	8	11	0	1	40
Model Repository (sharing, publishing, archiving 3-D models)	23	0	3	0	14	40
Collection development (selecting, organizing, appraising, or documenting models)	15	1	3	0	20	39
Total Responses	33	13	19	0	23	40

Please briefly describe any other type of fabrication/makerspace service not listed above that your library is planning, is pilot testing, has in production, or has discontinued. N=17

Planning N=9

Augmented reality

Laser etching, large format printing

Micro-controller kits; loanable video production equipment

Pending approval, purchase of a new 3-D printer to upgrade

Purchase and check out of Arduino kits, Makey Makey Invention Kits, Raspberry Pi computers, and Lego Robotics

Robotics and small programmable electronics

Small CNC machine availability

Vizualization walls, data analysis, informatics support for digital scholarship, 3-D printing, laser cutting tools

Workshops on 3-D design for 3-D printing, critical making, how to render scanning files, how to produce 3-D models from data sets

Pilot testing N=4

Big data analysis, informatics support for digital scholarship

Currently on hold due to broken machine.

Currently we lend a variety of technology at the Steacie Science and Engineering Library that could be used in a makerspace.

Subtractive manufacturing tools; low-cost, DIY scanning and photogrammetry stations

In production N=7

Borrowable prototyping: Arduino, Makey Makey, Raspberry Pi

Device/equipment/tool check out; Digital Media Lab

Microcontrolers, wearables/soft circuits, plane-table mapping

Pending new machine

Prototyping electronics lending and instruction.

Public 3-D printing service

We also provide large format printing and scanning (posters).

Discontinued N=2

3-D scanning was implemented in our 3-D lab, but discontinued because of low demand. May reconsider and re-implement. We purchased some 3-D models and have made them available for use; currently discontinued because of non-use.

We discussed but decided not to have a satellite printing service at the main library.

6. As applicable, for each service please provide the start and end dates of the pilot test, when the service went into production, when the service was discontinued. N=18

Reference N=17

Pilot start date:	Pilot completion date:	Production start date:
		01/01/2013
06/01/2013	08/01/2013	Fall 2013
		12/01/2013
		01/29/2014
08/01/2013	08/01/2014	September 2014
09/01/2013	08/01/2014	08/01/2014
		09/01/2014
		10/01/2014
		10/01/2014

Pilot start date:	Pilot completion date:	Production start date:
06/01/2014	01/15/2015	01/15/2015
		04/14/2015
03/01/2015	05/01/2015	
09/01/2015		
10/02/2015	10/03/2015	10/03/2015
2015	2017	
May pilot within one year.		
Planning		

Training N=16

Pilot start date:	Pilot completion date:	Production start date:
		September 2012
08/01/2013	08/01/2014	September 2014
		01/01/2014
		01/29/2014
03/01/2014	Ongoing	
Spring 2014	Spring 2015	Fall 2015
08/01/2014	12/01/2014	01/01/2015
		09/01/2014
		10/01/2014
01/01/2015		
01/15/2015	02/01/2015	02/01/2015
05/01/2015	08/01/2015	09/01/2015
09/01/2015		
10/02/2015	10/03/2015	10/03/2015
2015		
May pilot within one year.		

Hardware N=24

Pilot start date:	Pilot completion date:	Production start date:
		01/01/2013
		01/01/2013
08/01/2013	08/01/2014	September 2014
09/01/2013	08/01/2014	08/01/2014
December 2013	Ongoing	
		01/29/2014
03/01/2014	Ongoing	
04/01/2014	09/01/2014	10/01/2014
06/01/2014		

Pilot start date:	Pilot completion date:	Production start date:
08/01/2014	09/30/2014	10/01/2014
08/01/2014	Ongoing	
09/01/2014		
		09/01/2014
10/01/2014		
11/01/2014	01/15/2015	01/15/2015
01/01/2015		
01/01/2015		
01/01/2015	06/01/2015	
		02/24/2015
03/01/2015	06/01/2015	
		04/14/2015
06/02/2015	09/02/2015	10/02/2015
2015		
May pilot within one year.		

3-D Scanning Support N=20

Pilot start date:	Pilot completion date:	Production start date:
2012	08/01/2014	Sept 2014
		01/01/2013
		02/01/2014
03/01/2014	Ongoing	
Spring 2014	Spring 2014	
		08/01/2014
08/01/2014		
08/01/2014	12/01/2014	01/01/2015
08/01/2014	In process	Summer 2015 (projected)
11/01/2014	01/15/2015	01/15/2015
01/01/2015		
01/01/2015		
03/01/2015	06/01/2015	
04/01/2015		
04/14/2015	05/14/2015	05/14/2015
06/01/2015		
07/05/2015	09/05/2015	09/05/2015
Anticipated Fall 2015		
2016		
May pilot within one year.		

Model Repository N=6

Pilot start date:	Pilot completion date:	Production start date:
02/01/2015		
Did not pilot this service	na	03/01/2015
05/15/2015	na	na
Discontinued in 2012. May re-pilot within one year.		
Not started yet		
Planning		

Collection Development N=6

Pilot start date:	Pilot completion date:	Production start date:
2015		
02/01/2015		
Did not pilot this service	na	03/01/2015
05/15/2015	na	na
May pilot within one year.		
Not started yet		

Other Service N=7

Service	Pilot start date:	Pilot completion date:	Production start date:
Microcontrolers, wearables/soft circuits, plane-table mapping	01/01/2013	08/01/2014	September 2014
Public 3-D printing service			09/01/2014
Borrowable prototyping: Arduino, Makey Makey, Raspberry Pi	02/01/2015	05/01/2015	06/01/2015
Visualization wall, data analytics, design learning hardware/software	January 2015		
Device/equipment/tool check out; Digital Media Lab			1/1/2015; 6/1/2014
[SIUC did not specify an "Other" service in Q6. Delete this?]			01/29/2014
[Temple did not specify an "Other" service in Q6. Delete this?]	06/01/2015		

DECIDING TO MOVE TO PRODUCTION SERVICES

7. If your library pilot tested fabrication/makerspace services, please briefly describe how you determine whether a pilot project should move from an experiment to a production service or product. N=18

    Costs and usage; no special metrics

Decision to move forward from pilot project to production service based on scalability, capacity (staffing and equipment), demand, reliability, and opportunities for integration with campus research initiatives.

Demand and whether it supplements a campus class or academic program.

During our pilot phase, we gauged interest from anyone we could talk to, and it became clear that the applications for this technology are so broad that any department could use it. Existing printers on campus are typically limited to a single department or faculty member and cannot effectively be used for course assignments or experimentation by our large campus community. Moving to production would allow us to fill that void.

In testing now, will be piloting in a digital scholarship sense this coming year and will see how demand and work proceeds.

It depends on the service. We usually like to work with the students to ensure that the service we are piloting is something they want. We get the students to test and once they have tested it and we get the feedback from them. If the feedback is good we move it to production.

Our existing space isn't a makerspace, yet it has many forms of equipment one would expect in a makerspace. The switch to production was a gradual one as we constantly re-evaluate our service and look for new technologies and directions. Our method of evaluation relies heavily on those in the community using the service. Once we determined the technology was stable enough to deliver reasonable expectations consistently, we made it available to the community. Once released (i.e., in production) we continuously refined our understanding of the technology, refined our pricing model, and looked for new capabilities with the existing equipment or through adding to existing resources. We still do this even 10 years later.

Our first Makerbot printer and scanner were purchased with library technology funds and the second 3-D printer was acquired through an Initiative on Technology-Enhanced Learning grant received by a professor in the School of Business. Students in the Collaborative Design for Innovation course were tasked with developing prototypes for a non-profit organization that is in the process of developing a new snack food. The class was divided into teams of 4–5 students and each team had 5 weeks to create and iterate their design submission. The students worked with New Media Center staff to perfect their design ideas. The students brought in rough sketches or models that they had created in clay, then staff helped them develop their preliminary ideas into 3-D digital files and ultimately into 3-D objects printed on the Makerbot. Because our work with this class went extremely well, we felt that we could offer 3-D scanning and printing services to the broader community.

Still determining.

Sustainable financially and with space and staffing resources; continued user need; equipment functions in a way that can sustain the service; level of staff intervention and equipment maintenance required is reasonable and sustainable.

The quality of the final product needs to meet basic acceptable standards and a preliminary set of policies and procedures must be established.

The service model being used for the makerspace services has existed for the Media Commons video production service since 2007. The same model is being applied to makerspace services in this instance. In that sense, it has been piloted for 8 years. In other ways, our implementation actually is the pilot. Should the makerspace/3-D printers in Pattee be very successful, there may be effort to open more around campus or at other campuses.

We are looking at the overarching campus plans for design learning, fabrication facilities, and visualization and data analytics, 3-D printing, and 3-D scanning.

We offered workshops as part of a pilot/soft launch, but once the space was renovated, we transitioned to production. The transition also included a semester-long speaker series and a redesigned webpage that detailed makerspace options.

We printed a lot of different designs. Our makerspace manager told us when she was ready to move forward.

We tracked the number of jobs and requests via Google forms and gathered patron feedback. Based on this data, we were going to move forward with looking at pay services, promotions, and a collection repository.

We will assess based on the use of the service along with cost to the Libraries and staff time.

When the pilot service met the guidelines we had established for a sustainable public service.

8. If your library did not pilot test fabrication/makerspace services prior to offering them, please briefly describe how you decided to move ahead to provide the production service or product.
N=12

3-D printing services was available in Engineering Department. Lab manager wanted a simple printer to be available in the library.

Data gathering and consultation with other installations was considered sufficient.

Library staff was trained on the 3-D printer prior to offering it as a service. We received the printer from a not-for-profit group and they came to help us with the first demonstration. There were a lot of requests for the service so we simply began offering it from that point.

The campus is investing in a network of design facilities and services; the GLID2 and library will be nodes in this network.

The idea to have a 3-D printing service at the library was already around before I started at the university. My job was to figure out how to make it happen. I wrote a proposal for a service model, which was approved by the chief librarian. I then worked with a project manager in the chief financial officer's office who led me through the implementation of the project. It was not considered a pilot, as far as I know.

We began to receive feedback from our students that this was a service that they wanted. In order to better understand their needs, we met with the different departments on campus who were offering 3-D printing and learned that most students only had access to this technology when they were affiliated with specific courses/programs. Further, there were many disciplines that did not have any access.

We clearly filled a niche that existed on our campus and was not being met by others. Also, the cost of entry for many of the technologies is very low, aside from 3-D printers. Weighing the pros and cons of having Raspberry Pis, for example, can consume more resources than just moving forward.

We did not define the services as a pilot though things rapidly changed in the months after starting the service. We were fairly confident this would be well received.

We felt that the need was present, had a staff member that was familiar with the technology, and had donor interest in getting fabrication going so we went right into small scale production.

We had been hearing about the maker movement in the media/literature. We had just hired a new Entrepreneurship Librarian who suggested the creation of a makerspace, including 3-D printing, in 10/2013. He provided administrators with an overview of current maker activity on our campus and suggested how the library could best contribute to the effort in January 2014. After discussing the overview, the Library Executive Committee decided to ask him and the

supervisor of our copy center to proceed with planning. In April 2014, we purchased a 3-D printer with library funds and began experimenting with it. In October, we offered 3-D printing services to the university community. Business grew steadily throughout the academic year, prompting us to buy two more 3-D printers.

We have the fabrication device to test, but do not as yet have a pilot program developed. Still in planning stages.

We sometimes do not pilot all items, we have the IT staff in the Libraries test and work with the patron to implement.

9. Once a decision was made to implement fabrication/makerspace services, how long did it take your library to bring them online (excluding the pilot phase)? N=19

~6 months

10 months

2–4 months

6 months

Approximately 1 year

Approximately 6 months

Because there was a soft rollout, the service's value was consistently evaluated and not fully committed to until a few years in when we were looking at expanding our capacity and capabilities.

Either immediately (with our 3-D printing service) or within the first semester for most, while others are only mentioned minimally on the website and left to be discovered in person while visiting the lab for another purpose.

I'm not sure when the idea was first proposed, but I was called on to write the proposal in May 2014, we got the equipment in August, and the service was online in October 2014.

It took about 2 months to train, learn about the printer, and bring it online.

It usually takes about 2 weeks to implement a makerspace service.

No decision made yet.

No time at all.

Not yet in place.

Six-month investigation into location, models, and environmental concerns

Six months

The pilot phase was a year. During that time we worked out all the kinks. The decision to implement the service on an ongoing basis changed nothing, so if the pilot phase is not considered in the timeline then it took 1 second to implement.

Varies by service, but it was mostly connected to procurement for hardware, i.e., how long one must wait to get things. For courses, it was a matter of developing content, which also varies by course.

While we were working with the students in the School of Business course, we developed policies and procedures to open up the service more broadly. This included researching pricing models at other schools and how to accept file submissions. Creating the form and payment procedures took about a month, but this period overlapped the pilot phase.

SPACE

10. Please briefly describe where the fabrication/makerspace services are located in your library. N=37

3-D Printing and Laser Cutting are located in a small, dedicated space. Makerspace tools and kits are lent from the circulation desks of two libraries. Workshops and classes are held in multipurpose teaching spaces.

At the Norlin Commons Service Desk. Location at the Gemmill Library is TBD.

Digital Media Commons

Equipment is located in a librarian's office and moved as appropriate.

Grainger Engineering Library Information Center GLID2 for visualization, data analytics, informatics, and 3-D printing with plans to extend digital scholarship services to other areas in the library, including the Scholarly Commons.

In one part of the East Commons, a library commons providing academic social space, collaborative computing, and media services. The planned renovation of the library and the opening of the Clough Undergraduate Learning Commons made some commons services redundant. The design studio took over a group study space.

In the common area of a main public space, behind and including a former information commons service desk.

In the science library

It was added to an underutilized computer lab.

No decisions made yet.

One printer

Our 3-D printing service is co-located near our reference desk. We decided on this location because we have staff at this site every hour we are open and they are able to keep the printer running throughout the day.

Our equipment and staff are centrally located in a multi-disciplinary, media-rich building on campus called the Duderstadt Center. The machines occupy a 300 sq ft section of our larger office space. The room has one large glass door/wall (~20 ft long) that opens to a central collaboration area and a point of high traffic. The space is connected to a UPS to smooth out power spikes and outages, which can negatively impact a print. The printers each have their own circuit with equipment associated with the post process (tanks, sifters, ovens) share an additional circuit. Core staff and student staff are in the immediate space to facilitate monitoring and troubleshooting.

Our five 3-D printers, two 3-D scanners, sewing machine, and soldering stations are all located in a locking room within our library that was previously a collaboratory computer lab. In the open library area there are computer workstations, desks and chairs for patron use, and a design and modeling center with drawing/sketching/building supplies.

Our media center

Planned to be located in our Scholarly Services unit.

Proposed areas include: 1) a room on the main floor of a branch library where most of our STEM materials and expertise are located; 2) a room within a group study/collaborative project space in the main library.

Science and Engineering Library in an office space (not public)

The 3-D printer is located in an empty office in our library systems department.

The 3-D printing and scanning hardware/software are at the circulation desk of the Science Library, a branch library on campus.

The 3-D Printing Lab is being planned for Room W136 in the Libraries' Knowledge Commons at University Park. Penn State Hershey: in instruction lab.

The Digital Scholarship Center is roughly 2300 square feet and the makerspace services occupy a bench seating area along a wall that covers the space and a table for 3-D printing. All of this can spill out into the rest of the space if needed.

The machine(s) are in an area designated for experimentation with all types of devices, but they are not yet available to the public.

The makerspace services are located in the New Media Center, which is a unit in the main campus library.

The makerspace will be just inside the entrance to the Engineering Library, to allow for high visibility and impact.

The plan is to house at the Fine Arts Library.

The public printing service is offered through the Lyons New Media Centre in the main library (Mills). The makerspace is in the Lewis & Ruth Sherman Centre for Digital Scholarship in the same building.

The Science Help Desk

They are in a public space on the second floor of the library.

We added to the services of the Copy Center which already offered copying, printing, scanning, plotting and the Espresso Book Machine. This is located in a high-traffic area.

We are now planning for services to be launched in an area on the main floor of the main library building that was once occupied by copy services and is now vacant.

We have an information commons and that is where the makerspace is located.

We have identified space adjacent to our learning commons that we plan to have renovated for a makerspace.

Will begin initially as a staff-mediated consultation service, then may move into forthcoming Digital Media Lab in main public area of the library.

Within our Student Multimedia Studio, a multimedia lab that is available to all currently enrolled students.

Within something called the MADLab (mobile application development lab) which isn't technically part of the library system. It is staffed by one person and his job is to help people develop mobile apps. I think he was tapped to host the machines because it is a secure, private space within the library. He would also be able to keep an eye on things. We only have the 3-D printers, it's not really a "makerspace" so much as a desk with two printers on it. The rest of the space is quite large and it's mixed use. There are a couple rows of large monitors and an instruction space. We also use the lab to deliver training sessions.

Yet to be determined.

11. Please enter the square feet of the physical space of your library's makerspace. N=26

Square feet

Minimum	Maximum	Mean	Median	Std Dev
3	9000	949.33	312.50	1860.84

Additional comments N=2

It's not in a room, it's on an open floor.

Undecided, but expected to be about 30 x 50 ft.

12. Are fabrication/makerspace services in your library associated with or hosted by other organizations? N=38

Yes	6	16%
Not yet, but they will be	4	11%
No	22	58%
Not yet determined	6	16%

If yes or the services will be, please identify the organization and briefly describe its role in these services. N=10

A Design Center building and other areas on campus.

A makerspace that is currently a partnership between our faculty of Engineering & Applied Science and our Business School.

Engineering Department

Graduate school provided all funding.

Schools of Mechanical Engineering and Industrial Design will provide some of the necessary staff and funding to have 3-D printing in the library.

See above. I developed the service in collaboration with the manager of the MADLab, which is housed inside the library. We manage the service together. Since he has an office in the MADLab, he's around more when people are using the printer. He also takes responsibility for changing the filament and handling the Raspberry Pi remote monitoring system. I manage the reservation systems and keep our list of certified users updated. I evaluate and assess the service. We both run safety training, work on improvements, respond to reference questions, and speak about the service.

Student organization will provide troubleshooting support for the hardware.

The 3-D printing lab in the Libraries was conceived and developed by the university's Education & Training Services (ETS). They oversee the Media Commons, which has been part of the Libraries' Knowledge Commons since it opened in January 2012.

The library makerspace is coordinating services with a larger creatorspace group on campus to offer a variety of technologies in various locations. We have a uPrint SE Plus printer on loan from them until the campus space is ready to

open. We work collaboratively with the campus creatorspace's program manager and her office is temporarily located in the library. We jointly submitted a successful grant proposal to conduct a Maker-in-residence program.

The university's 3-D club is interested in partnering with us.

Please enter any additional comments you have about the location, size, or arrangement of your library's fabrication/makerspace services. N=16

3-D printing is noisy. Think about this when you are deciding where to place them, especially if you plan to schedule workshops in the same space when they are running.

It's only a 3-D printing service. The fact that it's in the MADLab reflects a kind of "collaboration of convenience." The MADLab's primary role is to develop mobile apps.

Makerspace services are a good fit with the Digital Media Commons. The 3-D printing is one of the services available through the service desk operated by student assistants (referred to as Digital Media Mentors).

Right now they exist in a spare office.

The 3-D printer is located in the office, but it is often taken out of the office and transported around the library and campus on a cart that holds the 3-D printer, filament, examples, and accessories.

The makerspace size above is not just used for makerspace activities.

We are currently in the process of building a much larger facility that is closer to 265 square feet.

We are in the preliminary planning stages to identify a makerspace.

We are opening a second dedicated space this summer that will be approximately 900 square feet and will offer instruction space for 20 people.

We have three pieces of equipment (2 printers and 1 scanner) and they are located in a multi-purpose staff area. It is not a separate, dedicated space, although we would like to have dedicated space in the future. The equipment moves around quite a bit, depending on whether we are demonstrating for a class or doing outreach.

We have at least seven library areas that could potentially host the service. Preferably, we would have a large room or series of rooms with computers, around 40 printers, presentation space, meeting space, and office space.

We have not yet determined how much space to allow for these particular devices. They will be located in a room that presently houses other hardware for student/faculty use.

We have the printers on a tall table facing the public to attract attention. We get a lot of interest and new users because people are able to see the printers in action. Since you cannot always tell what the printout will look like in the end, we also have a monitor facing the public that shows the final product.

We will be building a physical "makerspace" connected to the Copy Center which will also serve as a classroom for instructional programming.

We would love it if we had a more flexible space with a door than could lock with card key authentication system. As it is, our equipment can only be used when the space is staffed, but we would love to let trained users in whenever the library was open.

While any 3-D printing service will be operated by the library's Learning Spaces Program (with support from library IT), other staff across the library have also hosted Maker Fairs and other maker events/activities.

HARDWARE AND SOFTWARE

13. Please check all the fabrication equipment that is/will be available for use in your library. N=38

3-D printers	37	97%
3-D scanner	28	76%
Hand tools	14	38%
Laser printers	11	29%
Laser engraving	4	11%
Cutting system	4	11%
CNC milling machine	3	8%
Ultrasound cleaners	1	3%
Other equipment	15	40%

Please specify the other equipment. N=15

3-D pens, Leap Motion Controller

An Arduino starter kit is on reserve.

Arduinos, Raspberry Pis, and various shields; sewing machine; filament recycling machine (to come)

Arduinos, Raspberry Pis, digital cameras, sensors, Oculus Rift, etc.

Available Hardware: Mac Pro computers, gaming PCs, Makerbot Replicator 2 3-D printer, Nextengine HD 3-D scanner, Cannon HD camcorders, Sure Digital microphones, WACOM graphic tablets, SD card readers, Magic Planet Digital Globe, Newmark NS6 DJ mixer/controller, SMART Custom Digital Surface, contemporary and legacy gaming consoles

Drill press, Dremel tool, soldering irons, industrial sewing machine

Electronic kits (e.g., Arduino, Intel Galileo, littleBits, Makey Makey, Ototo Musical, and Raspberry Pi), sewing machine, and soldering capability for circuitry work

Electronic soldering/design equipment

Good Glass, Oculus Rift, and a small drone

Large-format printers and scanners (poster)

Microcontrollers

Not yet determined.

Soldering, sewing, modeling

Various motors, switches, etc. all for physical computing work around the Arduino and Raspberry Pi platforms.

Visualization equipment

14. Does your library charge for using any of this equipment? N=39

Yes	11	28%
Not yet, but we plan to	5	13%
No	12	31%
Not yet determined	11	28%

If yes or you plan to, please specify which equipment and briefly describe the fee structure. N=16

$1.50/half hour of reservation time on 3-D printer. The 3-D scanner is free.

3-D printing: we charge $0.10/gram to recover costs.

3-D printing costs 25 cents/gram.

3-D printing will be charged by weight.

3-D printing, have not yet decided on the fee structure.

Cost of materials for 3-D printing: $1.00 base fee plus 15 cents per gram for a printed item

For each object that is printed, we weigh the object and charge a per gram fee. There is also a setup fee that is charged.

Just for the 3-D printing.

Laser printers: per page; 3-D printers: based on volume

Services are broken into two tiers representing full-service and self-service models. Self-service models require the user to provide their own consumables while we provide access to working equipment free of charge. In the case of 3-D printing, our full-service model is derived from consumables (model material, support material, build plates, peripheral supplies, etc.) Our scanning service is based on consumables and staff time. More specifically, a user is charged a fixed rate per hour with a minimum of 2 hours. This rate includes student wages and markers required for the scanning process.

Some 3-D printing and scanning

The 3-D printer: We haven't figured out the fee structure yet (maybe per material weight and print time).

The charges primarily cover our costs for supplies.

We charge $.10 per gram for the filament and a setup fee of $5.00.

We charge based on material used, incorporating machine, maintenance, and staff costs, except where grant or donor funded. The new space will utilize a different model where the equipment is free to use, but will charge for consumables.

We had grant funding for the 2014–2015 academic year, but are looking at models for charging to cover material costs (i.e., price by the cubic inch or gram for 3-D printing materials.

Answered No N=1

So far no, but if students print multiple projects and use filament quickly, we will ask them to purchase their own spools of sanctioned PLA.

15. Please check all the fabrication software that is/will be available for use in your library. N=36

3-D design software (e.g., Sketchup, TinkerCAD)	32	89%
3-D conversion software (e.g., 123-D Catch)	29	81%
Other software	15	42%

Please specify the other software. N=15

3-D scanning, laser cutter software

Adobe CC, SketchUp Pro, Rhino 3-D, 3-DS max, NextEngine ScanStudio HD, Simplify 3-D, Netfabb

Arduino freeware

Audio Production: Pro Tools 11, Adobe Audition, Audacity, Garage Band Music Composition & Notation, Finale, Sibelius 7.5. Productivity Software: Microsoft Office 2011, Adobe Acrobat. DVD Authoring: Adobe Encore, iDVD. Video Production: Final Cut Pro X, Adobe Premiere Pro, Adobe After Effects, Adobe Speed Grade, Adobe Prelude, iMovie. Video Conversion: MPEG Streamclip. Web Development: Adobe Dreamweaver, Adobe Fireworks, Adobe Flash Pro, Adobe Flash Builder, iWeb. Graphics Editor: Adobe Photoshop, Adobe Illustrator. Text & Source Code Editor: Sublime Text. Animation & 3-D Graphics: Autodesk Maya, Autodesk Mudbox, Blender. Desktop Publishing: Adobe InDesign.

Autodesk 3-DS Max, AutoCAD, Blender, Meshlab and 3-D printer software (Cura and Makerware)

Blender, kokopelli (Mac only), MakerBot Desktop, Maya, MeshLab, meshmixer, netfabb, OpenSCAD, PyMOL, SketchUp, UCSF Chimera

CAD, GIS, 3-D modeling

Cubify Invent, Cubify Design, Cubify Sculpt, Onshape

File repair software: meshmixer

May be viewed as conversion software, but medical extraction software and mesh cleanup packages like meshlab, magics, etc. are available.

Pro-Engineer, AutoCAD, IntelliCAD, MatLab, Mathematics, SolidWorks, and others

Software that repairs and modifies 3-D models (e.g., Netfabb, Meshlab); Software that slices and preps models for printing (e.g., Makerware, MatterControl)

Solidworks, AutoCAD

We have a 3-D lab with software listed at the following URL: http://library.ttu.edu/services/technology/soft.php

We really don't make any design software available. We encourage our users to do all the design and conversion work on their own and come to the lab ready to print. We do hope to change this and offer more design workshops and support in the future.

16. Does your library charge for using any of this software? N=37

Yes	0	—
Not yet, but we plan to	1	3%
No	28	76%
Not yet determined	8	22%

Comments N=5

Any paid software would likely be standardized and available on all of our supported computers and lending laptops.

Have campus license agreements with vendors.

I doubt we would charge to use design software.

No charging yet, but some expensive licenses may require buy-in from partners and heavy users.

We only teach free software.

REFERENCE AND DOCUMENTATION

17. Does your library have any LibGuides or other pathfinders that include specific mention of rapid fabrication technologies? N=39

Yes	18	46%
Not yet, but we plan to	11	28%
No	3	8%
Not yet determined	7	18%

18. Does your library have a collection of rapid fabrication technology documentation, books, manuals, databases, or other resources? N=38

Yes	20	53%
Not yet, but we plan to	8	21%
No	2	5%
Not yet determined	8	21%

If yes or you plan to, what is/will be the depth of the collection? N=26

Basic information level	11	42%
Study or instructional support level	10	39%
Research level	3	12%
Minimal information level	2	8%

Comments N=9

It's a mix of technical manuals, research on 3-D printing, critical making, and rapid prototyping, and even leisure sci fi on topics related to 3-D printing.

Not sure at this point, currently have a few ebooks, and some instruction manuals at science library.

Small collection of print materials (e.g., instruction guides) and a number of ebooks

Unknown, I would have to defer to a librarian who would be involved.

We have a small and growing collection of books on micro controllers (e.g., Arduino, Raspberry Pi), 3-D printing and scanning, soldering.

We have an institutional subscription to lynda.com.

We have purchased a small book collection (about 50) to support these activities and have begun developing LibGuides.

We have purchased several books on rapid fabrication.

We subscribe to ProQuest's Safari Books and the lynda.com library, which both have excellent resources for 3-D technologies and rapid prototyping.

19. Does your library provide fabrication/makerspace reference services, such as model selection and design consultation? N=39

Yes	17	44%
Not yet, but we plan to	10	26%
No	1	3%
Not yet determined	11	28%

If yes or you plan to, what reference services are/will be offered? Check all that apply. N=31

Design consultation	23	74%
Model searching	21	68%
Model processing consultation	21	68%
Software selecting	20	65%
Model selecting	18	58%
Software searching	18	58%
Software downloading	9	29%
Other reference service	4	13%

Please briefly describe the other reference service. N=4

Project scoping, programming, file conversion, model creation with photogrammetry

The Gemmill Library plans to provide fabrication/makerspace reference services. The Norlin Commons provided the services during the pilot phase.

Unsure, it is too early for us to know.

While we don't directly provide this service in the library, we have partnered with campus IT, which is able to provide support on model design.

20. Who is/will be responsible for offering these reference services? Check all that apply. N=33

Technology librarians working in the makerspace	15	46%
Reference librarians with 3-D printing knowledge	14	42%
Outside experts (experts outside library, or outside the parent institution)	7	21%
Other staff position/category	24	73%

Please specify the other staff position/category. N=24

At different levels, paraprofessional staff, MLIS student resident, paid graduate student assistants

Digital Media Consultant (Management and Professional Staff); Digital Media Mentors (student assistants)

Graduate student consultants

I am a staff member who oversees science reference services of which 3-D printing is one.

IT staff

IT staff that works in the Libraries

L3 staff member

Library Assistant IV, Makerspace Coordinator & specialized student employees

Library assistants and student assistants

Library's Technology/Media Specialist and the Digital Media Lab's specialized student workers

Manager of the MADLab, graduate student library assistants

Media Support Technician

Multimedia specialists from central campus IT organization (Information Technology Services)

Multimedia Specialists in our New Media Center

One library associate

Reference Assistants

Resident staff experts and trained students

Student staff and full-time manager of Student Multimedia Studio

Student Tech Assistant and others TBD

Student workers

Support staff and student technology assistants

Technical staff and student staff working in the makerspace

Vizualization and Data Specialist

Volunteers from RSO's

21. Does your library document models and designs that users have created? N=38

Yes	5	13%
Not yet, but we plan to	13	34%
No	7	18%
Not yet determined	13	34%

If yes or you plan to, which library staff are/will be responsible for documenting these files? Check all that apply. N=17

Makerspace librarians	8	47%
Archive librarians	1	6%
Other staff category	12	71%

Please specify the other staff category. N=12

Digital Science Librarian

Graduate student assistants for website, repository librarian for institutional repository

Library assistants and student assistants

Library's Technology/Media Specialist and the Digital Media Lab's specialized student workers

Makerspace staff

Multimedia specialists from central campus IT organization (Information Technology Services)

Multimedia Specialists in our New Media Center

Reference Assistants

Resident staff experts and trained students

Support staff and student technology assistants

TBD - Gemmill Library

Technology librarians, vizualization staff, Research Data Service staff

FABRICATION TECHNOLOGY TRAINING

22. Does your library offer workshops or classes on how to use fabrication equipment or software, and/or other skill-building sessions? Please make one selection per row. N=38

Workshops/Classes	Yes	Not yet, but we plan to	No	Not yet determined	N
Using fabrication software	15	9	2	11	37
Using fabrication equipment	11	12	3	9	35
Other skill-building session	13	6	4	12	35
Total responses	19	15	7	13	38

If you selected Yes/Other skill-building session, please specify the skill. N=13

3-D scanning, 3-D modeling, and electronics work

3-D design, Arduino/electronics prototyping

Arduino IDE, basic electronics

Basics of 3-D CAD design, basics of 3-D scanning/photoalignment, basics of microcontrollers

Description of basic applications

Design principles

Discussion of other applications for 3-D printing and scanning

How to use the service (make reservations, continue certification process)

In our software classes we briefly go over designing for printing. When designing a model, you should always consider the manufacturing process.

Intro to microcontrollers, intro to wearables and soft circuits, using DSLR camera, plane-table mapping, screenprinting

Introduction to Arduino

We offer multiple levels of training with multiple channels depending on the student's needs. We offer open workshops, online webinars, course lectures, online videos, and a multi-tier badging track open to all students. Additionally, 3-D modeling, scanning, photogrammetry learning opportunities are offered.

We teach how to use the 3-D software and also how to scan

If you selected Not yet, but we plan to/Other skill-building session, please specify the skill. N=5

Digital Media Lab and equipment sessions like: What could you do with a Raspberry Pi or Oculus Rift?

Economics of 3-D printing in relation to entrepreneurship and tech development

Equipment, software, and other skills as the field develops

Possibilities include vector-based design (for laser cutting and vinyl cutting) and an introduction to circuitry.

Visualization wall training, design technologies and software, 3-D software, presentation and data analysis software.

23. If your library does or plans to offer workshops or classes, who are/will be the instructors? Check all that apply. N=30

Instructors	Using fabrication equipment	Using fabrication software	Other skill-building session	N
Librarians working in the makerspace	17	16	13	18
Teachers outside the library who teach 3-D printing-related courses	7	9	8	10
Librarians working in other departments	3	2	8	8
3-D printing experts outside the library	5	6	5	6
Other staff category	17	20	13	20
Total Responses	25	27	20	30

If you selected Equipment/Other staff category, please specify the category. N=16

Graduate assistants

Library assistant or student assistant

Library associate in charge of the makerspace area

Library's Technology/Media Specialist and the Digital Media Lab's specialized student workers; possibly IT staff

Management and Professional Staff and student assistants (support staff)

Manager of the MADLab, GSLAs

Media Commons multimedia specialists from central IT organization

Media Support Technicians

Multimedia Specialists in our New Media Center

Student consultants

Students involved in maker organizations

Support staff and students

Technical staff/students working in the makerspace

The current plan is to co-teach and co-develop workshops with one librarian and one non-librarian support staff. Our first class in 3-D modeling was taught by a local expert that we paid.

Training is provided by trained student and resident experts of the Lab.

Workshops will be offered on a variety of topics, methodologies, and software.

If you selected Software/Other staff category, please specify the category. N=14

Graduate assistants; staff with design software expertise

Library assistant or student assistant

Library's Technology/Media Specialist and the Digital Media Lab's specialized student workers; possibly IT staff

Management and Professional Staff and student assistants (support staff)

Manager of the MADLab, GSLAs

Media Commons multimedia specialists from central IT organization

Media Support Technicians

Multimedia Specialists in our New Media Center

Student consultants

Student employees

Students involved in maker organizations

Support staff and students

Technical staff/students working in the makerspace

Training is provided by trained student and resident experts of the Lab.

If you selected Other session/Other staff category, please specify the category. N=9

Library assistant or student assistant

Management and Professional Staff and student assistants (support staff)

Manager of the MADLab, GSLAs

Media Support Technicians

Student consultants

Student employees

Support staff and students

Technical staff/students working in the makerspace

Training is provided by trained student and resident experts of the Lab.

24. Does the library charge participants for any of these classes or workshops? N=38

Yes	1	3%
Not yet, but we plan to	0	—
No	30	79%
Not yet determined	7	18%

Comments N=3

Fee might be charged for Raspberry Pi workshops, if needed, though an initial batch of Raspberry Pi sets will be available in the library's Tech Lending Program.

Students pay for the credit class in 3-D design, but not for the workshops.

We may charge if workshops require consumable materials exceeding $5–10.

25. About how many rapid fabrication technology classes and/or workshops does your library offer/plan to offer on average per month? N=24

Average number of classes/month:

Minimum	Maximum	Mean	Median	Std Dev
0	5	1.92	1.00	1.50

Classes	N
0	3
1	10
2	4
3	1
4	5
5	1

Please enter any additional comments you have about fabrication technology training. N=10

1 every 3 months

Contents of training sessions vary based on the expertise and interests of the student assistants currently employed as Digital Media Mentors. Attendance and interest in training sessions continues to increase, particularly for 3-D printing workshops.

Currently rate is one workshop a semester, but that will rise when we are fully functional in the coming year.

During the Spring 2015 semester, we offered 2 sessions for embedded class support for specific assignments and 5 workshops open to the entire campus.

It is too soon to be specific about the types of training we will be offering. A new hire will be in charge of this once the position is filled.

Mostly at the start of semesters with advanced classes following. For the new space, we will have safety workshops with minimal equipment training that will be required before users can be certified to work independently in the space. These workshops will be numerous, and not included in the total above, especially at the beginning of each semester.

These suggestions are in a proposal to purchase a new printer for the Norlin Commons.

We have only offered a few workshops about 3-D modeling. Two were in spring of 2014 and wer open to all members of the university community. The third was a session held during our library's day of seminars for faculty and graduate students.

We plan to offer much of this as online modules, so the schedule doesn't apply.

Yet to be determined.

USERS AND USER OUTREACH

26. Who are (or are expected to be) the main users of fabrication/makerspace services? Check all that apply. N=38

Undergraduate students	36	95%
Graduate students	32	84%
Faculty members	23	61%
Staff	15	40%
Postdocs	10	26%
General public	6	16%
Other user category	4	11%

Please specify the other user category. N=4

Anyone that the library serves can also use these services.

Library Staff

Local K-12 students

Not yet determined.

27. If your fabrication/makerspace services are at a point where you want to encourage growth in users and community engagement, please indicate whether your library uses, plans to use, or has no plans to use each of the outreach activities below. Please make one selection per row. If your services are not yet at this point, continue to the next screen. N=27

Outreach Activities	Uses	Plans to use	No plans to use	N
Presentations	13	12	2	27
Build sessions	5	13	7	25
Show & Tell	6	17	2	25
New project nights	0	10	14	24
Meet & Greet	7	9	8	24
Food & Drink	1	10	12	23
Skill-building workshops	14	11	2	27
Competitions	1	13	11	25
Open make sessions	0	19	5	24
Maker fair participation	7	10	8	25
Other activity	7	3	2	12
Total Responses	16	26	17	27

If you selected Uses/Other activity above, please specify the activity. N=6

Article in university's electronic newsletter "UToday"

Demonstrations/tables at campus events, display cases

Social media

We allow a maker-themed student group to use our space for meetings.

We participate in local events, though not Maker-Faire.

We've presented at local events such at the Tucson Festival of Books and we are also presenting at local, regional, and national conferences to share our experiences.

If you selected Plans to use/Other activity above, please specify the activity. N=3

It would depend on staff availability, but we would be interested in nearly all of these activities.

We plan on having our student employees become ambassadors for this service and will encourage them to develop a plan for outreach.

We will solicit faculty to involve our service as part of their ongoing curriculum. Our focus is on being an academic support.

Additional comments N=2

The new makerspace has a soft opening in mid-June with a small ribbon cutting, and small reception for students and Friends of the Library. When students come back for the fall semester, we will have a full slate of events associated with the opening of the space.

We hold weekly demonstrations in our library lobby, showing our 3-D printers. We have held one 3-D printing competition in the past, challenging users to design a gadget that would have market value and meet a need. We have also participated in our university's Maker Faire twice to increase exposure to our service. We hope to hold maker workshops in the future.

28. If you have already had some outreach activities, please indicate up to 3 that have been most popular with users. N=22

Presentations	13	59%
Show & Tell	10	46%
Skill-building workshops	9	41%
Maker fair participation	7	32%
Meet & Greet	6	27%
Build sessions	1	5%
Open make sessions	1	5%
New project nights	0	—
Food & Drink	0	—
Competitions	0	—
Other activity	3	14%

Please briefly describe the other activity. N=3

Idea sessions for planning

New faculty, grad, and undergrad sessions. Collaboration with Architecture school and Teaching Resource Center.

Social media, we have a hashtag #gerstein3-Dprinting where people can share their print jobs.

Please enter any additional comments you have about users and user outreach. N=11

A Libraries Fellow and CRDM Graduate Assistant will help develop workshop, curriculum, and outreach programs for the space.

In Science/Engineering Library, targeted users include faculty and undergraduates. Presentations included: Introduction to 3-D Printing & Presenting the Raspberry Pi.

Increase in number of users with course-related or research-related interests

Our 3-D printing training sessions continually sell out and we always have to worry about scale at our institution. We don't do a lot of promotion beyond the website and social media. We have been considering doing a show-and-tell event in the library lobby, but we haven't been able to take a printer out of the service for an extended time yet (too busy!)

Partner with student organizations.

The next phase of the Norlin Commons pilot would include greater outreach.

We are also in contact with other units on campus that offer some of these services and the student 3-D printing club.

We held an event on the uses of 3-D printing in research, campus-wide, and it garnered a good deal of interest and exposure. We also host our Master of Arts in Educational Technology practicum workshops.

We hosted a 3-D Printing Expo day for 2 hours in the Research Commons at one of our libraries. Tables included MakerBot and the 3-D printing student club on campus. Many people stopped by, and we were able to capture interest through a survey.

We plan to institute project nights or show & tell opportunities. There are multiple student-run maker communities on campus, thus we are exploring if there is still a need for us to fill that need.

We took our 3-D printer and scanner out to four academic departments for show and tell sessions. The head of the New Media Center also gave demos to the Student Library Advisory Council and the Library Board.

SERVICE HOURS AND STAFFING

29. Are fabrication/makerspace services available all the hours the library is open? N=37

Yes	3	8%
Not yet, but they will be	5	14%
No	19	51%
Not yet determined	10	27%

If no, please briefly describe when services are available. N=14

3-D printing and scanning is currently a production service mediated by staff in the New Media Center. Hours can be found here: http://www.library.georgetown.edu/hours/gelardin

8am to 9pm M–Th, 8am to 6pm F, 10am to 6pm Sat

Existing production makerspace: 2–7pm, 6 days a week. The new "workshop" makerspace will be open: Sun–Thurs 10am–10pm, Fri 10am–6pm.

Hours have not yet been determined but plans are Sunday (1–9pm), Monday to Thursday (9am–9pm) and Friday (9am–4pm), during the academic year (Fall/Spring semesters).

Monday to Friday, 9am to 4pm; consultations can be arranged outside these times.

No service at nights and weekends.

Not fully determined, but unlikely initially.

Only available during MADLab hours, which are Mon–Fri 9–5.

Regular semester: 8am–1am Monday–Thursday, 8am-8pm Friday, 10am–6pm Saturday, 10am–1am Sunday.

Right now, 1–7pm Monday–Friday or by appointment.

Services are available all hours that the Student Multimedia Studio is open, which is 7 days per week during the school year.

Services are available during the day M–F. Sometimes prints are allowed to run overnight if very long. Also, outreach activities occur at other times as well.

Some resources are available 24/7, while support and consultations are limited to the Lab's hours of operation (9am–6pm, M–F). Full service submissions are queued up to make best use of unsupervised time.

The hours are within the library schedule hours with a margin on either side.

Additional comments N=3

It is open from 8am–5pm for anyone and from 5pm–11am for users that have been trained to use the space by themselves.

The library has not yet determined fabrication/makerspace hours.

We will be adding evening and weekend hours.

30. Please indicate who has been involved in developing fabrication/makerspace services at your library. Check all that apply. N=37

Librarians	33	89%
Library support staff	29	78%
University or parent institution partners	13	35%
Other academic institution partners	13	35%
Other external partners	4	11%
Archivists	0	—
Other developer	6	16%

Please specify the other developer. N=6

Graduate and undergraduate students

Librarian administration

Library technologists

Non-librarian reference staff and student employees

Primarily library IT and the library's Learning Spaces Program staff (librarians and technology staff)

We worked with a School of Business professor who had received a technology grant to purchase one 3-D printer and supplies. The grant was an internal, university-sponsored technology grant.

31. Please indicate which library staff are/will be responsible for the management of fabrication services and maintenance of equipment and/or software. Check all that apply. N=33

Staff Category	Management of services	Maintenance of equipment	Maintenance of software	N
Individual hired for this purpose	4	5	4	8
Individual who also has other responsibilities	20	18	17	22
A team of individuals	16	17	16	22
Other individual	0	1	1	1

Staff Category	Management of services	Maintenance of equipment	Maintenance of software	N
Other group	2	1	1	2
Total Responses	33	32	29	33

If you selected "Other individual" above, please specify the individual and briefly describe their responsibilities. N=1

Maintenance contracts: MLIS student doing a two-year residency.

If you selected "Other group" above, please specify the group and briefly describe their responsibilities. N=2

Not yet determined.

Office of Information Technology in collaboration with School of Industrial Design

Additional Comments N=3

Media Commons is a service provided by the campus central IT organization and is partnered with the library on providing services within the library Knowledge Commons. The Media Commons is staffed by multimedia specialists who provide curricular training on video and audio creation. The 3-D printing/makerspace will be developed and staffed by Media Commons in partnership with the library.

One Multimedia Specialist who has worked in the New Media Center for 14 years has primary responsibility for these services. He provides the majority of the training and maintenance, and he supervises the work of 5 student employees who have been trained to use the 3-D printer and support some reference services. The department head does presentations and outreach.

We would look to hire a new position to run the day-to-day operations, but overall support would be a team of people.

32. Please enter the number of library staff who support fabrication/makerspace services. N=29

Number of staff

Minimum	Maximum	Mean	Median	Std Dev
1	10	3.52	3.00	2.11

Staff	N
1	3
1.2	1
2	7
3	6
4	5
5	1
6	4
7	1
10	1

33. Please enter the position titles of up to three of the library staff who support fabrication/ makerspace services and estimate the percentage of time they spend on these services. N=27

Position title 1:	%	Position title 2:	%	Position title 3:	%
Academic Technology Support Technician		Librarian and Coordinator of Digital Scholarship Service Development		Post-doc Fellows	
All 4 positions total to about 0.5 FTE at the Library Information Associate level					
Associate Dean of the Graduate School	10%	Lab Assistant	50%	Library Specialist	10%
Commons Manager/Librarian	Varies, maybe 10–20%	Student Tech	Varies, maybe 10–30%	TBD	
Consultant, Digital Media	10%	Digital Media and Network Coordinator	15%	Digital Media Mentors	75%
Digital Fabrication Specialist	100%	Lab Manager	20%		
Digital Scholarship Librarian	15%	Associate University Librarian	5%	Programmer	10%
Digital Scholarship Services Librarian	50%	Design Architect	50%	Developer	30%
Digital Science Librarian	35%	Emerging Technologies Coordinator	25%		
Emerging Technology Services Librarian	80%	University Library Technician	50%	University Library Technician	20%
Entrepreneurship Librarian	25%	Copy Center Manager	10%	Make @ State Coordinator	100%
Faculty Liaison & Instruction Librarian	10%	Manager, MADLab	15%	Graduate Student Library Assistant	85%
Head, Library Systems	5%	Info Tech Specialist III	5%		
Library Assistant	10%	Operations Manager	5%		
Library Media Specialist	20%				
Manager of the Fordham Commons	15%	Unit Computing Specialist	5%	Art Librarian	20%
Media Support Technician	75%	Head of Circulation	50%	Graduate Research Assistant	50%
Multimedia Resources Center Manager	10%	Library assistant	10%	Programmer/Analyst	5%

Position title 1:	%	Position title 2:	%	Position title 3:	%
Multimedia Specialist	50%	Student Multimedia Assistant(s)	25% of one FTE (10 hours weekly total across 5 students' time)	Head, New Media Center	5%
Science Librarian	80%	University Library Technician	25%	Graduate Student Assistant (2)	100% (35 hours/ week)
Science Librarian	15%	L3 Library Tech	25%		
Science Librarian	20%				
Science Librarian	5%				
Science Reference Supervisor and Software Instruction Manager		Library IT Manager		Assistant Library IT Manager	
Student Multimedia Studio Manager	50%	Student workers	75%		
Technology Services Supervisor	10%	Technology Services Manager	5%		
Technology/Media Specialist	TBD	Emerging Technologies Librarian	TBD		

34. Does your library have a board of directors or advisors for fabrication/makerspace services? N=37

Yes	1	3%
Not yet, but we plan to	4	11%
No	24	65%
Not yet determined	9	22%

If yes or you plan to, please briefly describe the membership, their number, and their primary responsibilities. N=3

Right now we seek input on an informal basis, but as we create a dedicated makerspace area, we would like to have a group of students and faculty who are focused on improving services and outreach.

We are part of a campus consortium of makerspaces and provide support and feedback to one another.

Would like a Board of Advisers with a small number of individuals who could advise on industry trends and new educational opportunities.

Additional Comments N=2

But we do have a Friends of the Library Board, Student Advisory Board, and University Library Committee who are all very interested in the space and will give support and suggestions from time-to-time.

Nothing official, but we actively engage our users to help with strategic decisions.

BUDGET AND FUNDING

35. Is there (or will there be) a separate budget allocation for fabrication/makerspace services or is financial support part of the general library budget? N=33

Part of the general budget	25	78%
Separate budget	7	22%

Comments N=6

Besides the initial technology grant ($6,000), all the support for the makerspace is library-funded.

For the existing production service, the budget is hybrid between general budget (full-time staff effort) and service receipts pay for the student assistants, supplies, and equipment. For the new makerspace, the library paid for the construction and furniture, but a $25,000 grant and $25,000 donation are paying for the fabrication equipment. We received a $5,000 grant to pay for electronic consumables and will charge users for filament and other materials.

Hybrid model. Staff on general, consumables in separate

It is self-supporting (pays for itself). Initial investment came out of the general fund, though it has been paid back.

Research budget allocation was $10,000 for the year.

Separate budget of $11,000.

36. What items does/will the budget cover? Check all that apply. N=34

Equipment/Hardware	30	88%
Materials	29	85%
Software	24	71%
Peripherals	19	56%
Staff	16	47%
Specialized furniture	13	38%
Staff training	9	27%
Other item	1	3%

Please specify the other item. N=1

Equipment maintenance

37. **Which budget item is/will be the single largest expense?** N=31

3-D printers

Equipment/hardware (5 responses)

Equipment initially, possibly staff salary ongoing

Equipment. If we decide to take 3-D modeling training in order to provide workshops to our users, this might end up being more than the equipment.

Filament; however, we have not yet developed an equipment refresh plan.

Likely software

Likely to be equipment/hardware initially (3 responses)

Materials (2 responses)

Materials are easily the largest expense, second only to staffing.

Not sure at this point, probably the equipment.

Not sure if staffing or supplies will cost more when 3-D printers are made available.

Not yet determined.

Staff (7 responses)

Staff (ongoing), equipment

Staffing is first, but equipment/hardware is second.

Student staffing

The renovation and furniture are the biggest costs.

The servicing and materials, over the long run, end up costing more than the machine.

38. **What are/will be the most significant sources of funding for fabrication/makerspace services in your library? Check all that apply.** N=35

Internal library regular budget	19	54%
Internal library temporary or special project budget	14	40%
Usage fee	11	31%
Donations	11	31%
External grant funding	7	20%
Additional budget from parent institution	6	17%
Member fee	0	—
Class/Workshop fee	0	—
Other source of funds	4	11%

Please specify the other source of funds. N=4

Budget transfer from current service providers

Endowment monies

Unknown!

Unspecified currently, but likely the regular budget.

39. **Which source of funding is/will be the single largest source?** N=27

A temporary special budget at first to buy the equipment and then usage fees to pay back the cost.

Additional budget from parent institution.

As of now, the library budget. We hope to find outside/additional funding sources in the future.

Donations

I think it must be the regular budget? I don't really know.

Internal library regular budget (8 responses)

Not sure at this point.

Not yet determined (3 responses)

One-time funding for the renovation of space which included fixed and movable furniture and safety items such as ventilation snorkels and air scrubbers.

School of Mechanical Engineering and School of Industrial Design

The internal library regular budget will be the biggest source of funding into the future. We have received some money from the university for selected start-up costs.

Usage fee (3 responses)

Usage fee: we will cover all ongoing costs.

User-generated revenue will be our primary source of funding for operations, but we are working on larger grants to help expand capabilities and capacity on campus.

We are currently using a technology fund from an endowment but are seeking a donor for a makerspace.

We hope a donor. :)

SERVICE ASSESSMENT

40. **Has your library assessed or evaluated the performance of your fabrication/makerspace services, for example by collecting usage data, interviewing individuals or focus groups, surveying users, etc.?** N=38

Yes	15	40%
Not yet, but we plan to	10	26%
No, and we have no plan to do so	2	5%
We are not yet at the assessment stage	11	29%

If you answered that you do not have plans to assess services or you are not at the assessment stage, you will skip to a question on service gaps.

SERVICE ASSESSMENT METHODS

41. What assessment method(s) does/will your library use? Check all that apply. N=24

Collect and analyze data on use	22	92%
Observations	20	83%
User satisfaction survey	14	58%
Interviews with individuals	10	42%
Interviews with focus group	7	29%
Other assessment method	5	21%

Please briefly describe the other assessment method. N=5

Assessment is built into our plans. We don't have it open yet.

Log data

Talking with patrons as they come to get items printed.

This is in early planning stages and not fully fleshed out.

We have our users fill out a log book on their print jobs. We also hand out an evaluation form after each safety training session.

42. Of the assessment methods already used, which has been most useful for evaluating these services? N=16

Assessment is planned. Services are not yet active.

Collect and analyze data on use (6 responses)

Collection and analysis of data; Observations

Comments from both interviews and observations

Interviews with Individuals

Observations

Obtaining a detailed usage log of our full service has been incredibly helpful. We are investigating methods to track use of our walk-up, DIY service, but are finding it incredibly difficult due to the self-serve process.

Talking with patrons as they come to get items printed.

Training session evaluations let us know what people wish we did (offer design workshops, supervise the job for them); the people who answered the survey have primarily used the service so they are satisfied with the service model restrictions.

Use data, particularly providing demographics of all of the disciplines actively using this service.

We collect from users information on projects they create and how the Libraries helped them accomplish these.

43. Has any assessment of your library fabrication/makerspace services led to changing services, programs, or specific uses of the makerspace? N=20

Yes	11	55%
No	9	45%

If yes, please briefly describe what changed. N=11

Assessment of the service frequently leads to changes in our service offerings. Often these are subtle adjustments to pricing, outreach, and training, but the data also identifies new needs on campus and who we may be able to partner with for larger fund raising efforts.

Assessment supported the need for additional training/workshops for patrons.

Future equipment needs. Guiding future development of workshops and outreach.

It informed the library on which departments on campus to do more outreach and engagement with.

There's a clear need from our students for design training. We're working on offering that to our certified users for fall 2015.

Used in planning for expansion of services. Training session topics are more diversified. More hands-on use of equipment.

We assessed how students used the space by talking to them and we found out that the students prefer to do things themselves. So we do the initial training and they can use the equipment by themselves and if they need any help they can request it.

We decided to circulate objects printed on our 3-D printer based on a suggestion.

We have altered the focus and timing of the workshops based on user feedback.

We have revised our policies based on usage statistics and purchased a second 3-D printer to support the increase in demand for course-related prints.

We used to think that all files with non-manifolds were the fault of our patrons, but we found out that those files that wouldn't print on our machine were working fine on other's machines. This led us to take the blame more fairly for failed prints.

SERVICE ASSESSMENT: USAGE DATA

44. If you gather (or plan to gather) data on the use of fabrication/makerspace services, please indicate the type of data. Check all that apply. N=24

Number of service users	22	92%
Number of total 3-D prints	21	88%
Number of class/workshop registrations	18	75%
Number of class/workshop attendants	18	75%
Number of reference requests	14	58%

Number of website visits	13	54%
Number of participants at user outreach events	12	50%
Number of total 3-D scans	12	50%
Number of consultations	12	50%
Retention of models developed or printed	6	25%
Other data	7	29%

Please specify the other assessment data. N=7

Costs, revenue, and comparison with competition

How often particular software is used.

Log book has information about each print job.

Money spent on filament and other supplies.

Number of curricular applications as reported by users.

Print jobs broken down by type (personal projects vs. research oriented jobs), department of user, university status (undergrad, grad, staff, faculty)

Type of service user (which department, status of user)

45. Which type(s) of data has been most useful for evaluating these services? N=16

# of total prints

Assessment is planned. Service not yet offered.

Data on print jobs and workshop evaluation forms

Demographic data

Number and type of prints; number of reference/project planning requests

Number and type of service user (which department, status of user)

Number of 3-D prints

Number of service users (3 responses)

Number of service users, number of workshop attendees

Number of service users and engagement with our users (consultations, workshops, etc.) have proved to be helpful in identifying areas of improvement and evaluating the services' effectiveness. We also found that actively going to local maker events identifies who is not using our services and gives us an opportunity to understand why.

Number of total prints, curricular demand

The number of 3-D prints and workshop attendees

Type of 3-D printing (what type of machine used)

Unknown, too early

46. If you gather data on the number of service users, please give your best estimate of the number of the users for the current fiscal year. N=18

Minimum	Maximum	Mean	Median	Std Dev
15	1970	485.39	179.00	620.00

47. During what period of the year is your makerspace the busiest? N=18

Assessment is planned. Service not yet offered.

Beginning of each semester

During mid-terms and finals week

Early part of the semester

End of the semesters (November and April). Then number of users next year will increase dramatically with the new workshop focused Makerspace.

Fall (October–November)

Fall and Winter terms: midpoint of term is the busiest

Last month of the semester(s)

March–May

Near end of each term

November/December

Our services are near capacity so we do not see much fluctuation in utilization throughout the year, however, emphasis and urgency changes. For example, common deadlines for students (mid-terms, finals) translate into different submissions than the summer, which are typically more research oriented.

Spring and fall semesters

Three weeks before finals

Too soon to tell right now, but seems like it corresponds to class project due dates.

Towards the end of the semester as students are finishing up projects.

We are not sure yet.

We do not know yet.

We've only been around since October 2014. It's been steady since then.

SERVICE ASSESSMENT: INTERVIEWS AND SURVEYS

48. If you have interviewed or surveyed users, what aspects of makerspaces and fabrication technologies are of the greatest interest to them? N=11

3-D printing

Access and speed of services is very important. Pricing is also very important.

Access to the 3-D printing technology, knowing how a 3-D printer works, the 3-D printed object itself, 3-D modeling for design

Arduinos; 3-D printing

Assessment is planned. Service not yet offered.

How to do it, how much it costs and how long it will take to print the item and to complete the print job.

How to use the 3-D printer and 3-D scanner

Learning how to create 3-D models in different types of free software.

Our previous surveys showed growing maturity with technology and growing need to gain access to new capabilities (higher resolutions, new material types, etc.)

We have primarily interviewed individuals to learn more about how they are incorporating 3-D printing into their course work.

We haven't formally interviewed or surveyed users.

49. If your library has conducted a user satisfaction survey, please indicate the level of perceived satisfaction of the users of these services using a scale of 1 to 5, with 1 being very dissatisfied and 5 being very satisfied. N=5

1 Very Dissatisfied	0	—
2	0	—
Neutral	2	40%
4	1	20%
5 Very Satisfied	2	40%

Comments N=2

Our overall satisfaction score was a 3.5/4.

Satisfied with initial classes. Service itself not evaluated.

SERVICE GAPS

50. Overall, what are the most significant gaps in your current library services in this area? N=25

A wider variety of printing. Ability to submit print jobs remotely. The existing makerspace is a production service where users pay for the jobs (printed and laser cut objects). The new makerspace offers a DIY environment for hands-on experiences and workshops.

Currently, these services are not offered.

Currently we are seeing a fragmentation of our user base. There are, and will be, students who are matched to our low-cost, walk-up 3-D printers as they currently exist. However, after a short period of time these individuals mature and begin seeking more capabilities and capacity within the same DIY model. The challenge is in providing multiple tiers of resources and then training with them. We are instituting a badging track that will provide the foundation for this, but have yet to identify the equipment that would be the best fit for such an open environment.

Currently, we have a single printer for the pilot. We have no means to expand without funding, and so the campus community has no open place for rapid fabrication.

Design workshops, 3-D modeling and design

Dissoluble supports, large build volume, variable print materials (currently only offer PLA)

Keeping up with the demand for 3-D printing (equipment capacity) and for hands-on workshops (staffing capacity)

Librarian training in very complex 3-D modeling designs

Need to define this as a core service and staff and situate it (physically) accordingly.

Not a service gap, per se, but our services could be more integrated into coursework and/or research. We have had some uptake by instructors and faculty research advisors, but that is an area that we will continue to foster.

Not having a broader variety of maker tools, like robotics and laser cutting.

Our pilot service is in limbo. We need a technology upgrade.

Our users don't currently have personal, hands-on access to the tools and we don't have a dedicated space open to the community. Our printing and scanning is mediated by staff in a staff area.

Overnight access

Providing a cohesive, strategic set of equipment and services. Right now we are just piloting a 3-D printing program.

Reference model, expert consultation

Space for training and demonstrations

Staff support, self-service machines

Staffing

We are short on staff and the staff working with the makerspace have too many other responsibilities.

We currently offer no services in this area.

We have no service in place yet. The gap on campus is that there are makerspaces that are open to all users, but situated in faculties in a way that presents a barrier to outside users.

We need more coverage for more hours.

We offer a 3-D lab with numerous 3-D software applications, but currently do not offer 3-D printing or 3-D scanning.

We would like to supplement 3-D printing with 3-D scanning because many students do not have design skills. We may also explore higher-end model printers.

REWARDS AND CHALLENGES

51. Please briefly describe up to three rewards of providing rapid fabrication/makerspace services.
N=33

Anticipate filling a user need. Increased library engagement with users.

Attracts students to the library for things they never knew we did. Inspires staff and engages them in creative processes. Creates spillover effects into our other work: prototyping, etc.

Brings users into the library for other purposes than quiet study. Moving library services into the science research process.

Contributions to campus teaching and research. Participate in the end-to-end knowledge creation process. Develop informatics tools that can assist design learning.

Engage with users in different way. Staff appreciate ability to learn new skills.

Engaged students. Active library use. Providing access to services not available elsewhere in area.

Expand role of library, inspire students, help with student success, and support campus mission. Another service libraries can provide as the field evolves to help keep us relevant. Opportunity for staff (including library staff), faculty, and students to create.

Forging new connections to curriculum, research, and individual projects and students. Providing a new and needed service. Staff learning and employing new skills.

Fun. Accessible: seeing technology at work. Making your own project.

Getting undergrads interested in the library. Expanding our services. Keeping the university on the cutting edge of technology.

Giving students exposure to technology that they may not otherwise have access to. Developing new partnerships built around making and the maker culture. Increasing library engagement with students and community.

Interaction with entire campus, all schools. Forming a university-wide maker network to share expertise, equipment, training opportunities. Unveiling new methods to interrogate research questions.

It encourages patrons from several different departments to come to the library. Offers all students in all departments the use of this exciting technology. Allows for outreach and engagement of the library and its services to campus and the community.

Learning practice. Building community. Interdisciplinary learning.

Level the playing field for social science and humanities students and faculty members who don't have as much access to these services as those in STEM fields. Broaden scope of services provided by the library.

Opportunity for more collaborations and partnerships with campus colleagues. Profile on campus raised significantly. Engagement with researchers and other staff who are using the services which are now readily available and accessible.

Partnership with campus partners. Cool factor.

Provide general access to hard-to-find technology. Expand the role of the Libraries in supporting learning. Expand the opportunity of students to play with new technology.

Provide low-barrier access to a useful service. Provide instruction to a cross-campus, interdisciplinary audience. Support the curriculum.

Provide students, campus community a place to explore and utilize this technology. Increased collaboration with campus partners. High visibility, good press.

Provides hands on experience to all disciplines.

Providing access to services that enable innovative student projects that otherwise would not be completed. Exposing students to new technologies that they wouldn't see elsewhere. Introducing new pedagogical methods for faculty to use to teach.

Providing open access to maker technologies for our campus. (Don't have to be an Art student or enrolled in a particular class). Increased student engagement. Creating an innovative learning environment.

Rapid iteration of the design process. Applied, action-based learning. Smiles.

Researchers quickly get the tools or products they need. Students get to show off their design skill. It engages students such that they learn new skills.

Strong engagement with individual users. Broad interdisciplinary demand and potential. Stimulates innovation.

Student engagement! We get to speak to so many students and researchers doing fun and interesting things. We get to see them experiment and learn on the spot and share their ideas in our fun and easy-going environment. Collaboration! A wonderful project for me to collaborate on with my partner in the MADLab. Since we've started our safety training sessions, he's started doing more instruction in the lab on mobile app development. Mentoring and teaching! The project has been very rewarding for our GSLA to see how a service gets set up, managed, promoted, and evaluated. It has been very rewarding for me to mentor her on service development and have her work really be meaningful to this project.

Support faculty. Support students. Support scholarship.

The look of awe on users' faces the first time they see a 3-D printer in action. Being able to offer an emerging technology that would otherwise not be available to most of our users. Partnering with units on campus with whom we had not previously collaborated.

Unanticipated and novel use of technology. Student reaction and excitement. Opens up opportunities for new partnerships and relationships.

University saves money by having it centralized in the library instead of several around campus. The library is neutral ground. It has brought engineers into the library, which used to be difficult to do.

Using the service as an example to market the library to potential donors and other groups on campus. Giving non-technical students the opportunity to experiment.

Yet to be fully determined.

52. Please briefly describe up to three challenges of providing rapid fabrication/makerspace services.
N=34

Access for users. Gatekeeping on content. Building understanding among faculty.

Availability of staff/time expertise.

Controlling unrealistic turnaround expectations. Appropriately pricing 3-D print services. The future landscape of university 3-D printing services is unknown.

Cost to build and support. Technical and logistical (training, reservations, access, workflows, maintenance). Ownership & collaboration: who's in charge and how will they share?

Cost, expertise, and promotion. Technical issues/support problems including budgeting time when requests come all at once (student deadlines). Determining what to print re: ethics and campus policy.

Defining the library's role in design learning and digital scholarship. Providing adequate and useful support for digital scholarship. Getting the buy-in of teaching departments and faculty.

Equipment breaks down frequently. Users have too high of expectations of what 3-D printing can actually do. Requires a lot of training and upkeep.

Equipment doesn't always work as expected. Users need to learn what things the space/tools can and cannot do. Keeping up with the most current technology.

Fit a new service into an already tightly allocated budget. Developing staff skills and partnership needed to make it succeed.

Funding. Staffing. Time for outreach.

Funding (start up). Expertise for staffing. Maintenance.

Getting buy-in from faculty and students without a dedicated assignment requiring 3-D printing or other making. Double scheduling prints that take longer than estimated. Providing a sustainable service that also allows staff to maintain a reasonable workload.

I would love it if we could have people use the 3-D printer set-it-and-forget-it style. Because our service isn't really supervised, the users have to stay in the MADlab while their job is printing. This is extremely time consuming. I wish our printers could print faster... Handling the certification lists and reservations takes a considerable amount of time spent filing and sending confirmation emails. Would be nice to automate more of this process.

Keeping equipment updated. Promoting use. Determining printing policies.

Lack of staff time. Hardware malfunctions. Lack of funds to buy newer hardware models.

Limited funding. Ensuring needed expertise. Service sustainability.

Limited resources. Not widespread in use. Barrier of entry due to specialized skills needed.

Machine reliability. Tracking use in an open environment. Managing user expectations.

Maintaining currency/relevance as technology evolves. Determining scope of services, where the line is between library and departmental/specialized services.

Maintaining equipment to keep it operational. High cost of some machines and materials. Can be difficult to retrofit a traditional library space into a space supporting fabrication.

Maintaining hardware. Time commitment. Staffing.

Managing student expectations about what we can offer. Software licensing and installation. Campus culture of fear around new technologies and their safety.

Managing the services without dedicated staffing. Maintenance of equipment. Keeping on top of latest tech developments.

Money (for staff and supplies). Clarity of mission / justifying services as part of library services.

Providing adequate support.

Several aspects of the services have a steep learning curve. Labour-intensive: need to be onsite to work with users. Experience some dismissiveness of the services, e.g., "gimmick" or "fad".

Staffing. Space.

Staffing the makerspace. Keeping up with the demand.

Technology can be unreliable. 3-D printing is a slow technology that can lead to bottlenecks at busy times. Patron-designed files can have errors so they are unable to print correctly without repair/redesign.

The staff time needed to adequately support the service. The display space needed to showcase the objects. The funding required for a new "non-traditional" service.

The technology itself is tempermental. Providing staff support.

The time commitment. Keeping student staff trained. Keeping up with demand.

Time consuming. Troubleshooting problems can be difficult since this is newer technology. This sector is rapidly changing so it was difficult to determine what technology to purchase.

Yet to be fully determined.

FUTURE CASTING

53. Please briefly describe what you envision as the role of rapid fabrication and makerspace services in the future of research libraries. N=42

A central department-free place on campus for this technology is key, since the applications are so broad. Many individual researchers might lack the funding or expertise to utilize the equipment. Having a library service solves this problem and opens up the technology to the entire community.

As a catalyst for innovation.

As a component of scholarly communication, e.g., the visual display of quantitative data can now be 3-D.

As the technology becomes cheaper, service providers will move into higher-end printing as more people have access to cheaper 3-D printing. Service providers will also likely provide for printing of other types of materials not available in cheaper printers such as nylon, metals, and soluble support materials.

Assisting in the development and creation of critical making projects and bringing tangible and 3-D work into areas of research where it both has existed and traditionally may not have been possible previously.

At a basic level, libraries can provide the resources for experimentation and creative uses of materials. For example, the director of our Art Library has some interest in how 3-D printing could be used by studio art students.

At the university schools and departments proactively provided these services. Therefore the Libraries facilitates the individual schools and programs when needed.

Brings people together. A place to put technical skills into practice.

Given typical tight budget environments and space limitations across most universities today, it is important that academic libraries considering any services in the future will need to connect those services to the particular academic needs of the campus. Without doing that, any new service will not be successful. So, an assessment of need, applicability, and redundancy on campus is essential and will be highly individualized by campus. As an example, a well-appointed makerspace is less than a block from the library on campus. Other questions related to makerspaces relate to who would maintain the equipment (the library or IT (or other unit)); would libraries find themselves called upon to archive the products of these services; would there be internal uses for the technology (spare parts for obsolete technology in library); would this makerspace also include low-tech tools such as hammers, measuring tape, hand-tools

as libraries are already familiar with the storage and loan of items; what level of expertise would library staff need to provide this service and potentially train users.

I see the role of rapid fabrication and makerspace services in the future of research libraries as something that is needed and will be required by the students for them to succeed in their academic work.

I think teaching critical making and design skills will be more important than the access to the technology, esp. as the printers get cheaper and easier to use. I feel a lot of pressure to include 3-D design in our workshops. I think this will also be important for getting non-engineering students using the technology and seeing a need for the technology as part of their academic research and student experience.

I think the library can play several key roles in supporting digital scholarship and design learning. The primary campus fabrication and makerspace facilities will, for the most part, not be in academic libraries. Rather, academic libraries will offer collaboration and meeting spaces for students and faculty, information and literature review services, design software and hardware, visualization and data analysis tools, and overall project planning and support and services.

It has a future but should not be a major focus into the future since the technology will become more integrated into early education and people's lives.

It will continue to grow.

It will potentially have a similar role that "regular" printers and scanners currently have in research libraries.

Libraries are idea spaces, and makerspace technologies foster creativity and give research options to all disciplines rather than just those in the sciences, engineering, or architecture. I hope that libraries move away from 3-D printing as a Kinkos-like service, and toward conceptualizing fabrication as a tool to investigate, interrogate, and learn by doing.

Libraries are more and more about user-generated content, whatever the content type. We are platforms of discovery, empowerment, and growth. Makerspaces will be crucial to viability of research libraries, as our ways of acquiring knowledge are shifting to include hands-on technical and design creation. Integrated approaches to knowledge are crucial if research libraries want to survive.

Libraries have always served as community hubs for participatory and collaborative learning, providing shared resources that promote personal growth, learning, and exploration. Over the last two years, libraries have become a space to house, develop, and promote the maker movement, which is a growing community of individuals and groups who devote their time to designing and building rather than just consuming. The maker movement shares the library's devotion to the exploration of ideas and the development of skills and knowledge using shared resources and expertise, but with a more visible emphasis on creativity and hands-on learning. The trend in developing digital media resources within libraries and offering related programming is currently on the rise in academic libraries as universities recognize how shared access to and training in emerging technologies can benefit learners. By providing resources that are accessible to the entire university community and pairing those resources with the expertise of information professionals, academic libraries are well positioned to support maker activities, many of which allow students to develop the 21st century literacies, like digital and spatial literacy, that are vital to student retention and success, post-graduate career development, and lifelong learning. We will see makerspaces in academic libraries moving from a trend to a core service.

Makerspaces and fab labs are the next steps in active learning and in presenting scholarship. Makerspaces allow student learners to engage in learning by doing and hold the potential of a new form of scholarly communication. From videotapes to CD-ROMs to Internet access to color printing, libraries have always embraced new technology quickly in order to provide open and equal access, and makerspace is the next in line.

Makerspaces and rapid fabrication will continue to be an important part of future research libraries. Research libraries are open to everyone on campus and often in the community. Individuals can use library services regardless of what department they are a part of or what their affiliation is. Before, only certain departments or labs were allowed to use these types of resources. Makerspaces allow for new technologies to receive widespread dissemination and allow for a central location where people can learn about them, use them, and discover new uses. More libraries will make these technologies part of their everyday services and continue to teach and train patrons.

Makerspaces facilitate a different type of information literacy, and rapid protoyping extends the information lifecycle into the physical. Libraries can provide expert consulting, literacy building, collections development, and data management for this important new set of tools.

Manifestation of ideas!

Offering these services to all of the campus, not just students in programs where it's an inherent part, e.g., engineering. Connecting making to theory and critical inquiry.

Partnerships and collaborations will continue to increase, with equitable access to all disciplines and faculties. Provision of a common ground in support of interdisiplinarity. Support of research even at the undergraduate level: provides a critical skill at the entry level. Natural fit for libraries to participate in moving from digital to physical to digital forms of scholarship.

Provide services in a space that serves all campus users with the possibility of serendipitous interdisciplinary collaboration. Open for a large number of hours with staff able to help people. This provides greater ROI for the university for expensive equipment that is often inaccessible in departmental offices. As the needs of students and faculty changes, we will adopt new services as appropriate.

Providing a space, technology, and services that allow users to experiment and learn through experience despite their discipline and ability.

Rapid fabrication and makerspace services will be important to many, if not most, research universities. However, the location of these services will vary. Right now, these services are provided to a small segment of our students and faculty within specific departments. I don't know whether that will change.

Rapid fabrication and makerspaces seem a relevant future service that students, faculty, and staff at universities will want. Libraries, as they seek to define their future, could be very good places to provide makerspaces, as we have facilities, technologies, and other services with which makerspaces would seem to fit well, given appropriate staff training. However, it would be a new business for us, and only time will tell whether it is a desired and useful service.

Research libraries may provide research assistance for fabricators; however, the tools, equipment, and expertise are better provided by academic departments.

Research libraries that have an active multimedia design lab, such as the Student Multimedia Design Center, see a role for rapid fabrication and makerspace services that are centrally available to all users, particularly as a demonstration site, and for wide application for basic student needs.

Since the libraries support the scholarly resource needs of the entire university community, we envision including rapid fabrication services in the libraries' faculty lab, which is currently under discussion.

The 3-D printing service is useful for making quick prototypes; it's great to allow users to experiment. I envision it becoming more of a service than a research interaction with libraries purchasing more high-end equipment as the hardware becomes less expensive for the average consumer.

The library is the perfect home for such services provided they have the infrastructure to support it and invested partners on campus. I see a continued evolution of capabilities and a reduction in costs for 80% of user's needs. The remaining 20% will require highly specialized equipment that may not be appropriate for a general campus resource. (i.e., why would the library get an MRI machine…) As machines mature and become more reliable, there needs to be a shift towards content generation. This need is particularly strong in areas that currently do not embrace making as part of their academic and scholarly culture.

This is one of many new services to open the libraries to a new way of thinking regarding information access and creation in a public space. It's a first step in a much larger collection of services for users in the future.

This will continue to grow well into the future. Libraries will likely have more of a role with collecting and describing 3-D objects and helping connect researchers to each other.

University libraries serve departments across campus and are the perfect place to showcase emerging technologies, from 3-D printers to virtual reality goggles like the Oculus Rift. Our faculty and students need to be exposed to the latest and greatest technologies to be inspired and spark ideas about how all the disciplines can take advantage of creative resources and innovations. Libraries should not only provide access to resources for research purposes but also for production of new knowledge. Engineers and architects aren't the only people who can use 3-D printing, rapid fabrication, and makerspace services. Putting creative tools into the hands of all our faculty and students should be one of the primary goals of today's libraries. We'll be amazed at the outcomes these smart, savvy students can create when provided with the resources.

We are currently in discussions with our Science and Engineering faculties regarding renovations of our libraries located within their buildings. The Faculty of Science is interested in creating some makerspace, which could be located in the library. It is most likely that if we were to be engaged in delivering makerspace services, it would be in collaboration with one or both of these faculties.

We believe this is an incredibly important service for the campus, but not one that is limited to or the sole responsibility of research libraries. While these services are being offered by other campus departments, we will continue to serve as liaison to these services for our users, and keep abreast of the demands of these services. Should additional service points be prudent, we will certainly consider adding additional capacity for this service. We are observing that the areas of physical reproductions for visual studies, art history, and visualization of data analysis are quickly growing, as well as physical representations of models in the biological/life sciences and engineering. At this time, the demand in these areas are being fulfilled by makerspace services within or near the departments that offers these disciplines.

We expect the need for and use of this type of service to continue to increase; service supports the growing pedagogical practice of hands-on learning.

We have found the library has been very successful in building a campus (and regional) community for making activities. This includes identifying and partnering with other spaces on campus that offer rapid fabrication/makerspace services. The library is partnering with the Communication, Rhetoric, and Digital Media department by supporting one graduate assistantship who will be imbedded in the library to develop workshops and research/instructional opportunities for faculty on campus. There are several faculty members who have modified their curriculum to include our services in student learning, research, and assignments. The existing makerspace has supported several senior design projects, some of which were turned into entrepreneurial opportunities for the participants.

We have struggled with this for seven years. We believe there is a role, same as there is a role for 3-D software and 3-D visualization and fabrication labs in research libraries. We have had a 3-D lab at this library for eight years. 3-D software is heavily used by patrons. We have discovered that 3-D printing is increasingly desired by many of the patrons we serve for research, pedagogy, class assignments and projects, etc. We see 3-D visualization and fabrication as a key aspect

of emerging information representation and application or applied information and library sciences and the associated mission and services of research libraries.

We most likely will be a satellite location for other programs actively using the technology.

ADDITIONAL COMMENTS

54. Please enter any additional information that may assist others in understanding your library's experience managing rapid fabrication technologies and/or makerspaces, or what you would tell other libraries preparing to offer such services. N=23

3-D printers are not a turnkey device; they require "care and feeding."

Although we are pushing for a large-scale service, we have plans for implementing much smaller services as well. There is a fear that any small-scale service would get overwhelmed and be very difficult for already-busy staff to manage. In addition, we believe that a small-scale service would discourage faculty from incorporating 3-D printing into their curricula, as we would not be able to guarantee access to such a limited resource. Regardless, we hope that we move forward and, at the very least, demonstrate the need for a large-scale service.

As part of a library renovation project, we hope to investigate the possibility of creating a makerspace or augmenting an existing capability in the Digital Media Center (which is not part of the library). Our investigation will be based on current capabilities within the Digital Media Center and within the Maryland Institute College of Art (MICA).

Based on our experience in providing makerspace services since September 2014: don't be afraid to experiment with workshop topics; don't have to operationalize at the outset; don't feel compelled to fulfill all aspects of such services; work within the context of your library; be prepared to be informed by your users; enable them and push the experimental aspects.

Be aware of what departments, schools, and programs are doing in order to understand needs and existing services.

Be inclusive, not exclusive!

Get involved, take some risks. The expense, initially, need not be huge and yet it can have impact.

Have a clear outreach strategy. Have fun showing off what your awesome printer can do!

It is a popular service but many users want projects printed that are for personal use (valentine's gifts) or are too large and time consuming for our equipment and staff.

It is definitely worth trying. Don't get too hung up on the details and start small to see if there is demand in your local community.

It is not like inkjet or laser printers in that it requires someone tech savvy just to operate it. These require frequent troubleshooting and maintenance. The time commitment involved is huge.

Make sure you have staff that like working on these types of services and are interested in keeping up with technology changes.

Marketing new services like 3-D printing is very important. You can't simply buy a 3-D printer and expect people to flock to you. Setting up demonstrations around campus and writing articles for the campus newspaper can help get the word out. Our student employees have become very adept at using software programs like Tinkercad and have been able to assist with managing the print queue from patrons. Having a dedicated staff member assigned to get this service off the ground has been essential, though.

Please note that this survey combines responses from librarians who are engaged with both 1) a small-scale makerspace service in a branch library and 2) a planned, larger-scale makerspace service within the Digital Scholarship Center (to be opened this summer).

So far we have not been convinced that the cost of ownership of this technology is within our means to support.

Such services require a strong understanding of your environment and potential user base since the technology, training, and support requirements can vary greatly depending on those factors. Due to our service exceeding 10 years in age, we had the privilege of growing with interest on campus, This allowed us to pivot and adjust relatively quickly due to the deep expertise in-house.

The library is seriously considering 3-D printing as a service. This is not high-priority because 3-D printers and other fabrication labs are already available on campus.

The NCSU Libraries is the primary academic library participating in an IMLS National Leadership Grant on Makerspaces lead by the Children's Museum of Pittsburgh as a collaborative campaign to promote the establishment of makerspaces throughout US libraries and museums.

The UT Foundry (aka Creativity Commons). The University of Texas Libraries in collaboration with the College of Fine Arts is developing the UT Foundry, a Creativity Commons that will be located at the Fine Arts Library (FAL). The UT Creativity Commons will be a makerspace that will have a visual and performing arts focus while integrating engineering and computer science elements, resulting in a STEAM (Science, Technology, Engineering, Arts, and Mathematics) teaching and learning center. The University of Texas at Austin is one of the largest public universities in the United States yet the campus community does not have open access to a makerspace. The UT Foundry project will fill this gap and provide this much needed space and service. It will be open to all students, staff, and faculty at the University of Texas at Austin. The intention is to support non-curricular and curricular projects simultaneously. For example, both the layperson who walks in and wants to create a high-quality sound recording for a personal project and a professor who is developing a classroom assignment around printing a 3-D object will have equal access to the staff expertise and technology. The "creative class" is thriving in Austin, Texas from maker meet ups to the gaming and app development private sector to a community of non-professional musicians and more. Learning happens outside the classroom as well as inside-and teaching is being done by librarians, IT specialists, and fellow students, as well as faculty. The UT Foundry will be a center for arts learning, facilitating exploration. For example, students have interests that they want to develop, but they may not be studying the subject in the classroom. Faculty may be moving into new areas of teaching but need access to tools and expertise to develop an idea. An individual may have set a personal goal and needs the tools to accomplish it. The UT Foundry will play a role in these cited examples. The UT Foundry will include a Game Development Studio, a Recording Studio, a Video Production Studio, a 3-D Print Workspace, a Maker Workshop and a Digital Media Lab. Equipment and devices will be available to check out. Project activities will include training teaching and supporting patrons on effectively using the technology, developing programming and organized activities based on stakeholders input, and outreach. The goal for the project is to have a robust facility and service that is fully utilized by the university community. Desired outcomes for the user include acquisition of new skill sets or refining a fledgling skill, as well as progress or completion of projects. Not only will this initiative develop space and services central to arts teaching and learning, there are two other major outcomes: the development and diversification of information professionals, and the building of community in the DIY and maker movements on the UT campus. The UT Foundry is designed to have an impact on immediate learning, experience, and quality of life, as well as long-term transferrable skills and lifelong learning. Compare the creative experience to a physical experience at the gym. The gym experience not only improves long-term health, but immediate health as well. Similarly, the UT Foundry will have an immediate impact on a person's mind, encouraging creativity while a skill set will be acquired that can be used outside the space. The patron of the UT Foundry will be able to learn new software, hardware, and technology to assist them in realizing their own project goals. The University of Texas Libraries has put several pieces of this initiative in place during the 2014/2015 academic

year. 1. A device library has been established. Devices available for check out include cameras, tablets, microcontrollers, superdrives, keyboards, motion and gesture controllers, etc. 2. Funding has been secured for the recording studio component through the Hornraiser crowdfunding initiative. As of this report, $15,695 has been raised. 3. A Media Technician position has been approved and will be recruited over the summer. This will be a support and training position. 4. The UT Libraries is considering the addition of an Arts and Creative Technologies Librarian to provide the vision, outreach, and programming for the UT Foundry. 5. A Graduate Research Assistant position will be transferred from another area within the Fine Arts Library to support the work of the UT Foundry. 6. A project assessment plan has been developed so that we will be able to solicit feedback and fine tune this important new initiative To completely build out the UT Foundry, approximately $300,000 is needed for facilities upgrades, improvements, and equipment purchases. For more information see: http://news.utexas.edu/2015/02/02/beyond-textbooks-high-tech-tools-help-students-build http://blogs.lib.utexas.edu/texlibris/tag/creativity-commons/

This survey is limited in scope and language, given its focus on fabrication and makerspace functions. Academic libraries will be involved at a higher level, I think, in digital scholarship and design learning activities. Libraries should be involved in all aspects of the end-to-end knowledge creation process. I see a number of ARL libraries offering collaboration spaces and equipment, visualization walls and services, data analysis tools, data management support, and design technology software and equipment, including 3-D printing and scanning.

Utilize your students. Some of them have a deep interest in building and making, and they will be invaluable in figuring out what settings, filaments, code, etc. works, and what doesn't. Do not expect to start a makerspace without at least one person who enjoys taking equipment apart, fixing it, and putting it back together. The printers especially, even though they purport to be consumer-ready, do require a DIY ethos, and manufacturer support can be sparse.

We are actively involved in gathering information and becoming more aware of the services on campus, and growing demand for them. We are also involved in investigating the appropriate policies necessary for responsible use of these services, and learning more about how other departments that currently host these services set policies at their sites.

We offer a user-mediated service-- this means that anyone who wants to use our printer (and has a library card) must become certified (attend safety training, sign a waiver, pass a knowledge test). Then they book time on the printer during our open hours and then they print their object in a relatively unsupervised, secure space. We DO NOT supervise the printer, offer consultations on design (although we do help with the makerbot desktop software part), or print the object for people. Right now our service is focusing on teaching people how to use the printers (makerbot replicator 2) safety and effectively.

RESPONDING INSTITUTIONS

University at Albany, SUNY
University of Alberta
University of Arizona
Boston University
Brigham Young University
University of British Columbia
University at Buffalo, SUNY
University of Calgary
University of California, Irvine
University of California, Los Angeles
University of California, San Diego
University of Colorado at Boulder
Colorado State University
Columbia University
University of Connecticut
University of Delaware
Duke University
Florida State University
Georgetown University
Georgia Institute of Technology
University of Hawaii at Manoa
University of Illinois at Chicago
University of Illinois at Urbana-Champaign
University of Iowa
Iowa State University
Johns Hopkins University
University of Kansas
Kent State University
University of Kentucky
Library of Congress
University of Louisville
McMaster University
University of Manitoba
University of Maryland
Massachusetts Institute of Technology
University of Michigan
Michigan State University
University of New Mexico
New York University
University of North Carolina at Chapel Hill
North Carolina State University
Northwestern University
Ohio University
Oklahoma State University
University of Oregon
Pennsylvania State University
Purdue University
Queen's University
Rutgers University
Smithsonian Institution
University of Southern California
Southern Illinois University Carbondale
Syracuse University
Temple University
University of Texas at Austin
Texas Tech University
University of Toronto
Vanderbilt University
University of Virginia
Virginia Tech
Washington State University
Washington University in St. Louis
University of Wisconsin–Madison
York University

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