FABO ACADEMY X - CHINA

ADDITIVE MANUFACTURING

FABO ACADEMY X 同济大学设计创意学院 Fabo | Shanghai

3D PRINTING

Additive manufacturing or 3D printing works by adding material layer by layer to build up an object. The benefit is you can build almost any shape.

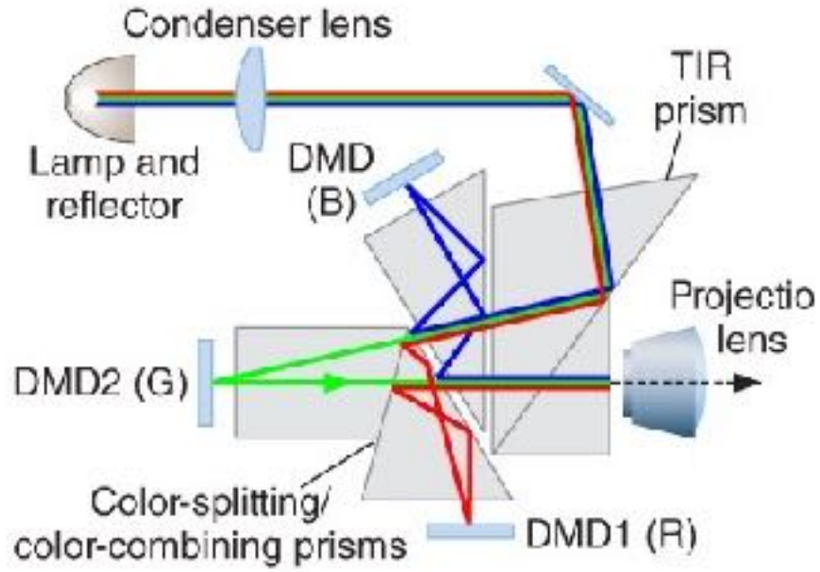
3D PRINTING WORKFLOW

- 3D Design File (Rhinoceros, Fusion 360...)
- Slicing (Slic3r, Cura, Makerbot Print)
- Printing (Gcode)

3D PRINTER TECHNOLOGIES

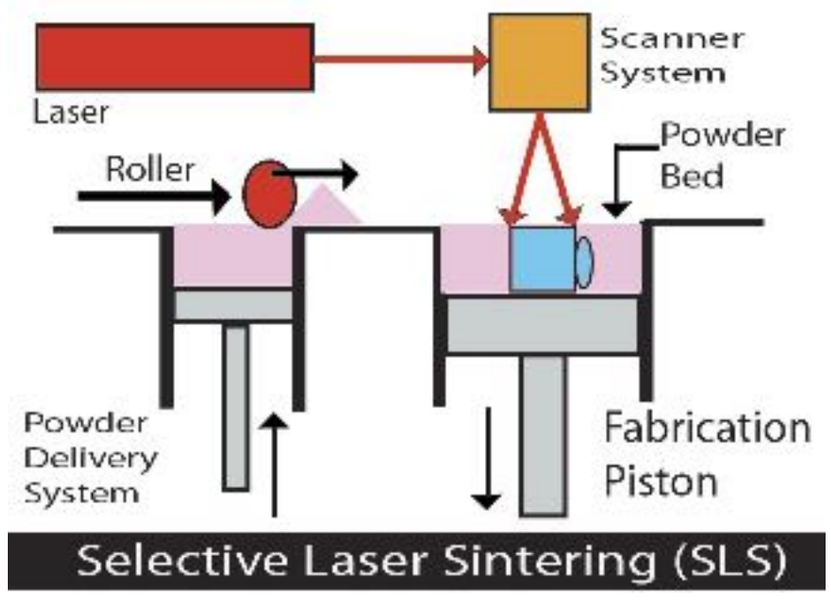
- **SLA:** Stereolithography.
  Liquid resin + Laser beam

- **DLP:** Digital Light Processing.
  Liquid resin + light



- **SLS:** Selective Laser Sintering.
  Nylon powder + Laser beam

- **FDM:** Fuse Deposition Modeling.
  Plastic filament + Heated nozzle

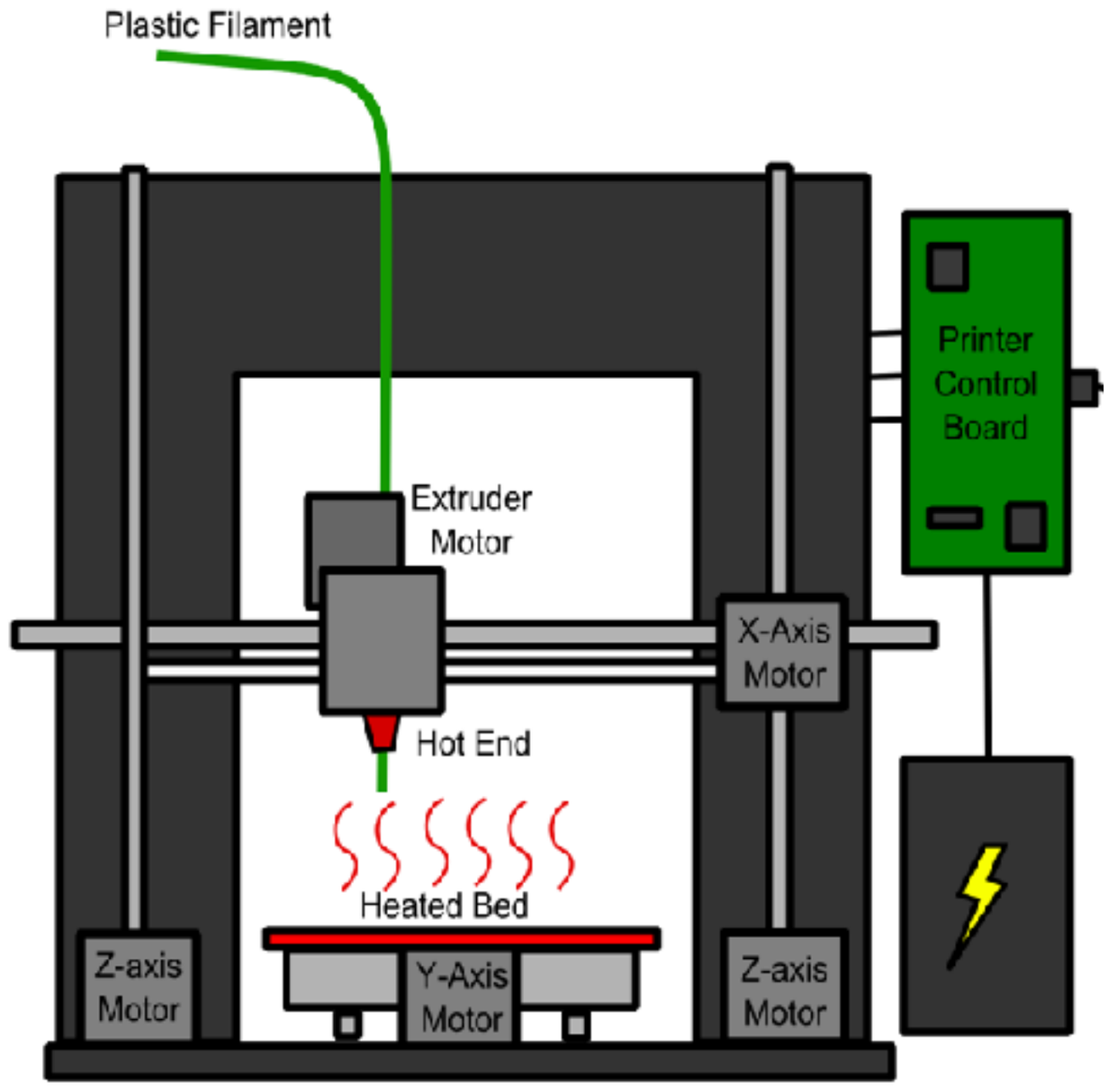


FDM PRINTING MATERIAL

- ABS (Acrylonitrile butadiene styrene)
- **PLA** (Polylactic Acid)
- Nylon (PA, Polyamides)
- Rubber (TPE, Thermoplastic Elastomers)

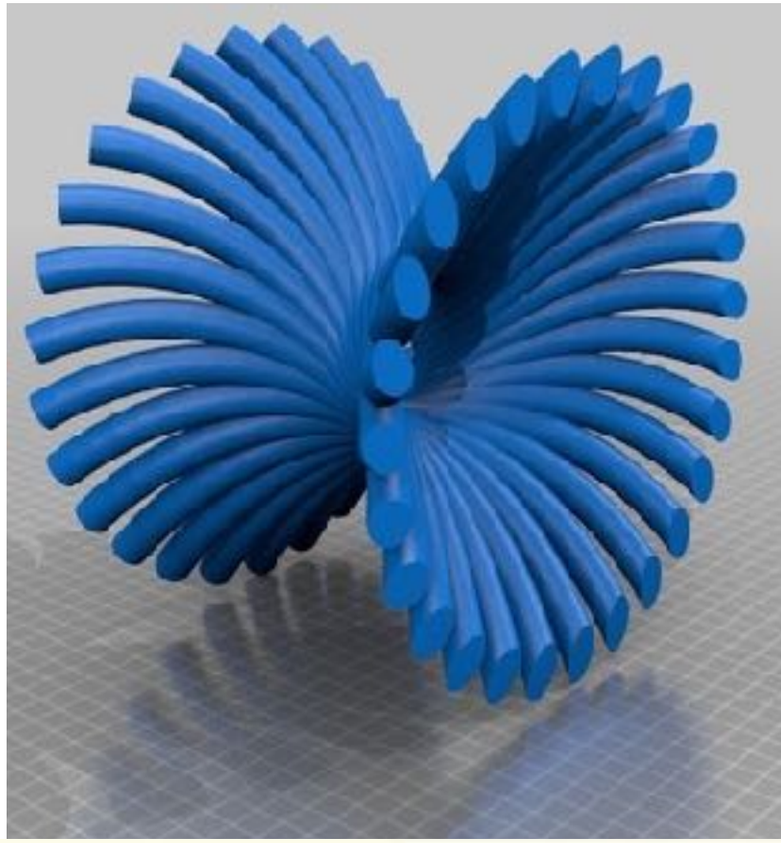
FDM PRINTING COMES DOWN TO A COMBINATION OF:

- Nozzle (Hot end) temperature
- Print Speed (XYZ Motors)
- Flow Speed (Extrusion speed of plastic filament)
- Heatbed Temperature



WHAT CAN BE 3D PRINTED?

THINGS THAT CAN ONLY BE 3D PRINTED



WHAT CAN BE 3D PRINTED?

CUSTOMIZED, PERSONALIZED OBJECTS

WHAT CAN BE 3D PRINTED?

CLOTHES

PROSTETHICS

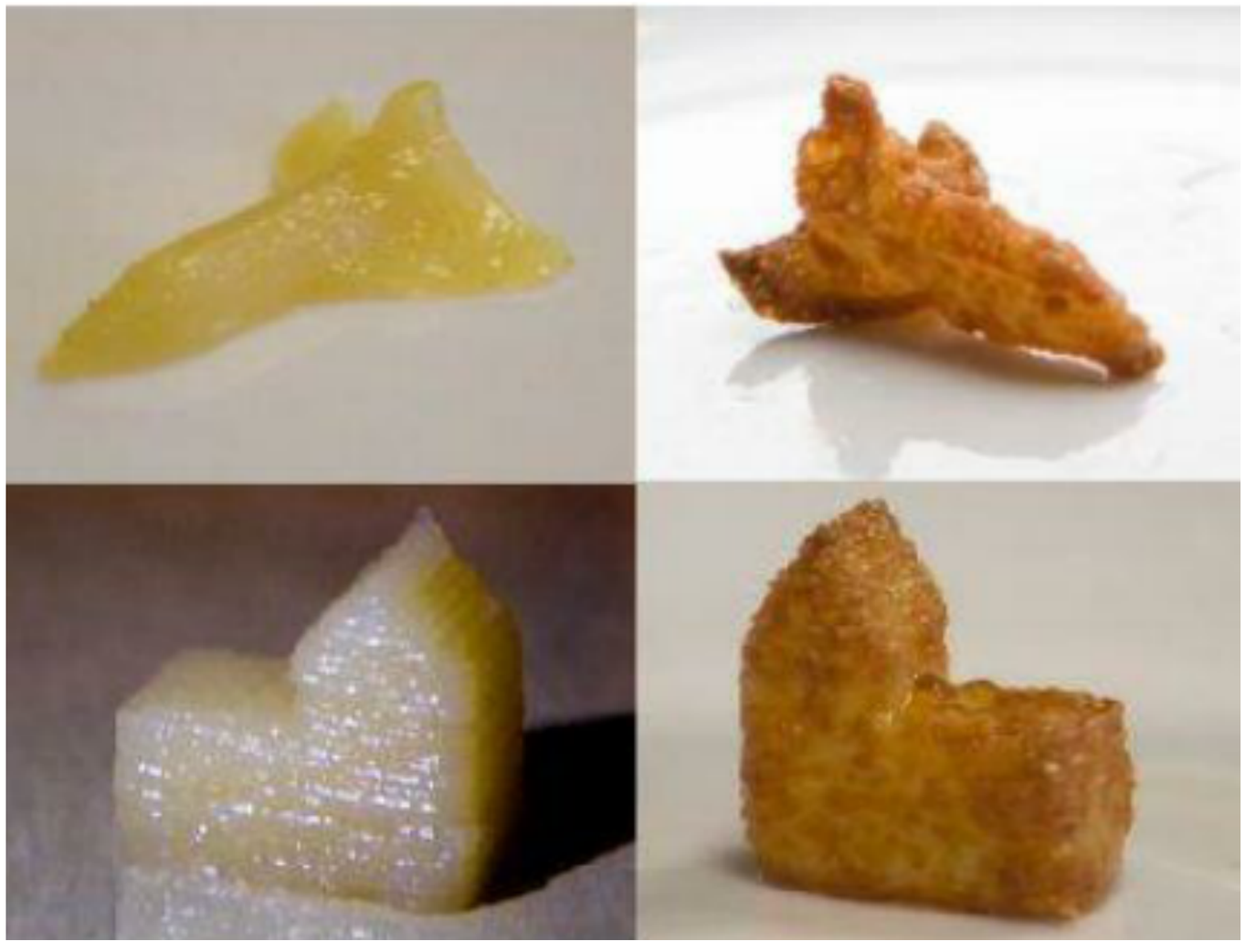
WHAT CAN BE 3D PRINTED?

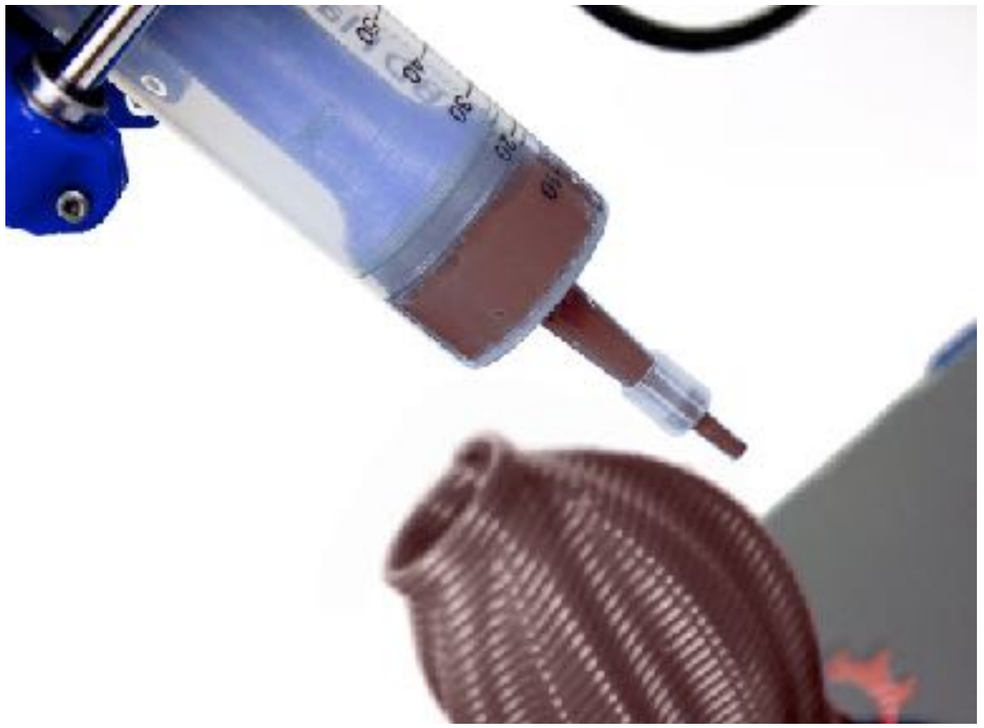
HOUSES

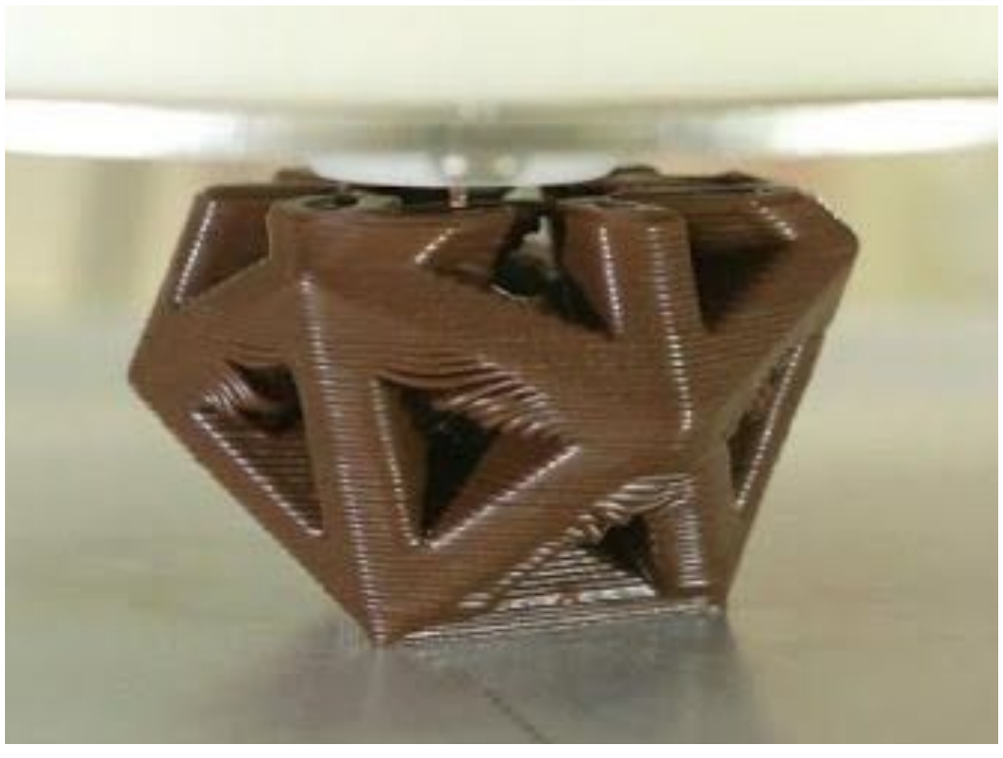
https://www.youtube.com/watch?v=W5WMDRM7rHc

WHAT CAN BE 3D PRINTED?

FOOD, CHOCOLATE







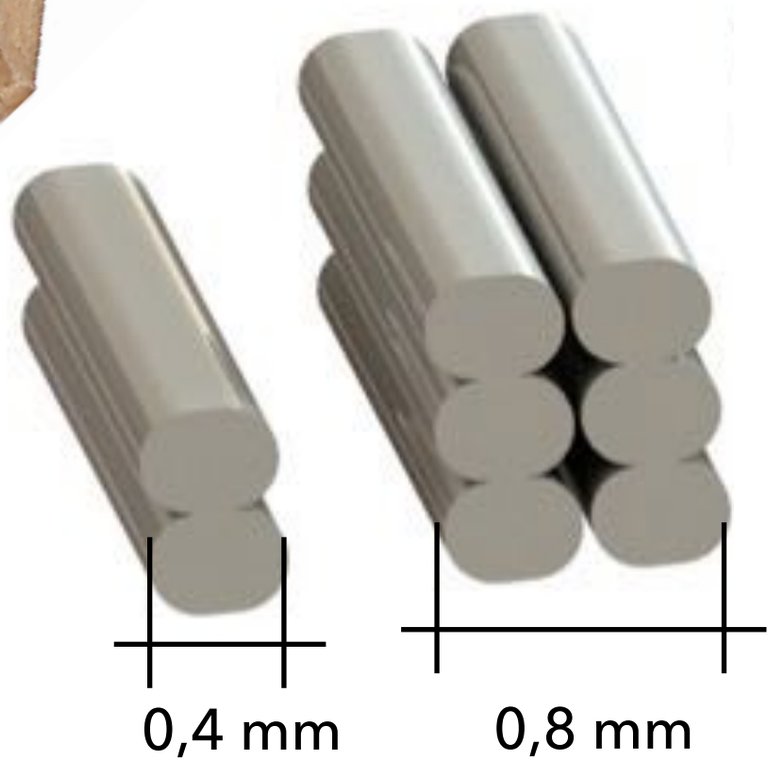
DESIGN RULES FOR YOUR PRINTER

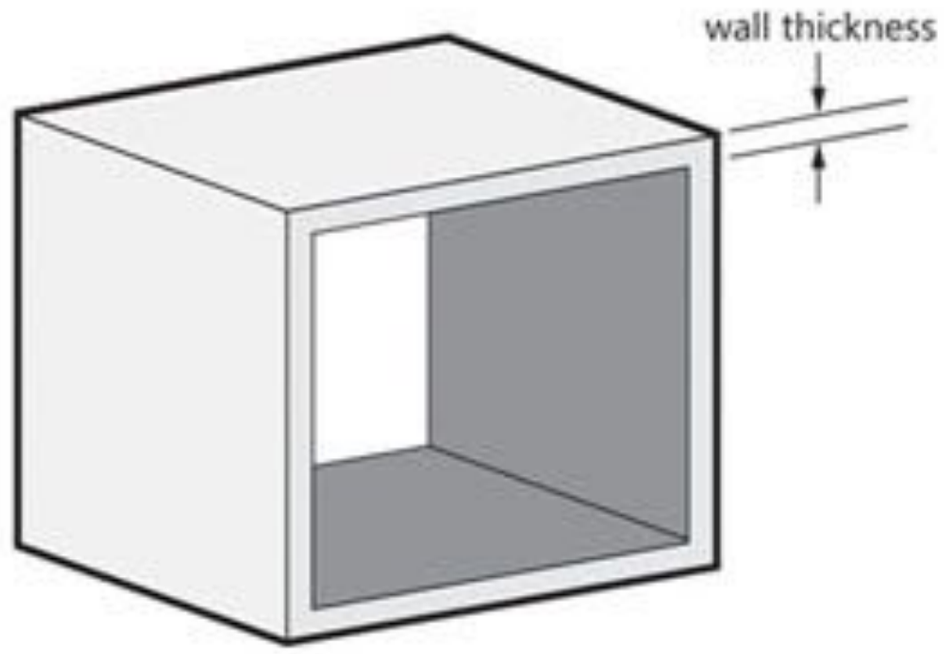
- Wall Thickness/Shell Thickness (nozzle size)
- Minimal Gap of separation between moving parts.
- Overhang (45 degree rule)
- Layer Height
- Bridging
- Filling
- Build plate adhesion

DESIGN RULES FOR YOUR PRINTER

Minimum Thickness of walls and shells (nozzle size)

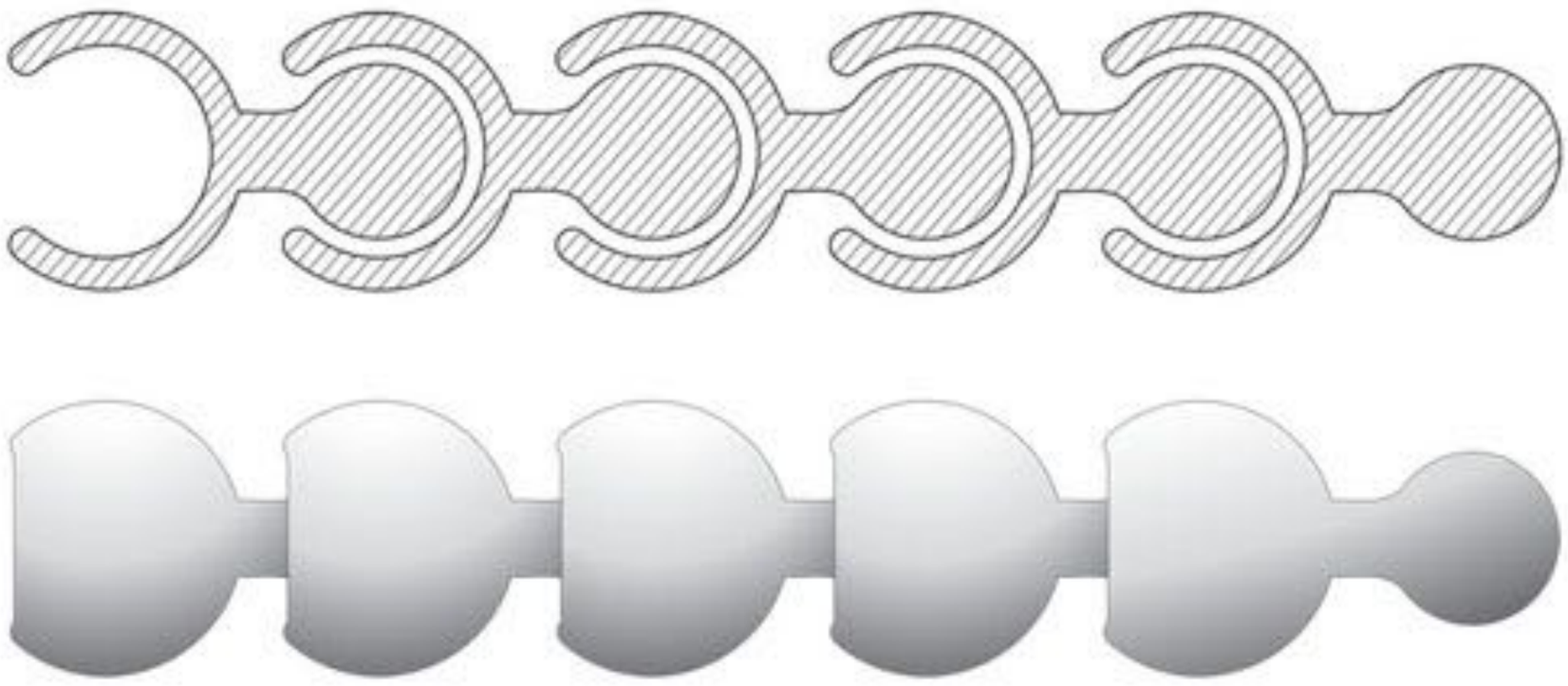
The minimum thickness must be a multiple of the size of your nozzle. If your nozzle is 0.4mm your object must be 0.4 or 0.8 or 1.2 and so on.





DESIGN RULES FOR YOUR PRINTER

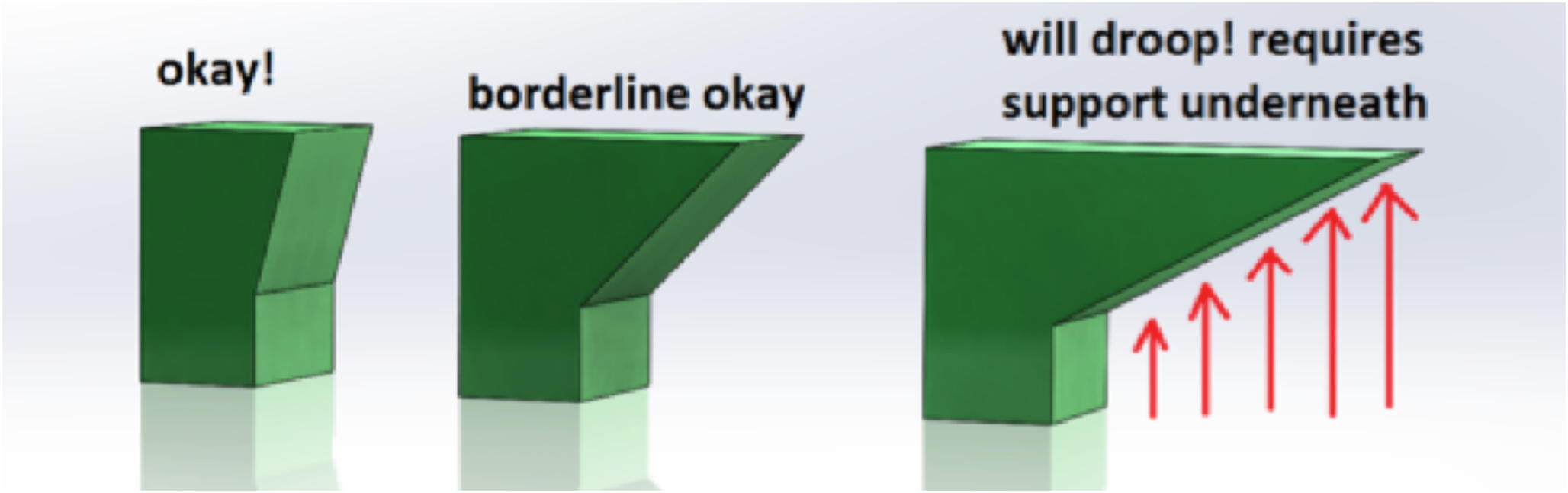
Minimal Gap of separation between moving parts
If you have moving parts, you must calculate the minimum size of the gap between the parts to be sure they are not connected. If, for example, your nozzle size is 0.4 mm, the gap must be *at least* 0.4mm.

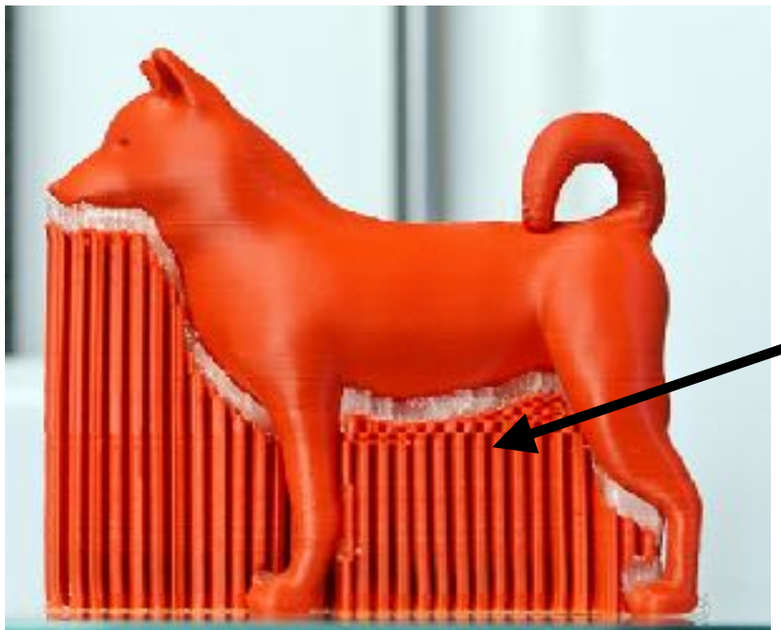


DESIGN RULES FOR YOUR PRINTER

Overhang (45 degree rule)

With FDM printing you cannot “print in the air”, you always need material from the previous layer to support. Overhang is ok until 45°. After this limit, you need to add support material, that will be removed later.



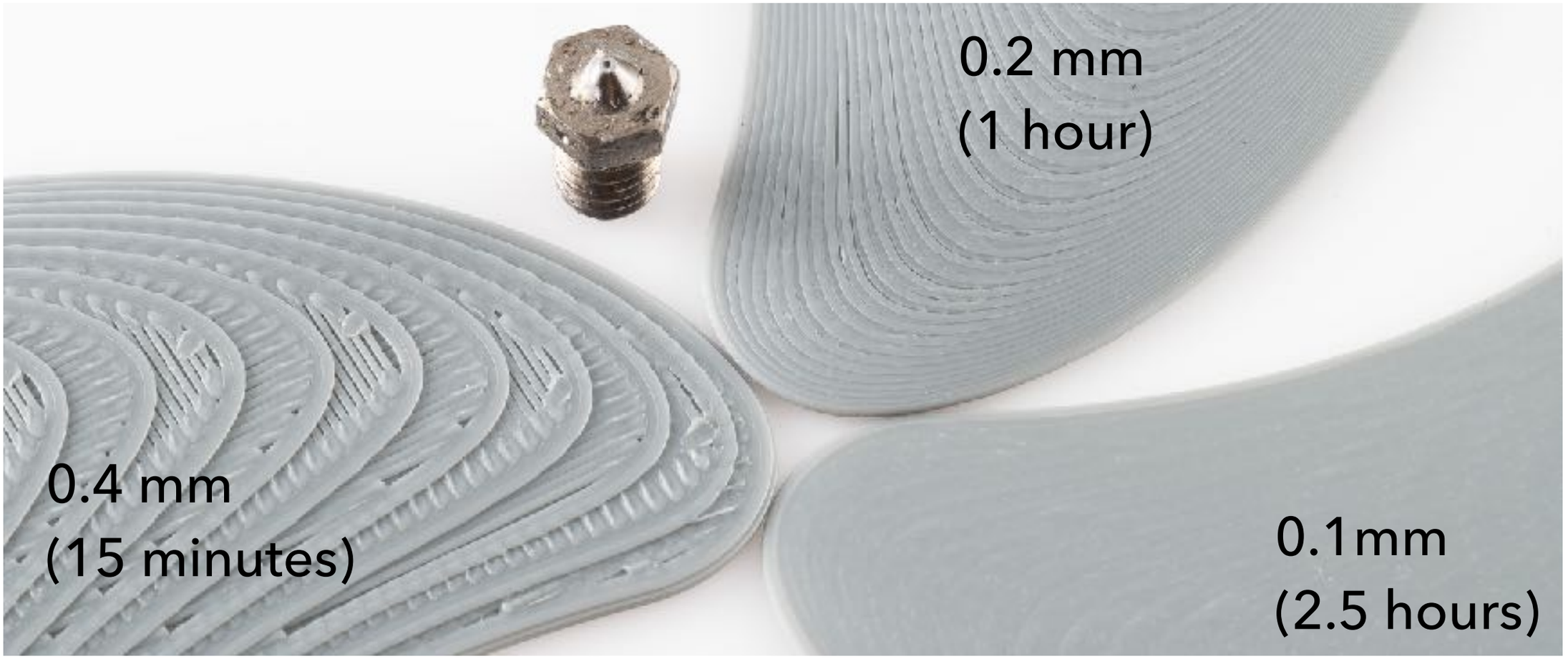


Support material is good, but can also be very tricky to remove, use it with moderation

DESIGN RULES FOR YOUR PRINTER

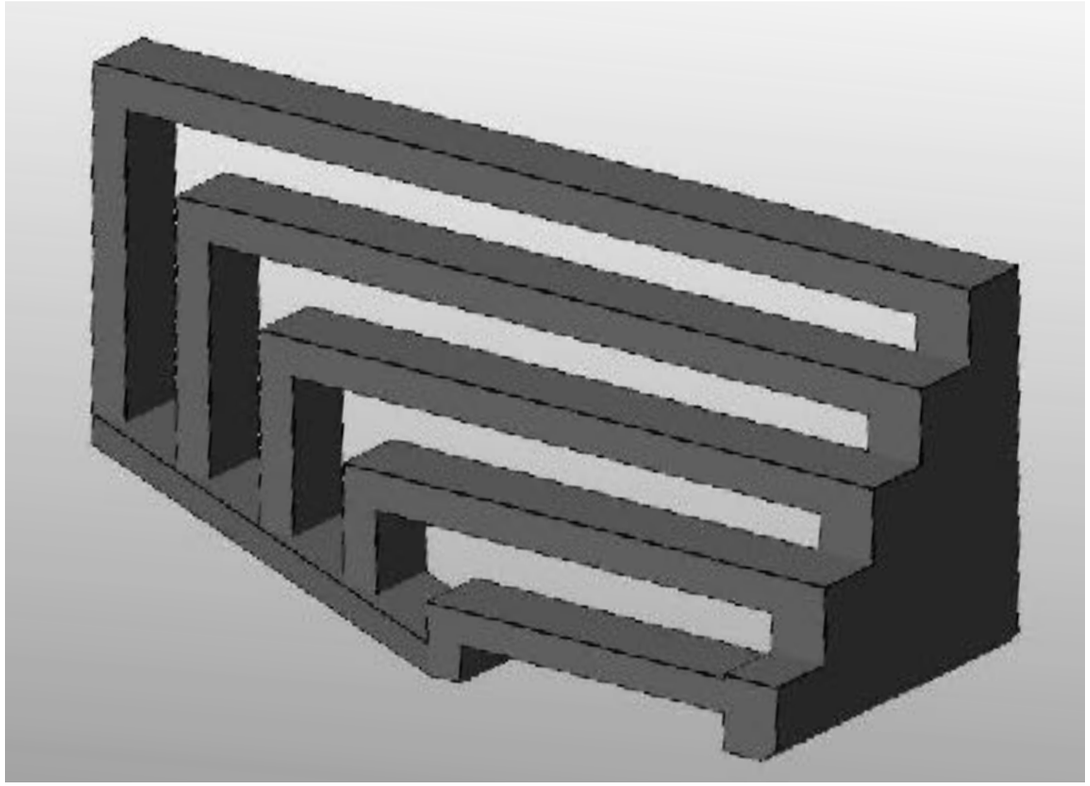
Layer Height

The height of each layer affects the resolution, the detail and the smoothness of your print. Differences in layer height can be especially seen in horizontal curved shapes. Bigger layer height can be used to quickly print test models.



DESIGN RULES FOR YOUR PRINTER

Bridging.
In one case you can connect two parts of the model by “printing in the air” by creating a bridge with the filament. It is important to set the right speed, flow and temperature to get a good result.



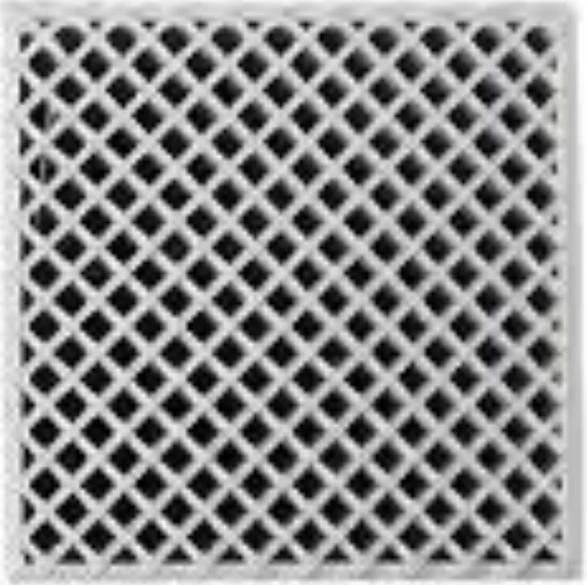
DESIGN RULES FOR YOUR PRINTER

Filling.
A model shouldn't be empty inside, so it requires an option called "filling". Most of the time a setting of 20% is enough to make a sturdy model that doesn't take too much time to print. More dense filling is generally not needed.

10%

20%

30%

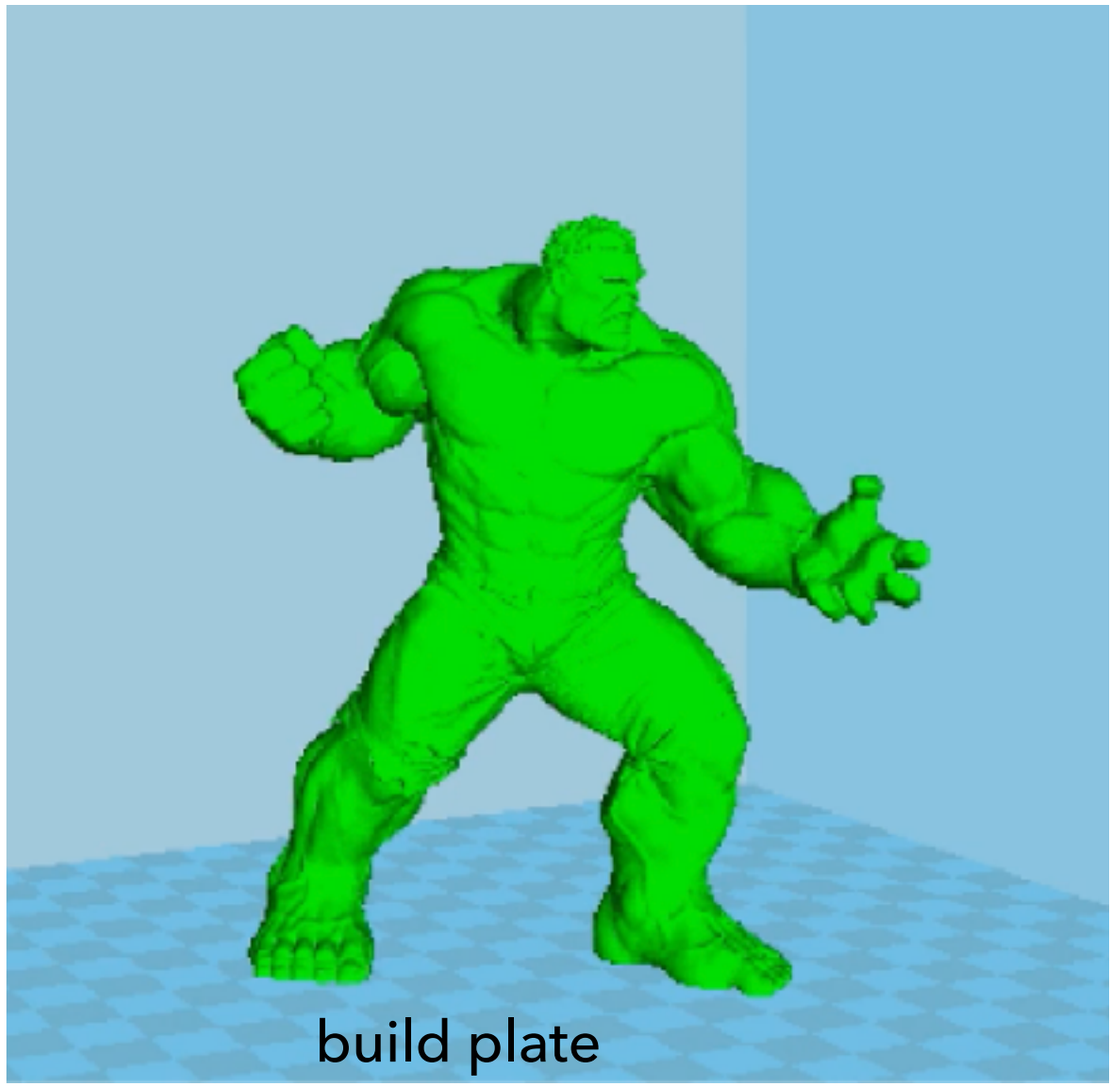


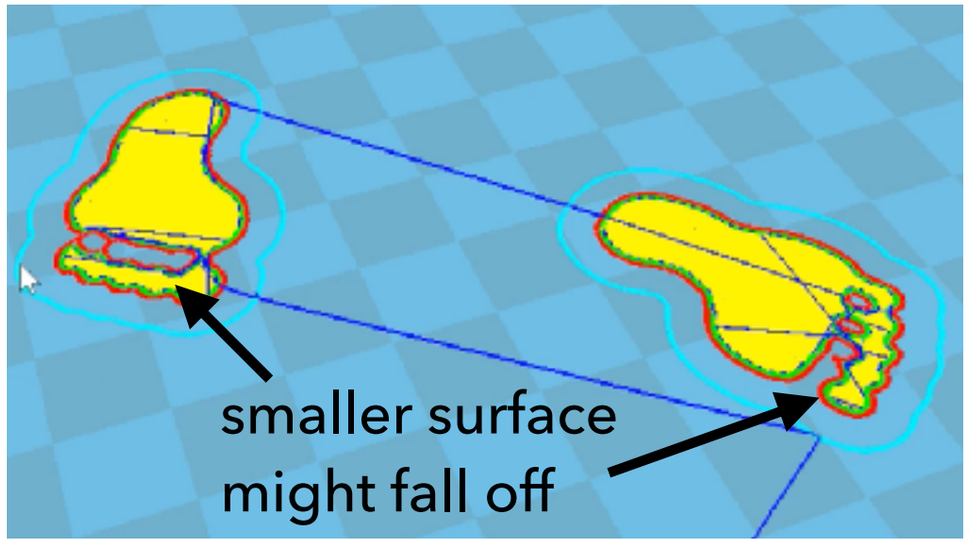
DESIGN RULES FOR YOUR PRINTER

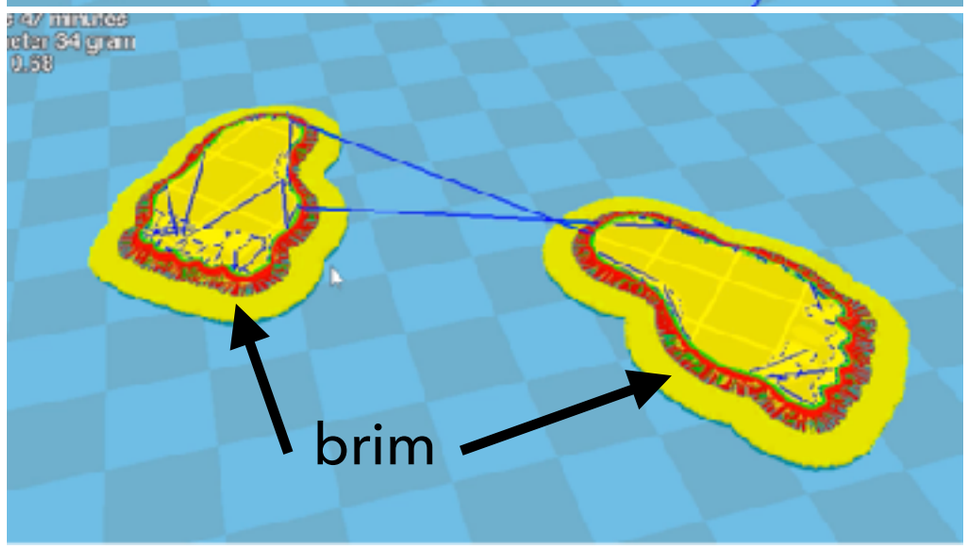
Build plate adhesion

If the first layer of your model (the part that touch the 3D printer's plate) is not flat, or is not very large, the model may disconnect from the plate.

To help smaller parts stick to the plate, we use an option called "**brim**". It create a border around the object that will be cut away after the model is printed.







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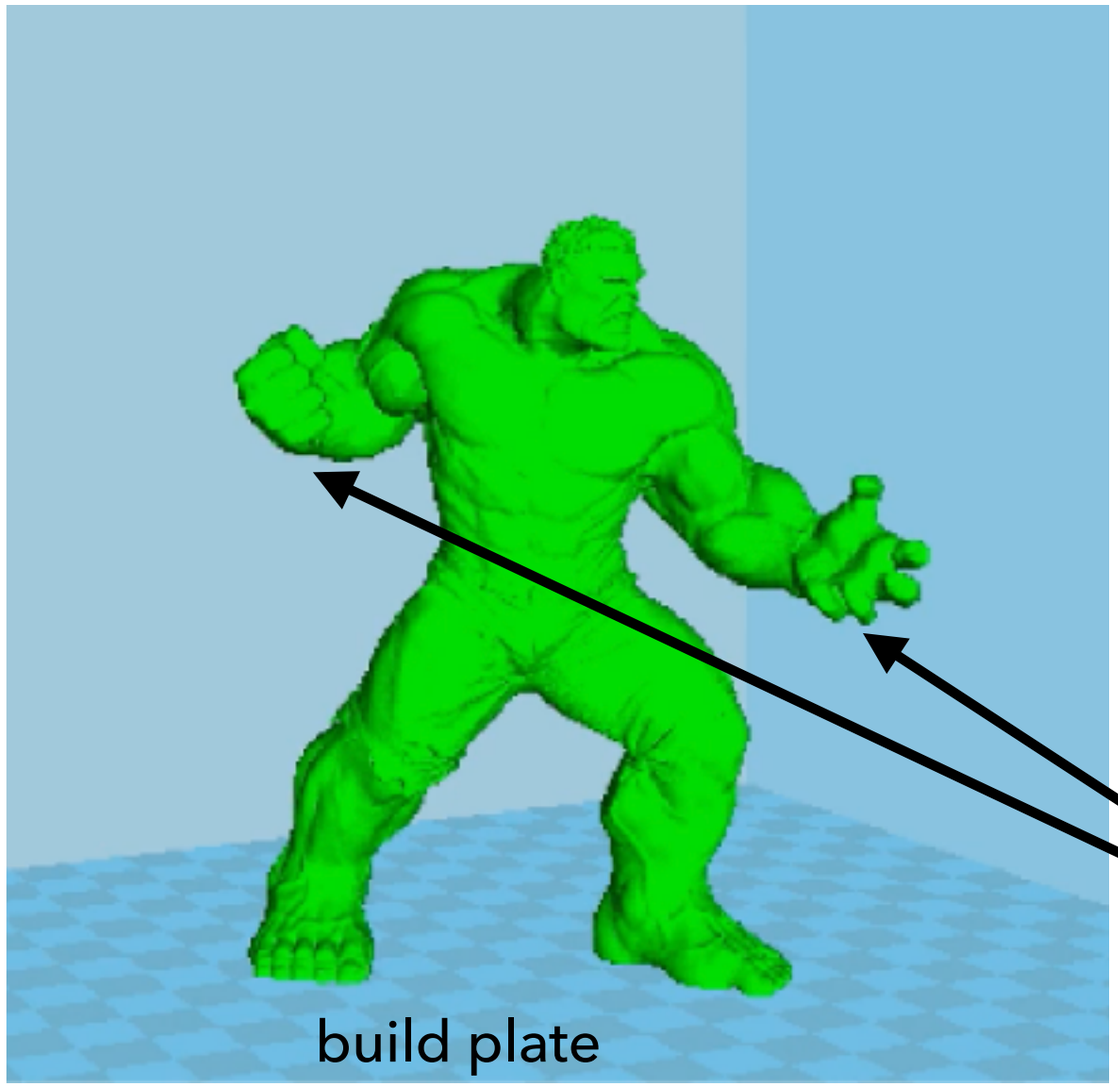
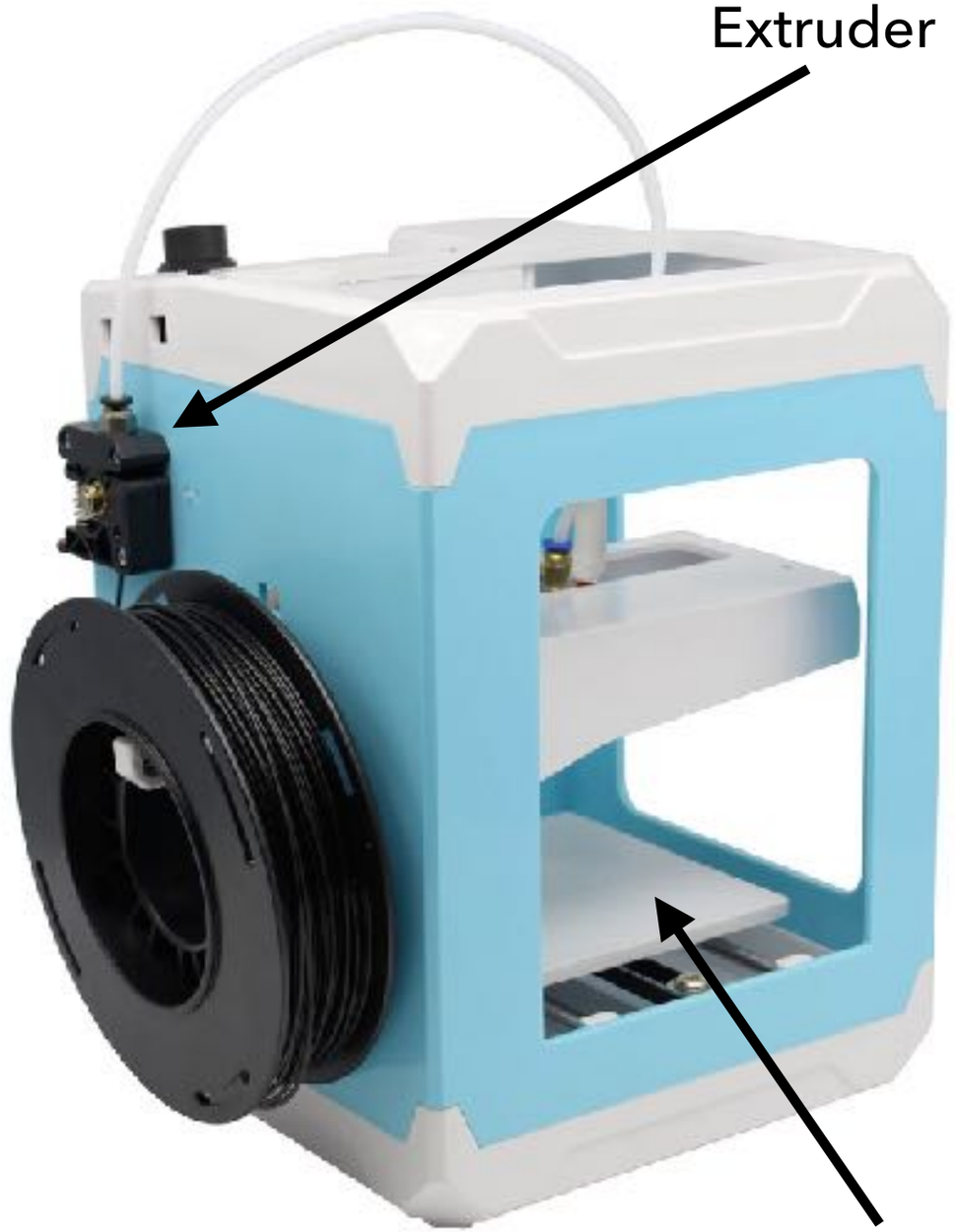


IUP3D PRINTERS

Micro SD Card slot
(card connectors face right)

Z axis zero (Z0) adjustment screw.
Turn clockwise to lower the Z0 point.
Turn counter clockwise to rise the Z0 point.

Extruder



Flexible and magnetic print bed
(4 screws at each corner to adjust the bed leveling)

IUP3D PRINTERS CONFIGURATION

Update the settings in the red boxes, you can leave the rest unaltered

Printer | Extruder 1

Printer Settings

X (Width)	110 mm
Y (Depth)	110 mm
Z (Height)	125 mm
Build plate shape	Rectangular
Origin at center	
Heated bed	
G-code flavor	Marlin

Printhead Settings

X min	15 mm
Y min	10 mm
X max	15 mm
Y max	10 mm
Gantry Height	20 mm
Number of Extruders	1

Start G-code

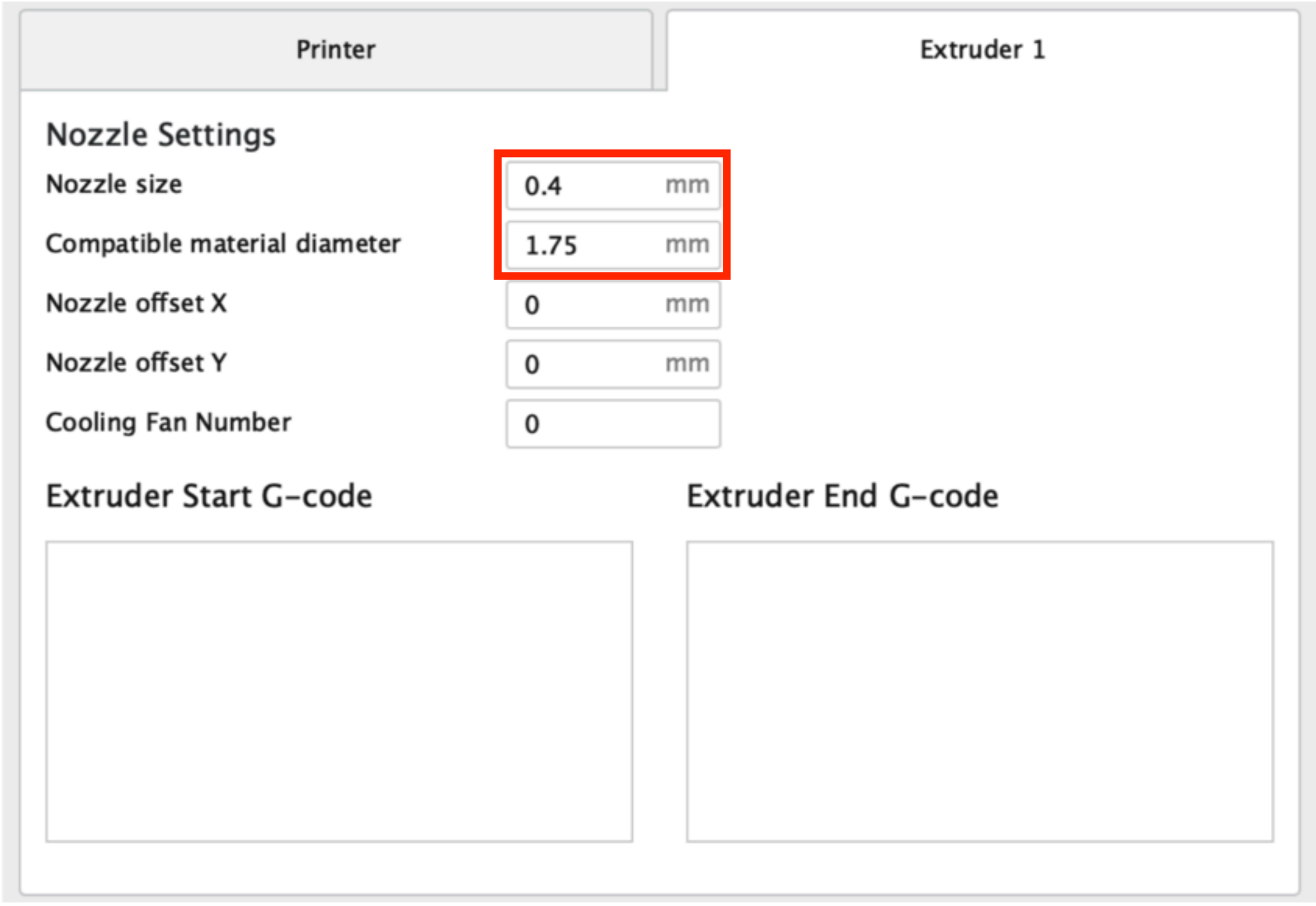
```
G28 ;Home
G1 Z15.0 F6000 ;Move the platform down
;Prime the extruder
G92 E0
G1 F200 E3
```

End G-code

```
M104 S0
M140 S0
;Retract the filament
G92 E1
G1 E-1 F300
```

IUP3D PRINTERS CONFIGURATION

Update the settings in the red boxes, you can leave the rest unaltered



IUP3D PRINTERS CONFIGURATION

<u>Basic settings for a standard print</u>

Layer Height: **0.2 mm**

Wall line count: **2**

Top/Bottom thickness: **0.8 mm**

Infill Density: **20%**

Printing Temperature (PLA): **205°C**

Buildplate Adhesion: **Skirt**

Support: **No**

TROUBLESHOOTING

- http://support.3dverkstan.se/article/23-a-visual-ultimaker-troubleshooting-guide

Pillowing

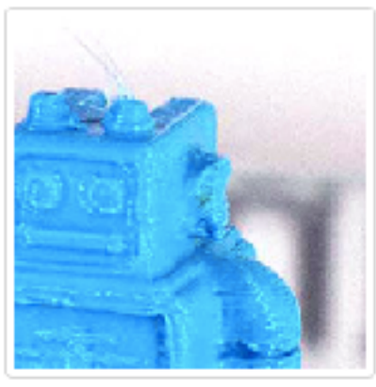
Top surfaces are not closed properly or come out bumpy.

Elephant's foot

The lowest layers of the print flare out.

Irregular circles

Circles come out misshapen and lines are not properly touching.



Ugly overhangs

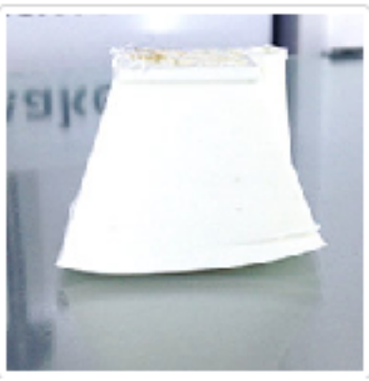
The lower surface of overhangs come out ugly

Gaps in bottom surface

Lines are overly visible or spaced apart on the first layer

Shifted layers

Parts of the print suddenly shift along the X or Y axis.



Warping

Corners of the print lift and detach from the platform

Stringing

Unwanted strands of plastic span across the print

Ringing

Waves/shadows appear in the print

Prints are leaning

Prints gradually lean over or become skewed

Under extrusion

The printer is not extruding enough plastic leaving gaps in the print

Walls not touching

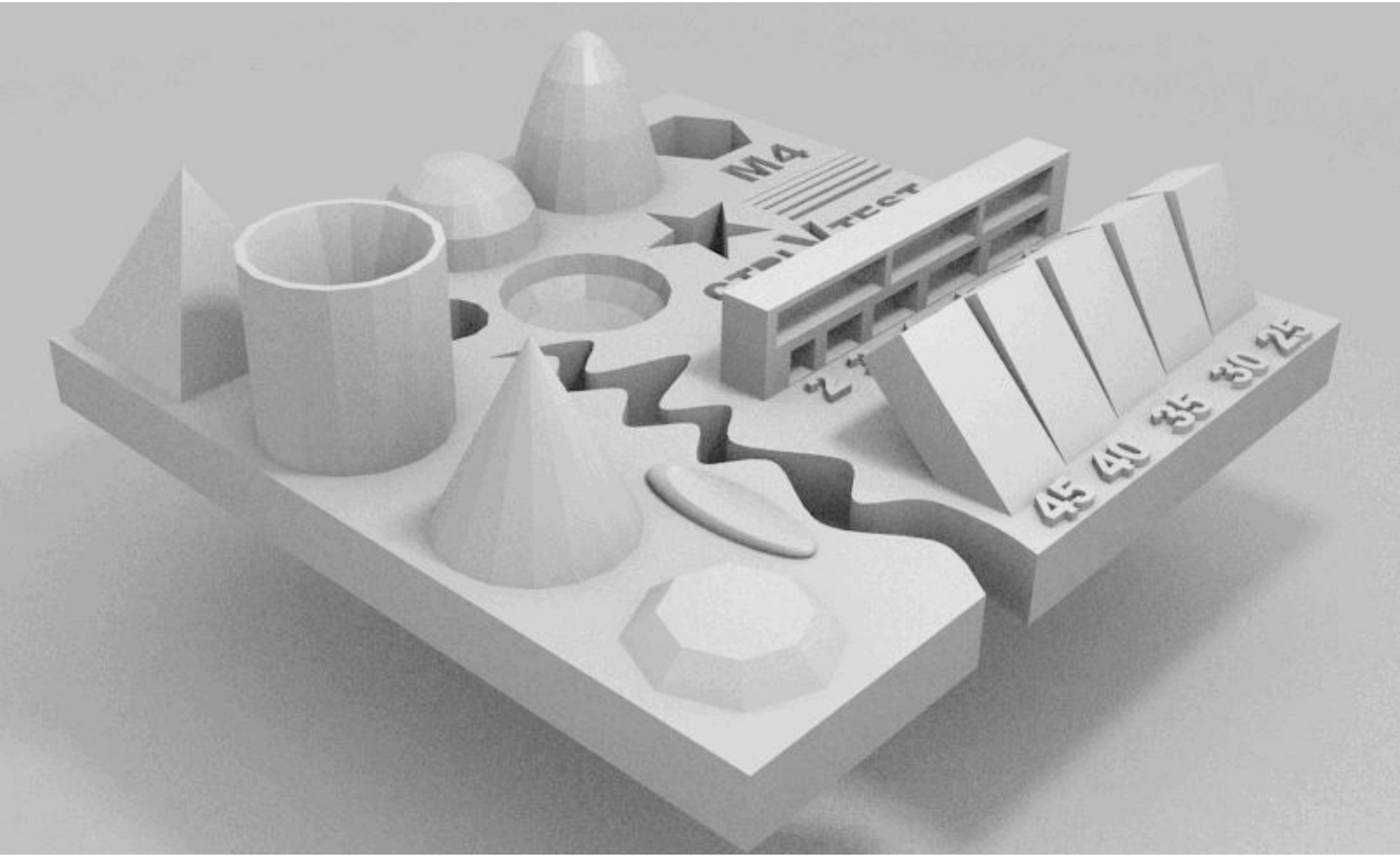
Parts of, or entire walls of the print are not fused and touching

LOST IN ACRONYMS?

- http://reprap.org/wiki/Glossary

PRINT A MODEL TO TEST YOUR PRINTER'S DESIGN RULES

Exercise 1



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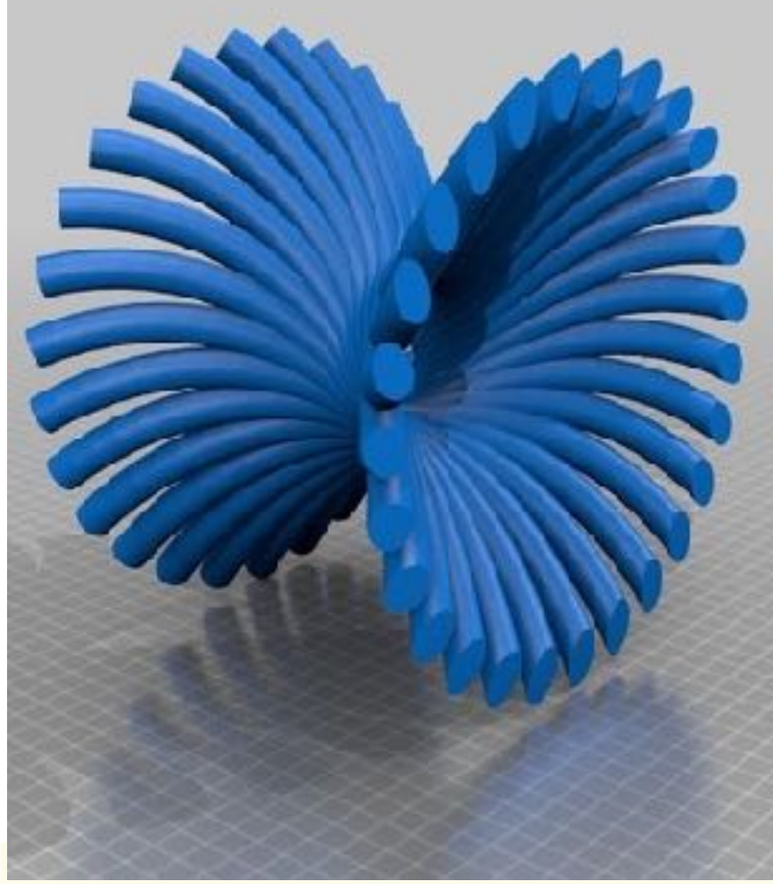
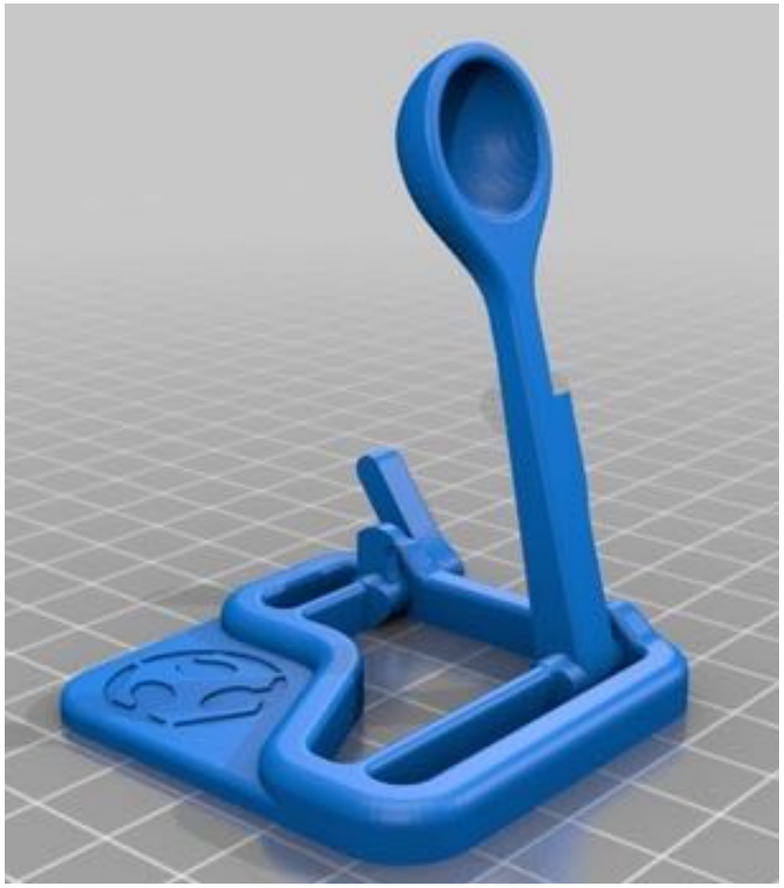
DESIGN AND PRINT ONE OF THE MODELS OF YOUR VISUAL STORYTELLING.

It must be something that could not be made using a laser cutter*.

***Extra credit: explain the difference**





Designed by Tulio Lannan