ROHINI COLLEGE OF ENGINEERING AND TECHNOLOGY

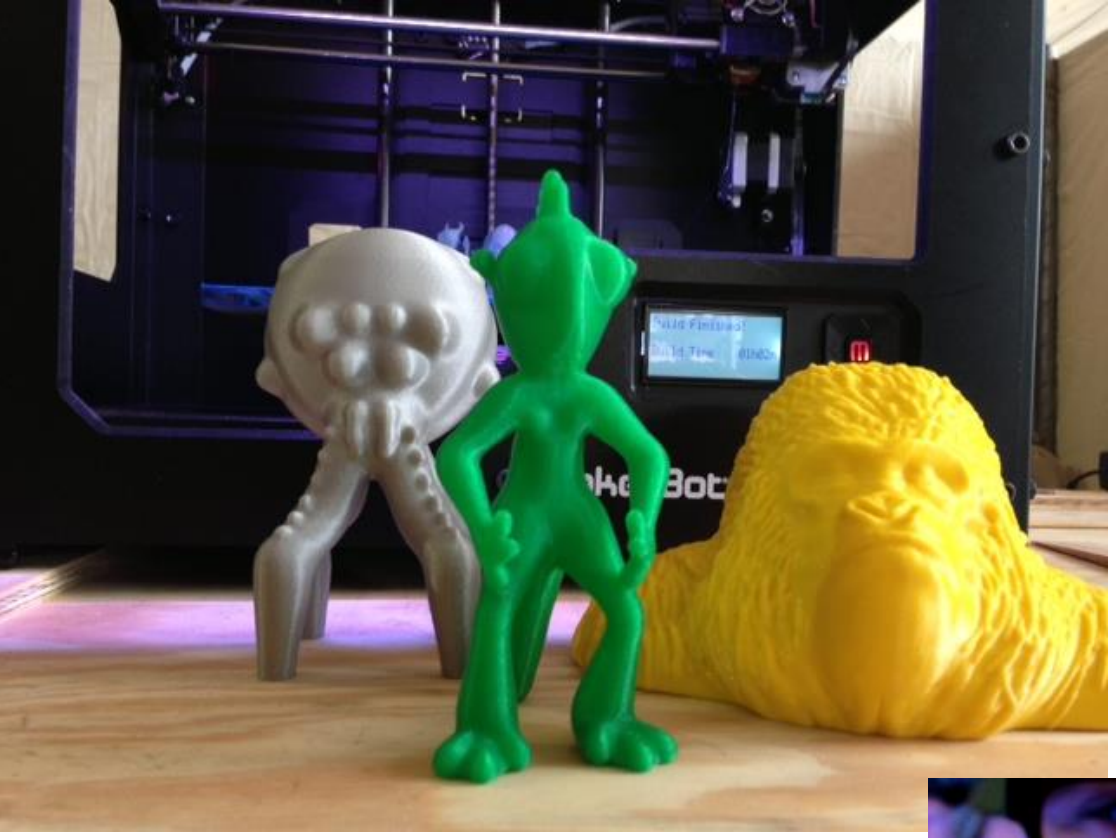
Kanyakumari Main Road, Near Anjugramam, Palkulam, Tamil Nadu 629401

Department of Mechanical Engineering

VALUE ADDED COURSE ON 3D PRINTING

3D Printing

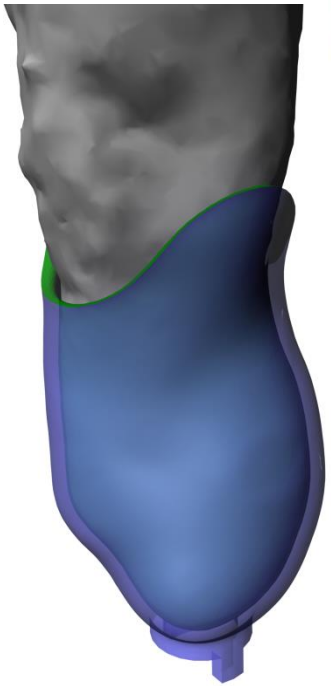
Fizgig's Gargoyle, created by colinfizgig



Custom Prosthetic Sockets

Goal: speed up production of prosthetic sockets for children in the developing world.

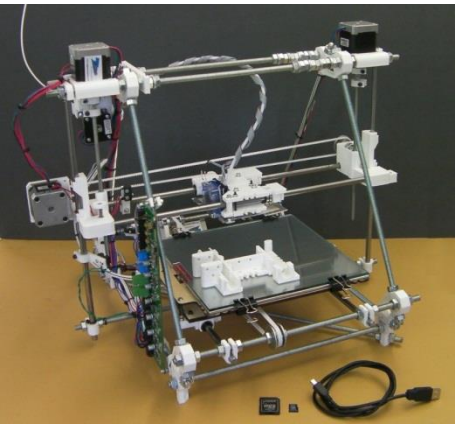
1) 3D Scan with Kinect
2) Model prosthetic socket from scan using Meshmixer
3) Print with Makerbot



How 3D Printing Works

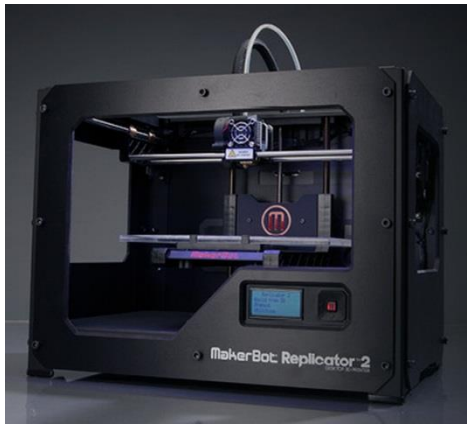
3D Printers

RepRap



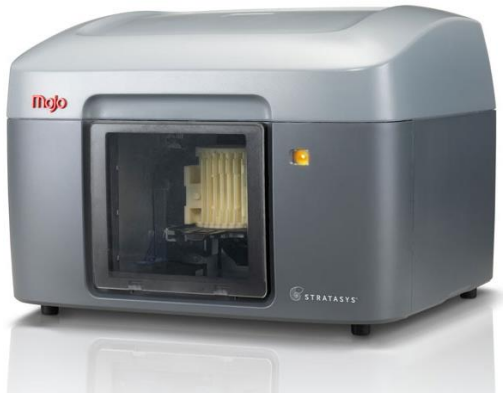
$500

Replicator 2



$2,500

Stratasys Mojo

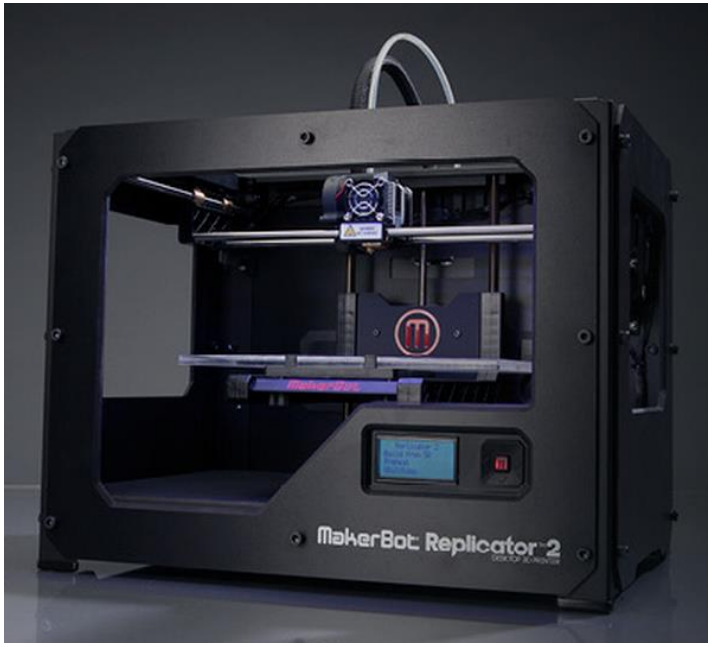


$10,000

Objet Connex

$200,000+

MakerBot INDUSTRIES



- $2,199
- Materials are cheap plastic
- Hackable FDM process
- Quality / reliability? well…

formlabs

- $3,299
- Materials are liquid resin
- SLA (lasers!)
- Higher quality (reliability?)

Makerbot Replicator 2

- Single-material FDM/FFF Printer
  *(**F**used **D**eposition **M**odeling)*
  *(**F**used **F**ilament **F**abrication)*

- Uses plastic **PLA** filament (cheap!)

- Max print volume is 11” x 6” x 6” *“loaf of bread”*

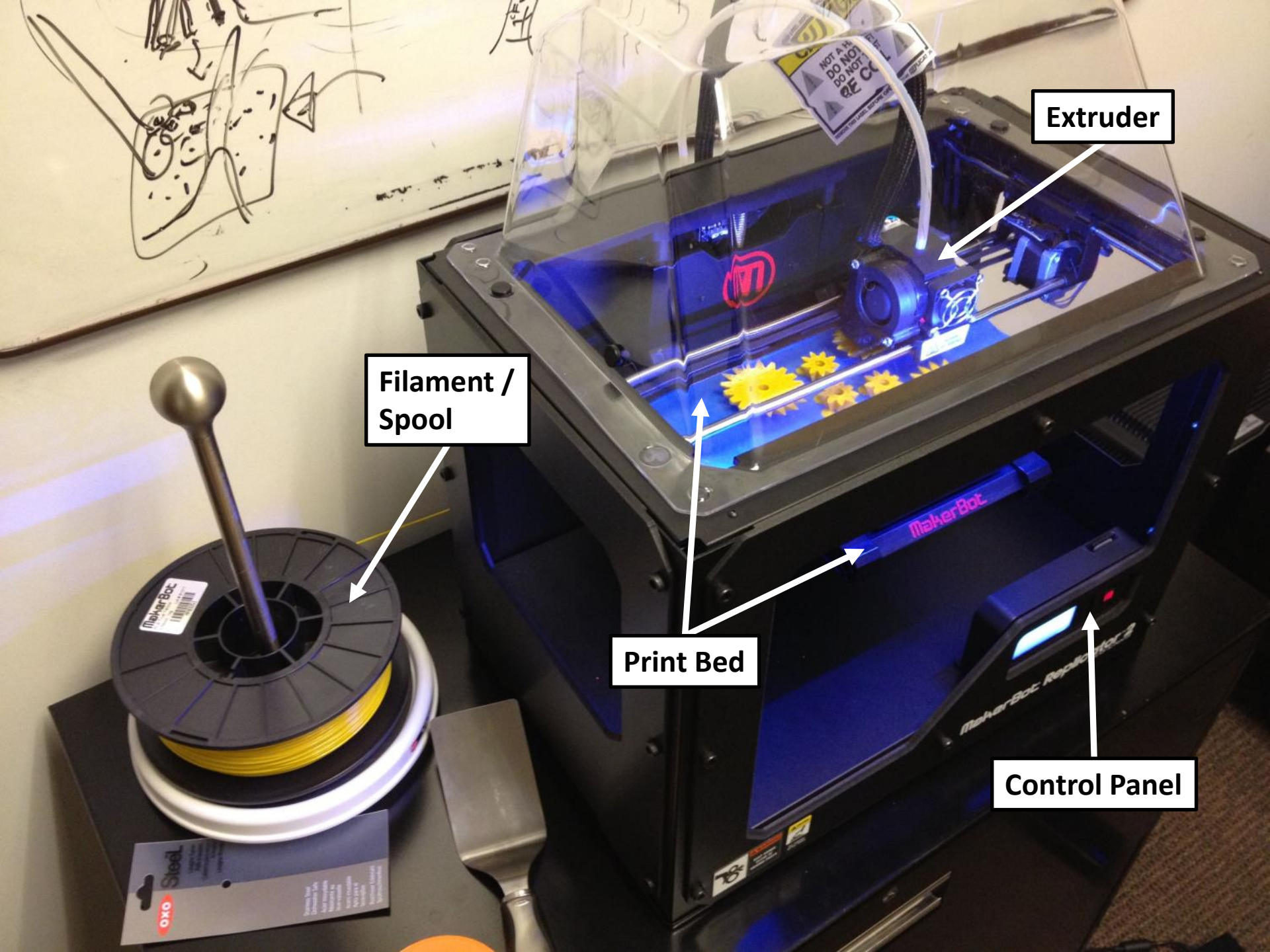
PLA vs ABS

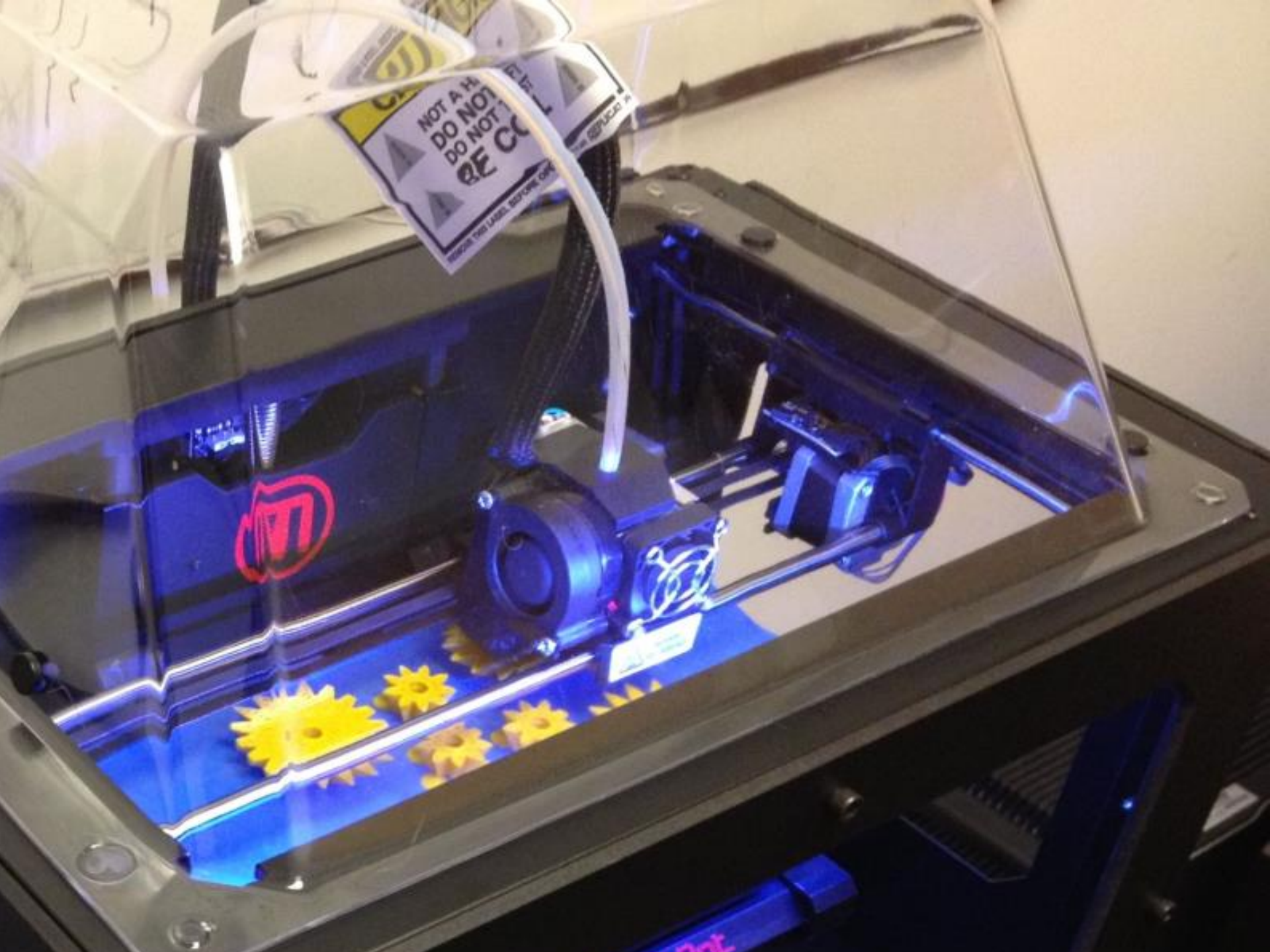
- PLA
  - Starch-based bioplastic
  - Compostable at commercial facilities (not your yard)
  - Melts at lower temperatures, sticks better
  - Not very temperature-resistant
  - Can be semi-transparent, glow-in-the-dark

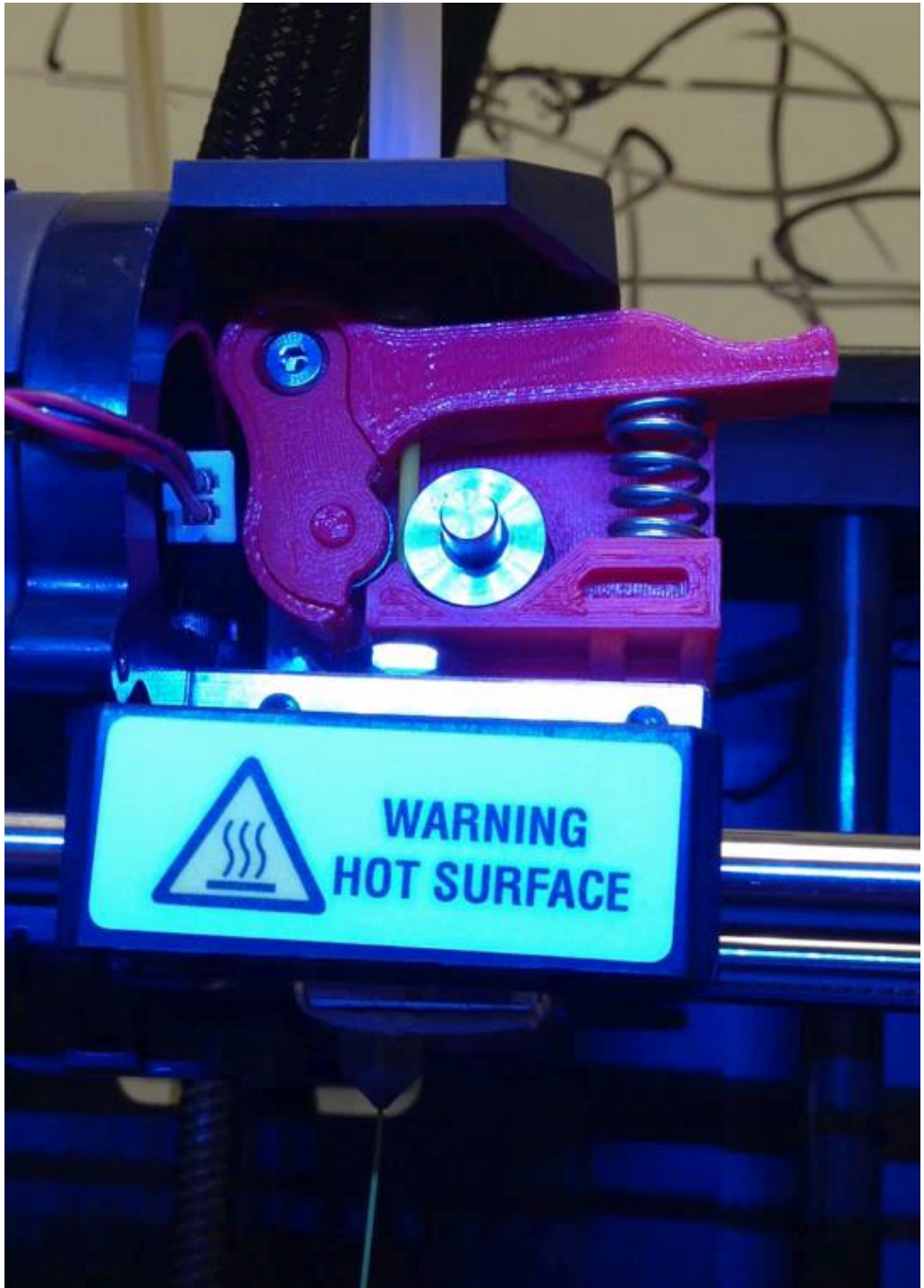
- ABS
  - Extremely common petroleum-based polymer
  - More prone to curling & cracking
  - Better strength, flexibility, machinability, temperature and impact resistance *(but sensitive to sunlight)*
  - Can join parts with acetone

New Types of Filament

- “Wood” filament
- Rubber filament (prints are bendy)


Extruder
Filament / Spool
Print Bed
Control Panel
MakerBot
MakerBot Replicator 2
MakerBot
OXO
Steel




WARNING
HOT SURFACE

How Printing Happens

- Bottom To Top in 2D layers

- For each 2D layer:
  1) Outer “Shells”
  2) Rasterization pattern on solid layers
  3) “Infill” pattern for interior volume
     - Uses less material

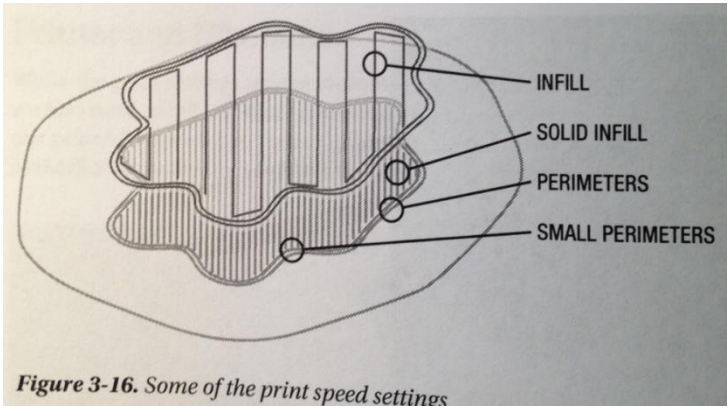


Figure 3-16. Some of the print speed settings

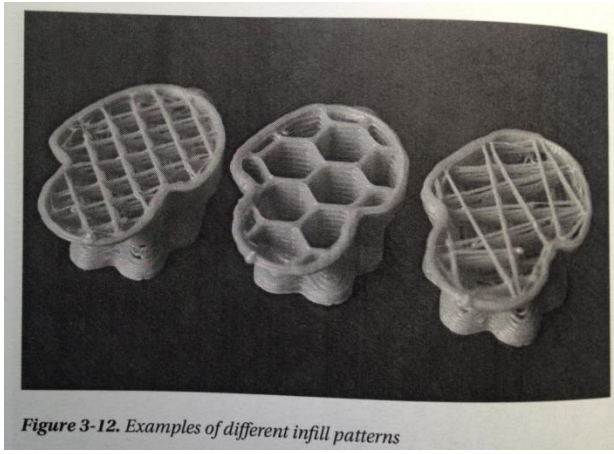
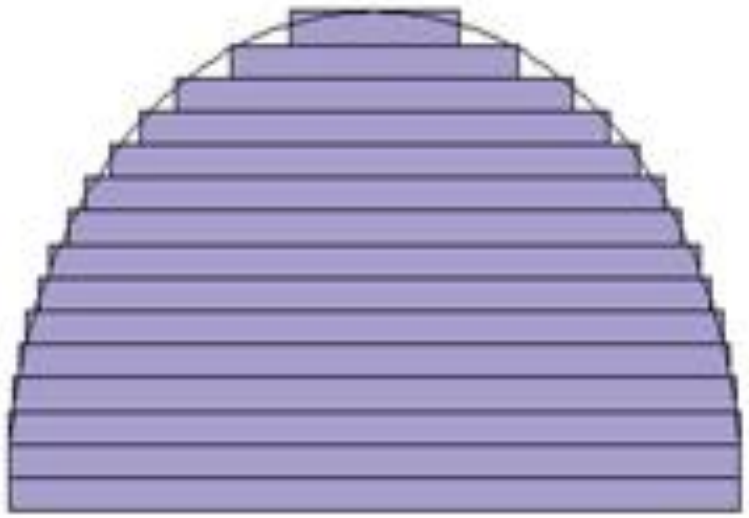
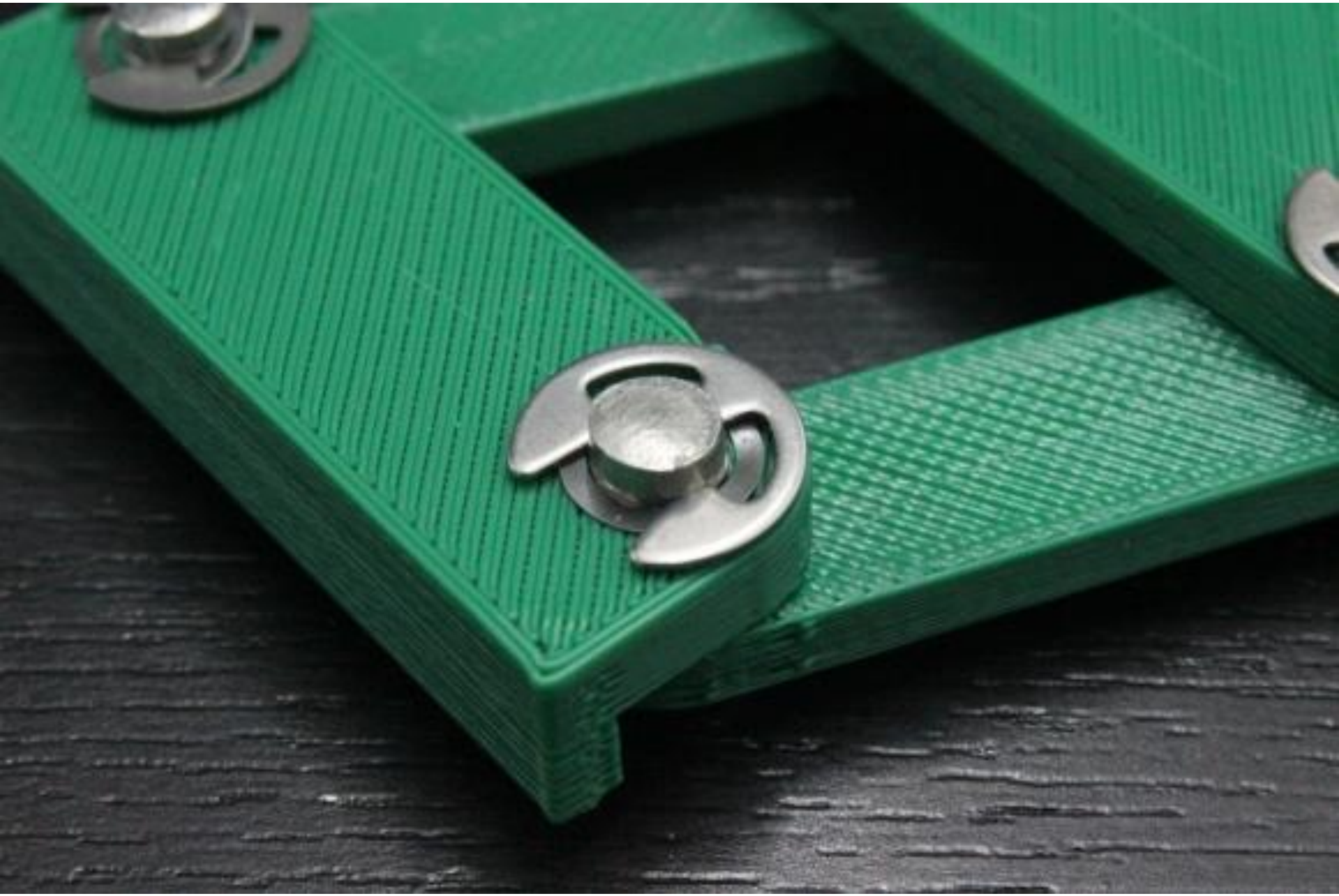


Figure 3-12. Examples of different infill patterns





Limits of 3D Printing

1) **Print size**

2) **Overhangs**

3) **Thickness**

Print Volume

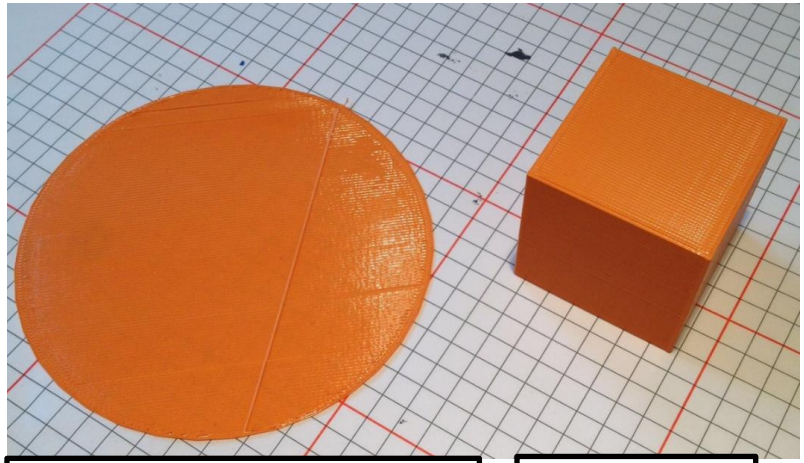
- **Print Time**
  is proportional to
  3D Volume
  and
  Surface Complexity

- To print in 30 minutes, your objects will have to be **SMALL** and **FLAT**

Print Time

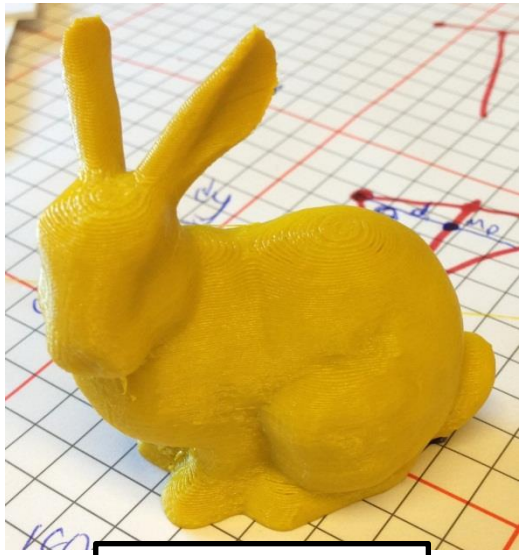
- Hard to estimate
  - Volume
  - Surface area
  - Toolpath
  - ???

15cm high, 10 hr



10cm x 1 layer, 10min

4cm^3, 1hr

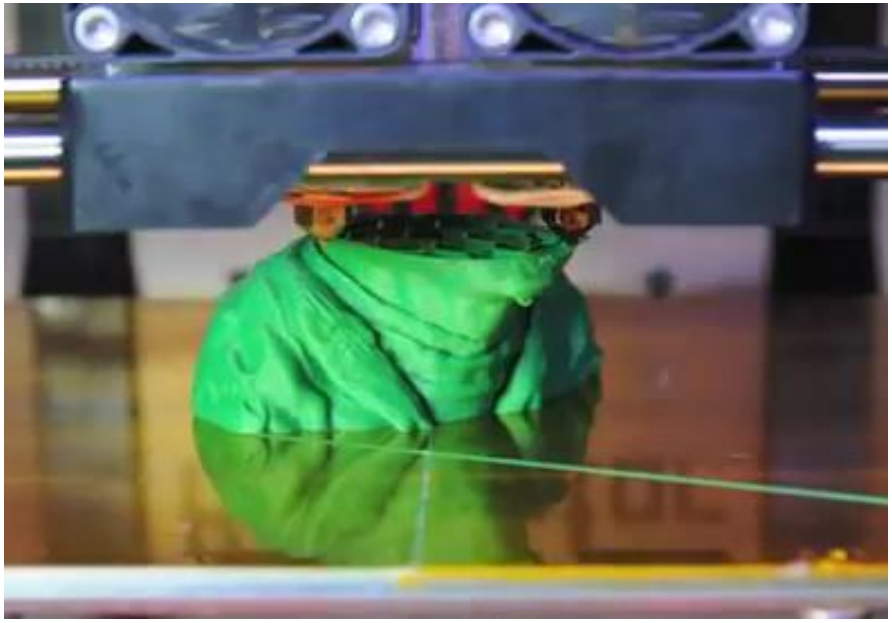


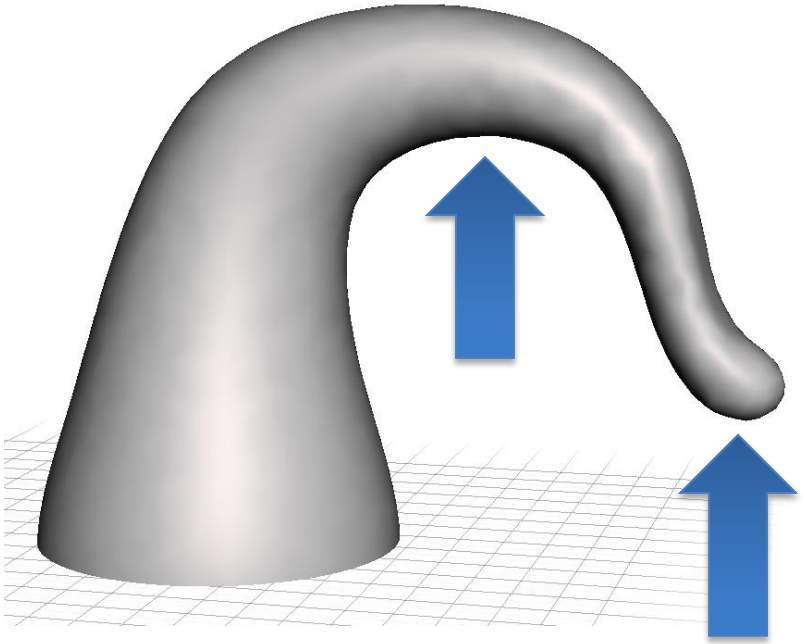
5cm high, 45m

8cm high, 3hr

Overhangs

- Printer prints bottom-to-top
- If there is nothing underneath…





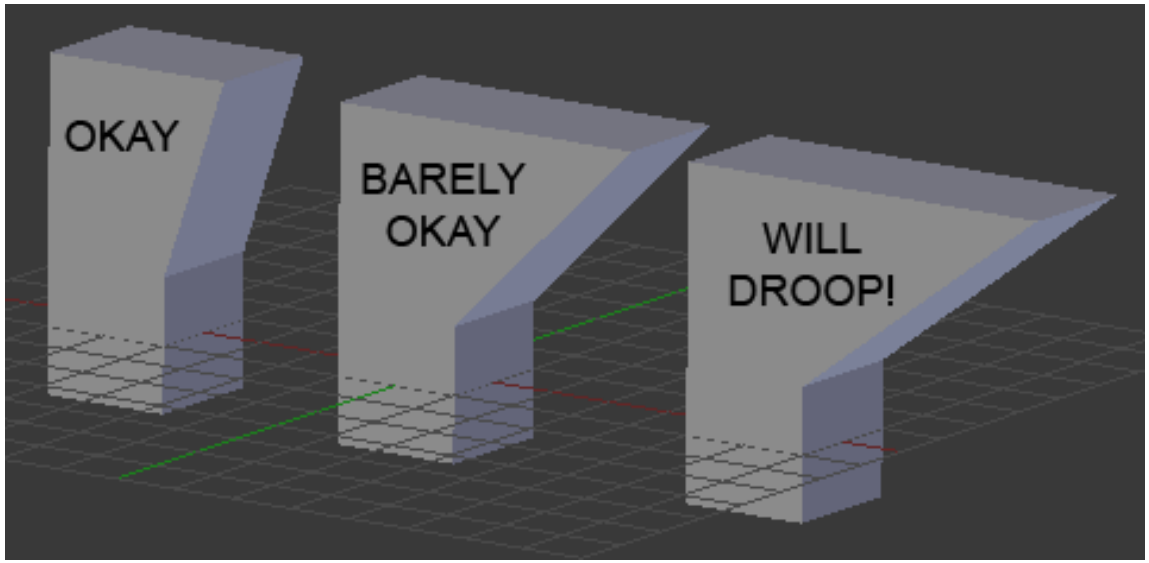
“Drooping”

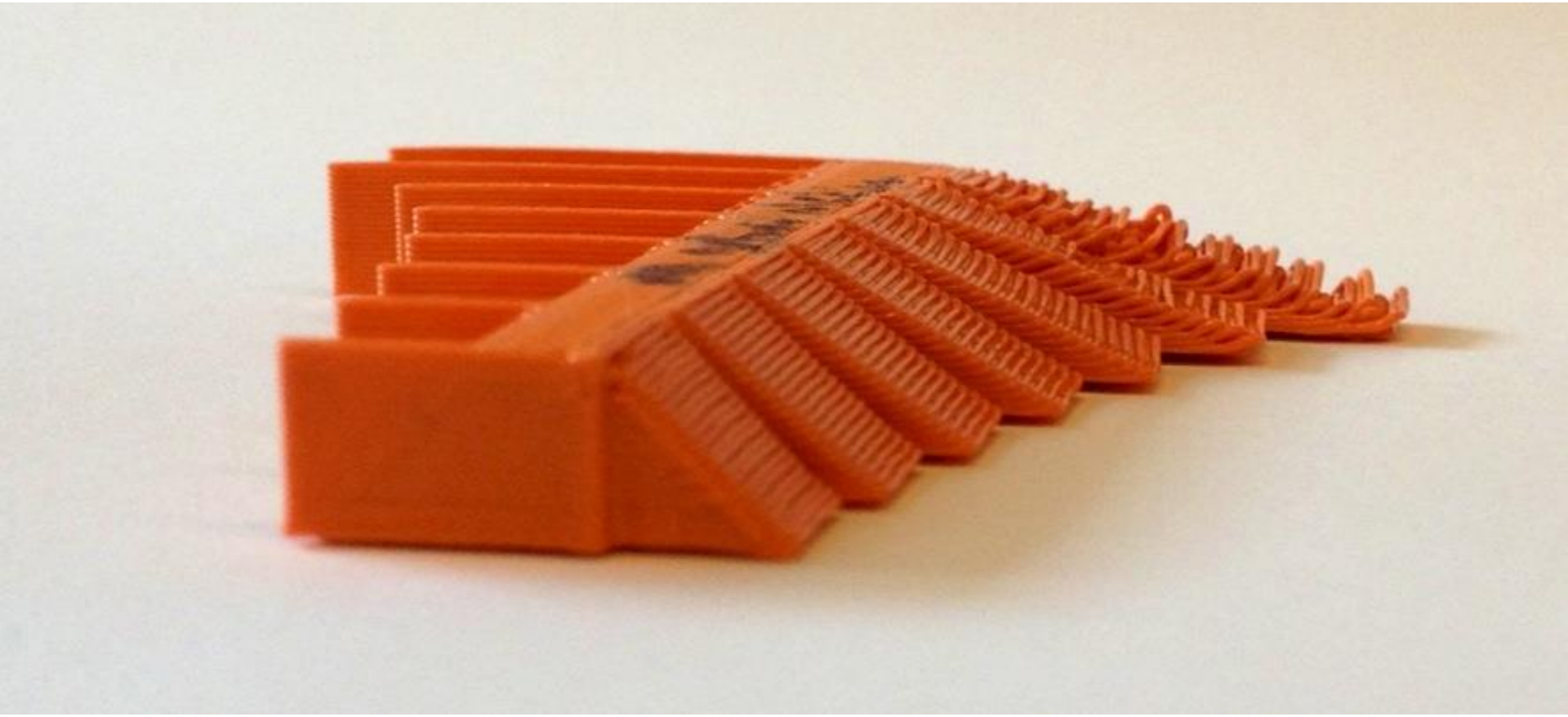
Draft Angle

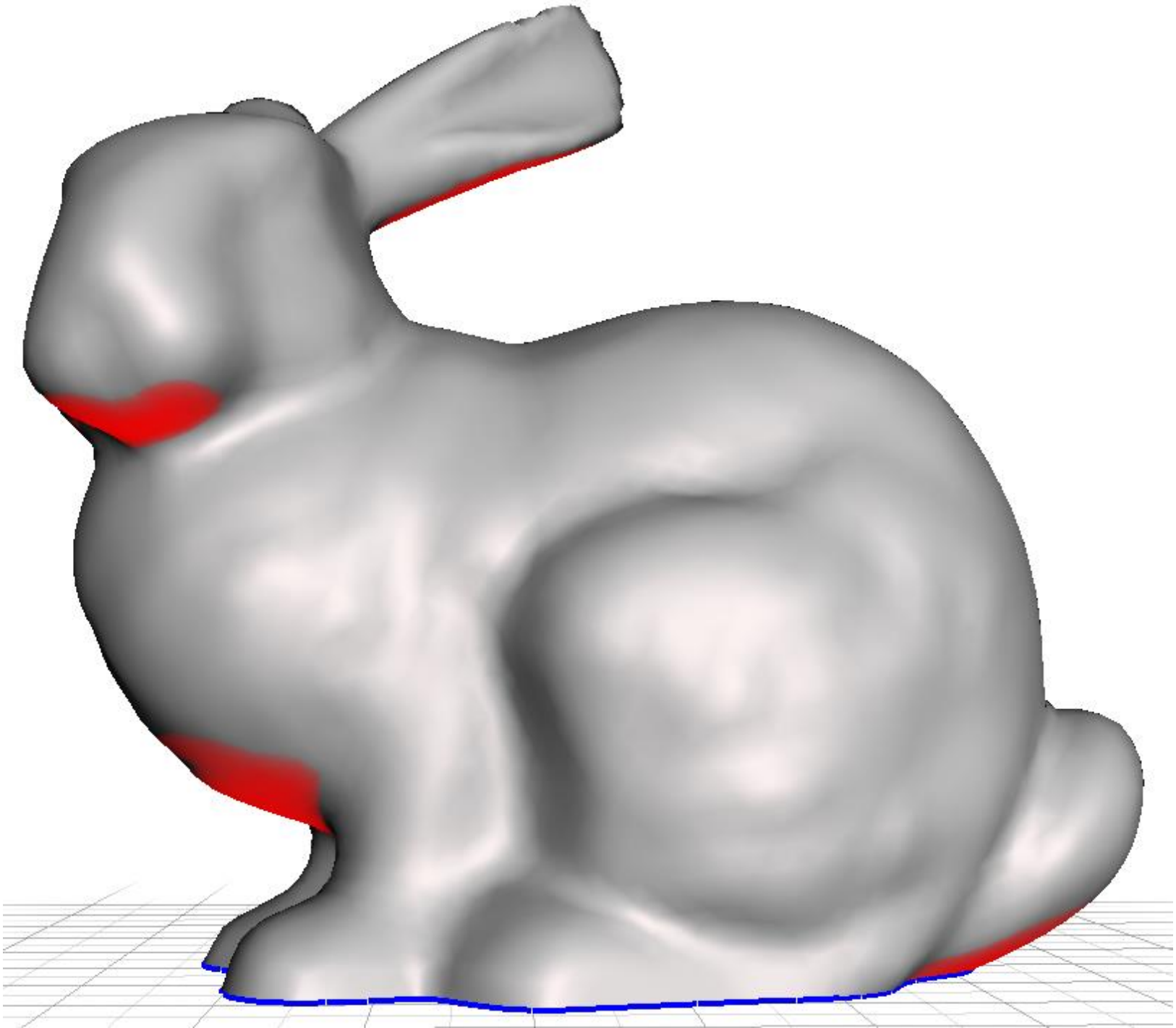
- Shallow angles need support too

- Rule-of-thumb is 45 degrees

(but 25 works…)

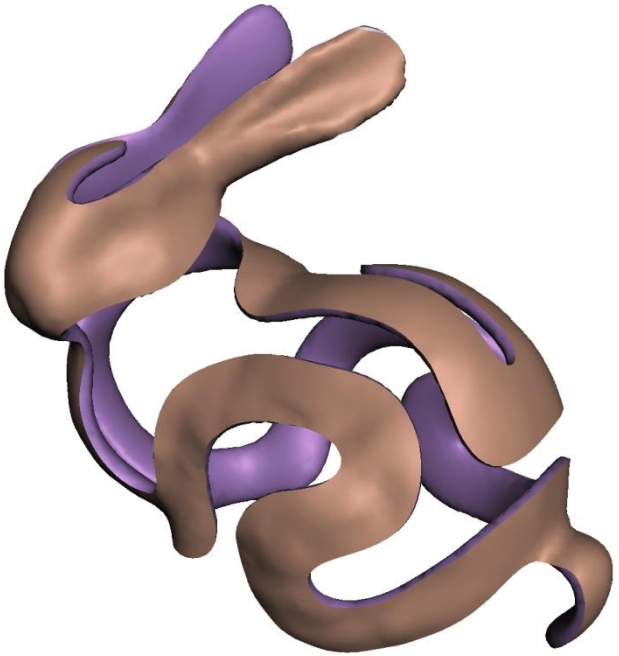




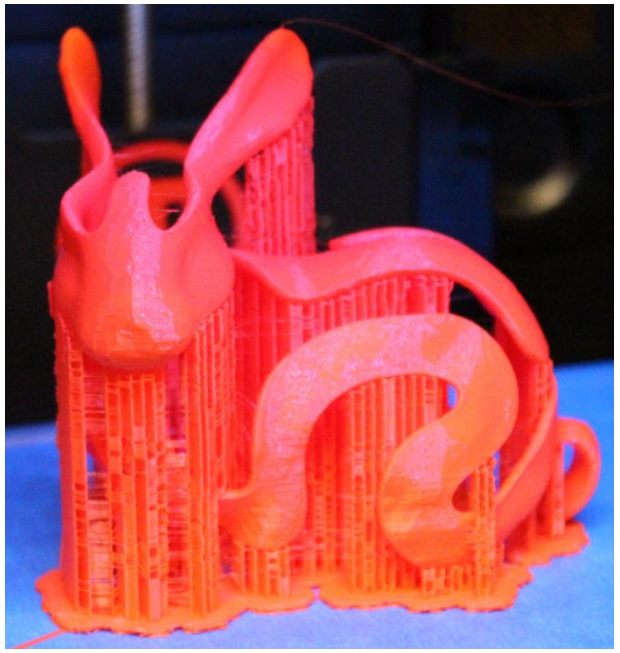


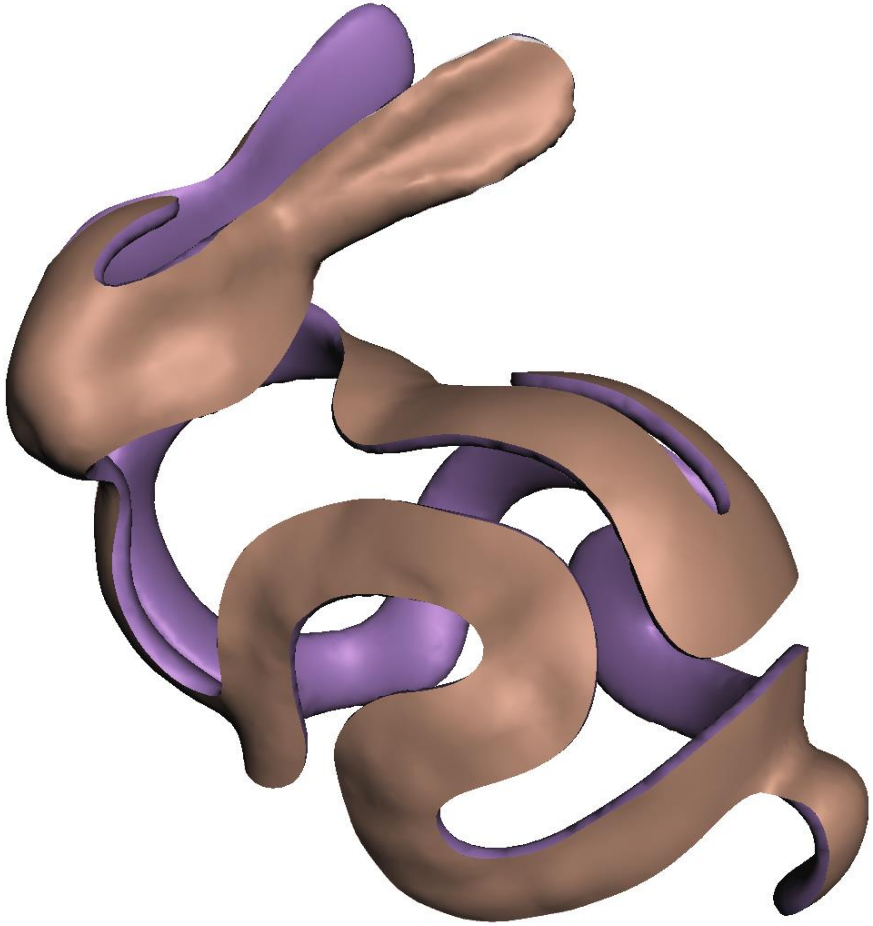
Support Structures

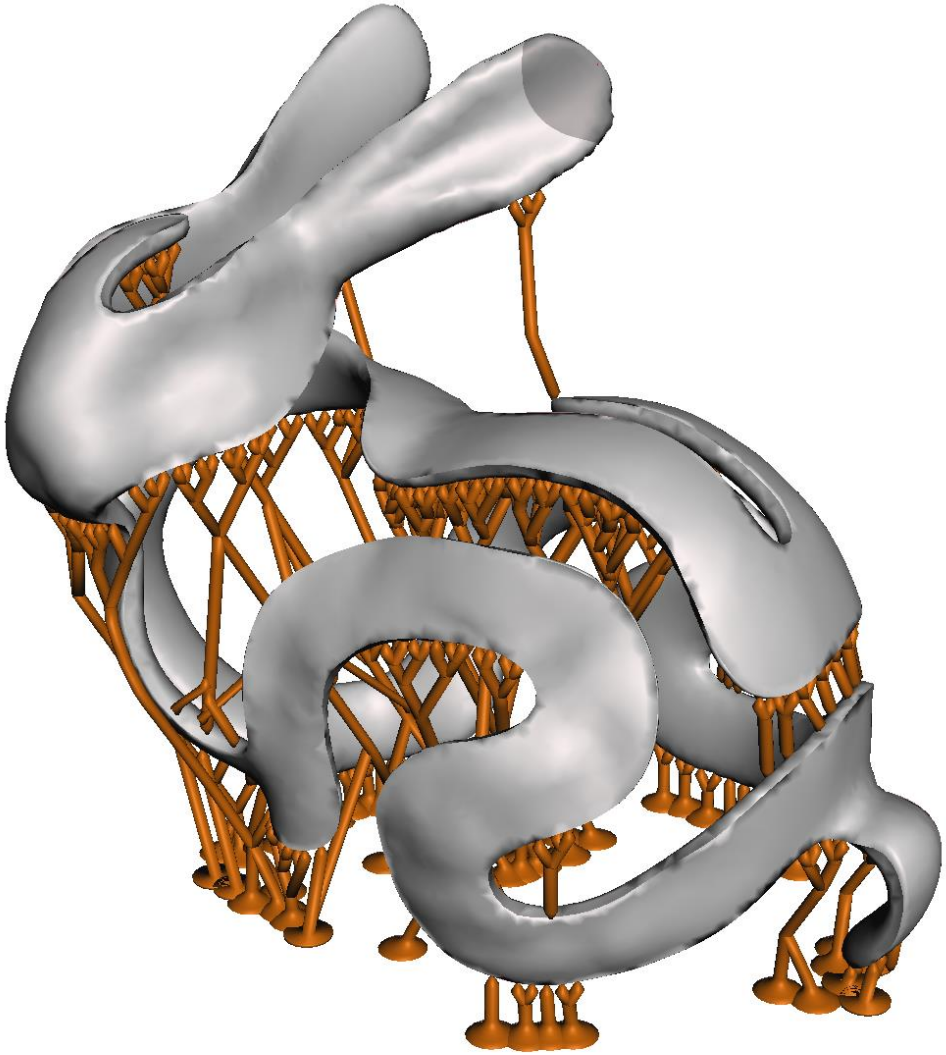
- Add parts to your model that you have to manually snap off aftewards

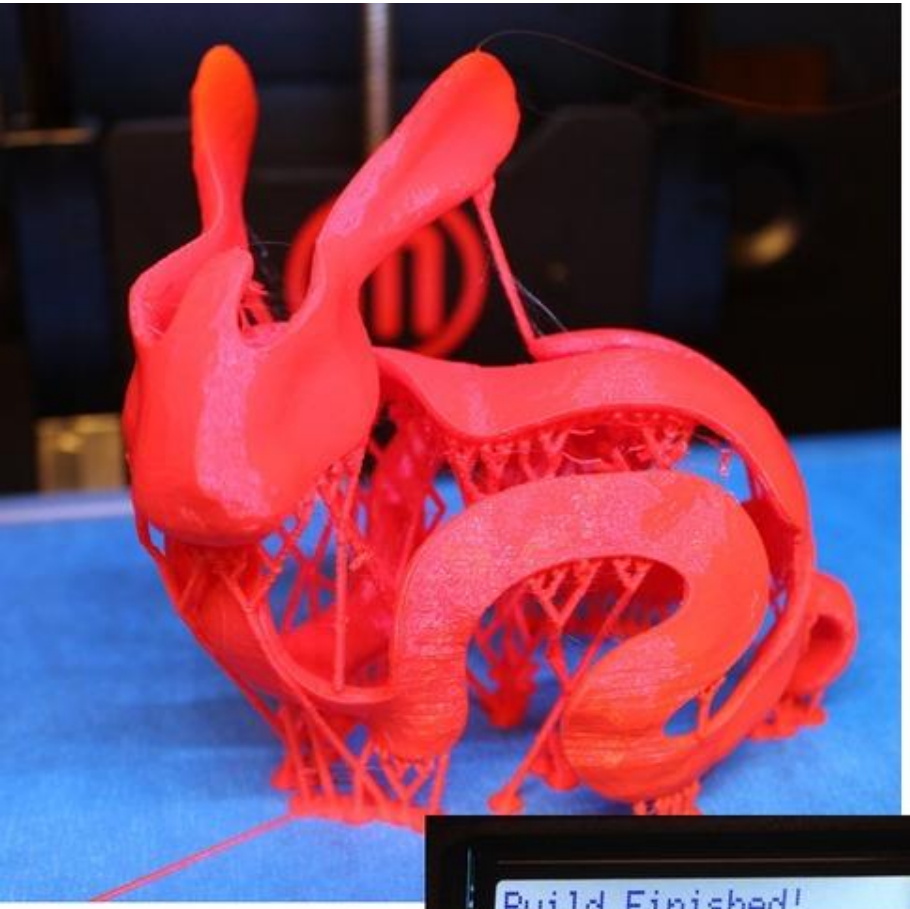


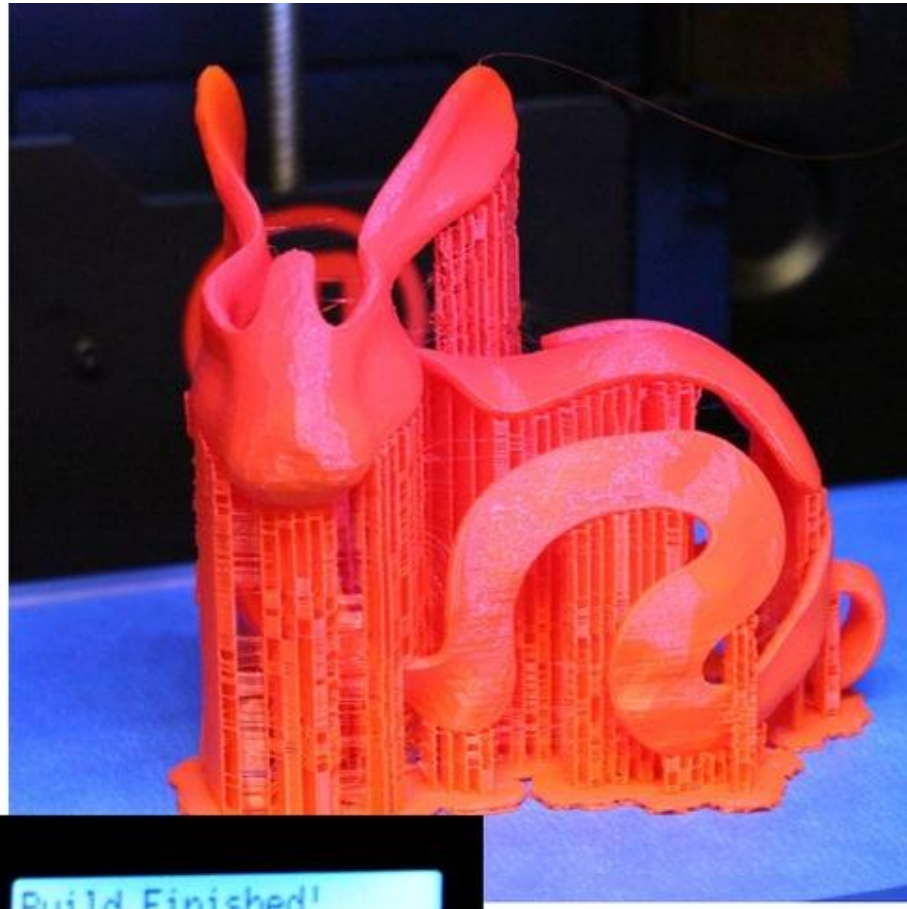
- Affects print quality
- Wasted plastic & time

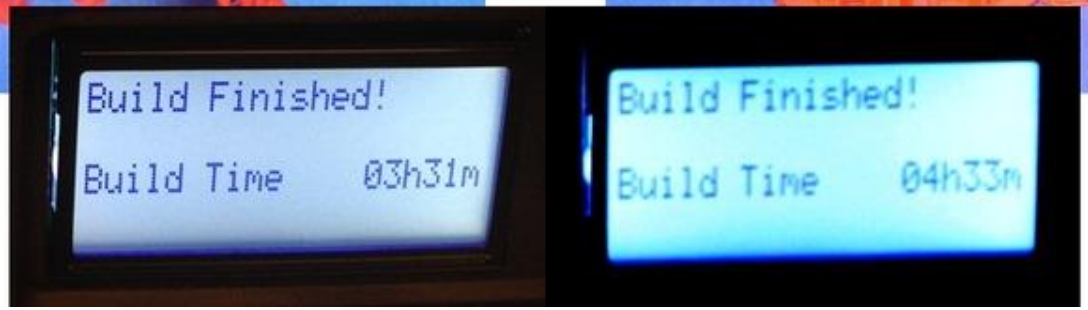










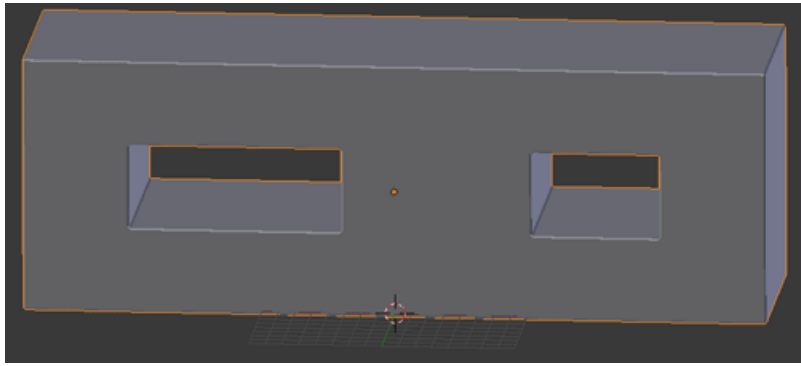


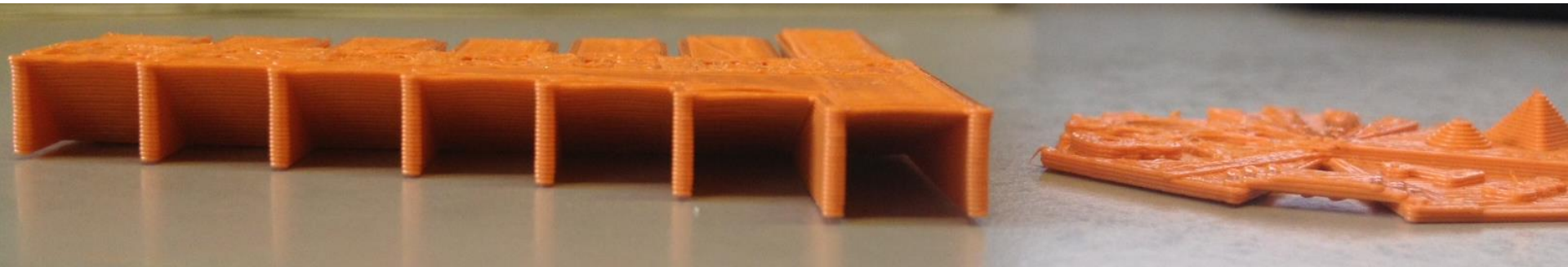
AUTODESK.

AUTODESK.

Bridging

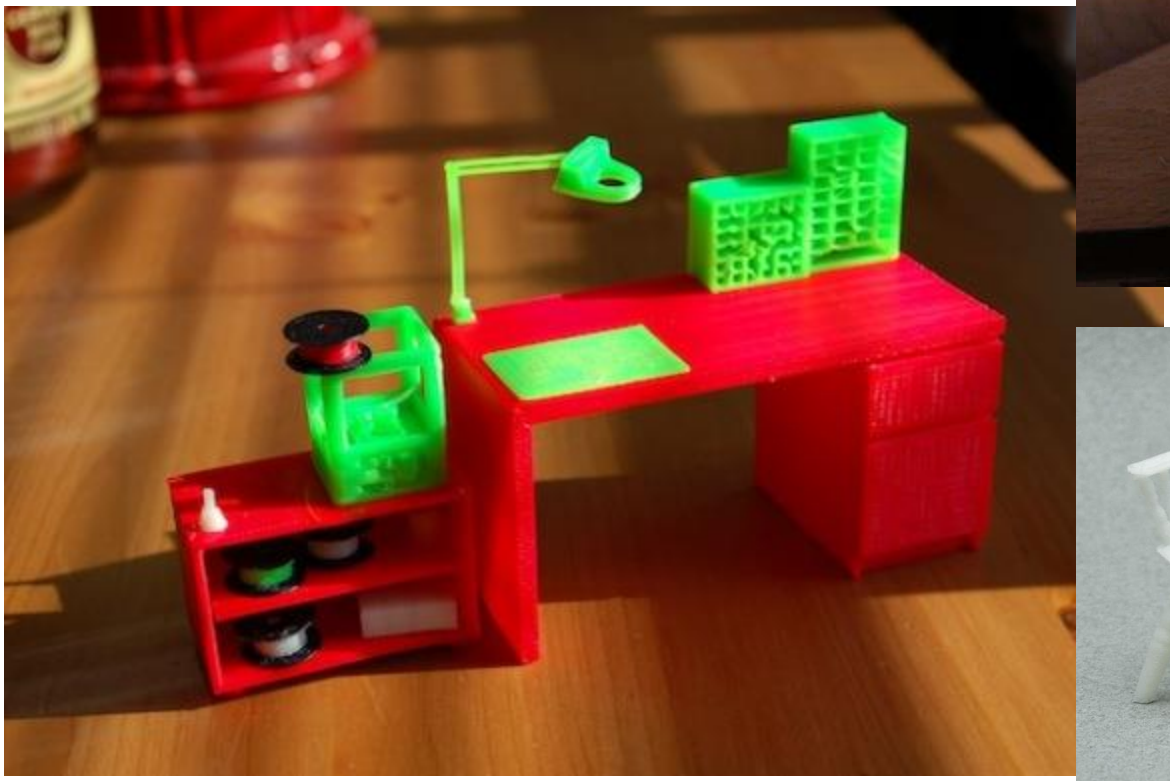
- Small overhangs actually OK
- Printer speeds up for first overhang layer
  - Called “Bridging”
- Rule is ~1cm is safe
- Good for small holes, slots, etc





Size / Thickness

- 3D printers have limited **RESOLUTION**



Minimum Feature Size

- 2mm is the rule-of-thumb
- Vertical fidelity higher than horizontal
- Can get quite small details if you design for the specific printer