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.

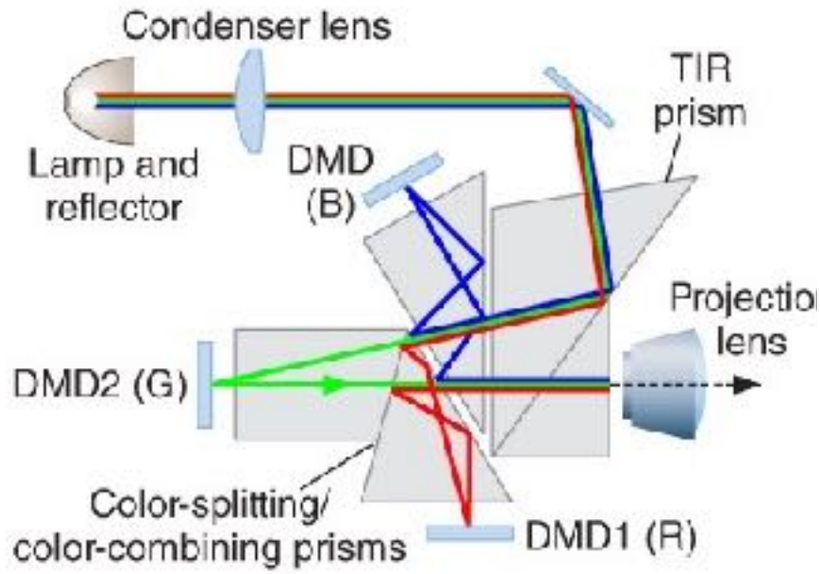
3D PRINTING WORKFLOW

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

3D PRINTER TECHNOLOGIES

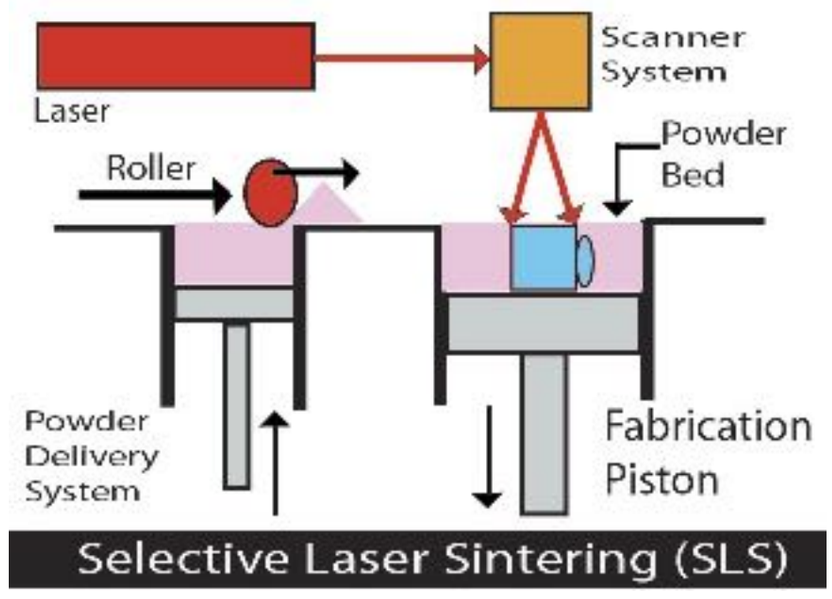
- **SLA:** Stereolithography.
  Liquid resin + Laser beam

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



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

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

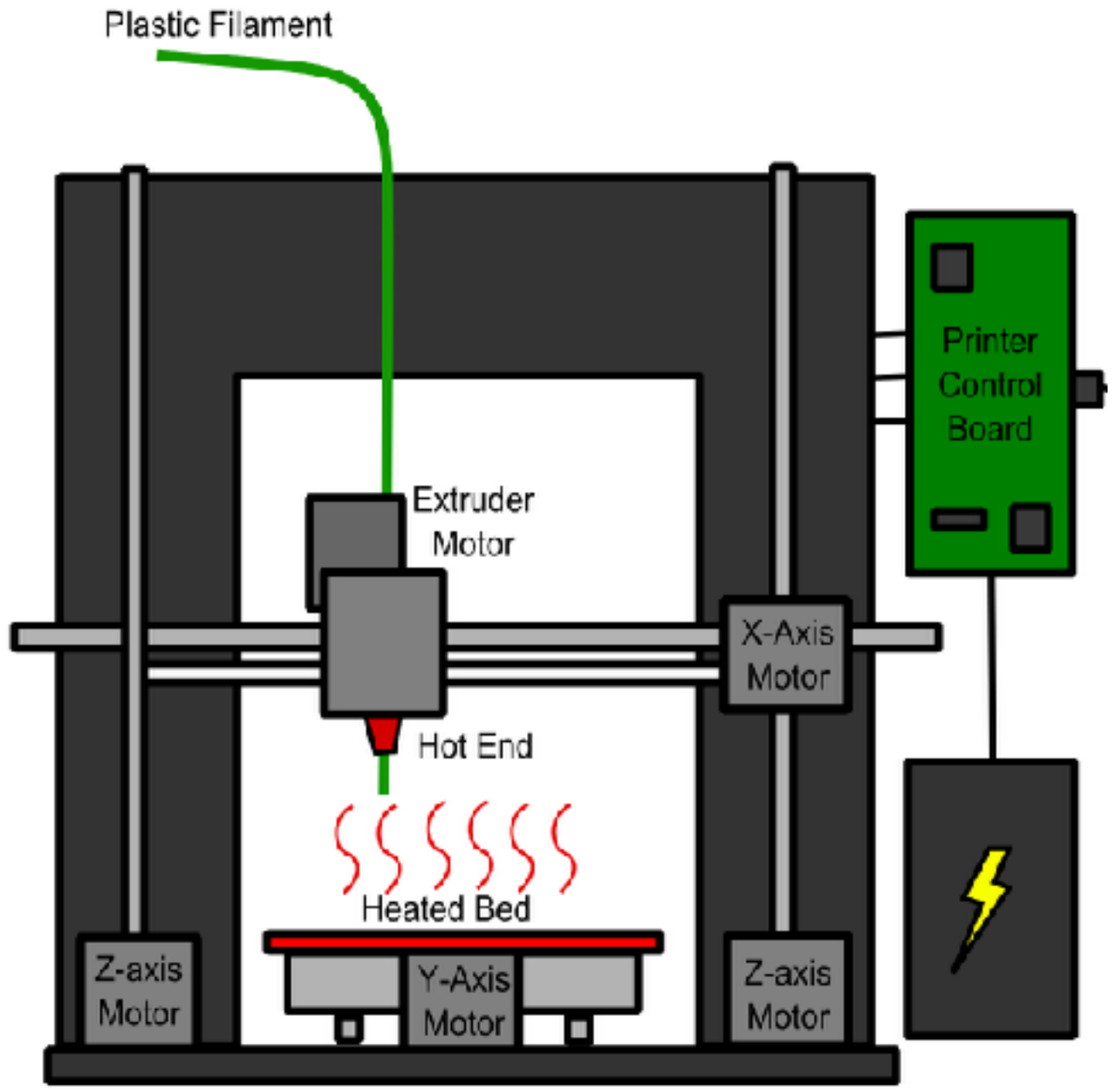


FDM PRINTING MATERIAL

- 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



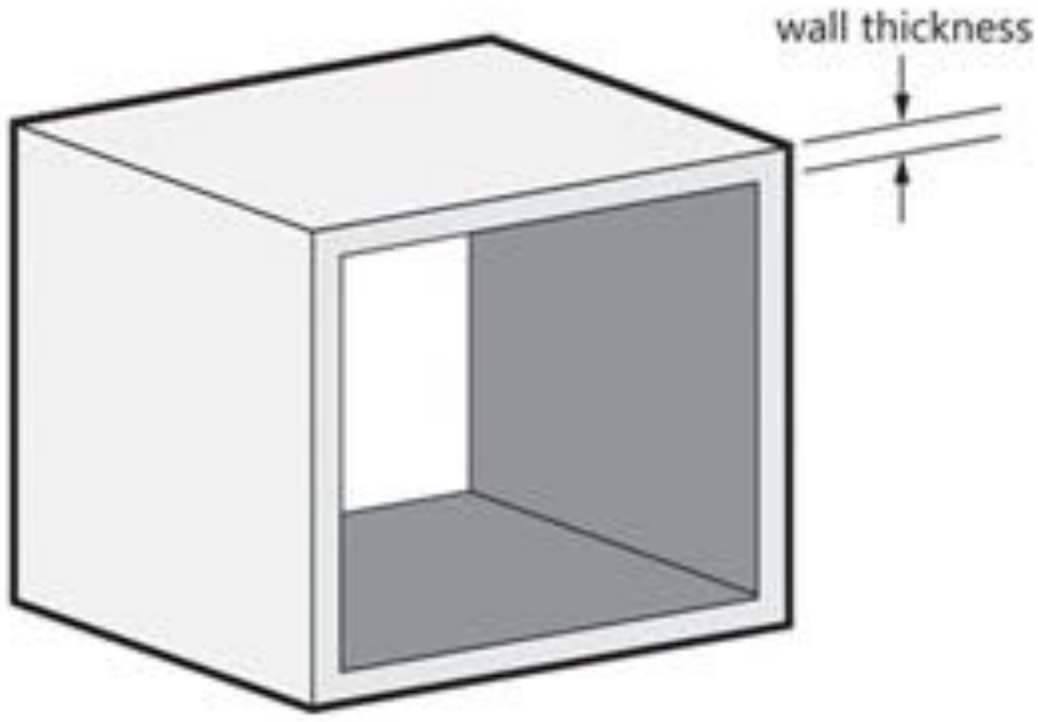
DESIGN RULES FOR YOUR PRINTER

- Wall Thickness/Shell Thickness (nozzle size)
- Minimal Sharpness of corners
- Minimal Gap of separation between moving parts.
- Overhang (45 degree rule)
- Layer Height
- Material Shrinking
- Bridging

DESIGN RULES FOR YOUR PRINTER

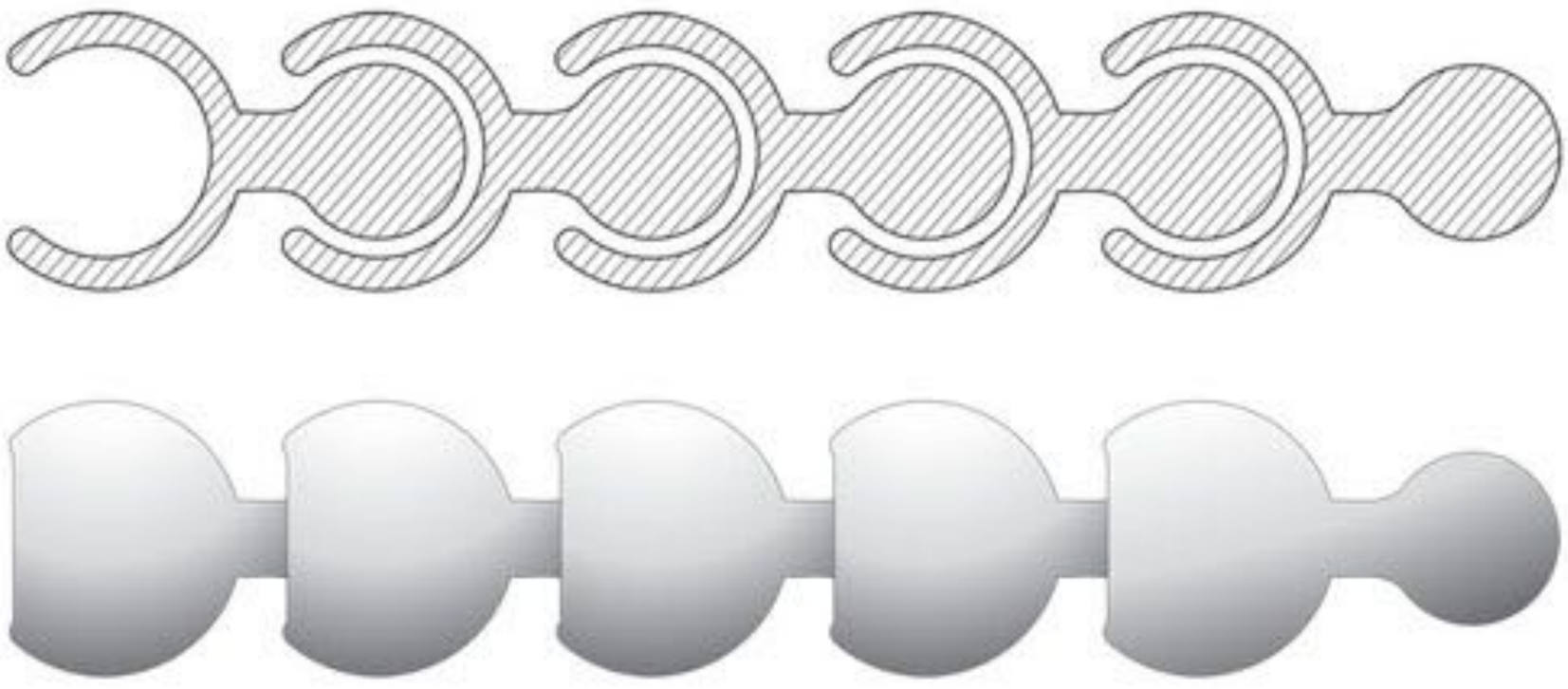
Wall Thickness/Shell Thickness (nozzle size)

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



DESIGN RULES FOR YOUR PRINTER

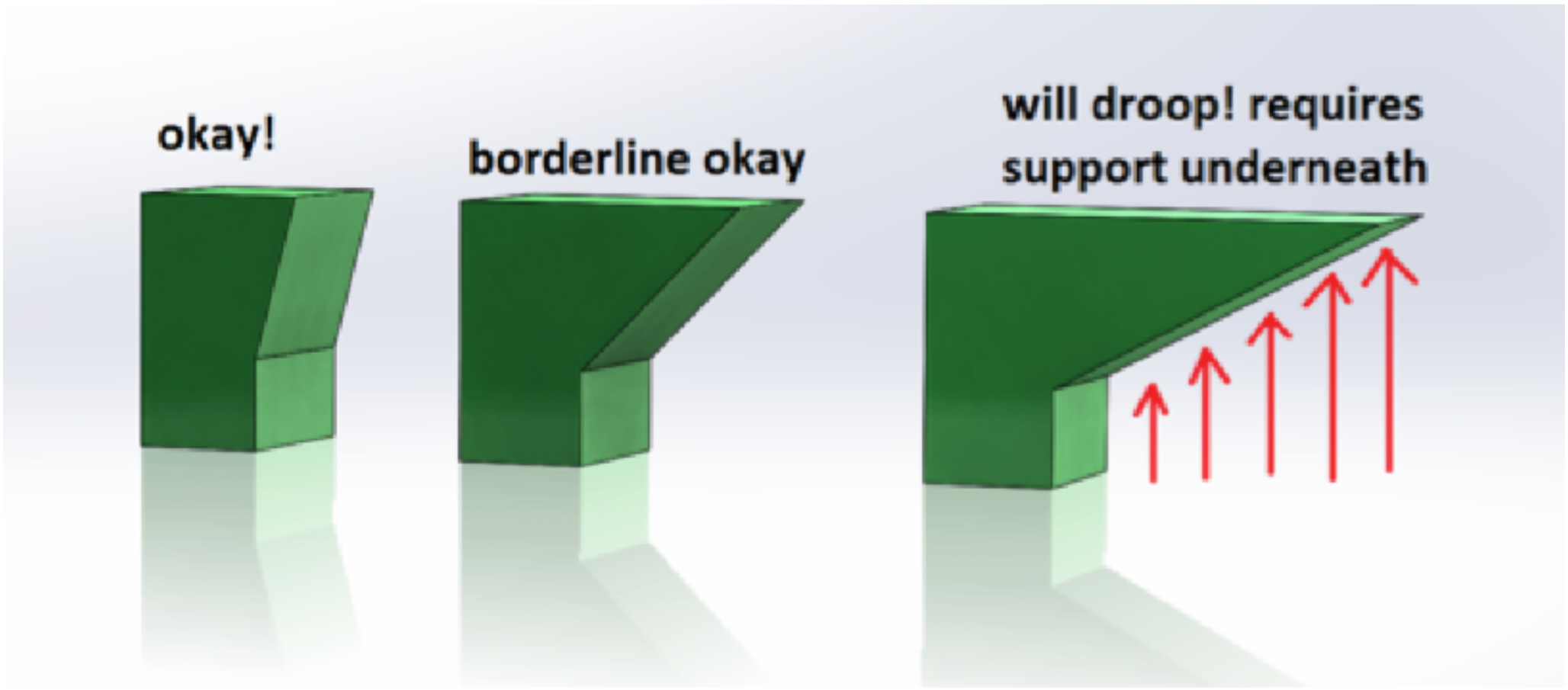
Minimal Gap of separation between moving parts
If you have moving parts, you must calculate the minimum size of the gap between the parts to be sure they are not connected. If, for example, your nozzle size is 0.4 mm, the gap must be *at least* 0.4mm.



DESIGN RULES FOR YOUR PRINTER

Overhang (45 degree rule)

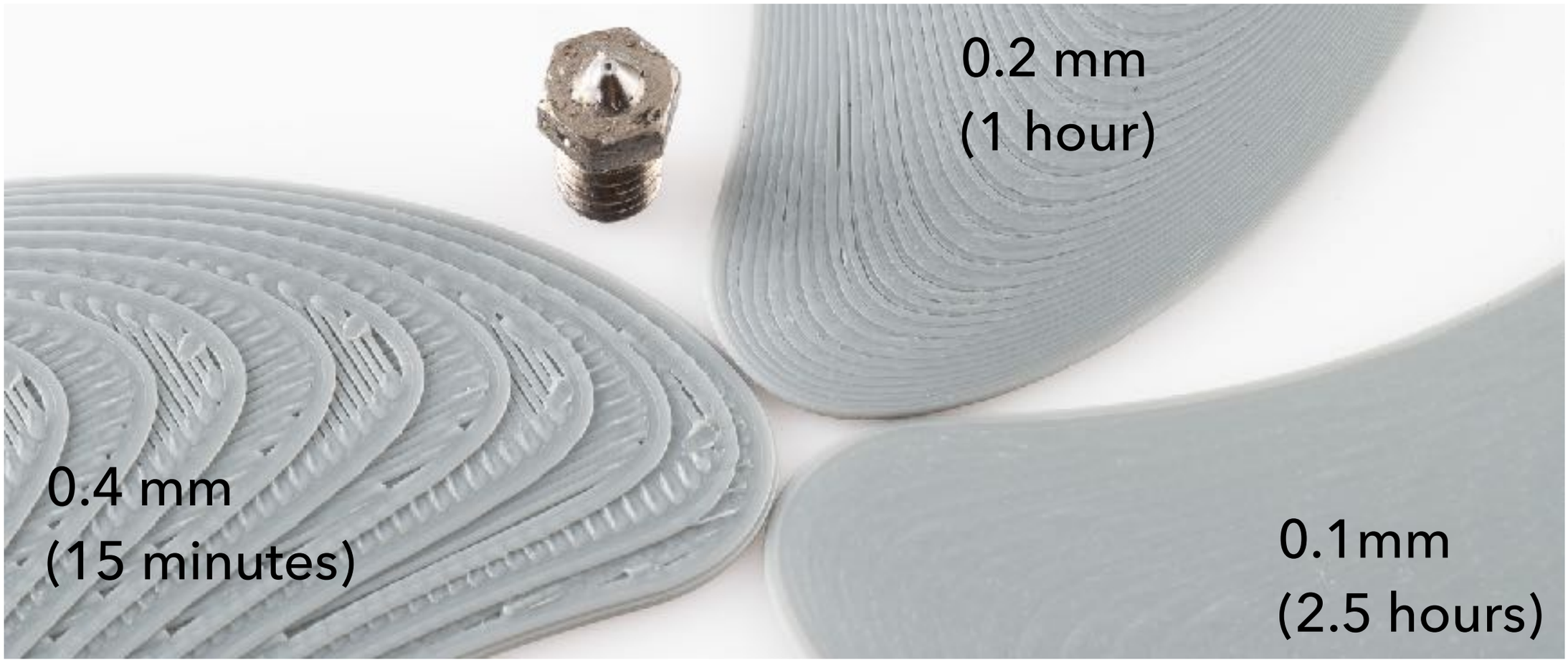
With FDM printing you cannot “print in the air”, you always need material from the previous layer to support.
Overhang is ok until 45°. After this limit, you need to add support material, that will be removed later.



DESIGN RULES FOR YOUR PRINTER

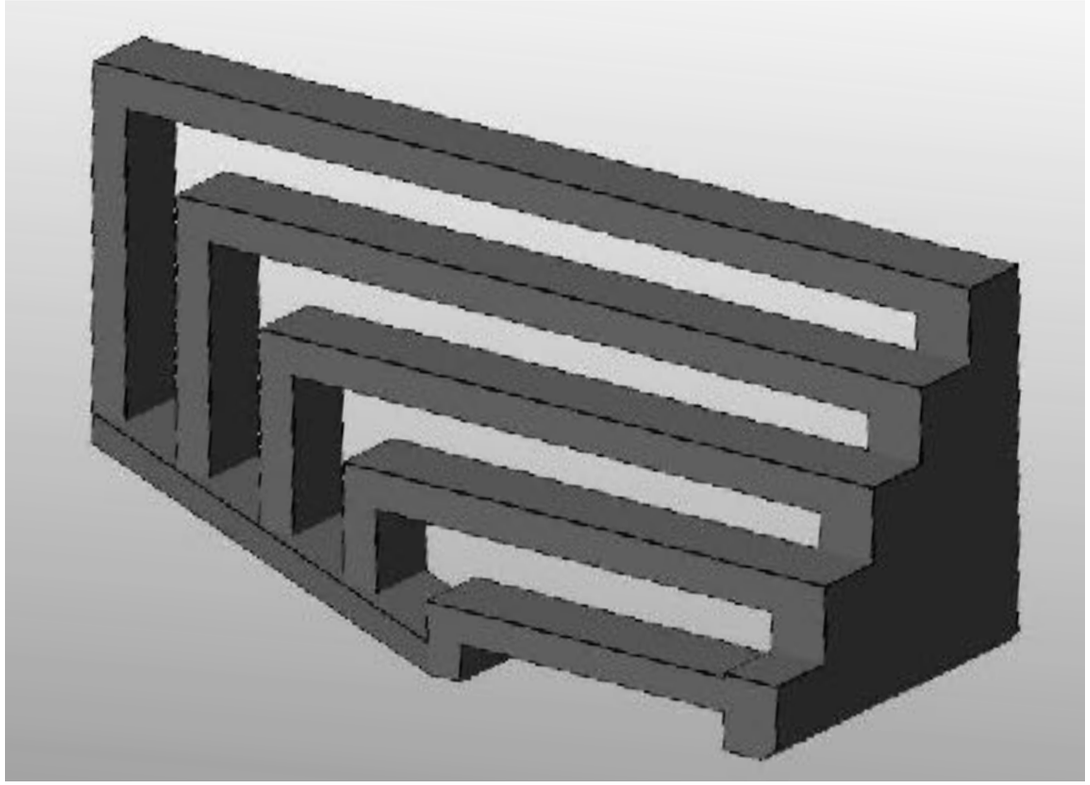
Layer Height

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.

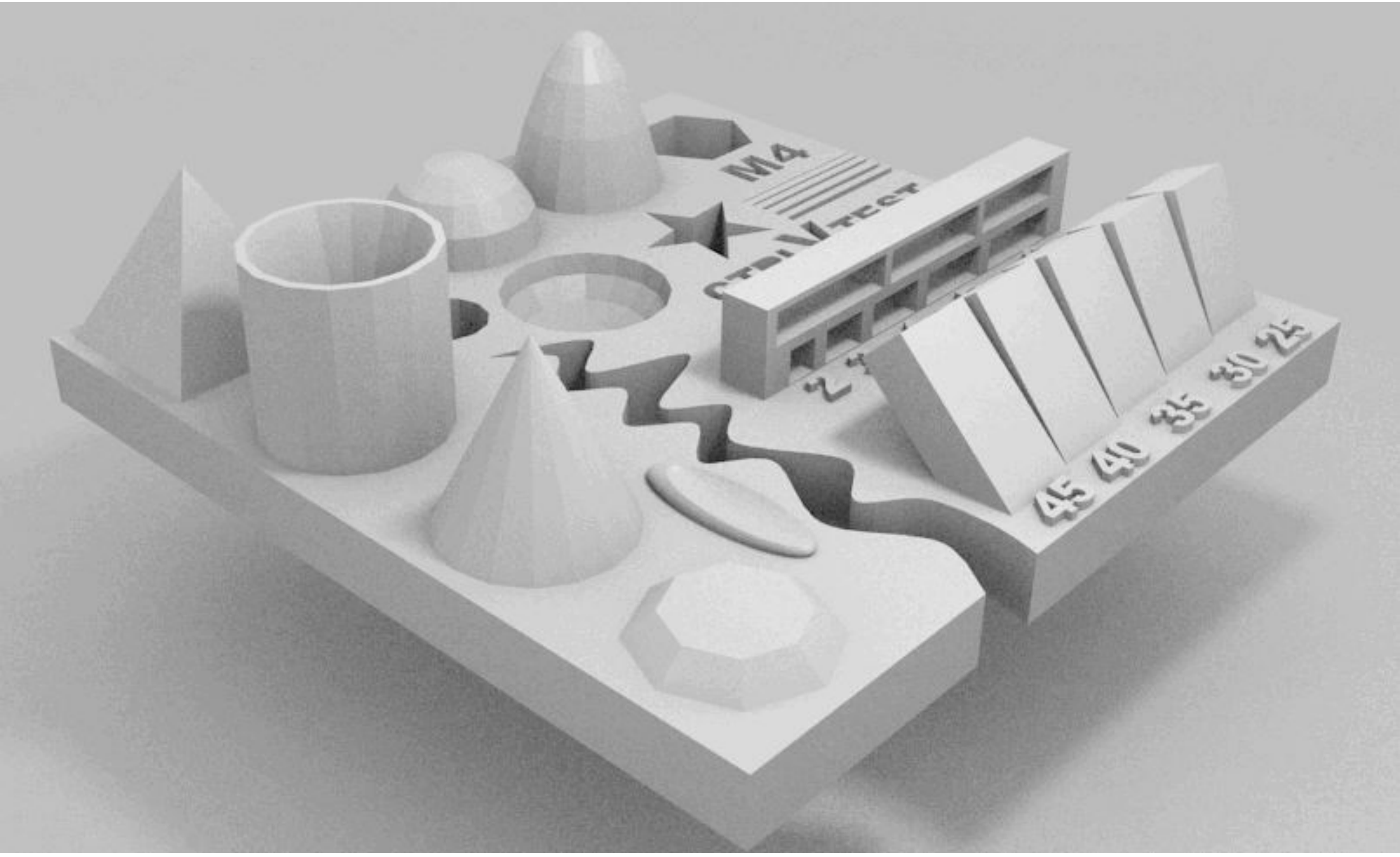


LOST IN ACRONYMS?

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

PRINT A MODEL TO TEST YOUR PRINTER'S DESIGN RULES

Exercise 1



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TROUBLESHOOTING

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

Pillowing

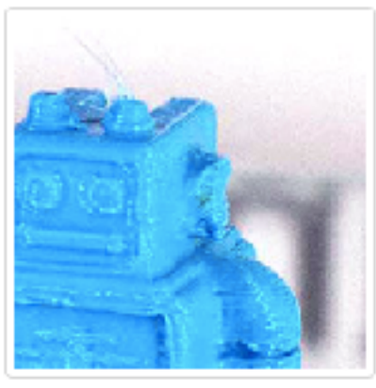
Top surfaces are not closed properly or come out bumpy.

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

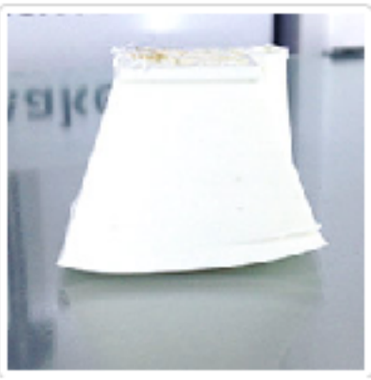
The lower surface of overhangs come out ugly

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

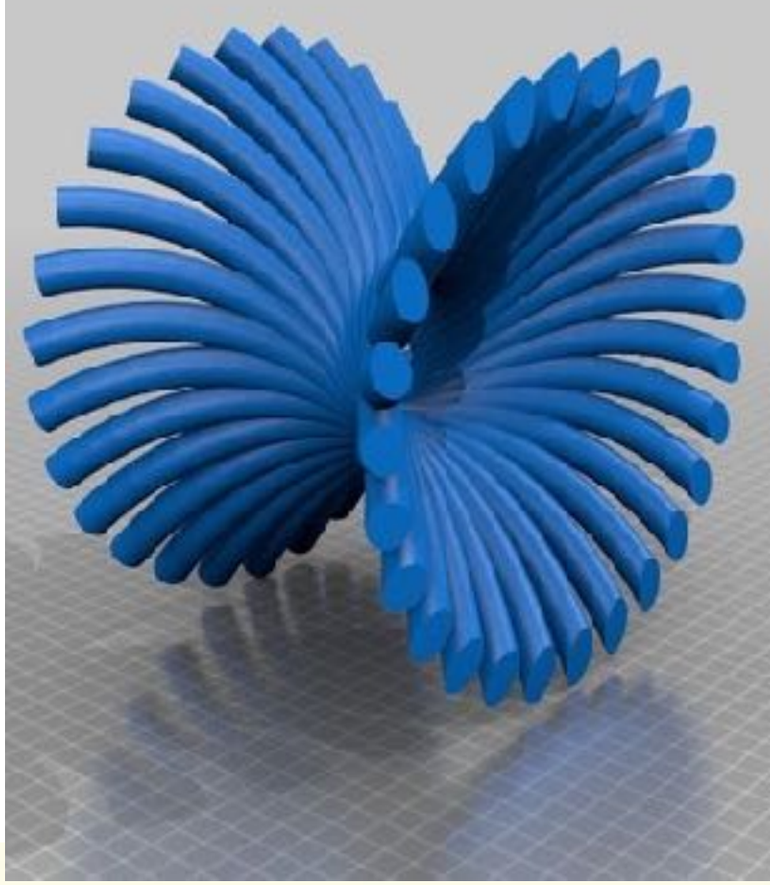
The printer is not extruding enough plastic leaving gaps in the print

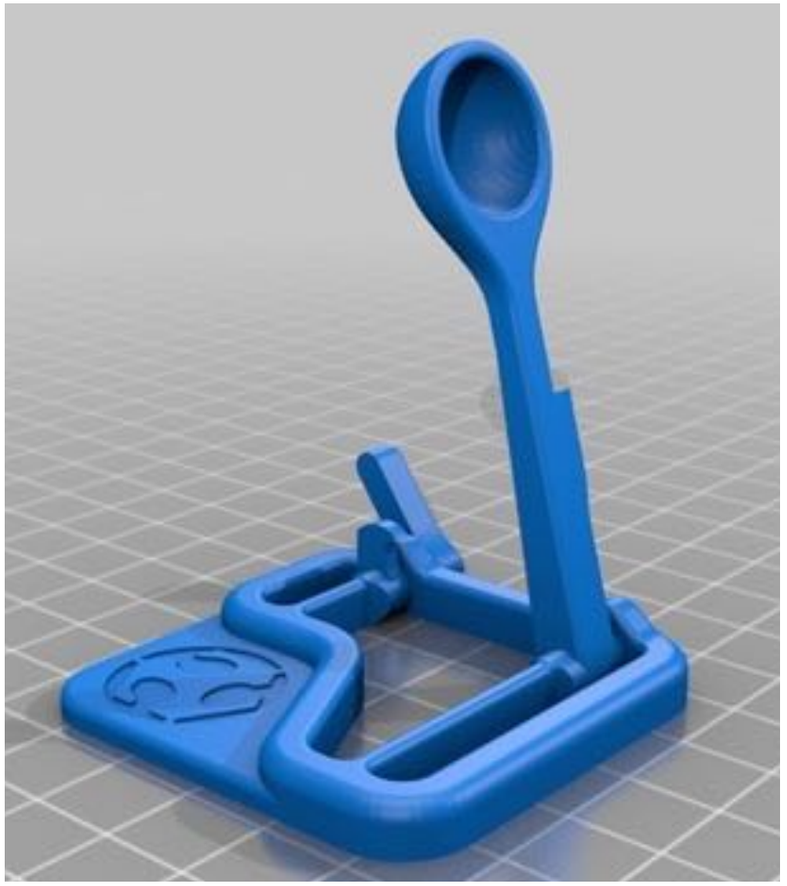
Walls not touching

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

DESIGN AND PRINT SOMETHING THAT CANNOT BE LASER CUTTED.

Exercise 2






Designed by Tullio Lucatelli