

Appendix 1.

Environmental Scan : Academic Library Makerspaces

1. BYU Harold B. Lee Library

<http://guides.lib.byu.edu/3Dprinting>

The Harold B. Lee Library of Brigham Young University has a LibGuide about their 3D printing service and has a detailed 3D printing policy. The 3D printing service is offered as part of its mission to provide resources and services that support and advance the education and scholarship of BYU students and faculty.

Their 3D printer is Makerbot Replicator 2 and the material used is PLA plastic. Accepted file formats are .stl, .obj, and .thing. All 3D models are printed by the library staff, and all library patrons – students, faculty, and also library card holders – can use the library’s 3D printing service. The library charges \$0.20 per gram for standard (0.2mm) resolution, and \$0.30 per gram for high (0.1mm) resolution. The library offers 4 classes: Printing process using the Meshmixer software, 123D Design for basic CAD (computer aided design) skills, Blender, and Adobe. Their 3D printing policy is located at <http://guides.lib.byu.edu/content.php?pid=529916&sid=4445576>.

2. Dalhousie University Libraries

http://libraries.dal.ca/locations_services/services/3d_printing.html

Dalhousie University Libraries offer 3D printing services. Their 3D printer model is Makerbot Replicator 2 and they are located at the Help Desk in the Killam Library, on the main floor of the Kellogg Library, and the Circulation Desks in the Sexton and MacRae Libraries. The material used is PLA plastic. Accepted file format is .stl, and patrons request the 3D printing service by filling up an online form (<http://util.library.dal.ca/3DPrinting/>). All 3D models are printed by the staff. The cost of printing a 3D model is \$1 per hour of printing time.

Dalhousie University Libraries also offer one NextEngine 3D scanner for patrons to create 3D models of physical objects. No training or workshop is listed in the library webpage about the library’s 3D printing service at this time, but the webpage offers information about what 3D printing is and where to find 3D model files. The Dalhousie University Libraries also keep a collection of 3D printed objects in their digital repository.

(<http://dalspace.library.dal.ca/handle/10222/15234>)

Dalhousie University Libraries plan to continue promoting 3D printing and scanning technology to more departments, offer instruction courses in 3D scanning and other methods of 3D data visualization such as 3D modeling and 3D printing, and expand currently offered 3D software in the Killam Library Learning Commons to encourage student innovation. In their article,

Groenendy and Gallant (2013) warn that simply providing 3D printing and scanning technology without instruction, however, will impede effective use of these technologies due to the lack of experience of students and faculty and that the case of the Dallhousie libraries show the need for demonstrations and various instructional seminars.

3. Grand Valley State University Libraries

<http://gvsu.edu/library/maker-space-228.htm>

GVSU libraries offer makerspace equipped with two 3D printers and specialized modeling software for use by current GVSU students, faculty, and staff. It is envisioned as a lab for people to create, tinker, and explore. It is housed in the Technology Showcase in the Mary Idema Pew Library Atrium. Two Librarians manage the makerspace and help library patrons to load files into the printer and troubleshoot printing problems. The GVSU libraries makerspace webpage refers to some courses for designing and using the 3D printing software at GVSU. It also offers workshops from time to time. The fee is \$.35 cents per gram of material used, with a \$6.00 minimum. From the photo in the webpage, their 3D printers appear to be Replicator 2 by Makerbot.

4. Miami University Libraries

<http://www.lib.muohio.edu/computing/3d-printing>

Miami University Libraries offer 3D printing service with their Makerbot Replicator 3D printer. The pricing is \$.20 per gram of the finished print. The 3D printing service is initiated by a consulting session, in which a patron and a librarian discuss the project, the limitations of what can be done, the possibility of splitting the project into pieces if it is too large or will take too long to print. The webpage includes very little information.

5. NCSU Hunt Library

<https://www.lib.ncsu.edu/spaces/makerspace>

Hunt Library at North Carolina State University runs a makerspace that offers two 3D printers, two 3D scanners, a laser cutter, and a Kinect with 3D sensor. The type of equipment and pricing are as follows:

- **uPrint 3D Printer:** \$10 per cubic inch of material (ABS), with a \$5 minimum
- **MakerBot 3D Printer:** \$0.35 per gram of material (PLA), with a \$5 minimum
- **Epilog Laser Cutter:** \$5 per 15 minutes of appointment time, with a \$10 minimum
- **NextEngine 3D Scanner:** Free for use; to access, reserve Green Screen Production Studio (room 4217).
- **Microsoft Kinect for Xbox 360 3D Sensor:** Free for use; can be checked out for up to 3 days from the Ask Us center.
- **MakerBot Digitizer 3D Scanner:** Free for use; visit us in the Makerspace for a 3D scan.

All 3D models are printed by the staff after the payment is made. The accepted file format is .stl for 3D printers. Patrons need to bring the file to the library makerspace during its open hours and the staff helps patrons to decide which machine to use, informs them how much it will cost and how long it will take to print. The software used for files sent to the laser cutter is Corel Draw and Adobe Illustrator. No training or workshop is listed in the library webpage about the library's 3D printing service. The library's makerspace webpage provides detailed information and FAQs for each equipment and type of service.

In addition to the library maerspace, NCSU Engineering school has Open Hardware Makerspace, which is operated by student volunteers and provides technical skills workshops, an interdisciplinary and collaborative community.

(<http://ncsu.orgsync.com/org/openhardwaremakerspace/About>)

6. St. Petersburg College, Seminole Community Library - Innovation Lab

<https://newsspc.wordpress.com/2014/05/28/innovation-lab-opens-june-3-on-seminole-campus/>
(Opening on 06/03/2014)

St. Petersburg College Seminole Community Library will open its Innovation Lab on June 3, 2014. The space aims at providing an area where people with common interests like computers, technology, science or digital arts can socialize and collaborate on ideas and learn new skills. The Innovation Lab will open to the public and visitors can learn how to program different devices, such as the Raspberry Pi, the Arduino Genuine Mega 2560 Circuit Board and the ProtoSnap LilyPad Development Board.

The Innovation Lab offers the following resources:

- FreeFab3D Monolith 3D Printer built locally using other 3D printers
- littleBits Synth Kit
- Arduino Genuine Mega 2560 Circuit Board Experimentation Kit
- Avid Fast Track Duo Audio Interface with Pro Tools Express
- An iMac, 2 Linux computers, and 1 Windows computer
- A variety of Open Source Software applications for 3D printing, design etc.
- MaKey MaKey: Original Invention Kit
- Cubelets KT06 Kit
- ProtoSnap LilyPad Development Board
- 2 CanaKit Raspberry Pi Ultimate Starter Kits
- Apollo Precision Tools 53-Piece Tool Kit
- Parallax Programmable Boe-Bot Robot Kit
- Elenco Deluxe Learn To Solder Kit
- Samsung 32-Inch 1080p LED HDTV with Logitech TV Cam HD for Skype Calls
- Chromecast

- Online File Distribution System for access to project files, open access resources, etc.
- Reference collection including books and magazines

7. Southern Illinois University, Edwardsville, Lovejoy Library

<http://siue.libguides.com/3D>

Southern Illinois University, Edwardsville, Lovejoy Library launched their 3D printing service in September 2012. Two Makerbot Replicators and a NextEngine 3D Scanner HD were purchased. Students and faculty submit a file and pick up the printed object at the circulation desk. The 3D printer is operated by the library staff only. The cost was originally \$2 per hour of printing time and then was reduced to \$1 as the demand grew.

The Lovejoy Library spent nearly 2 months calibrating, testing, evaluating, tightening screws, tweaking software settings, and developing policies. (Pryor, 2014) Through the service's first year, the library has processed 117 individual print requests from 30 separate users that include both students and faculty. Twelve of these 30 users have made repeat requests.

Their 3D printing policies are as follows (Pryor, 2014):

- 3D Printing instructions and tutorials for users will be available at <http://siue.libguides.com/3d>.
- Cost: \$1.00 per hour of printing, to the nearest half-hour, as estimated by the printer control software. This charge accounts for plastic costs, machine wear, occasional print failures requiring reprints, and so on.
- Users are responsible for creating their own 3D models. Library staff may perform trivial repairs using automated software processes (checking for duplicate edges, unfilled holes, and so on), but staff cannot and will not assist in creating or editing designs. When a user has an object to 3D scan, library staff will perform the scanning and create a printable .stl file.
- Print requests will be submitted through the "File Upload" capability of Library3lp—in other words, while staff are available and logged into the 3dPrint chat queue. Staff will:
 - Accept the file
 - Process the file in the printer control software (ReplicatorG)
 - Notify the user of errors or problems
 - Give the user a cost estimate
 - Schedule the job and give a pickup date, taking the user's name and email address
- Print requests are also accepted via email and will be processed as soon as possible after receipt.
- At or before the scheduled start time for a print job, staff will print the object, attach the user's information with the quoted cost ("Lovejoy Library 3D Printing Service Pickup

Form”), and deliver the object to the circulation desk, where the user will pay for and pick up their item.

- Some objects (such as those with steep overhangs) require temporary support material to be printed. This material is easily removable; the user will be completely responsible for removing this material—library staff will NOT remove support material.
- Items printed on the Makerbot Replicator may have small surface defects such as bumps or holes. These routine defects will not be cause for refund or lack of payment for the object. Also note that while the Replicator is very accurate, we will not guarantee any precise tolerances on fitting of multi-part objects.
- All submissions are subject to approval based on scheduling and availability. We reserve the right to decline any print request for any reason.

8. University of Alabama – Rogers Science and Engineering Library

<http://www.lib.ua.edu/print3d>

The Rogers Science and Engineering Library of University of Alabama has a 3D printing studio. The Studio consists of one 3D printer (Bits from Bytes 3D Touch Printer), multiple 3D design workstations, and other supporting equipment. Software for 3D design and file preparation including SolidWorks, AutoCAD, Google Sketchup Pro, and BFB Axon 2.1 are installed on 15 computers within an instruction room adjacent to the 3D printer. A toolkit, instruction materials, and log book, which patrons log their use of the 3D printer, are available to check out at the circulation/reserve desk by authorized 3D printer users only. (Scalfani and Sahib, 2013) The cost is free for the current piloting period. The studio is managed by the Science and Engineering Librarian and has a detailed standard operating procedure manual, which serves as a training guide for both library staff and new 3D users.

(http://www.lib.ua.edu/sites/default/files/rogers/Rodgers%203D%20Printing%20SOP_V2.2.pdf).

Unlike other libraries listed above, which offer 3D printing as a full service, the Rogers Library’s 3D printing studio is open-access for the authorized 3D printer users. It promotes users to create and explore research independently; after training, the user is responsible for printing their own 3D objects. The Rogers Library requires a current student, faculty, or staff to go through the two-step process in order to become an authorized 3D printing user. (1) A two-hour 3D training workshop covers the basics of the printer technology, operation of the instrument, safety training, scheduling policies, resources, and software. During the workshop, patrons work interactively throughout the training with 3D design and 3D conversion software. They are also exposed to the controls and functionality of the BFB 3D Touch printer. (2) An individual consulting for 30-60 minutes once a user completes the workshop and sign up for 3D

print time online, for assisting with instrument calibration, starting the print job, and then assisting with the removal of the completed 3D printed model. (Scalfani and Sahib, 2013)

The 3D Studio training and support is offered as a specialized service and one librarian and one staff member currently manage the operations. The librarian is responsible for management policies, material procurement, workshop training, and instruction materials, while the full time staff member facilitates scheduling, and performs the daily maintenance of the 3D printer. Both the librarian and staff member are responsible for providing individual assistance to new 3D users. (Scalfani and Sahib, 2013)

According to the article about the 3D printing studio at the Rogers Library, “Model for Managing 3D Printing Services in Academic Libraries” (<http://www.istl.org/13-spring/refereed1.html>), 50 users have attended training workshops during early implementation. 3D users have experimented in the Studio with projects for advanced coursework and independent research. The 3D printing studio was also incorporated into some courses. Approximately 25 % of trained users have attended individual meetings and successfully printed their own 3D objects independently. The cost for materials and maintenance support over the Fall 2012 semester has been approximately \$150 per month (estimated use of 120 hours per month). The operating cost is dependent on user demand, printer type(s), and print material type. (Scalfani and Sahib, 2013)

Scalfani and Sahib (2013) recommend starting with a small 3D Printing Studio and then look towards expanding as user demand increases in order to avoid operating costs becoming quickly unsustainable even with user charging schemes in place. They note that that positioning the 3D Studio in a visible open access area and allowing authorized 3D users to experiment in the 3D Printing Studio independently greatly contributed to high user participation and interest across the UA campus.

The University of Alabama Libraries also has a LibGuide - “Makerspaces: Makers, Hackers, DIYs, and Hobbyist Reference Guide,” which includes resources about 3D printing, laser cutting, electronics, programming, Arduino, Raspberry Pi, and fabrication. (<http://guides.lib.ua.edu/makerspaces?hs=a>)

9. University of Mary Washington Library - ThinkLab

<http://umwthinklab.com/>

ThinkLab is a makerspace located in the Simpson Library at the University of Mary Washington. It is a collaboration between the Division of Teaching and Learning Technologies, the College of Education, and the Library and hosts a variety of emerging technologies and tools including 3D printing, robotics, and electronics work using Arduinos and simple breadboard kits.

The equipment offered are Makerbot Thing-O-Matic, Printrbot+, and Makerbot Replicator. The software available are Sketchup, ReplicatorG (control software that interfaces with Makerbot 3D printers and accepts STL files and converts the 3D models to gcode that runs on the Makerbots), and ReConstructMe (3d scanning). The webpage indicates that there are courses that directly use ThinkLab in addition to as open houses and other programs although no detailed information is available at this time.

10. Univeristy of Nevada, Reno, DeLaMare Science and Engineering Library

<http://campusguides.unr.edu/content.php?pid=424521&sid=3471413>

The DeLaMare Library is the first academic library that started offering 3D printing service. Its vision is to make the technology available outside of a lab, so that students and faculty can prototype models and experimental apparatus in support of ongoing research. The Director of the DeLaMare Library, Paul T. Colegrove says "3D printers are typically purchased by a faculty member with grant funds in support of a particular research project, and installed in isolated departmental locations. Printers remain largely inaccessible to students and faculty outside of a select few. We've changed that." (Wolterbeek, 2012)

Their 3D printer is a Stratasys uPrint SE Plus supporting ABS and PLA plastic. The accepted file format is .stl and the printing cost is \$7.20 / in³ of modeling material (raised to \$8.45 starting July, 2014). Available software are: AutoCAD 2013, Autodesk Inventor Fusion 2013, Blender 2.65, Google SketchUp 8, Rhinoceros 4.0. The DeLaMare Library offers 30-minute consultations with 3D Wranglers, who are student workers trained in 3D printing and the software used to create models, for general questions, getting started with modeling software, or troubleshooting a current project.

11. University of Tennessee, Chattanooga, Libraries

<http://www.utc.edu/library/services/technology/3d-printing.php>

University of Tennessee, Chattanooga, Libraries offer 3D printing service. They currently have a MakerBot Replicator (Maria Makerbot) and are in the process of building a Rostock Max, a robot 3D printer. The material used is PLA plastic. One faculty librarian manages the service and the printer has been out of service for a while due to the need for repair and the long time for a part replacement.

12. Valdosta State University, Odum Library

<http://www.valdosta.edu/academics/library/depts/media-center/services/3d-printing.php>

The [Odum Library](#) offers the Media Center, which facilitates the access to two Makerbot Replicator 3D printers. Use of the 3D printer costs \$2.00 per hour of print time. Use of the Makerbot requires attendance at a workshop that covers the basics of 3D printing and policies governing the machine's use. Patrons wishing to use the Makerbot must also reserve time for its use in advance. The 3D printer policies are located at <http://www.valdosta.edu/academics/library/depts/media-center/services/odum-library-3d-printer-policies.php>.

13. University of Michigan Library

<http://um3d.dc.umich.edu/>
<http://um3d.dc.umich.edu/3d-printing/>

University of Michigan Library has the Digital Media Commons, which offers services in 3D printing, scanning, rapid prototyping, advanced visualization, motion capture. The UM3D Lab is part of the Digital Media Commons and is operated by 6 full-time librarians/staff, 10 students, and 4 part-time staff members. It is probably the largest 3D printing operation in academic libraries. The UM3D Lab supports an open door policy and offers a collection of Cube 3D printers. They also offer many other hardware including 3D printers for resin and epoxy, Fused Deposition Modeling (FDM) machines for ABS plastic, a laser cutter, a laser scanner, and 3D digitizer. (<http://um3d.dc.umich.edu/resources/hardware/>)

The UM3D Lab webpage includes video tutorials for how to use the Cube 3D printer. The UM3D Lab's YouTube Channel has over 150 tutorial videos that thoroughly explains in detail how to print a 3D model using the 3D printer available at the UM3D Lab. Library patrons need to purchase 3D printing cartridges directly from the Cube 3D printer website.