3D Printing
at the
Florida Public Library
What is 3D “printing”
Types of technology used by 3D printers
Application of 3D printing
What printer is at the Florida Public Library
How does it work
How can we make use of it
  – Software
  – Materials
  – Printer Demonstration
What is 3D Printing

• A process for making a physical object from a three-dimensional digital model, typically by laying down many successive thin layers of a material.

• Also referred to as “Additive Manufacturing”
<table>
<thead>
<tr>
<th>Type</th>
<th>Technologies</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extrusion</td>
<td>Fused deposition modeling (FDM)</td>
<td>Thermoplastics (e.g. PLA, ABS), HDPE, eutectic metals, edible materials, Rubber (Sugru), Modeling clay, Plasticine, RTV silicone, Porcelain, Metal clay (including Precious Metal Clay)</td>
</tr>
<tr>
<td>Wire</td>
<td>Electron Beam Freeform Fabrication (EBF³)</td>
<td>Almost any metal alloy</td>
</tr>
<tr>
<td>Granular</td>
<td>Direct metal laser sintering (DMLS)</td>
<td>Almost any metal alloy</td>
</tr>
<tr>
<td></td>
<td>Electron-beam melting (EBM)</td>
<td>Almost any metal alloy including Titanium alloys</td>
</tr>
<tr>
<td></td>
<td>Selective laser melting (SLM)</td>
<td>Titanium alloys, Cobalt Chrome alloys, Stainless Steel, Aluminum</td>
</tr>
<tr>
<td></td>
<td>Selective heat sintering (SHS)</td>
<td>Thermoplastic powder</td>
</tr>
<tr>
<td></td>
<td>Selective laser sintering (SLS)</td>
<td>Thermoplastics, metal powders, ceramic powders</td>
</tr>
<tr>
<td>Powder bed and inkjet head 3D printing</td>
<td>Plaster-based 3D printing (PP)</td>
<td>Plaster</td>
</tr>
<tr>
<td>Laminated</td>
<td>Laminated object manufacturing (LOM)</td>
<td>Paper, metal foil, plastic film</td>
</tr>
<tr>
<td>Light polymerised</td>
<td>Stereolithography (SLA)</td>
<td>photopolymer</td>
</tr>
<tr>
<td></td>
<td>Digital Light Processing (DLP)</td>
<td>Photopolymer</td>
</tr>
</tbody>
</table>

ref. a
Application of 3D Printing

- Architecture
- Construction
- Industrial design
- Automotive
- Aerospace
- Military
- Engineering
- Dental and medical industries
- Biotech (human tissue replacement)
- Fashion
- Footwear
- Jewelry
- Eyewear
- Education
- Food
- and many other fields.
Printing with SUGAR

Large scale 3D printing
FPL’s 3D Printer

Simple Maker's Edition (1405)
• **Build Volume:** 4” x 4” x 4” / 100mm x 100mm x 100mm / 64 cubic inches
• **Filament:** 1.75mm PLA
• **Print Resolution:** 100 Microns (0.1mm)
• **Print Speed:** 60mm/sec max recommended
• **Extruder:** Alum. Extruder, with Ubis Hot End, 0.4mm nozzle
• **Motors:** NEMA 17 stepper
• **Print Bed:** Not heated
• **Electronics:** Printrbot Rev D Printrboard with micro-USB & micro SD card slot
• **Auto Leveling:** Auto-Leveling Probe enables software to calib. Z axis height
• **Power Requirements:** 12V (5 amp) laptop power supply
Key Printer Parts

- Extruder
- Hot End
- Print Bed
- Auto Leveling Probe
- Bearing Rods
- Y-Axis Drive
- Linear Bearing
- Z-Position Acme Threaded Rod
- Z-Axis Drive
The technology used by most 3D printers to date—especially hobbyist and consumer-oriented models—is fused deposition modeling, a special application of plastic extrusion.

Simply put-

1. Plastic filament is melted and squirted out of a tiny nozzle onto the printer’s bed.
2. The bed and the nozzle are moved so as to “draw” a single layer of our 3D object.
3. The nozzle is then moved up a small amount and the second layer, or slice, of our object is drawn on top of the first layer.
4. This process continues, layer upon layer, until the object is fully formed.
3 Stepper Motors are used to control the position of the Extruder

- X, Y and Z

Power fed to the extruder heats it to ~200 °C (392 °F)

A 4th stepper motor feeds the plastic filament into heated extruder

A microprocessor based circuit board controls these 4 motors as well as the exact temperature of the extruder

The microprocessor receives instructions from a data file of G-code

G-code is sent to the printer using a computer or a memory card
Let’s Do It

THE BASICS

1. Get an idea*
2. Use CAD software to draw your design idea
3. Feed CAD data into a “slicer” program to generate G-code
4. Feed the G-code data to the printer
5. Warm the extruder
6. Load the plastic filament
7. Print
• CAD software- -------------- SketchUp (free)
  – http://www.sketchup.com

• Slicer software- ----------- Slic3r (free)
  – http://www.Slic3r.org

• Printer Interface software- - Repetier-Host (free)
  – http://www.repetier.com

• 3D file repair service- ------ -- NetFabb (free, cloud based)
  – https://netfabb.azurewebsites.net/index.php
Q. Do I have to use the CAD software to get something to print?
A. No. There are many designs available on the Internet ready to download.

Q. What is a good website to go to for interesting designs?
A. A good place to look is www.thingivers.com. Most are free downloads.

Q. SketchUp was mentioned as a free 3D CAD program. Are there other free programs that may be worth trying?
A. Yes. Microsoft is getting into the 3D printing game and offers an AP called 3D Builder. Also, check out the free programs from Autodesk and Tinkercad.

Q. Can I get my design printed if I don’t want to use the library’s printer?
A. Yes. You can even get it printed in stainless steel if you wish. Microsoft has partnered with “3D Systems”. “Shapeways” is another such service.
Some interesting web site URL

www.sketchup.com  Computer Aided Design (CAD) software (free & versatile)
www.Autodesk.com  Computer Aided Design (CAD) software
www.tinkercad.com  Computer Aided Design (CAD) software (Easy to use)
www.repetier.com  3-D printer driver program (free)
www.slic3r.org  “Slicing” program for 3-D printing (free, incl. with Repetier)
www.candyfab.org  3-D candy printing, novel application
www.shapeways.com  3-D fabrication services
www.3dsystems.com  3-D fabrication and high-end 3-D printers
www.printrbot.com  Low-cost 3-D printers and kits
www.makerbot.com  High-end desktop 3-D printers and imagers

netfabb.azurewebsites.net/index.php  Cloud-based “repair” utility, use it when your design doesn’t “hold water”

en.wikipedia.org/wiki/3D_printing  A wealth of information on 3-D printing
Demonstration Time

- Draw a 3D object using Sketchup
- Load Sketchup data into Repetier
- Slice with Slic3r
- Print 3D object