3D PRINTING @ YOUR LIBRARY

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WORKSHOP
OUTLINE
The Plan

- What is 3D printing?
  - Brief overview
- Make a model
  - “Step 0” of 3D printing
- Start printing
  - 1 or maybe 2 per table
- Library services
  - Now that you know what’s involved
- Ask or write Qs as we go along
A little about you

- Have a 3D printer?
- Definitely getting a 3D printer soon?
- Interested/hoping for a printer?
WHAT IS 3D PRINTING?
What is 3D Printing?

Additive manufacturing

Variety of materials

Many different technologies
FFF-Fused Filament Fabrication

Most well-known type. Dominates the hobby market and lower-end “prosumer” printers

Fusion F306
Stereolithography - SLA

Cures resin with near-UV lasers

Step 3:
Print it!
SLS - Selective Laser Sintering

Binds a layer of powder to form a layer
Expensive

Block of nylon is removed from the machine.

Part is sand blasted to remove the all un-sintered Nylon.

Excess un-sintered powder is removed from parts surface.

Part is complete and ready for shipment to customer.
Paper-based

- Mcor Printers use paper and glue
<table>
<thead>
<tr>
<th>Acrylonitrile Butadiene Styrene (ABS)</th>
<th>Poly Lactic Acid (PLA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petroleum</td>
<td>Plant starch</td>
</tr>
<tr>
<td>Durable, strong, slightly flexible, heat resistant</td>
<td>Tough, strong</td>
</tr>
<tr>
<td>210-250 C</td>
<td>160-220 C</td>
</tr>
<tr>
<td>Easy sanding, gluing, dissolves in acetone</td>
<td>Sanding possible, doesn’t easily dissolve</td>
</tr>
<tr>
<td>Smooth finish, Durable and difficult to break Ideal for mechanical parts</td>
<td>Bioplastic – good environmental properties Good smell when heated &amp; nontoxic No heated printbed necessary Less warping or shrinking issues</td>
</tr>
<tr>
<td>Petroleum-based</td>
<td>Low heat resistance</td>
</tr>
<tr>
<td>Non-biodegradable</td>
<td>Easier to break then ABS</td>
</tr>
<tr>
<td>Heated printbed necessary</td>
<td></td>
</tr>
<tr>
<td>Fumes</td>
<td></td>
</tr>
</tbody>
</table>
Our library uses PLA because:

- corn-based – biodegradable and doesn’t smell
- Warps less than ABS
- Extrudes at a lower temperature
FINDING A 3D MODEL
3 ways to get a 3D model

Download an existing model

Scan an object and upload it to create a model

Make your own model
First - Model File Formats

STL most common file type
STL = STereoLithographic

Also OBJ, + many others
Plan A: Download a Model

**Important!**

- Download .stl or .obj file.
- Look to see if it's been printed before. Can’t always trust a model if you don’t make it yourself.
- Can clean up the model using free Netfabb or Meshlab.
Plan B: Scan an object

- Scan an object and upload it to create a model
  - Use a 3D scanner
  - Take photos around an object and upload to 123D Catch, which converts to model
Plan C: Create Your Own Model

<table>
<thead>
<tr>
<th>Simple:</th>
<th>Medium:</th>
<th>Complex:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tinkercad, Tinkerplay</td>
<td>Sketchup(X), 123D Design</td>
<td>Solidworks, Inventor, AutoCAD, Blender, Maya, OnShape</td>
</tr>
</tbody>
</table>

Remember

- Not all software is designed for 3D printing
WHAT MAKES A GOOD MODEL?
What makes a printable model?

- Good design
- Accommodates printer limitations
- Customized or adjusted before submission
Good Design

- Structurally sound
  - Parts/edges touching completely
  - No unintended holes
- Accomplishes the designer’s goal
  - Appearance
  - Functionality
- Elements are proportional
  - Piece(s) make sense
  - Walls are thick enough
Printer limitations

- Size of plate
  - Make smaller pieces and glue together
- Walls and sides must be thick enough
  - Must be >1mm
- Supports (if needed) must be viable
  - Not to damage object during removal
- Printer material - appropriate to function?
  - Strength, flexibility, waterproof, etc.
Difficult to remove supports
Too thin, barely stable

- No supports
- Sideways – barely 1mm
- with supports
Customize before submitting

- Scale to size before saving the model
  - Don’t leave resizing to the printer software
    - May lose structural integrity

- Lettering, loops, cutoffs, add-ins must be changed in modeling software

- Printer may only change color, resolution, temperature
Prepare 3D Model for Printing

- Use software to control printer and “slice” model

- Free software: Cura, Repetier

- Proprietary: Makerbot Desktop, others

- Simplify3D: $149/2 licenses. Expensive but works with many printers
Learn with Tinkercad

- Create your own model
PLANNING AND IMPLEMENTING YOUR SERVICE
How we are funded

- UF collects a Student Technology Fee
- Units on campus submit proposals
- We proposed printers, starter filament, and a 3D scanner
- Included quotes from faculty in several disciplines regarding impact
Planning a proposal

- Gather your arguments: Why the library?
  - Environment that supports creative thinking and collaboration
  - Open to everyone – not just “members only”
  - Known for universal access to technology
Planning a proposal

- Identify local advocates and supporters
  - Supporters who will ensure/promote use
    - Patrons with a backlog of desired jobs
    - Teachers who will craft assignments
  - Other nearby services
    - Unmet demand
- Identify potential donors
  - Your usual suspects
  - Technology supporters
Budget – visible costs

**Initial**
- Printers range $300-$3000
- Computer – dedicated?
- Software
- Filament, tools, supplies

**Ongoing**
- Filament
- Supplies
- Replacement parts
Budget – hidden costs

Space prep
- Printer and computer setup
- Power/ventilation
- Safety and security
- Shelves, racks, cabinets

Staffing
- Training
- Patron interaction
- Managing the jobs
Budget

- To charge or not to charge?
  - Income vs. hassle
  - Lots of variability
    - Publics and academics: yes & no
    - Schools: assume mostly no
- Sustainability
  - Continued source of income
    - Restock printers and supplies
    - Staffing
Pulling it all together

Reference
Interview

Policies

Workflows
Preparing Staff

- Training – Online Tutorials, Beta Test
- Address staff concerns
  - As with any other new service, you’ll have early enthusiasts, slow accepters, and never-buy-ins
    - Encourage testing and personal jobs
    - Offer shadowing until comfortable
Planning the service - Location

Choose secure yet visible location

Staff access

Storage of supplies

Patron visibility
Planning the service - Location

Consider Printer Footprint!

- Patron needs
- Portability

http://on3dprinting.com/tag/uprint-se-plus/
Choosing a printer

- Advice and recommendations from:
  - 3DHubs
  - Make magazine (advertising!)
  - Company support forums and Reddit
  - Our guide has links to libraries with 3D Services
  - Librarymakerspace-L
Environmental Health & Safety

Address environmental health and safety issues

- Ventilation
- Post-processing chemicals
- Hot extruder
What Type of Service to Offer?

Level of Service

- Staff OR Patron OR Both
What Type of Service to Offer?

- **Level of Service**
  - Assist with modeling?
  - Offer other 3D services
  - Post-processing

- **Depth of Support**
What Type of Service to Offer?

Level of Service

Depth of Support

Hours

- When to accept models?
- When to print?
What Type of Service to Offer?

- Level of Service
- Depth of Support
- Hours
- Priority

- Who can use the printer?
- Jobs equal?
- Reservation system?
Workflow Options

Delivery of files

- In-person or form?
Workflow options

Delivery of files

File processing

• staff OR patrons OR both?
Workflow Options

Delivery of files

File processing

Handling the printer
- Starting jobs, changing out filament
- Staff OR patrons OR both?
Workflow Options

- Delivery of files
- File processing
- Managing the printer

Payment

• On drop off, pickup, or either?
UF Library service workflow

1. Bring a .stl file to a library with a 3D printer.
2. We will look at the file with you and process it, discussing options.
3. Cost based on time and weight of material. Prepay with a credit or p-card.
4. Job is added to queue. We contact when finished to pick it up.
IMPLEMENTATION PHASE
Implementation phase

- Start gradually
  - Find some beta testers
  - Keep printer out of public view until enough staff are comfortable
Implementation phase

- Staff training
  - Identify the eager starters
  - Don’t expect that everyone can develop the skills
  - Let staff find/make and then print their own piece
Develop your policy

- Cost and payment options, if relevant
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- Time estimates. *Don’t promise!*
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- Adherence to copyright and computer use policy
Sample policy statements

- “The Library reserves the right to refuse any 3D print request.”
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- “The Library’s 3D printer may be used only for lawful purposes.”
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- “The Library’s 3D printer may be used only for lawful purposes.”
- “Users may 3D print or scan any object for research, education, or personal hobbies with the following exceptions: 1) No weapons or weapon accessories; 2) No illegal objects; and 3) No copyrighted objects or any other objects that violates patents and trademarks.”
Sample policy statements

- “Staff are acting as facilitators to provide access to the 3D workstation and printer. Staff do not necessarily have the skills to assist you with its operation especially during evening hours.”
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- “I understand that I will not be reimbursed for jobs that failed on my part, but I will receive a voucher for jobs that fail on the library's part.”
Sample policy statements

- “Children under the age of 12 need to have a parent or legal guardian with them.”
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- Reservations required.
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- [Patron] “must be there to supervise the printing process.”
The Reference Interview

- Develop and match the workflow
- Prepare for a wide range of knowledge bases among staff and patrons
- Prepare for the variations and options for each request
The Reference Interview

- Questions we ask:
  - “Have you printed with us before?”
  - Deadline?
    - Can we meet it with the current queue?
  - Assignment or fun?
    - May govern priority and level of assistance
  - “Which is the most important side to be perfect?”
- Estimates and charges (if used); pickups
SUCCESS STORIES
Natasha Vitek (graduate student), is collaborating with a 4th grade teacher to teach students to count to 100 by ones and by tens by printing out magnified objects from her laboratory in increments of 10, 100, and 1000.

She printed a rhinovirus, tardigrade, louse, and plagioctenoides. This also helps introduce students to what these biological organisms look like in a larger state.
Fun & Useful

- Toys, gifts, & repairs
Research

- Visualization and create custom lab equipment
Studying Baby Gopher Tortoises

Gabriel Kamener (undergrad) modeled and printed a baby gopher tortoise.

Used models to study predator attacks in the wild.
Generational Relief in Prosthetics

GripUF.com
MORE INFORMATION?
What is 3D printing?

- Fabrication of 3D models
- Additive manufacturing
  - Most commonly involves the extrusion of thin layers of plastic
  - Great for custom or low-volume production
  - Wide variety of materials and technologies

Many methods of printing

- FFF – fused filament fabrication
  - Most well-known type
  - Dominates the hobby market and lower-end "prosumer" printers
- Stereolithography
  - Cures resin with near-UV lasers
- SLS – selective laser sintering
  - Binds powder to form a layer
- Exotic (non-plastic) filaments
  - Precious metals
  - Wood, paper
  - Food, including chocolate

Lots of options

- Many manufacturers
- Many models per manufacturer
- Wide price range

Glossaries

Some examples of 3D printing glossaries. Each includes a mix of universal and local (printer-specific) terms.

- Kent State University
- University of Florida
- Lake Forest Academy (IL, grades 9-12)
3D Printing: A Practical Guide for Librarians
Join our list (>550 library staff)

- LIBRARYMAKERSPACE-L@lists.ufl.edu

- To join, send message to:
  - listserv@lists.ufl.edu

- In body of message:
  - Subscribe librarymakerspace-l yourname
Q&A