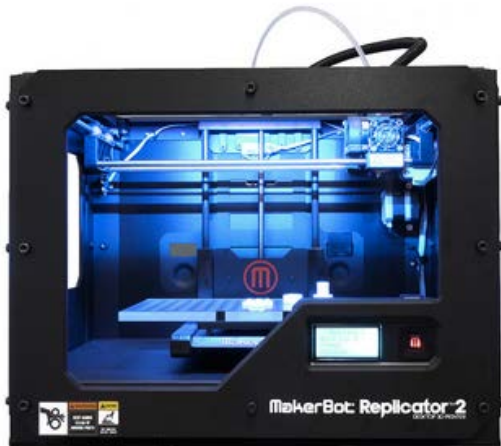


# Introduction to 3D Printing



## HS/HSL Workshop

Health Sciences and Human Services Library  
At University of Maryland, Baltimore

Bohyun Kim, Associate Director  
for Library Applications and Knowledge Systems  
[bkim@hshsl.umaryland.edu](mailto:bkim@hshsl.umaryland.edu)



# Let's Get to Know One Another!

What Do You Do?

&

What Do You Plan  
to Use 3D Printing For?

# The Potential of Technology

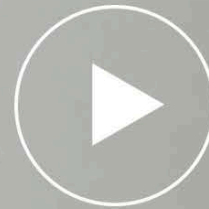


FAQ

Press

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Status



## Be My Eyes

Lend your eyes to the blind

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Sighted Blind Helped

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Help us spread the word #BeMyEyes

<http://www.bemyeyes.org/>

# What We Will Cover Today

1. How 3D Printing works & its relevance to health sciences
2. Where to find and download 3D model files online.
3. What steps to take to ensure that the .STL file can actually be printed including scaling and checking for non-manifold geometry issues.
4. An introduction to how to operate 3D printers - Makerbot Replicator 2X (ABS) and Afinia H480 (PLA), available at the HS/HSL Innovation Space.

**See a detailed how-to-guide at**

<http://guides.hshsl.umaryland.edu/inspace>

# 1. 3D Printing in Health Sciences

- A Baltimore-based startup company, Verve, launched [a Kickstarter campaign](#) for their 3D printed device for posture and pain relief called ARC and raised over \$7,000 in less than 24 hours. The company includes Dr. Gene Shirokobrod, a UMB faculty member in the School of Medicine.
- ["3-D printer helps doctors prep for complex surgeries"](#) - *Boston Globe* A surgeon in Sinai Hospital of Baltimore performed a total knee replacement surgery [using 3D printing technology to cast an implant and manufacture the jigs](#) — plastic cutting guides — that direct incisions.

# 2. 3D Printing in Health Sciences

By: Press Release Nation

## Baltimore Startup's Kickstarter Raises \$7000+ in less than 24 hours



Discovery Channel's Big Brain Theory winning engineer, Corey Fleischer, introduces new product, The ARC, a 3D printed device for posture and pain relief, on Kickstarter,

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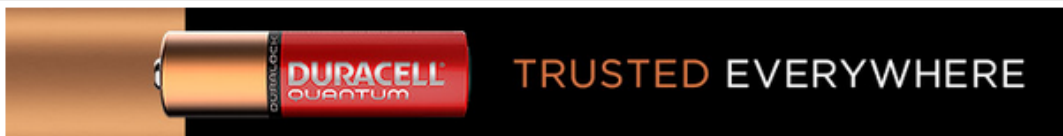
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[http://stocks.moneyshow.com/intershow.moneyshow/news/read/27146844/baltimore\\_startup%E2%80%99s\\_kickstarter\\_raises\\_\\$7000+\\_in\\_less\\_than\\_24\\_hours](http://stocks.moneyshow.com/intershow.moneyshow/news/read/27146844/baltimore_startup%E2%80%99s_kickstarter_raises_$7000+_in_less_than_24_hours)

# More 3D Printing in Health Sciences

- Pharmacists are exploring a way [to use 3D printing to produce medicine](#) to make it more affordable and customizable to the needs of individual patients.
- A man in Massachusetts created [a prosthetic hand](#) for his son who was born without fingers using a 3D printer at only a fraction of the cost for a commercial prosthetic hand.
- The National Institutes of Health recently launched [NIH 3D Print Exchange](#), so that researchers can share 3D print files, thereby acknowledging the important role of 3D modeling and printing technology in biomedical and scientific research. Scientists are already [bio-printing human tissues and attempting to 3D print a human organ itself](#).



# Dad Uses 3D Printer To Make His Son A Prosthetic Hand (VIDEO)

[http://www.huffingtonpost.com/2013/11/04/dad-prints-prosthetic-hand-leon-mccarthy\\_n\\_4214217.html](http://www.huffingtonpost.com/2013/11/04/dad-prints-prosthetic-hand-leon-mccarthy_n_4214217.html)

Posted: 11/04/2013 7:05 pm EST | Updated: 11/04/2013 7:05 pm EST



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Leon McCarthy was born without fingers on his left hand, but with some help from his dad, he can now draw, pick up food and hold a water bottle using a homemade prosthetic.

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**DEC 2013**

**NOT IMPOSSIBLE'S "PROJECT DANIEL" USES 3D PRINTERS TO MAKE PROSTHETIC ARMS FOR CHILDREN OF WAR IN SOUTH SUDAN**

Just before Thanksgiving 2013, Mick Ebeling returned home from Sudan's Nuba Mountains where he set up what is probably the world's first 3D-printing prosthetic lab and training facility. More to the point of the journey is that Mick managed to give

<http://www.notimpossible.com/labs/project-daniel>

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This entry was posted in [Arts and Culture](#), [Health](#), [Science and Technology](#) and tagged [art](#), [Dahlongega](#), [physical therapy](#), [visual arts](#).

# 3D printing enters the world of physical therapy

January 15, 2013 by Mike Marshall






## Bionic Leg: 3D Printing Better Physical Therapy Devices

 Solid Concepts Inc. ✓

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# 3D Printing Going Mainstream

- 3D printing is being quickly adopted in health sciences and healthcare for both educational, research, and clinical purposes.
- 3D printing is also going mainstream with low-price desktop models being sold at common retail stores such as Best Buy.
- HS/HSL opened the Innovation Space in Apr. 2015 to provide **hands-on experience in 3D Printing/Scanning** for faculty/students on the UMB campus.

## HS/HSL Innovation Space



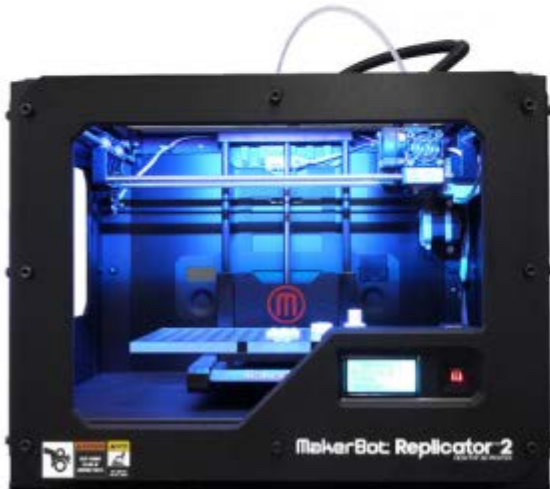
### Welcome to the HS/HSL Innovation Space!

The Innovation Space is designed for innovative and collaborative hands-on learning experience. It offers two 3D printers, a 3D scanner, over 3,500 video tutorials from Lynda.com, a large DNA model, two molecule kits, a button maker, and a 3D printing pen. The staff provides an orientation as well as workshops on a regular basis for those who are new to 3D printing and 3D scanning.

# What You Can Use at the Innovation Space

## Makerbot Replicator 2X

Transform your idea into a physical object with 3D printing! Bring a .STL file with you. Relicator 2X offers two extruders. You can use ABS or dissolvable filament.



## Afinia H480 3D Printer

The Afinia H480 is a small but reliable 3D printer. It has one extruder and supports the PLA filament.



## Tutorials from Lynda.com

Great learning resource that offers 3,500 video tutorials by experts. Topics range from 3D modeling to computer programming. Learn how to operate a 3D printer, how to build a 3D model in Tinkercad or Blender, and how to program in Python or Ruby. (Available on-site only at the Innovation Space.)



lynda.com

# What You Can Use at the Innovation Space

## 3D Scanner

Try 3D scanning with an object of your choice! You can scan an object as small as a book or as big as a person. Yes, you can save the resulting 3D model and 3D print it!



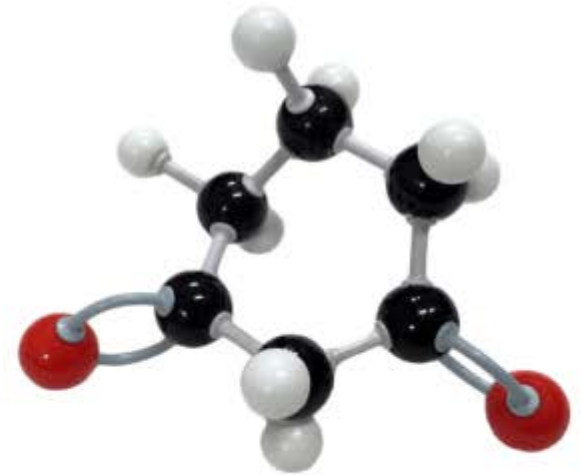
## DNA Model

Come play with the human DNA model. Assemble and disassemble while learning about the DNA structure! [Check out the assembly instruction.](#)



## Molecule Model

Explore the chemical structure of molecules! You can build methane, ethane, benzene, acetone, and more.



# What You Can Use at the Innovation Space

## Button Maker

Button making is easy - if you have the right button making equipment! This 3" button making system will include everything you need to make high-quality 3" buttons.



## 3Doodler Printing Pen

Draw in 3D by extruding heated plastic filament that cools almost instantly into a solid, stable structure. You'll be able to draw up into the air and create anything you can think of.





# What We Will Cover Today

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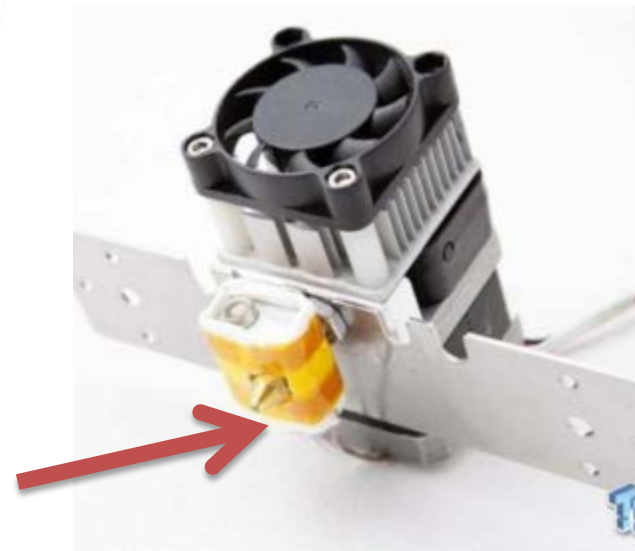
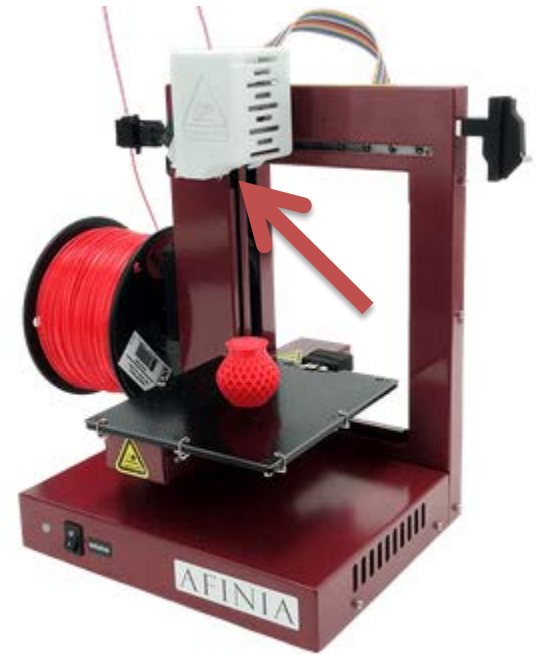
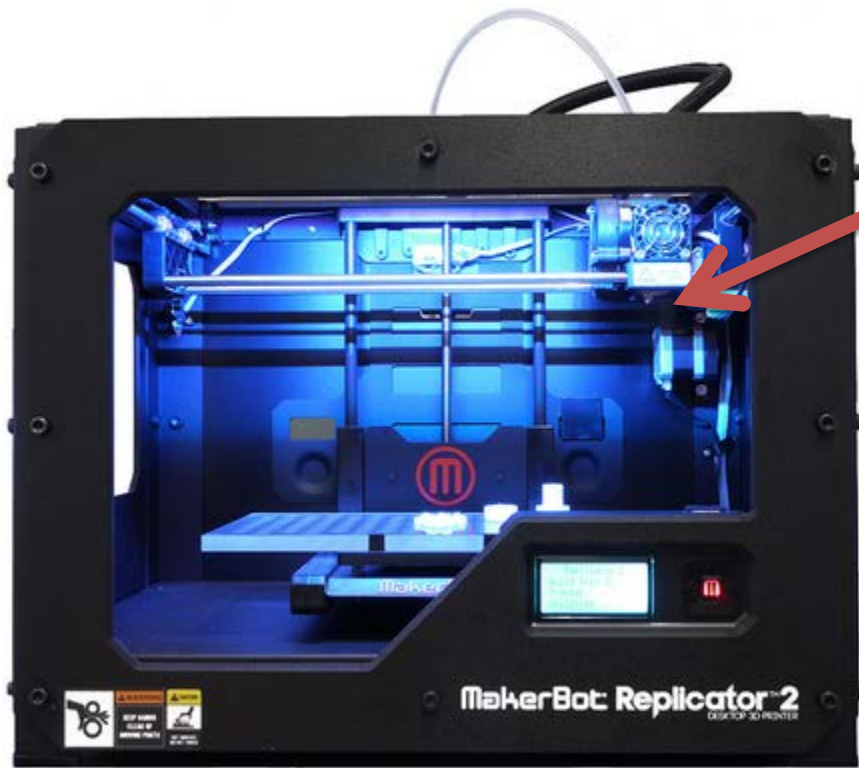
**<http://guides.hshsl.umaryland.edu/inspace>**

# What Is 3D Printing?

- **3D Printing** refers to the additive manufacturing process that builds a physical object from a three-dimensional digital model. There are many different types of 3D printing machines used for both personal/hobbyist and industrial purposes.
- **How Does 3D Printing Work?**  
Most entry-level desktop 3D printers are equipped with a heated extruder. The extruder takes the plastic filament, melts it, and lays down the material layer by layer to create a 3D object.

Source: <http://guides.hshsl.umaryland.edu/c.php?g=163717&p=1087293>

# Extruder

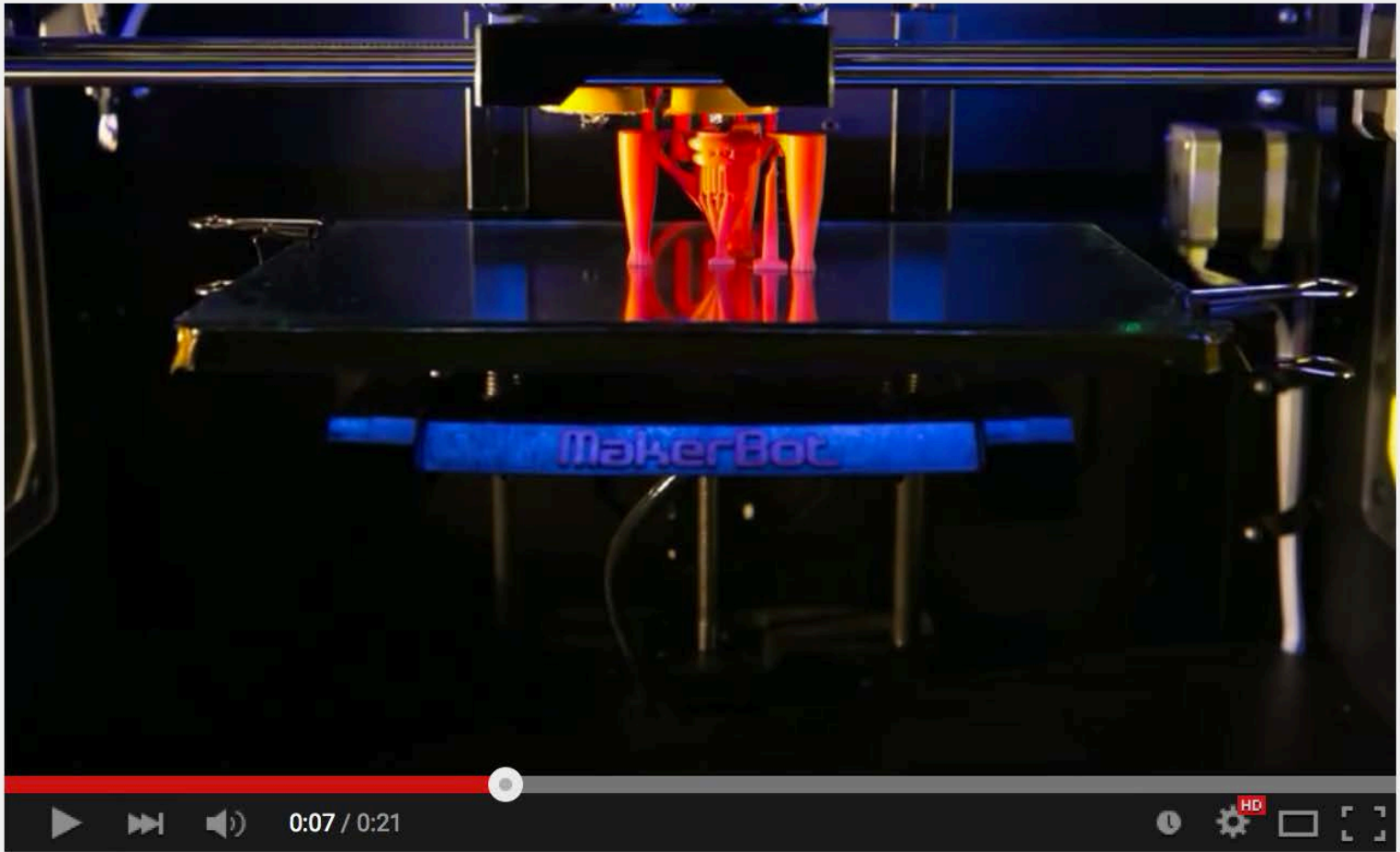


# How Does 3D Printing Work?

YouTube



<https://www.youtube.com/watch?v=-gaC5BpXljU>



MakerBot 3D Printing Timelapse

# 3D Printing in Progress




# 3D Print Job Completed


2015-04-21 20:26:05



# 3D Model Examples - .STL

MakerBot Thingiverse DASHBOARD EXPLORE CREATE  SIGN IN / JOIN

 **CT Scan of Mouse Femur (half)**  
by 10monthspregnant, published Sep 12, 2014



Thingiview

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<http://www.thingiverse.com/thing:460437>

Thing Info	Instructions	Thing Files	0 Comments	0 Made	2 Collections	0 Remixes
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## 2. Finding **.STL** 3D Model Files

- [NIH 3D Print Exchange](#)
- [Thingiverse](#)
- [Instructables](#)
- [3D Warehouse](#)
- [GrabCAD](#)
- [Ponoko](#)
- [Nervous System](#)
- Not all 3D model files found here are 3D printable!

More information at


<http://guides.hshsl.umaryland.edu/c.php?g=163717&p=1075331>





<http://www.thingiverse.com/>

131 results for "prosthetic": THINGS ▾

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 **The Prosthetic Hand Kit** May 2, 2010  
by spedzero





♥ 37    📦 46    💬 3

 **Ody Hand RP 1.0 (a Prost...** Jun 8, 2014  
by MacGyvrBot



♥ 33    📦 41    💬 1

 **Multiplexed Prosthetic De...** Apr 21, 2015  
by sandrabaskharon




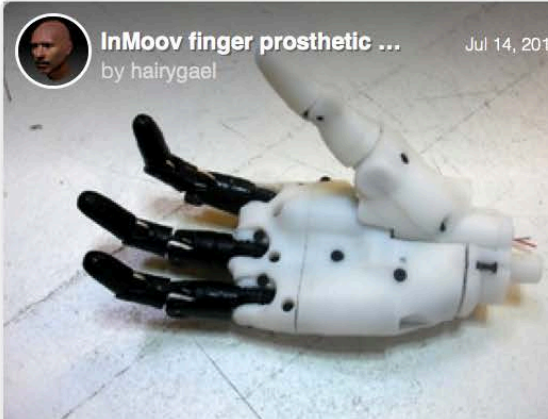
♥ 9    📦 3    💬 0

 **Prosthetic Hand for desig...** Aug 7, 2014  
by MacGyvrBot



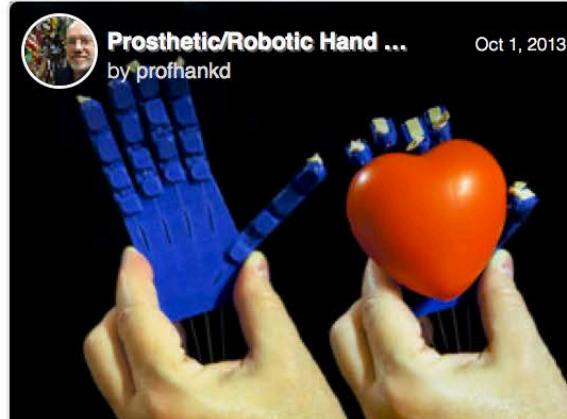
♥ 59    📦 54    💬 6

 **InMoov finger prosthetic ...** Jul 14, 2013  
by hairygael



♥ 144    📦 153    💬 8

 **Prosthetic/Robotic Hand ...** Oct 1, 2013  
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# NIH 3D Print Exchange



DISCOVER



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ENGAGE

3D printing technology is advancing at a rapid pace, but it is difficult to find or create 3D-printable models that are scientifically accurate or medically applicable. The NIH 3D Print Exchange provides models in formats that



## Special Collections



Prosthetics

Curated by e-NABLE



Neuroscience

Curated by EyeWire



Heart Library

Sponsored by Jump Simulation



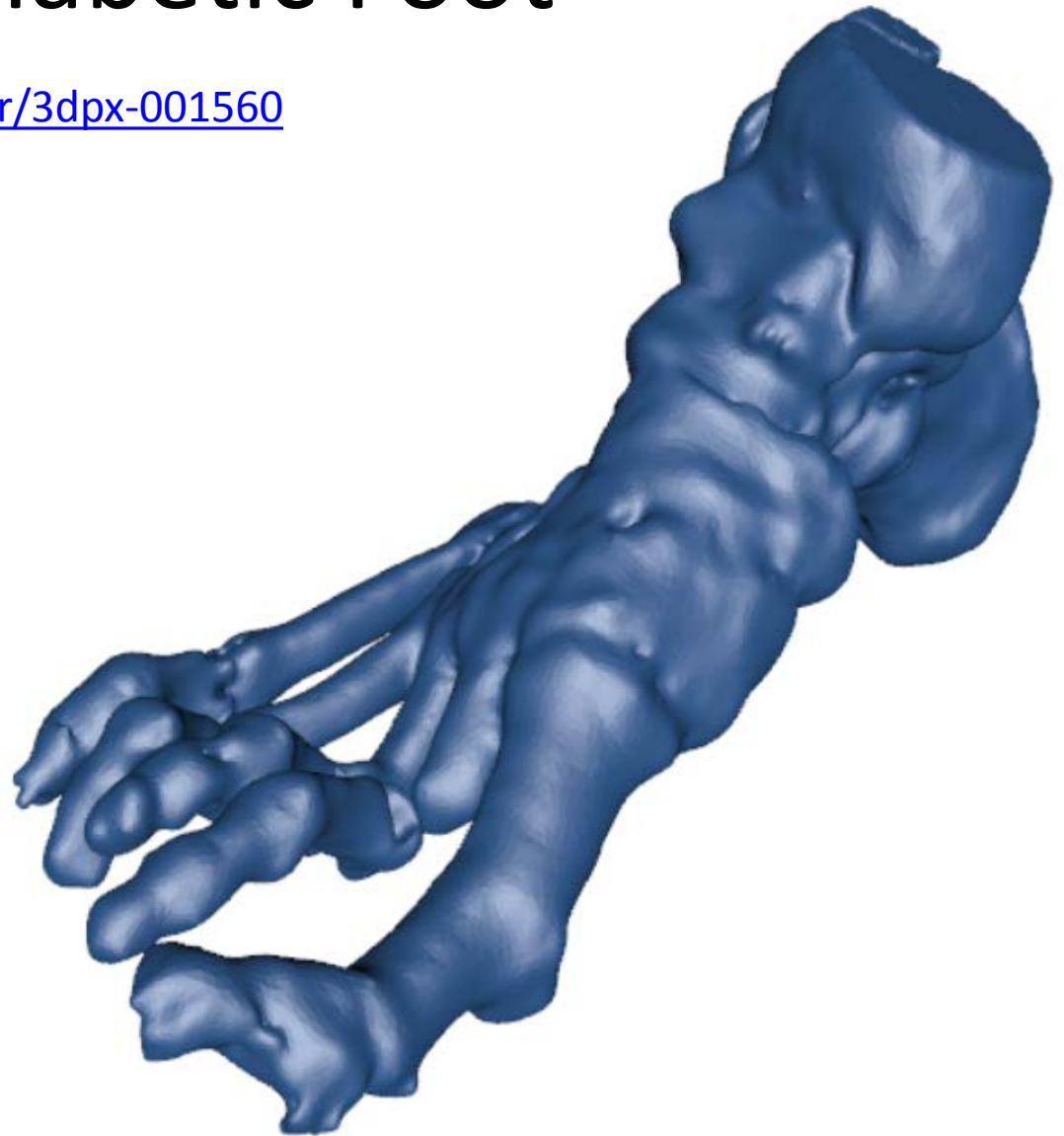
Molecule of the Month

by the RCSB Protein Data Bank

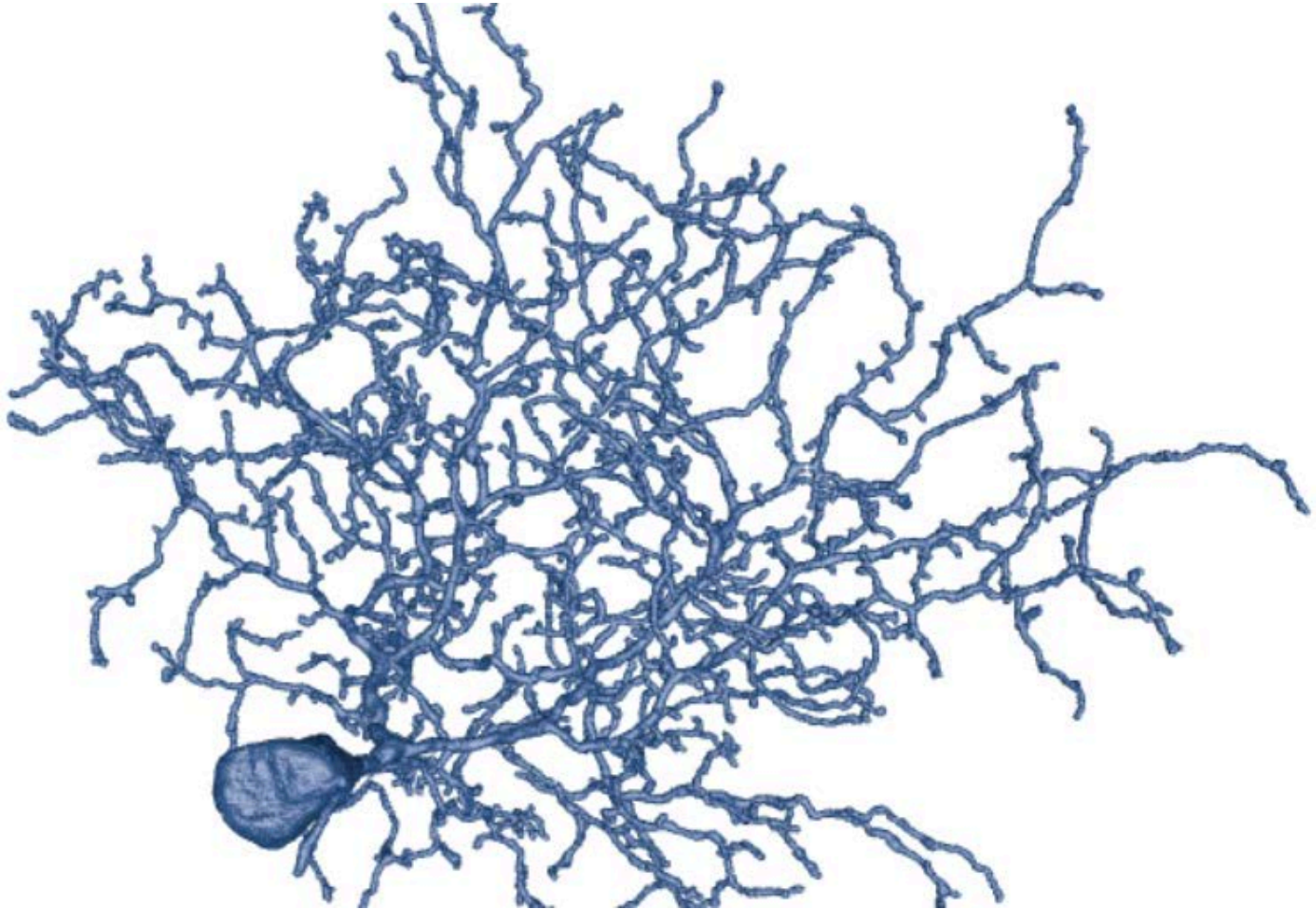
<http://3dprint.nih.gov/>

# Diabetic Foot

<http://3dprint.nih.gov/discover/3dpx-001560>

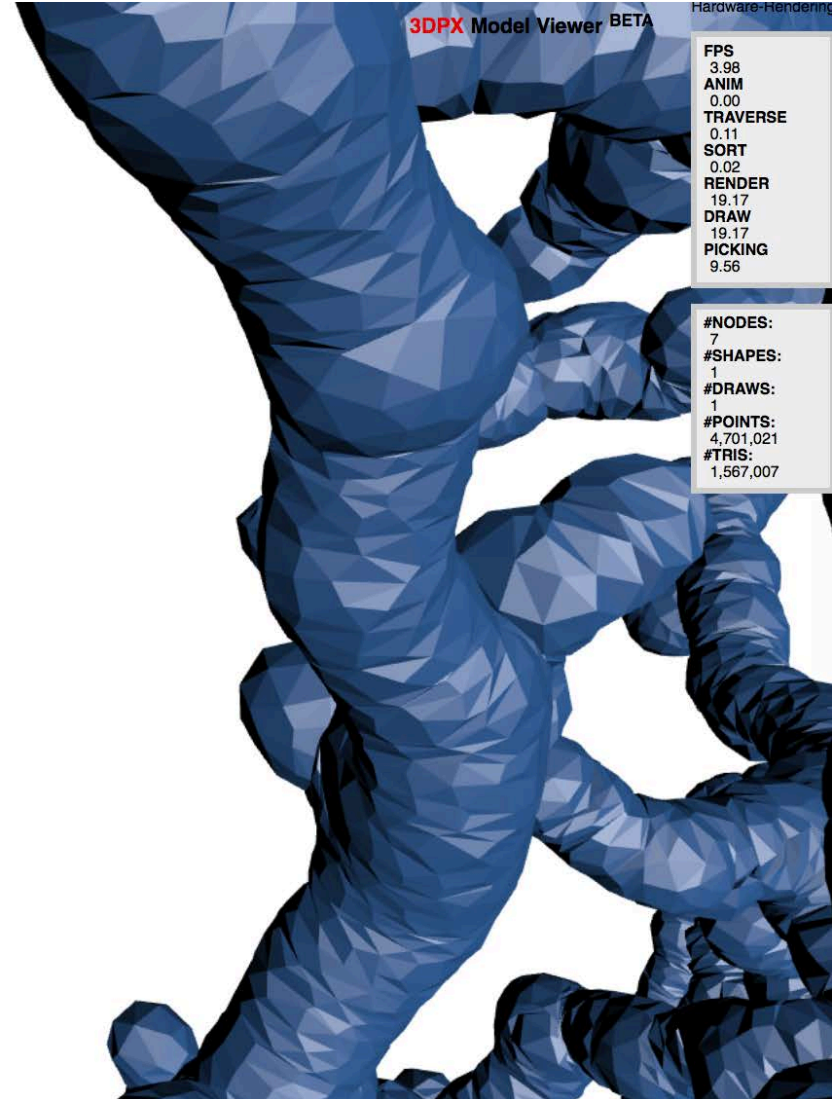
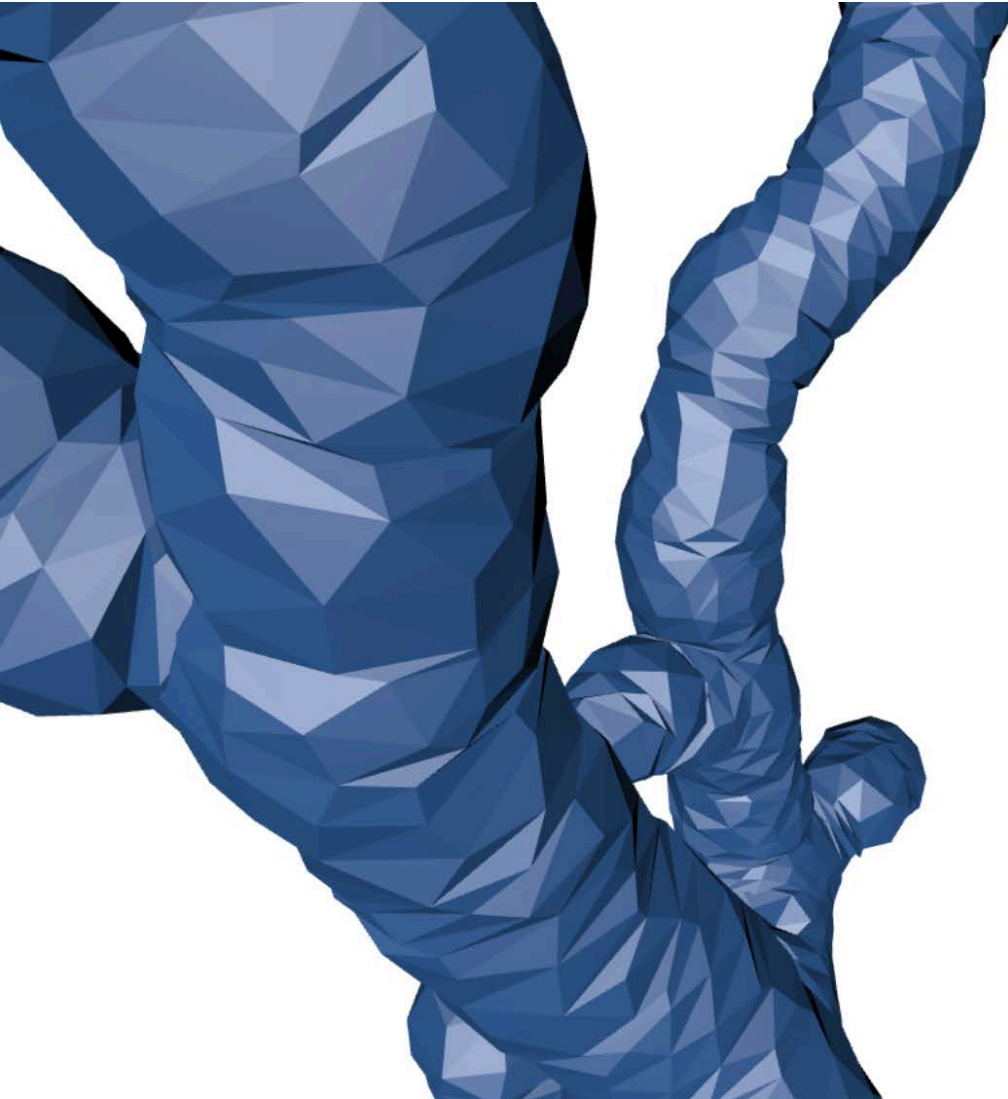


# Neuron



<http://3dprint.nih.gov/discover/3dpx/000912/x3d>

# Triangles in a Mesh





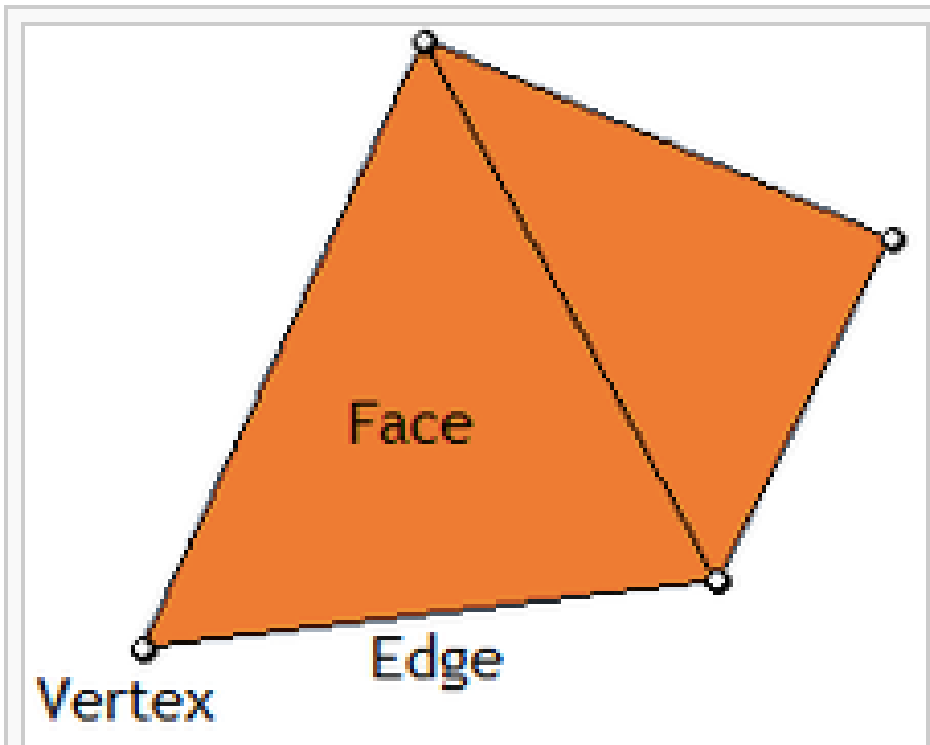
# Meshes That Cannot Be 3D-Printed



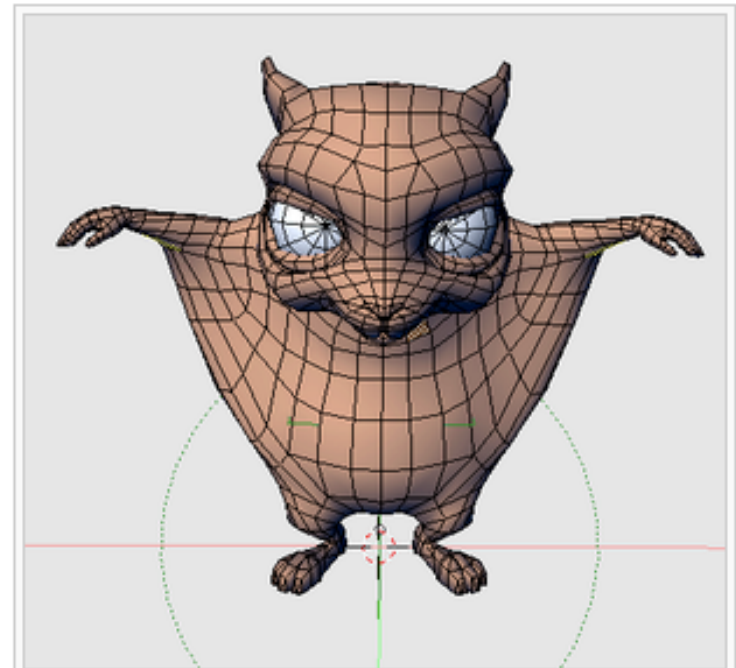
# 3D Mesh Modeling

- A **mesh** is a collection of vertices, edges, and faces that describe the shape of a 3D object.
  - A **vertex** is a single point.
  - An **edge** is a straight line segment connecting two vertices.
  - A **face** is a flat surface enclosed by edges. (Some other applications call these "polygons")
- Source:  
[http://en.wikibooks.org/wiki/Blender\\_3D:\\_Noob\\_to\\_Pro/What\\_is\\_a\\_Mesh%3F](http://en.wikibooks.org/wiki/Blender_3D:_Noob_to_Pro/What_is_a_Mesh%3F)





Your sketch might look like this.



A character from the "Yo Frankie!" 3D video game in Edit Mode, showing edges and faces.

The model is "(c) copyright Blender Foundation: [apricot.blender.org](http://apricot.blender.org)".

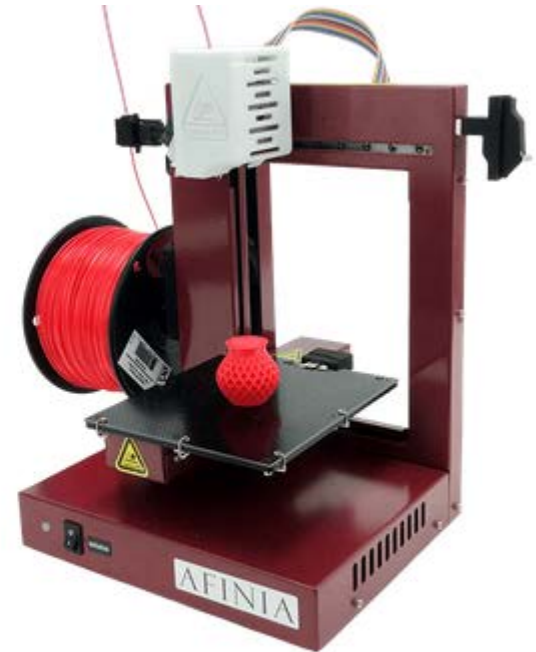
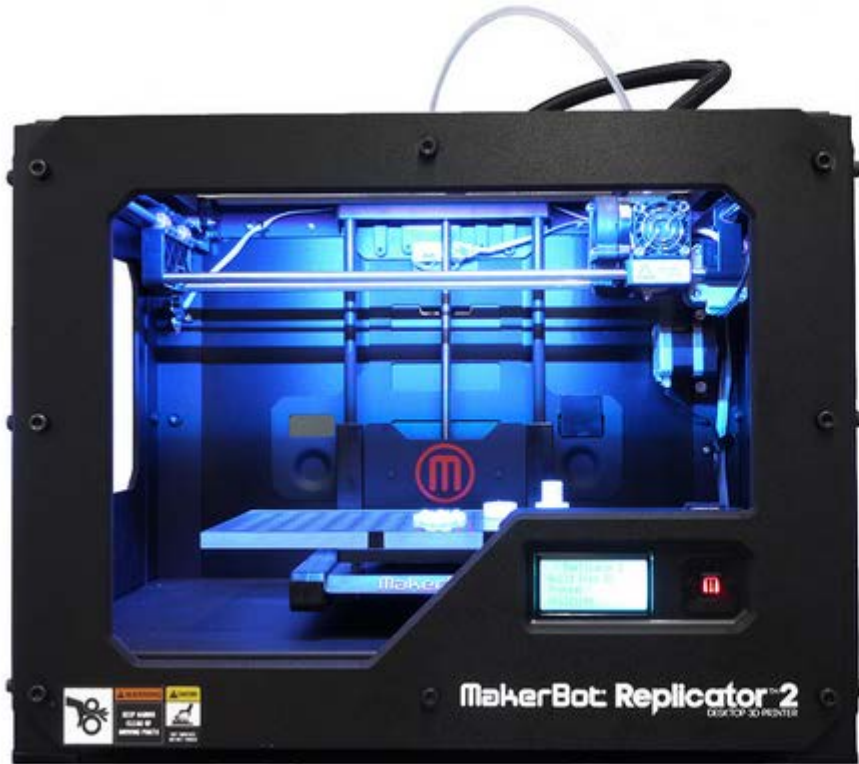
Source:

[http://en.wikibooks.org/wiki/Blender\\_3D: Noob to Pro/What is a Mesh%3F](http://en.wikibooks.org/wiki/Blender_3D:_Noob_to_Pro/What_is_a_Mesh%3F)

# 3. Checking if the File Can Be 3D-Printed

- **Correct Non-Manifold Geometry Issues**
- Is your 3D model solid/watertight and has the valid 3D geometry?
  - This means that all faces are closed and they form one or more closed entity.
  - There must be no open gaps/holes, non-manifold edges, self-intersections, zero-length edges, naked edges, degenerate faces, duplicate faces, or inverted triangles.
  - Upload and repair your file through the free [NetFabb Cloud Service](https://netfabb.azurewebsites.net/) - <https://netfabb.azurewebsites.net/>
  - Download the repaired version.
  - (Optionally, you may use other software to do the repair.)

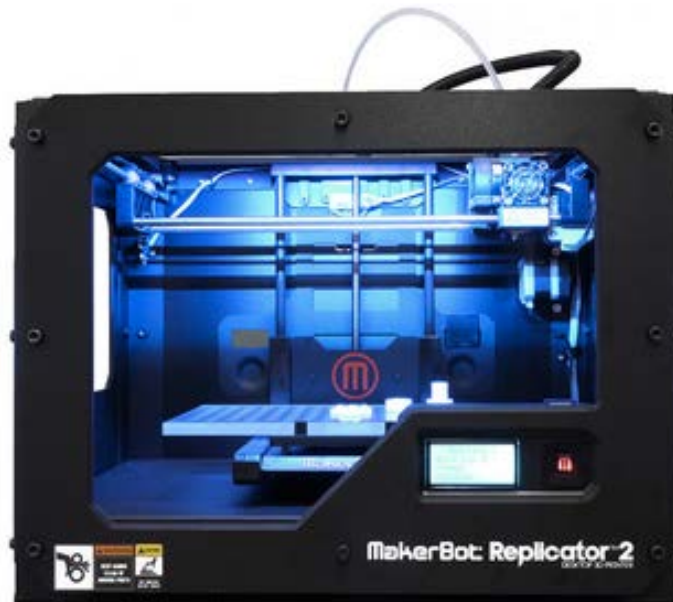
# 4. How to Operate 3D Printers



# Replicator 2X

- Detailed instruction here:

<http://guides.hshsl.umaryland.edu/c.php?g=163717&p=1598497>



# Afinia H480

- Detailed instruction here:

<http://guides.hshsl.umaryland.edu/c.php?g=163717&p=1598500>



# Scale the Size and Add Raft/Support

- **Raft / Support**

- The model with an overhang over 45 degrees will require a raft.
- A model may also need to be printed with a support as the base.
- Raft /Support can be added in the MakerBot 3D printer setting.
- Raft / Support will require more plastic and make the printing time longer.
- Raft / Support should be carefully removed from the model once it is printed.

More information at

<http://guides.hshsl.umaryland.edu/c.php?g=163717&p=1075332>

# 3D Printing Process Checklist

- <http://guides.hshsl.umaryland.edu/c.php?g=163717&p=1075333>

## 3D PRINTING AND 3D SCANNING AT THE INNOVATION SPACE

Get hands-on learning experience with 3D printing and 3D scanning!

Enter Search Words Search

### What Is 3D Printing?

3D Printing in Health Sciences

3D Printers at HS/HSL

### How-To Guide for 3D Scanning

Editing a 3D Scanned Image with the Sense 3D Scanner

### How-To Guide for 3D

## 5. 3D PRINTING PROCESS CHECKLIST

**\*You must ['Prepare and Repair Your 3D Model as a .STL file'](#) before starting a 3D print job.\***

1. Check with the CATS staff if the [maintenance has been recently performed](#).
2. For the successful 3D printing, the platform needs to be leveled properly, and both the platform and the extruder need to be clean.
3. You may apply or replace the blue painter's tape on the plate to remove the printed object more easily.
4. Make sure you have enough filament on the spool.

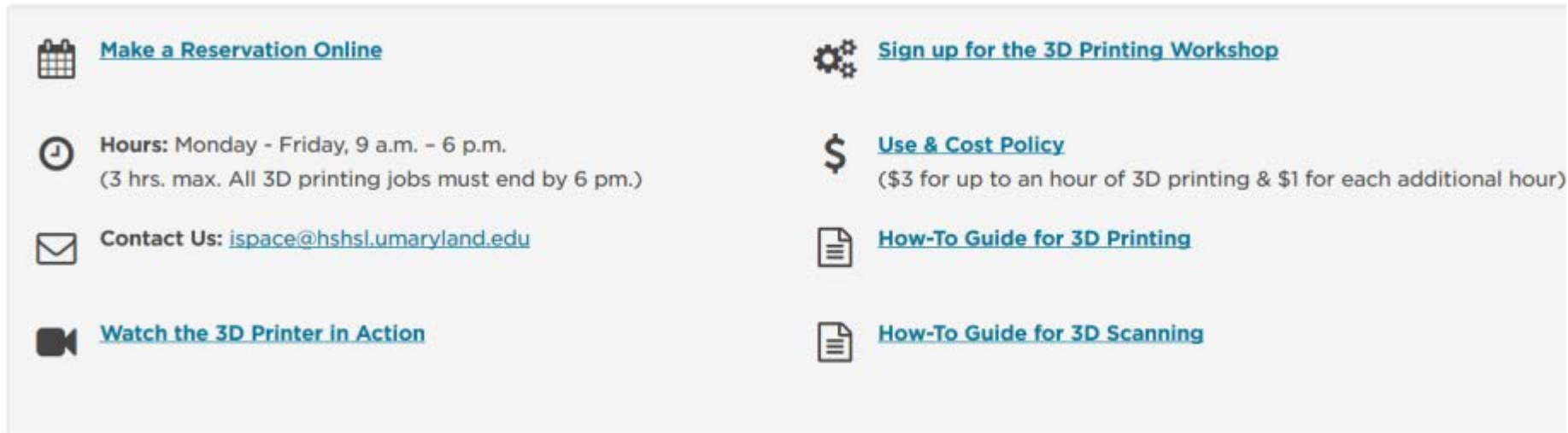
# Next Steps

- Let's go up to the HS/HSL Innovation Space to take a look at the 3D printers!
- All questions are welcome.
- After the workshop,
  - Check the Innovation Space Guide!
  - <http://guides.hshsl.umaryland.edu/c.php?g=163717&p=1075336>
  - Make a reservation for the Innovation Space.
  - Take the orientation & 3D Print and Scan!











# After this workshop,

- Make a reservation for orientation/use!  
<http://cal.hshsl.umaryland.edu/booking/inspace>.



A screenshot of a website menu for 3D printing services. The menu is organized into two columns. The left column contains: a calendar icon for 'Make a Reservation Online', a clock icon for 'Hours: Monday - Friday, 9 a.m. - 6 p.m. (3 hrs. max. All 3D printing jobs must end by 6 pm.)', an envelope icon for 'Contact Us: [inspace@hshsl.umaryland.edu](mailto:inspace@hshsl.umaryland.edu)', and a video camera icon for 'Watch the 3D Printer in Action'. The right column contains: a gear icon for 'Sign up for the 3D Printing Workshop', a dollar sign icon for 'Use & Cost Policy (\$3 for up to an hour of 3D printing & \$1 for each additional hour)', a document icon for 'How-To Guide for 3D Printing', and another document icon for 'How-To Guide for 3D Scanning'. All links are in blue text.

 <a href="#">Make a Reservation Online</a>	 <a href="#">Sign up for the 3D Printing Workshop</a>
 <b>Hours:</b> Monday - Friday, 9 a.m. - 6 p.m. (3 hrs. max. All 3D printing jobs must end by 6 pm.)	 <a href="#">Use &amp; Cost Policy</a> (\$3 for up to an hour of 3D printing & \$1 for each additional hour)
 <b>Contact Us:</b> <a href="mailto:inspace@hshsl.umaryland.edu">inspace@hshsl.umaryland.edu</a>	 <a href="#">How-To Guide for 3D Printing</a>
 <a href="#">Watch the 3D Printer in Action</a>	 <a href="#">How-To Guide for 3D Scanning</a>

- Prototype, create, collaborate!

# Contact Us!

- E-mail [ispace@hshsl.umaryland.edu](mailto:ispace@hshsl.umaryland.edu)
- HS/HSL Innovation  
Space: <http://www.hshsl.umaryland.edu/services/ispace/>
- 3D Printing/3D Scanning How-To Guide  
<http://guides.hshsl.umaryland.edu/ispace>