introduction exercise

Introduction to 3D printing

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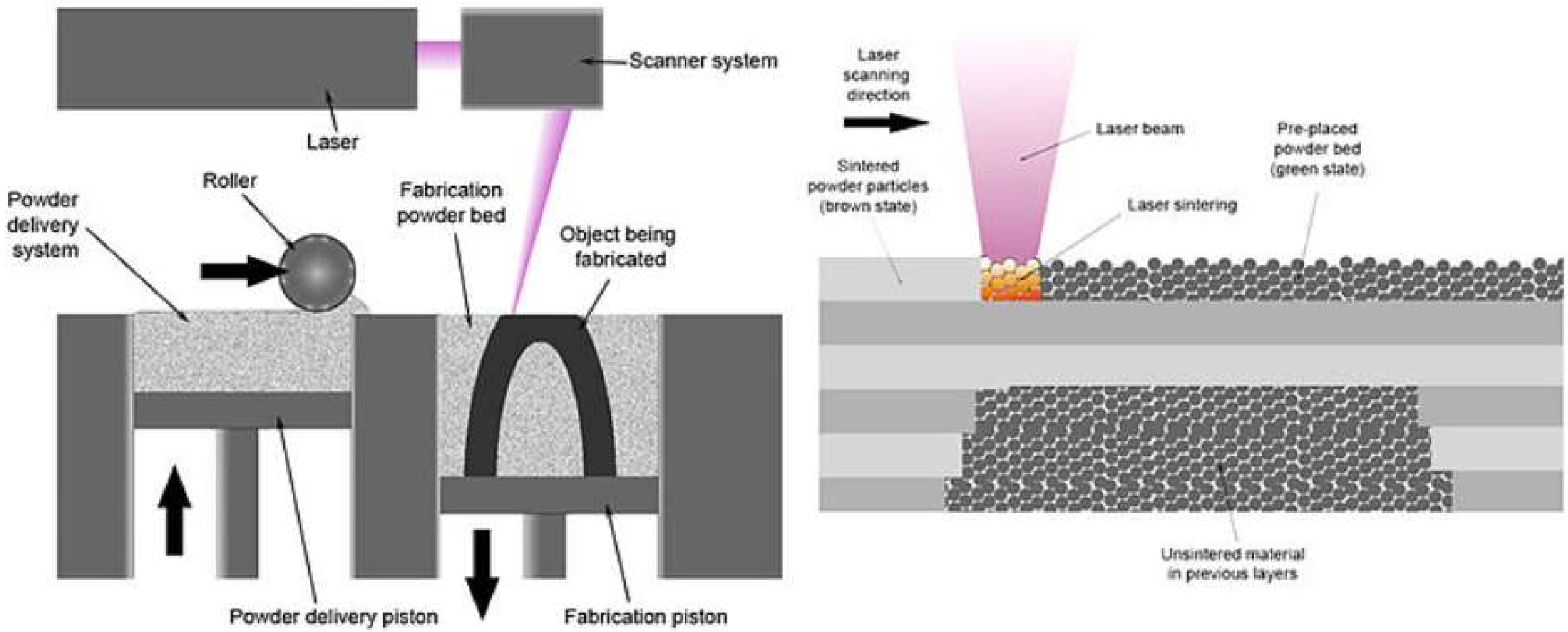
The 9 Different Types of 3D Printers

- Stereolithography (SLA)
- Digital Light Processing (DLP)
- Fused deposition Modeling (FDM)
- Selective Laser Sintering (SLS)
- Selective Laser Melting (SLM)
- Electronic Beam Melting (EBM)
- Laminated Object Manufacturing (LOM)
- Binder Jetting (BJ)
- Material Jetting (MJ)

The 3 Main Types of 3D Printers

- Stereolithography (SLA)
- Fused Deposition Modeling (FDM)
- Selective Laser Sintering (SLS)

Selective Laser Sintering (SLS)



An American businessman, inventor, and teacher named [Dr. Carl Deckard]() developed and patented SLS technology in the mid-1980s. It's a 3D printing technique that uses high power CO2 lasers to fuse particles together. The laser sinters powdered metal materials (though it can utilize other materials too, like white nylon powder, ceramics and even glass). Here's how it works:

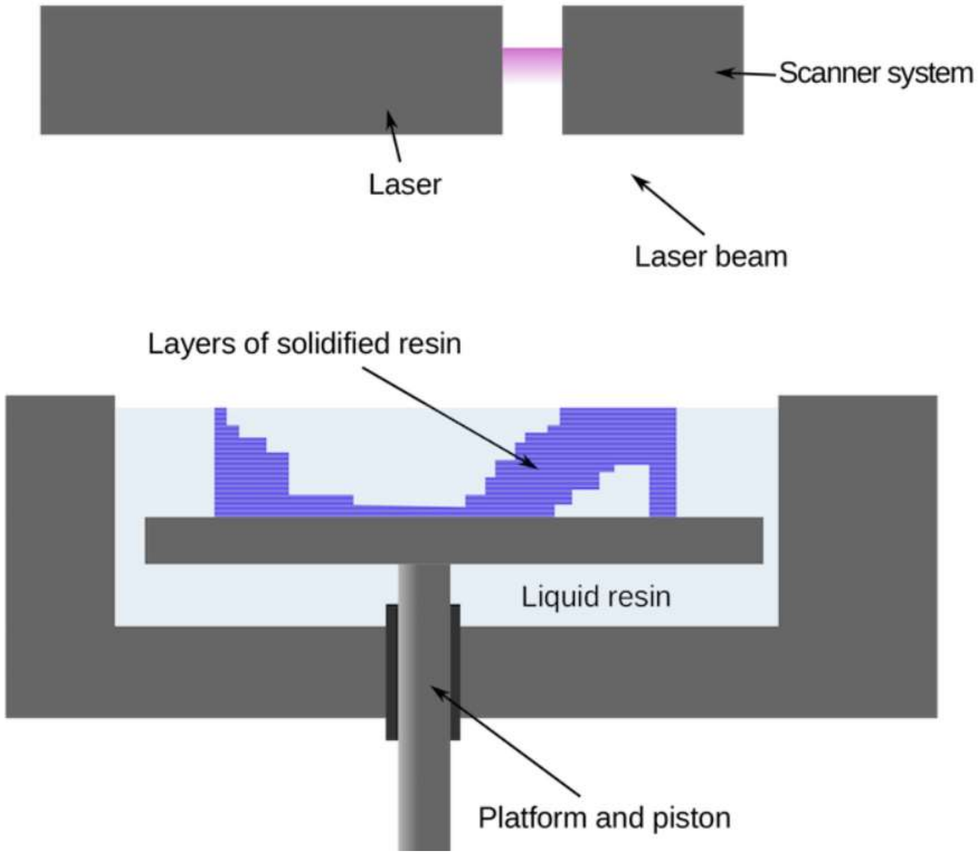
The build platform, or bed, lowers incrementally with each successive laser scan. It's a process that repeats one layer at a time until it reaches the object's height. There is un-sintered support from other powders during the build process that surround and protect the model. This means the 3D objects don't need other support structures during the build. Someone will remove the un-sintered powders manually after printing. SLS produces durable, high precision parts, and it can use a wide range of materials. It's a perfect technology for fully-functional, end-use parts and prototypes. SLS is quite similar to SLA technology with regards to speed and quality. The main difference is with the materials, as SLS uses powdered substances, whereas SLA uses liquid resins. It's this wide variety of available materials that makes SLA technology so popular for printing customized objects

Selective Laser Sintering (SLS)

Stereolithography (SLA)

SLA is a fast prototyping process. Those who use this technology are serious about accuracy and precision. It can produce objects from 3D CAD data (computer-generated) files in just a few hours. This is a 3D printing process that's popular for its fine details and exactness. Machines that use this technology produce unique models, patterns, prototypes, and various production parts. They do this by converting liquid photopolymers (a special type of plastic) into solid 3D objects, one layer at a time. The plastic is first heated to turn it into a semi-liquid form, and then it hardens on contact. The printer constructs each of these layers using an ultra violet laser, directed by X and Y scanning mirrors. Just before each print cycle, a recoater blade moves across the surface to ensure each thin layer of resin spreads evenly across the object. The print cycle continues in this way, building 3D objects from the bottom up.

Once completed, someone takes the 3D object from the printer and detaches it carefully from the platform. The 3D part will usually have a chemical bath to remove any excess resin. It's also common practice to post-cure the object in an ultra violet oven. What this does is render the finished item stronger and more stable. Depending on the part, it may then go through a hand sanding process and have some professional painting done. SLA printing has become a favored economical choice for a wide variety of industries. Some of these include automotive, medical, aerospace, entertainment, and also to create various consumer products.



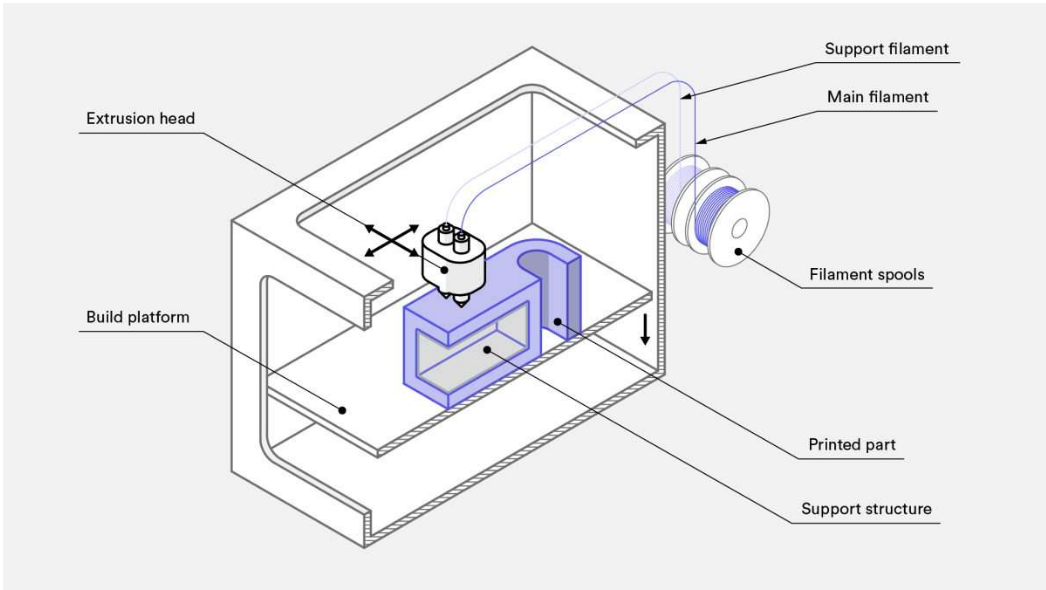
Stereolithography (SLA)

Fused deposition Modeling (FDM)

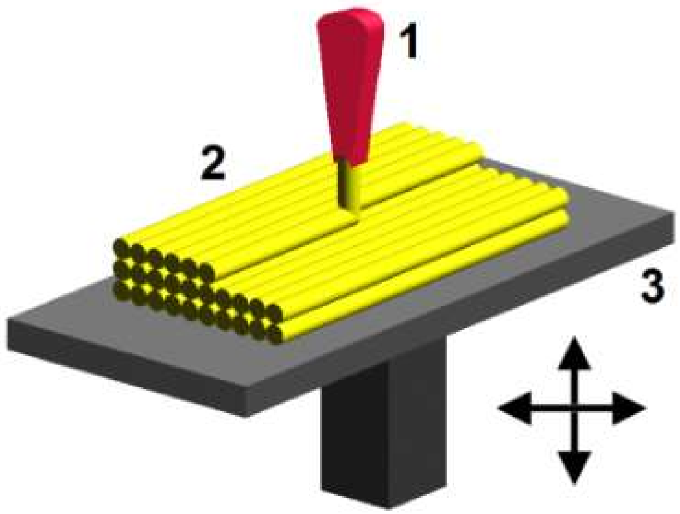
FDM is a 3D printing process developed by Scott Crump, and then implemented by Stratasys Ltd., in the 1980s. It uses production grade thermal plastic materials to print its 3D objects. It’s popular for producing functional prototypes, concept models, and manufacturing aids. It’s a technology that can create accurate details and boasts an exceptional strength to weight ratio.

Before the FDM printing process begins, the user has to slice the 3D CAD data (the 3D model) into multiple layers using special software. The sliced CAD data goes to the printer which then builds the object layer at a time on the build platform. It does this simply by heating and then extruding the thermoplastic filament through the nozzle and onto the base. The printer can also extrude various support materials as well as the thermoplastic. For example, as a way to support upper layers, the printer can add special support material underneath, which then dissolves after the printing process. As with all 3D printers, the time it takes to print all depends on the objects size and its complexity.

Like many other 3D technologies, the finished object needs cleaning. Raw FDM parts can show fairly visible layer-lines on some objects. These will obviously need hand sanding and finishing after printing. This is the only way to get a smooth, end product with an even surface. FDM finished objects are both functional and durable. This makes it a popular process for use in a wide range of industries, including for mechanical engineering and parts manufacturers. BMW uses FDM 3D printing, as does the well-known food company Nestle, to name just a couple.

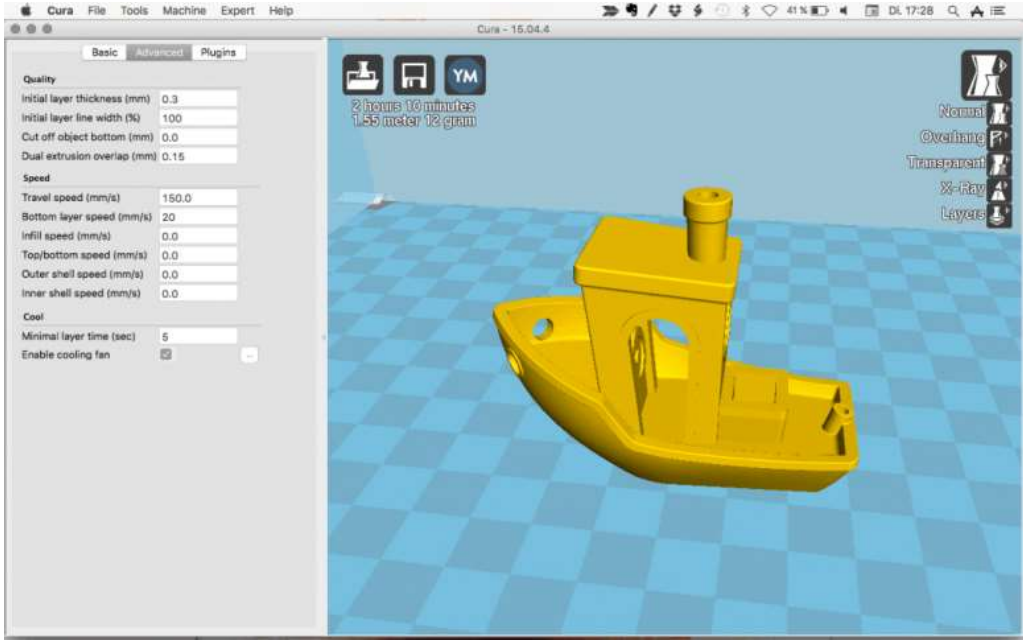


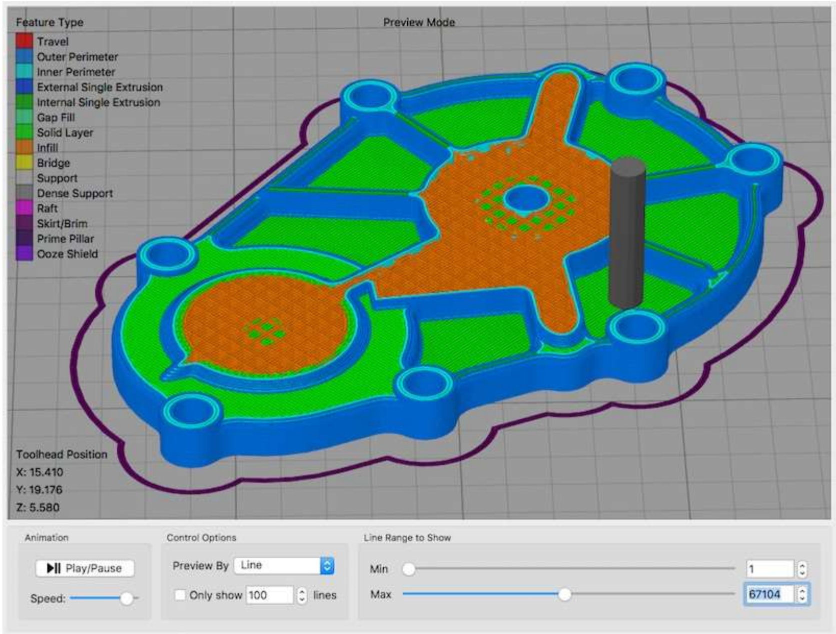
https://www.hubs.com/knowledge-base/what-is-fdm-3d-printing/



Fused deposition Modeling (FDM)

slicers





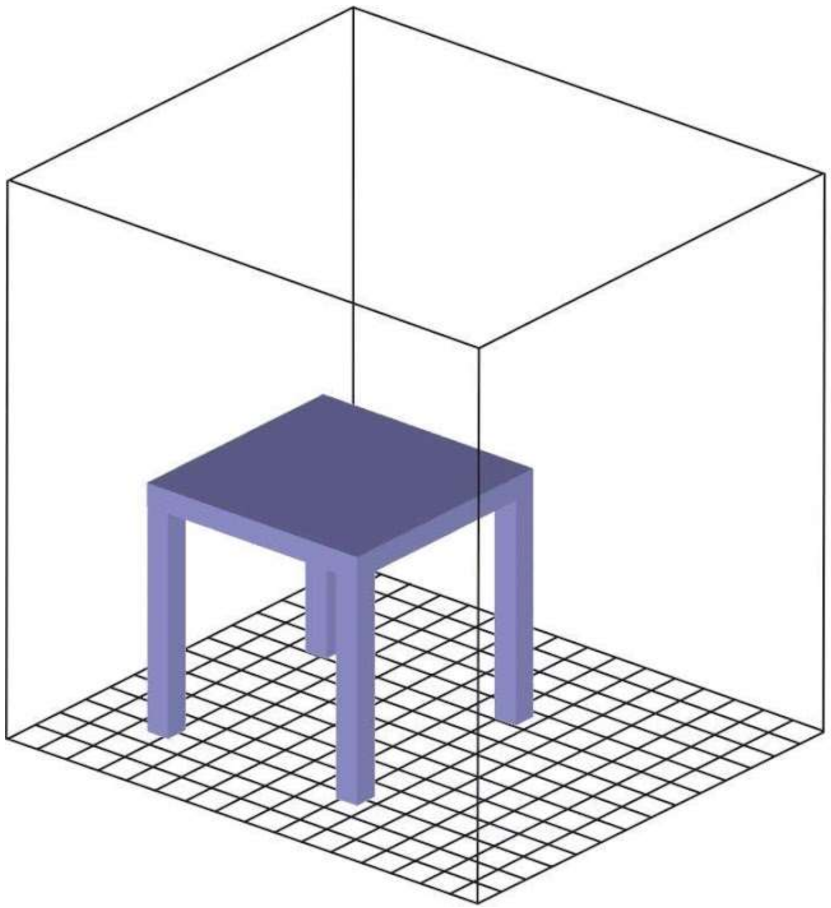
Slicer. Slicing is the process of transforming the 3d model from a mesh to G-code. It us done in an external program called “Slicer”.

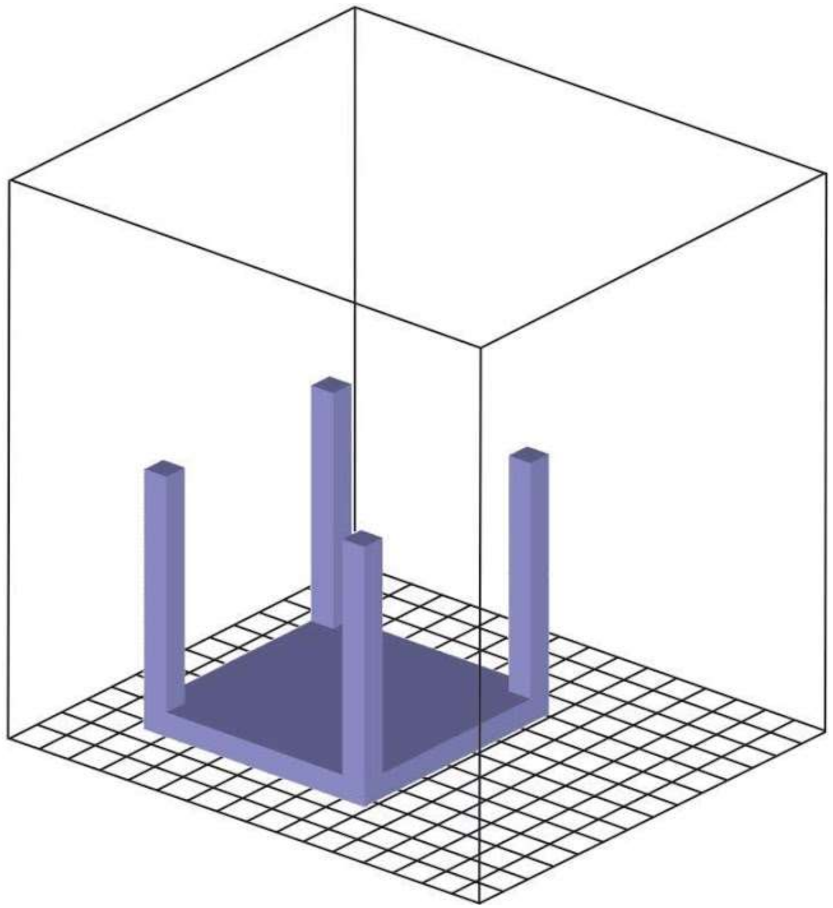
3D printing elements

3d model

3D printer model. Not all 3D printers are created equal. Try printing an overhang test to see how well your printer does. If a 60-degree overhang doesn’t look so good, you should put supports on models with similar overhangs.

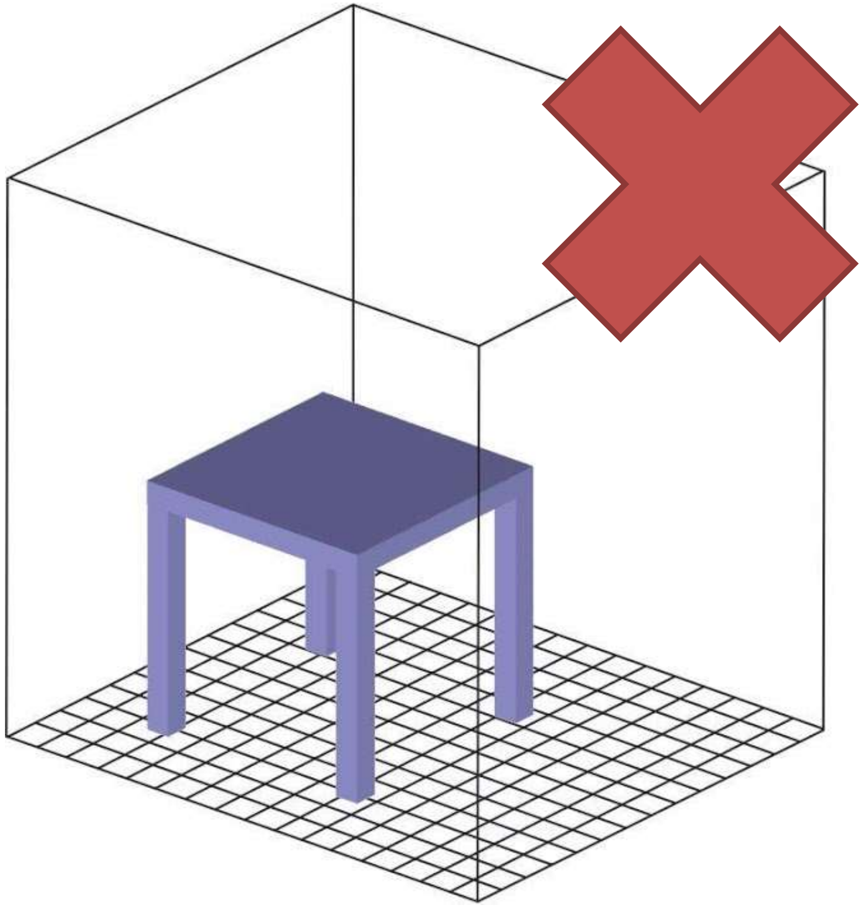
What's better?

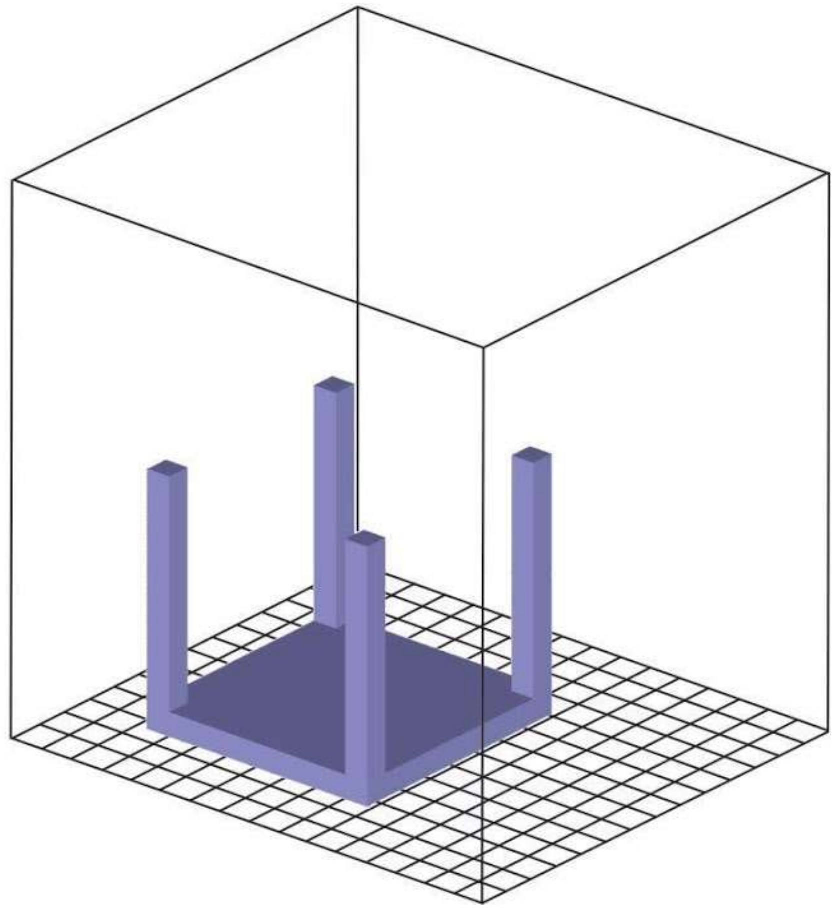




Orientation. Place the 3d object in a way that will accommodate best the 3d printing process.

What's better?





Architectural Applications

TRUSSCHAIR – Alejandro Estrada [link]

3D Printed Wood-joinery – Olle Gellert [link]

3D printed pedestrian steel bridge – Joris Laarman & MX3D [link]

Architectural Applications

TECLA – 3d WASP [link]

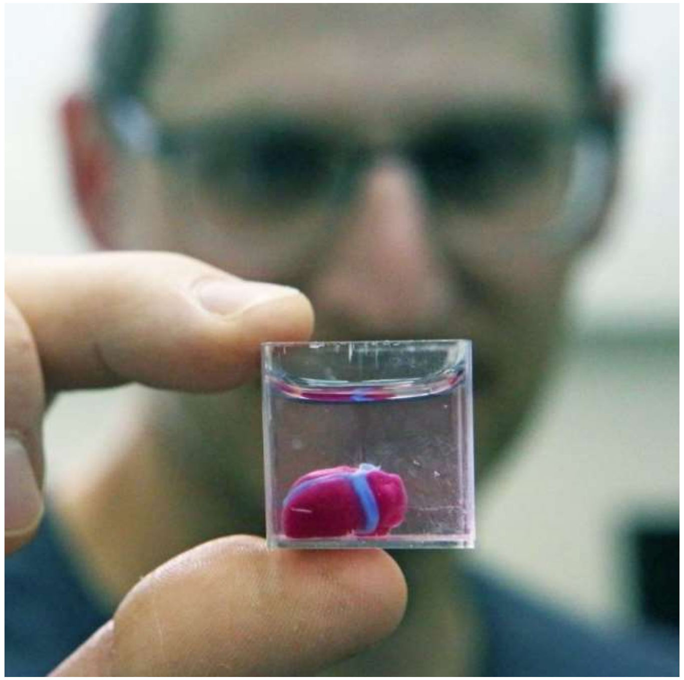
Mataerial – Petr Novikov & Sasa Jokic [link]

Load bearing earthen wall with timber structure – IAAC & WASP [link]

3D Printing Research

threeASFOUR – Harmonograph Dress [link]

FOOD Ink – 3D Printing Food Restaurant [link]

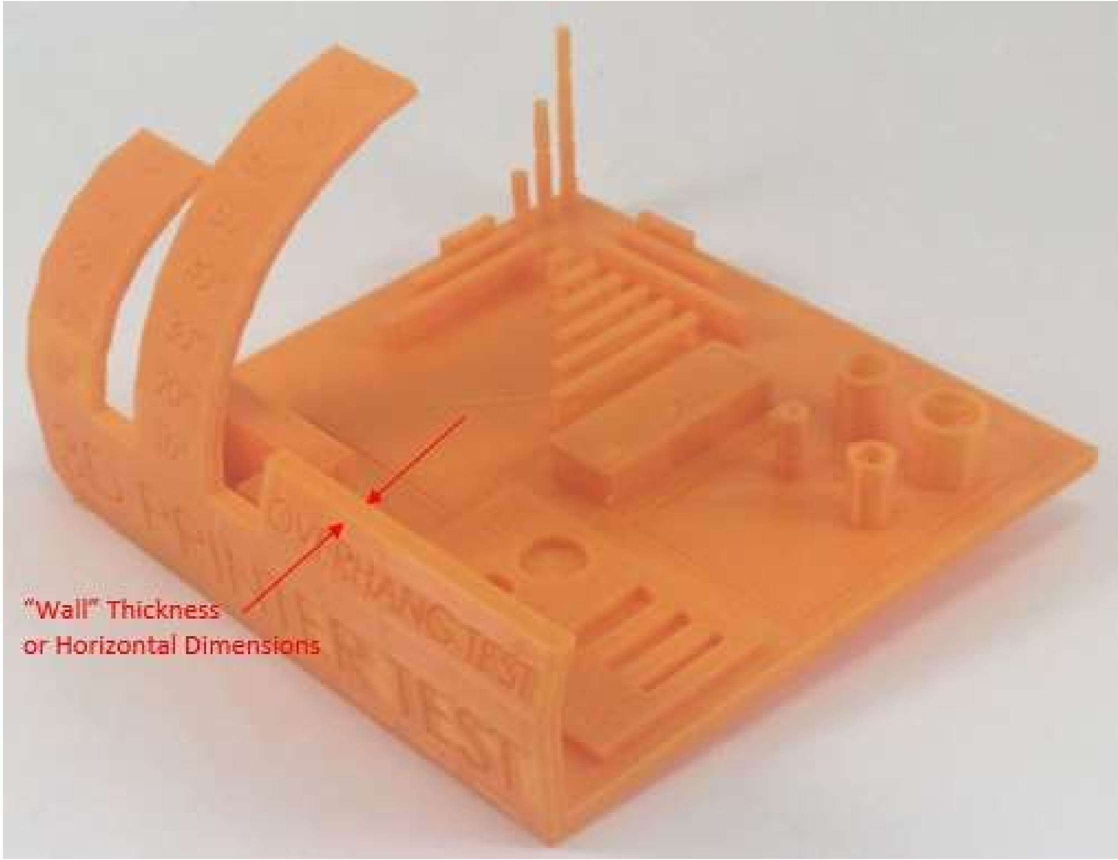


World's first 3D printed heat with blood vessels [link]

Is this the future of Construction? 3D Concrete Printed Homes

3D Printing Do's and Don't's

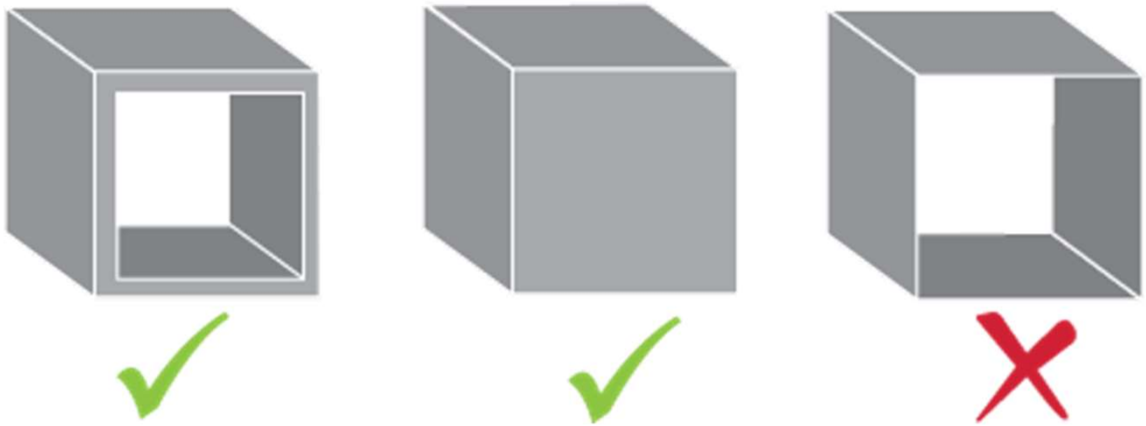
Do: Consider The Tolerances of The Printers



https://buildit.sdsu.edu/printing-considerations/

3D Printing Do's and Don't's

Do: Make walls and volumes – closed polysurface



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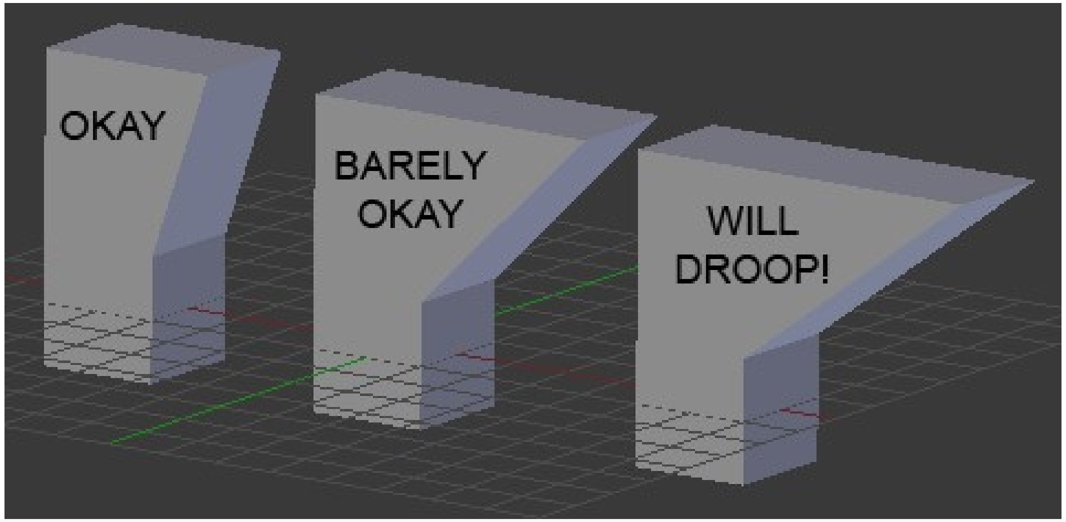
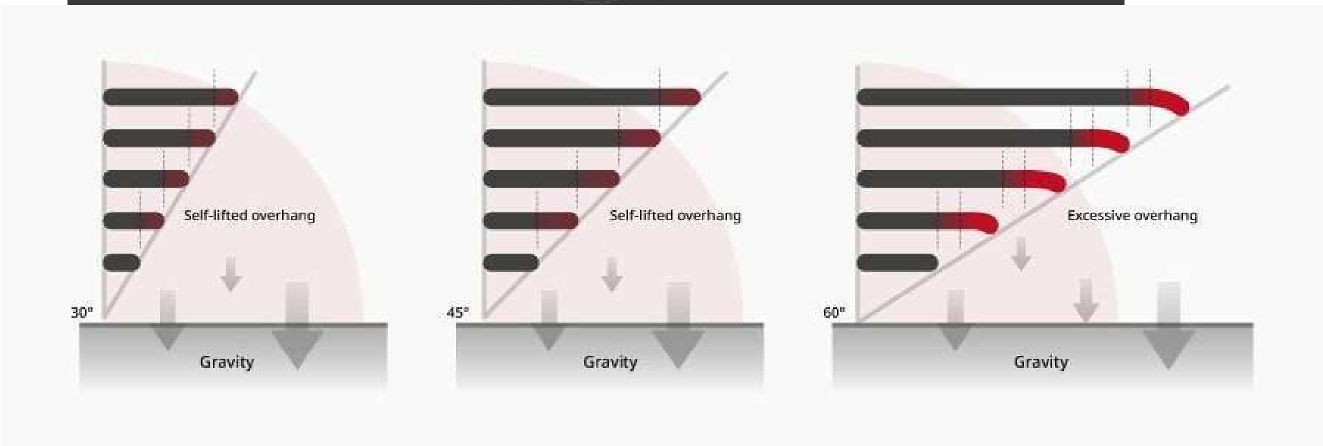
3D Printing Do's and Don't's

DO: Plan for Overhangs

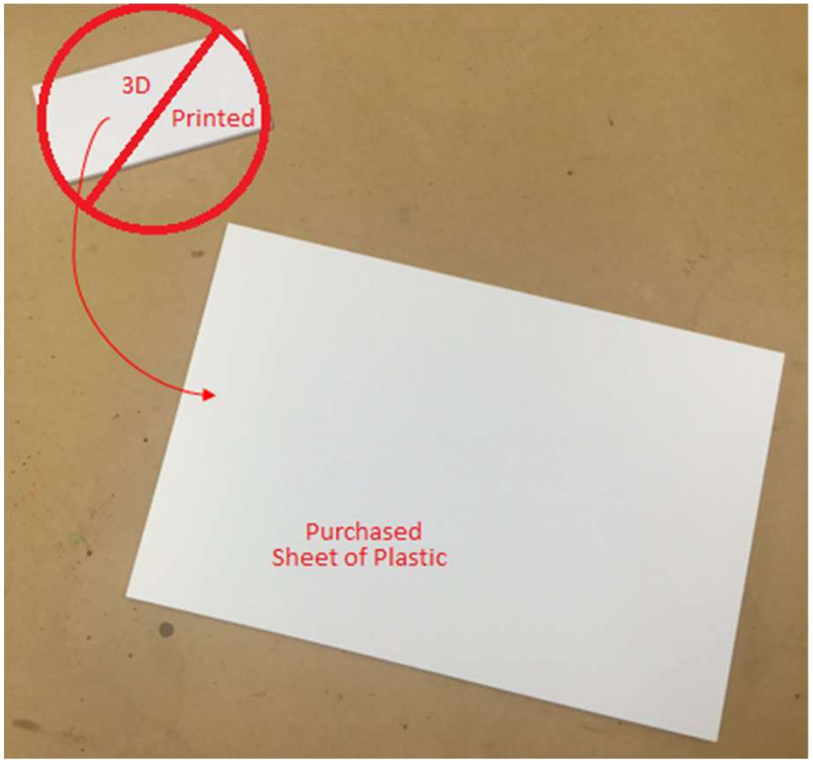




https://www.simplify3d.com/

3D Printing Do's and Don't's

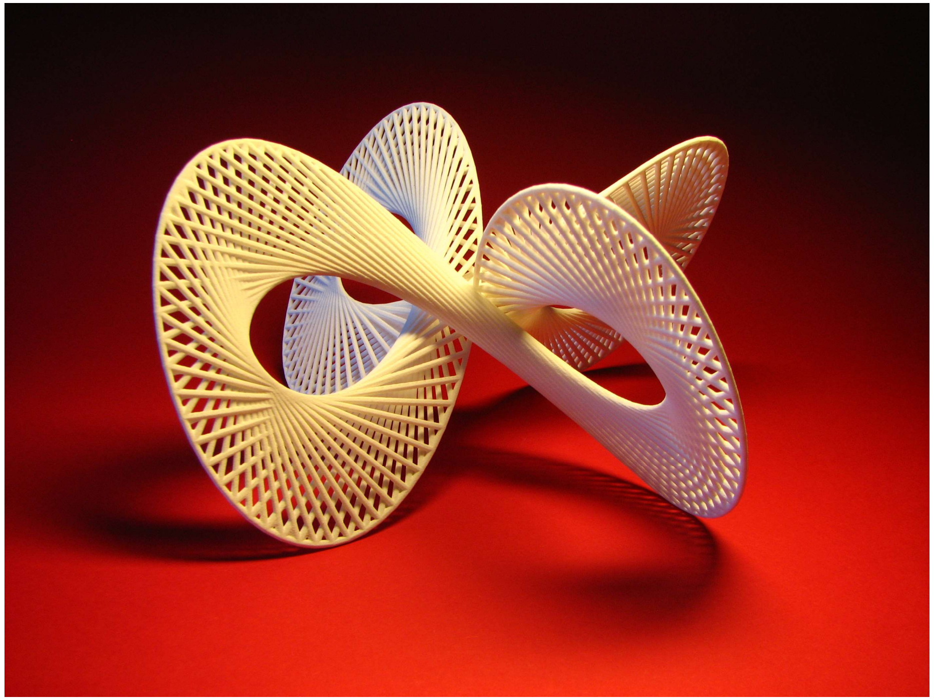
DO: Ask Yourself If 3D Printing Makes Sense



https://buildit.sdsu.edu/printing-considerations/

3D Printing Do's and Don't's

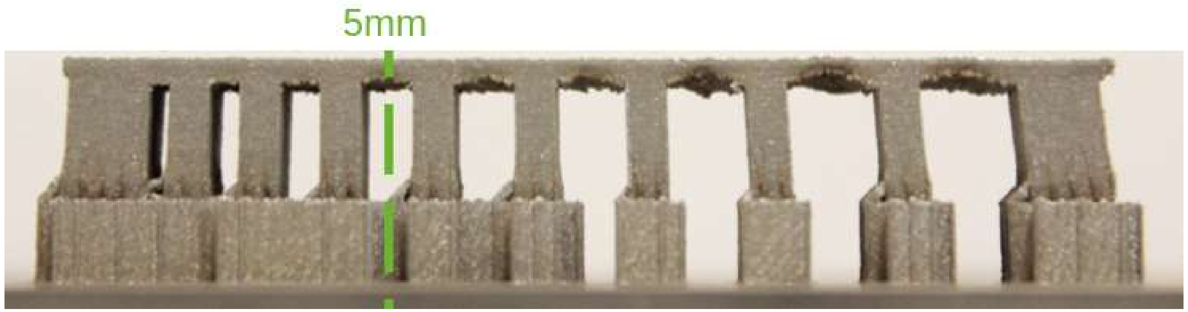
DON'T: Design Your Object With Small or Curved Sides



https://buildit.sdsu.edu/printing-considerations/

3D Printing Do's and Don't's

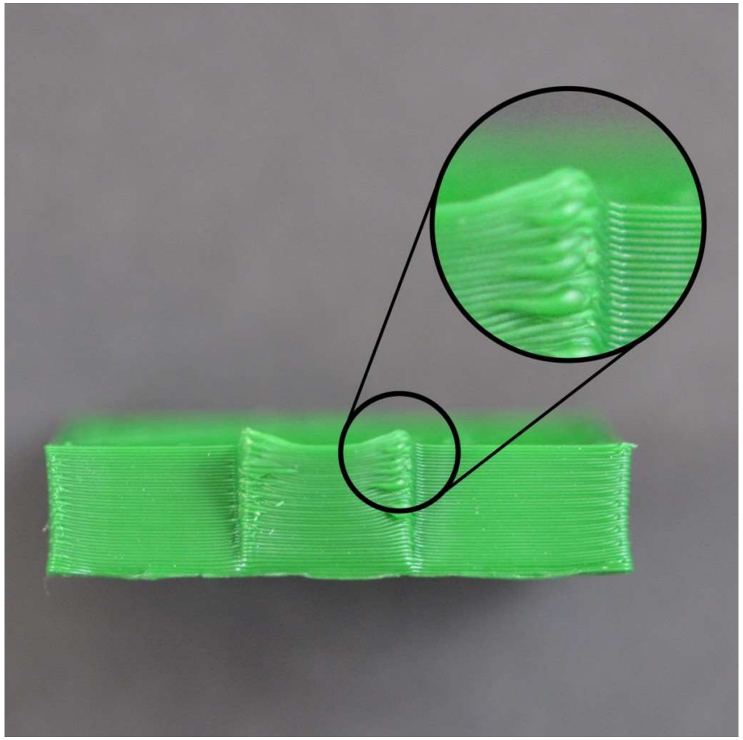
DON'T: Design small holes and cracks



https://www.simplify3d.com/

3D Printing Do's and Don't's

DON'T: Design for sharp edges



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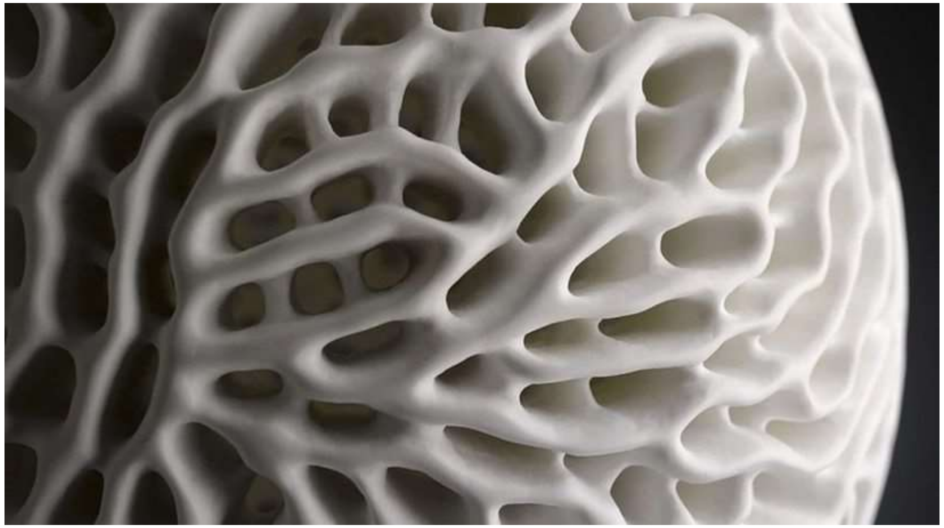
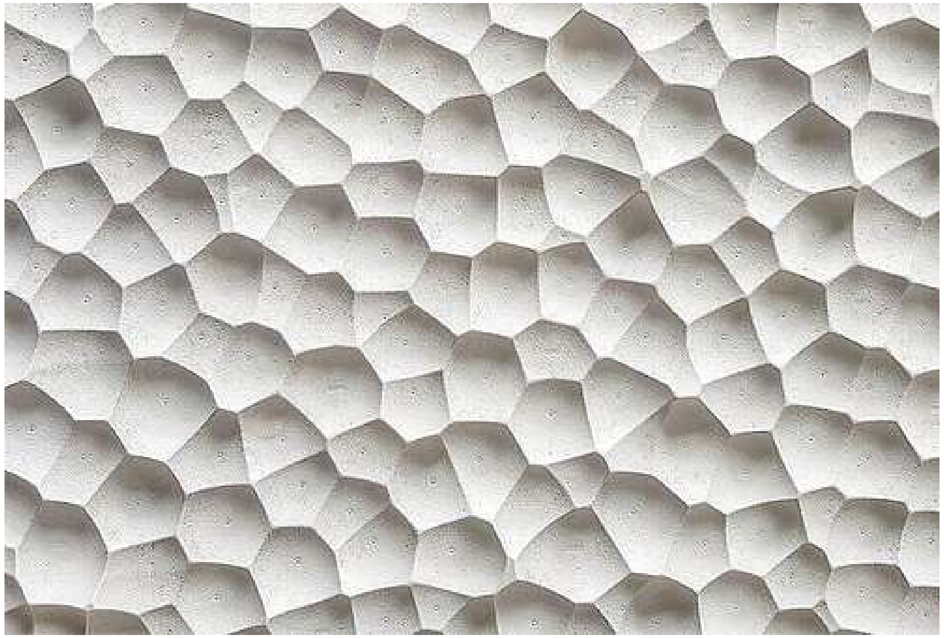
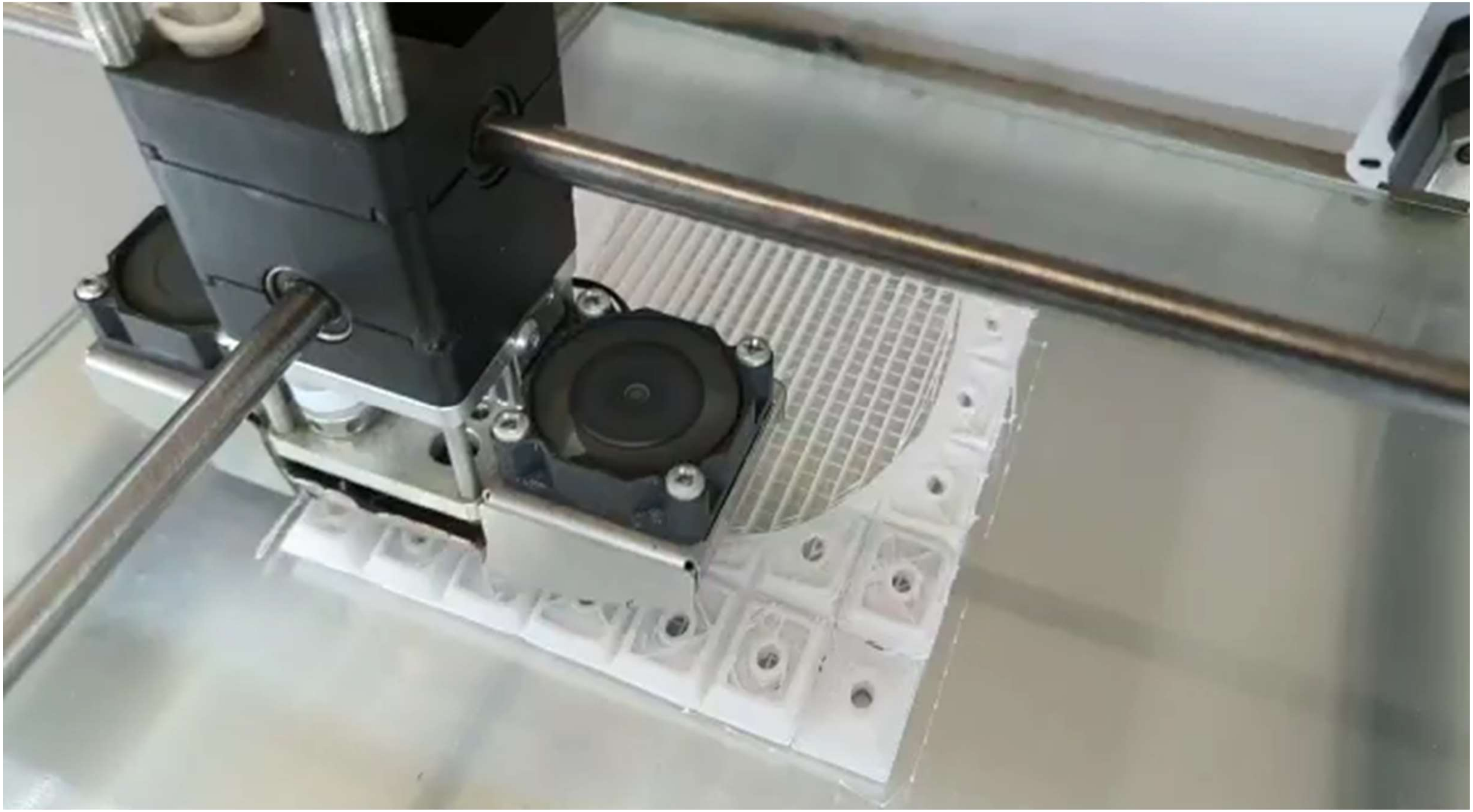
3D Printing Do's and Don't's

DO: Create Complex geometries



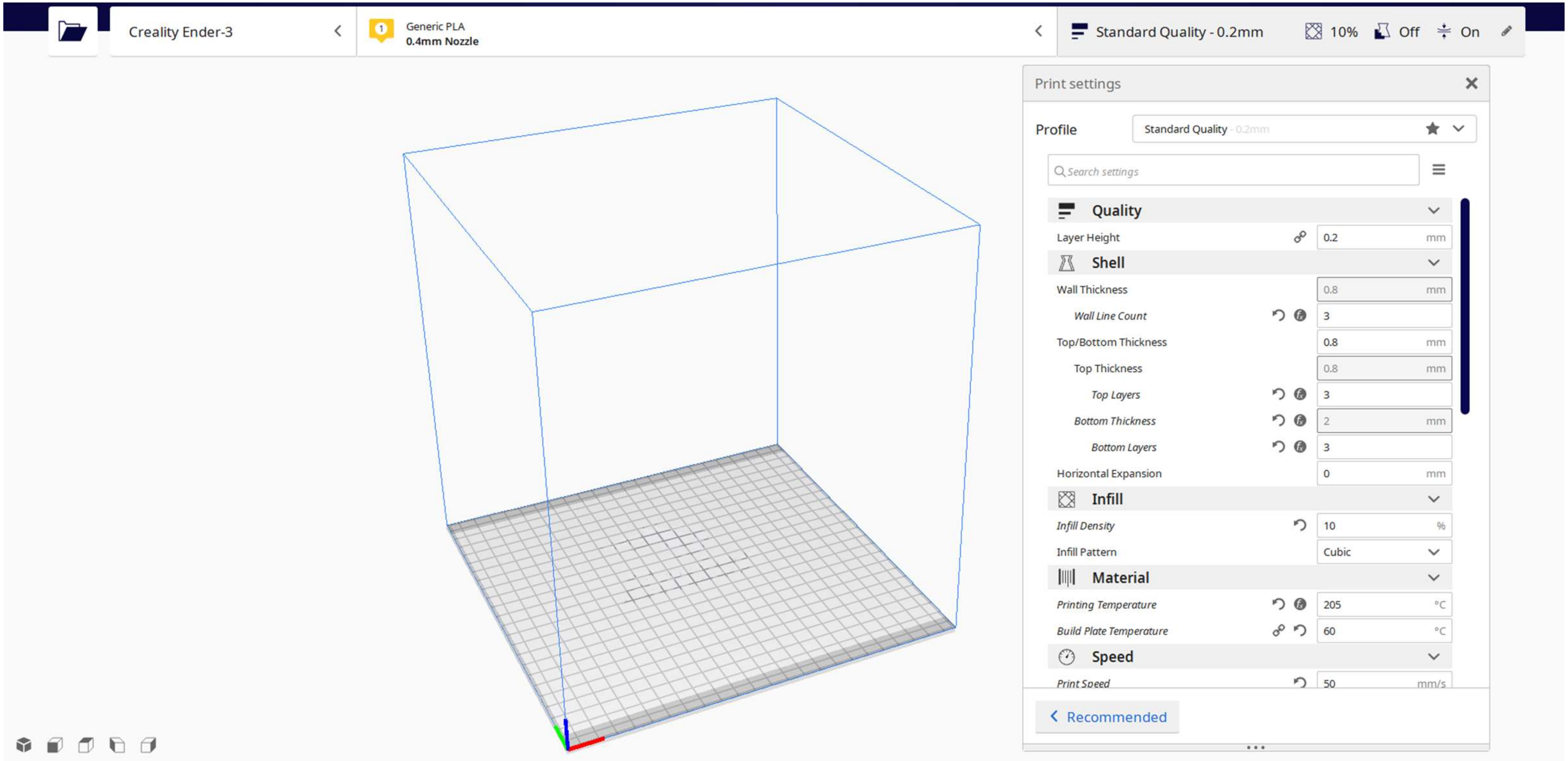


Fused deposition Modeling (FDM)



3D printing Slicer - Cura

Cura

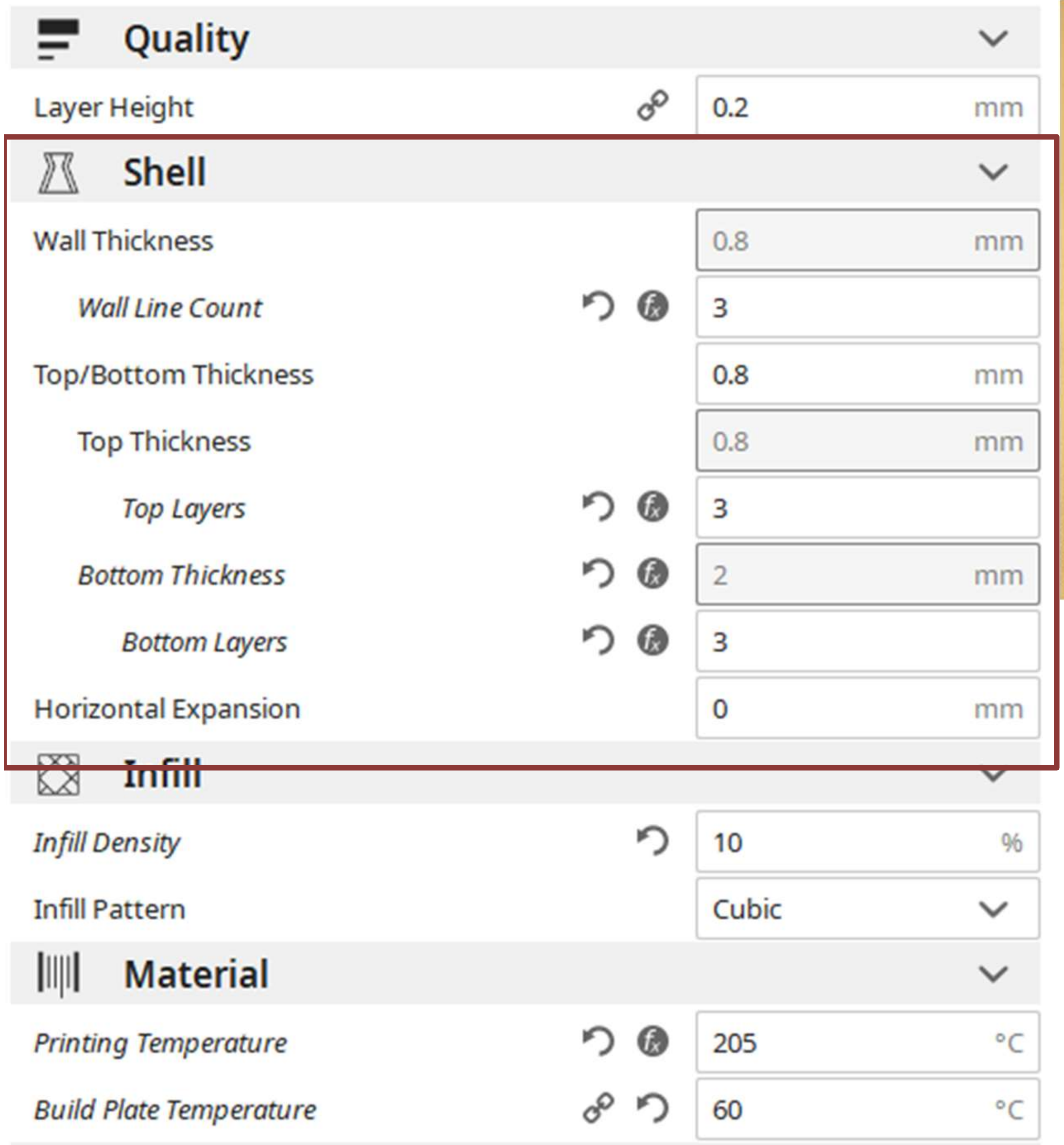


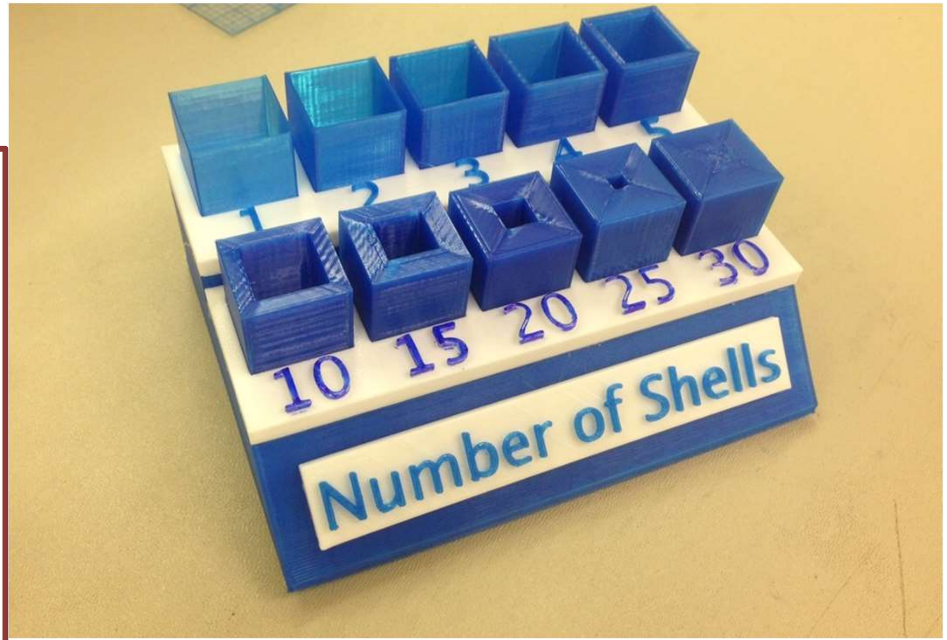
Creality Ender-3
Generic PLA
0.4mm Nozzle
Standard Quality - 0.2mm
10%
Off
On
Print settings
Profile
Standard Quality - 0.2mm
Search settings
Quality
Layer Height
0.2
mm
Shell
Wall Thickness
0.8
mm
Wall Line Count
3
Top/Bottom Thickness
0.8
mm
Top Thickness
0.8
mm
Top Layers
3
Bottom Thickness
2
mm
Bottom Layers
3
Horizontal Expansion
0
mm
Infill
Infill Density
10
%
Infill Pattern
Cubic
Material
Printing Temperature
205
°C
Build Plate Temperature
60
°C
Speed
Print Speed
50
mm/s
Recommended

Cura


Quality
Shell
Infill
Material
Speed
Travel
Cooling
Support
Build Plate Adhesion
Experimental

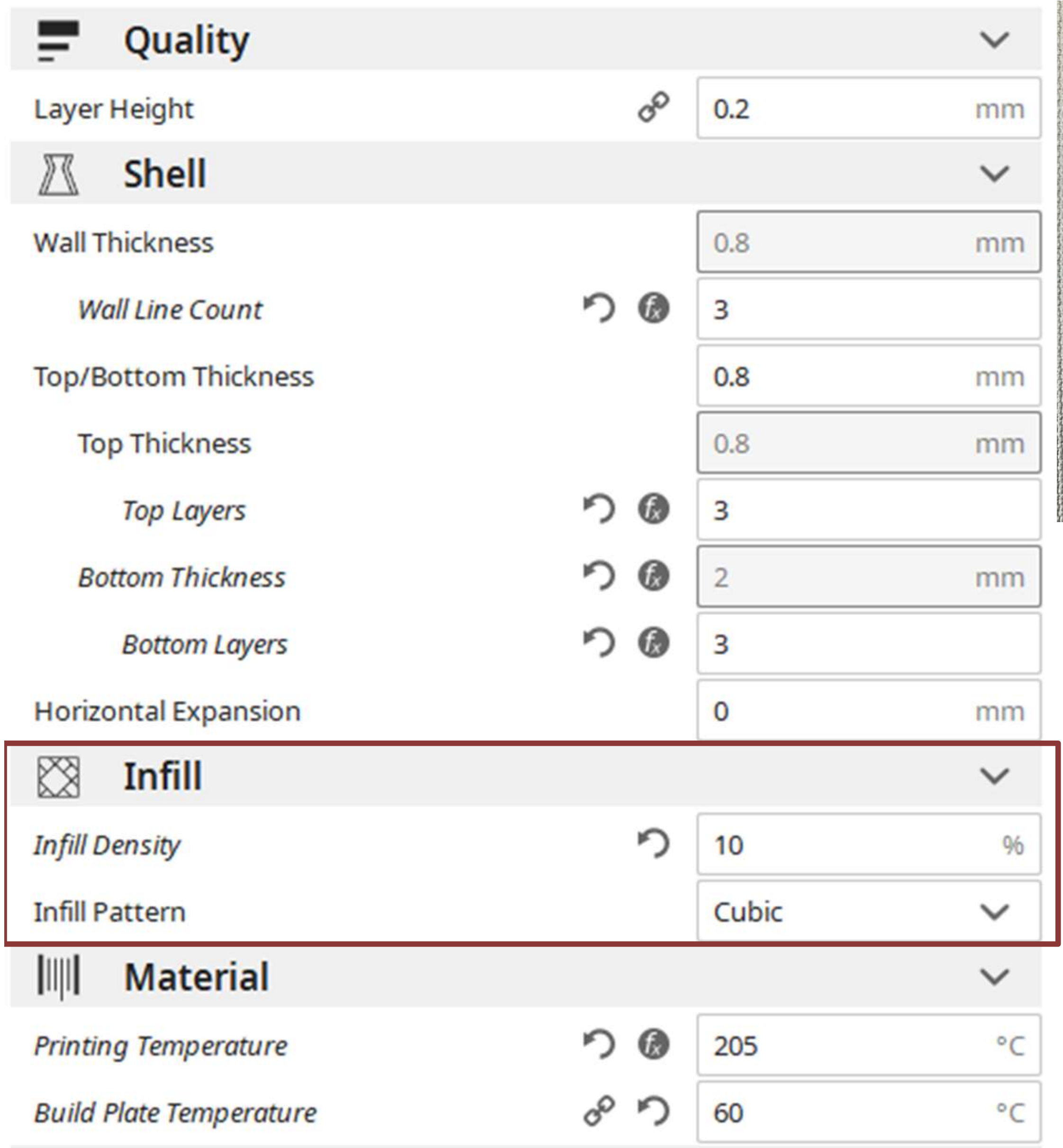
Cura

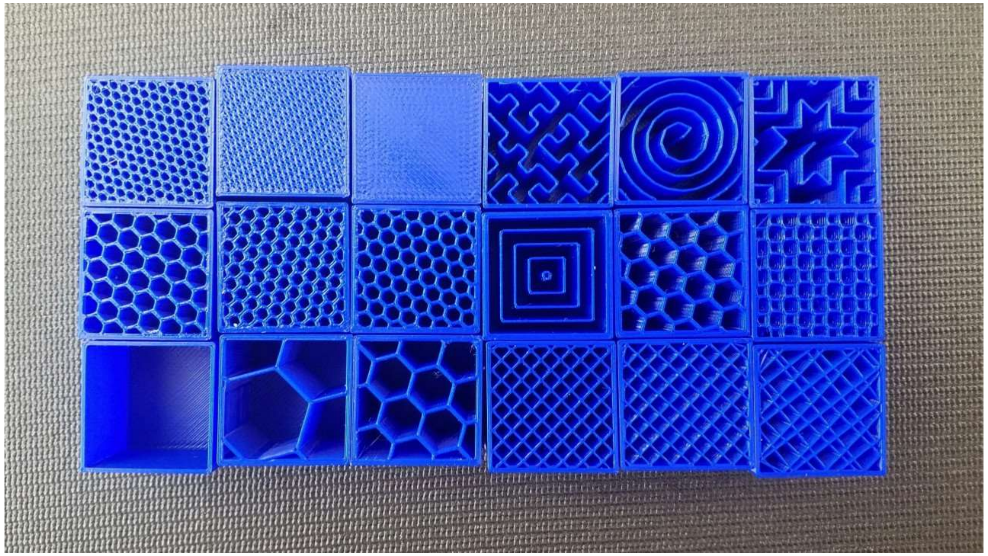




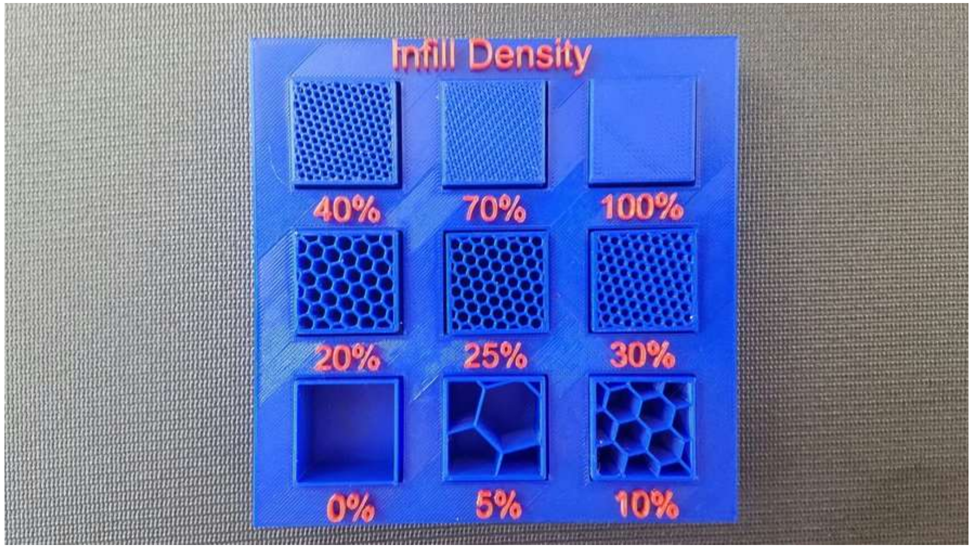
Shell. The shell is the main part of the print, and the shell thickness is derived from the number of the extruder passes on the sell in multiplication pf the nozzle size.

Cura

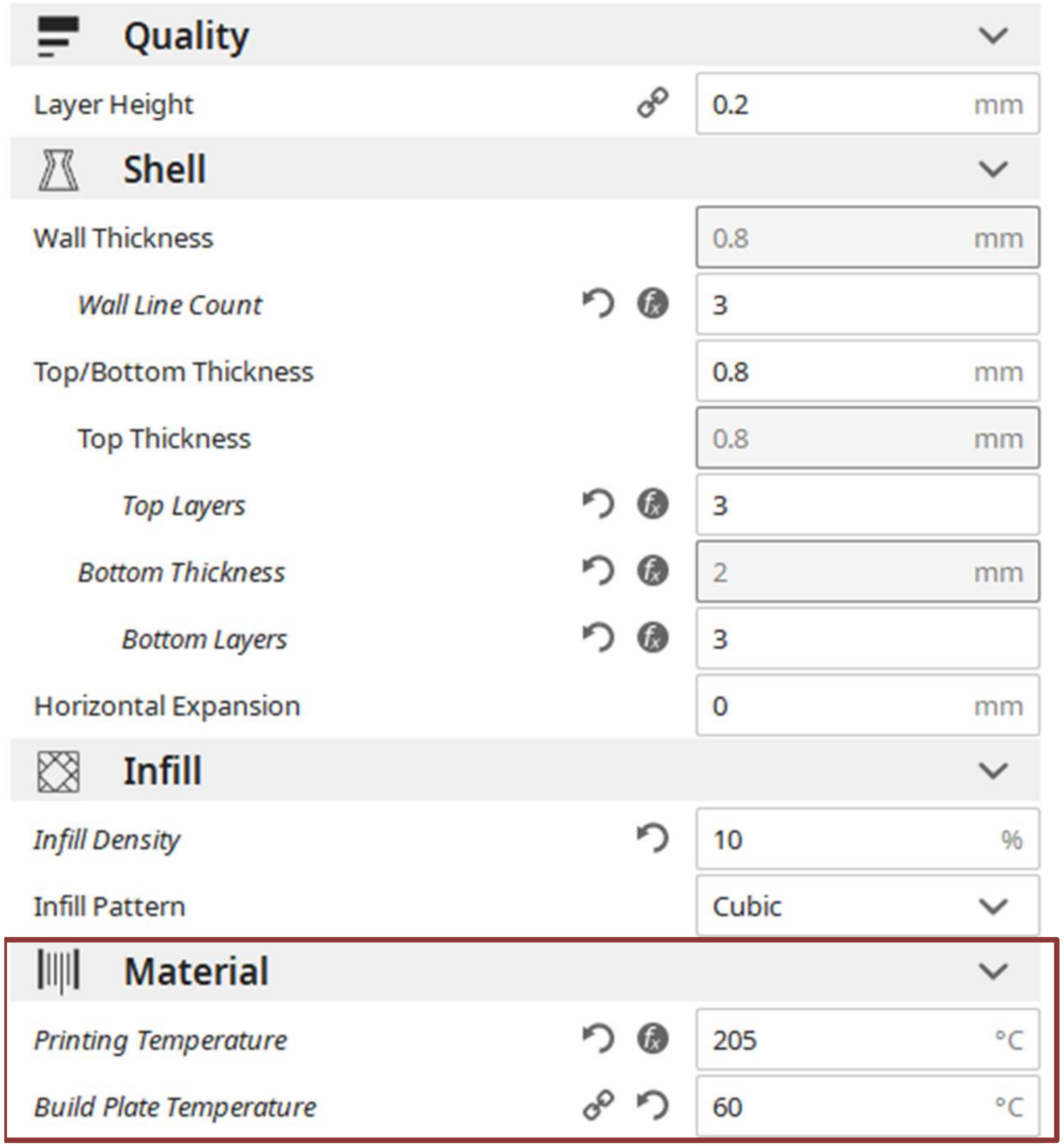




InFill. The infill of the 3d printed object should reflect the strength of the desired outcome and the denser the infill is the stronger the object will become.
The patters give directional strength to the object.



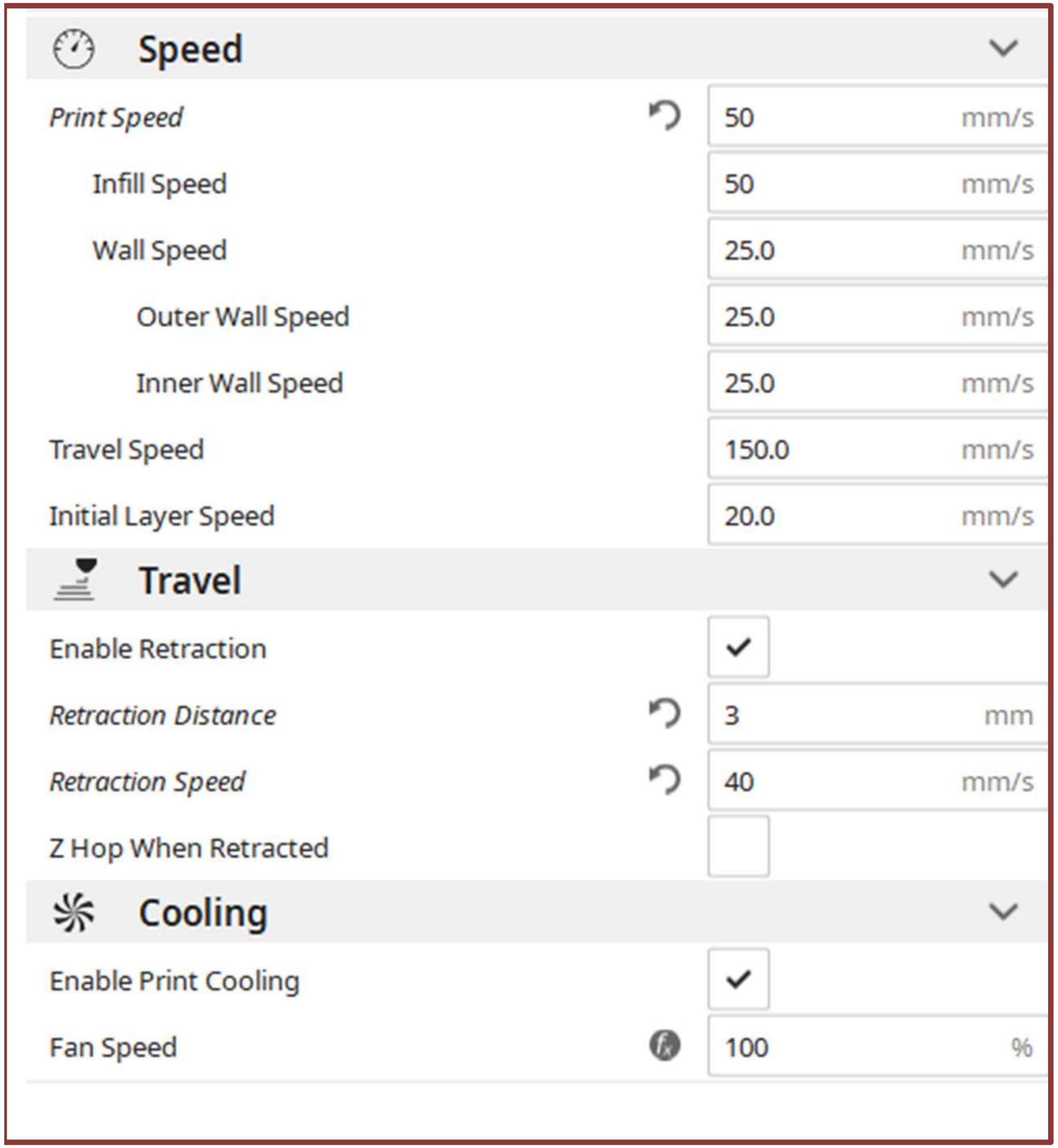
Cura



Materials

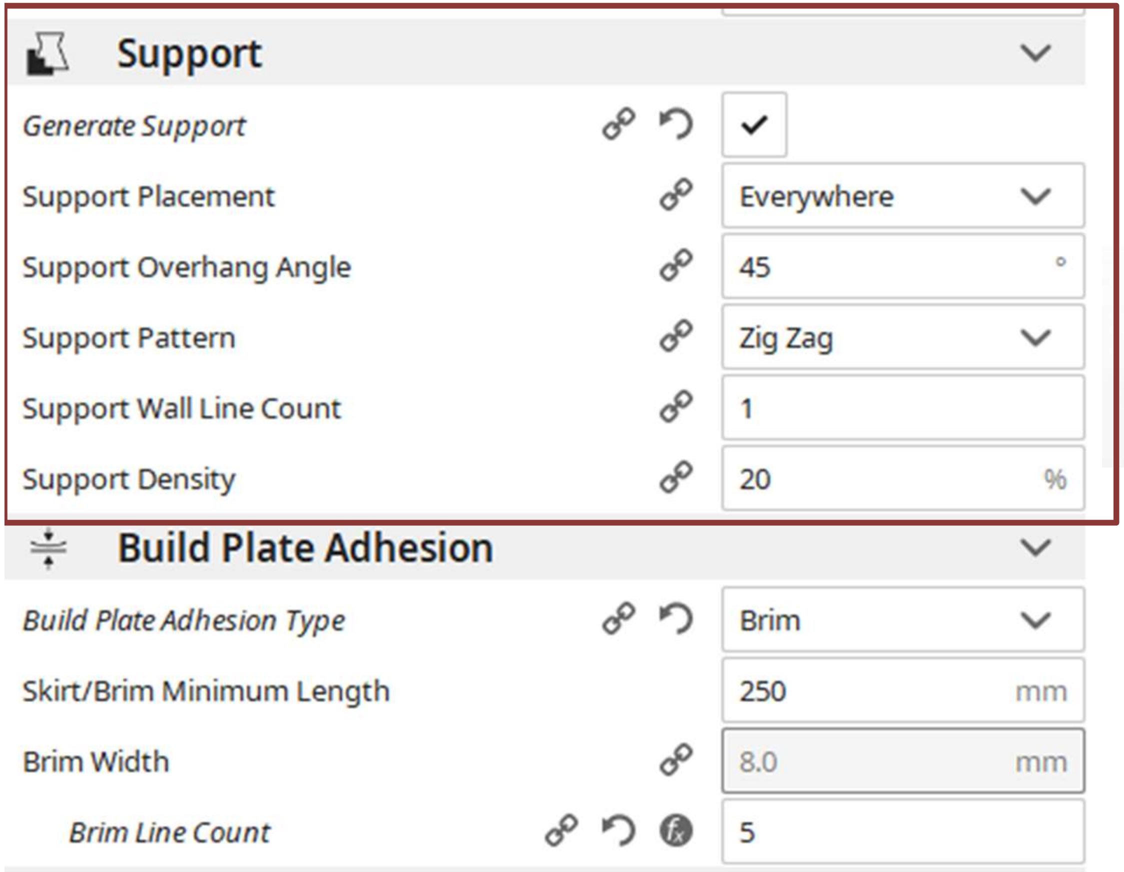
Shell. Many different materials can be used for 3D printing, such as ABS plastic, PLA, polyamide (nylon), glass filled polyamide, stereolithography materials (epoxy resins), silver, titanium, steel, wax, photopolymers and polycarbonate

Cura



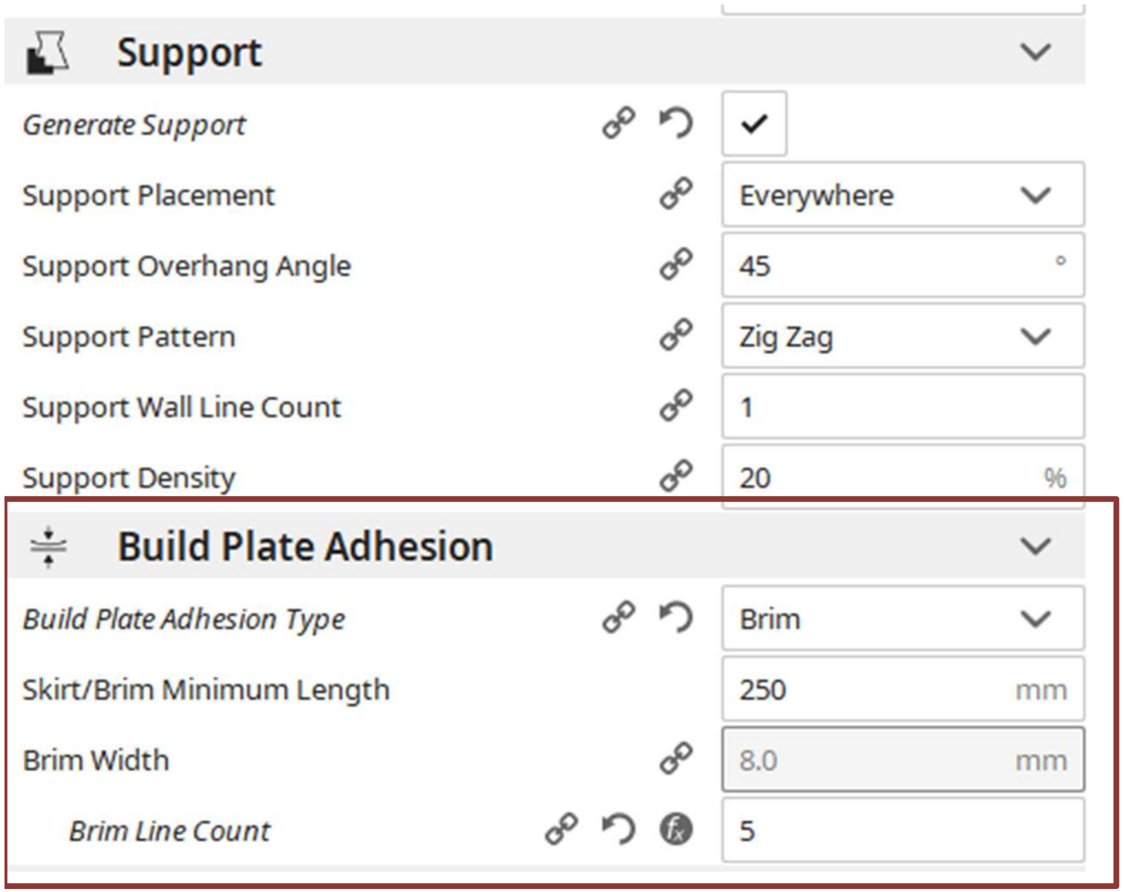
Print speed. Generally, slower print speeds lead to higher quality prints. But when it comes to 3D printing supports, that's not always the case. The faster the print speed, the better overhangs and especially bridges turn out. If you tend to print slowly, make sure to turn supports on.

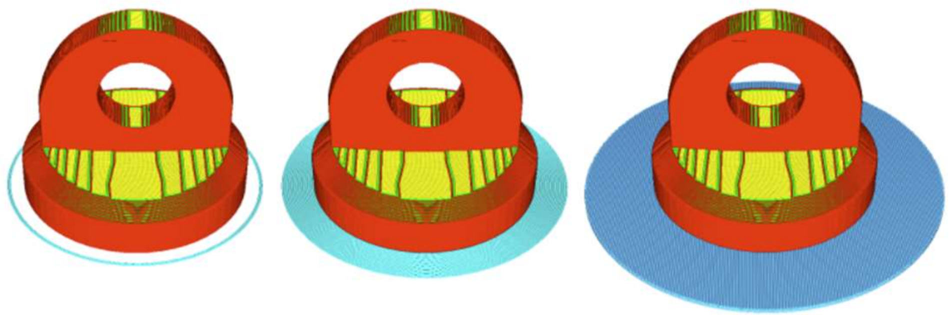
Cura



Angle of overhangs or bridges. Overhangs are places where the printer would have to print partially or completely over air, such as the arms of the letter T or Y printed vertically. Bridges are overhangs that are connected to the model on both ends, such as the middle of the letter H. These are typically measured by angle, measured from the Z axis above the overhang. For example, the letter T contains a 90 degree overhang, while the letter Y has a 45 degree overhang. **If you spot severe overhangs in your model (above 60 degrees), you probably need supports.** And if your model has overhangs of over 90 degrees (eg. a lowercase r), supports are necessary.

Cura





Brim - Brim adds a single layer flat area around the base of the model to prevent warping. The brim is connected to the model and makes the bottom surface area bigger. This increases the adhesion to the build plate and, in case of warping, the corners of the model are less likely to curl up because of the brim attached to it.
Raft - A raft adds a thick grid with a roof between the model and the build plate. This can be useful when the bottom surface of a model is not completely flat or has little adhesion to the build plate. A raft ensures that the model will stick better to the build plate.
Skirt - A skirt is a line printed around the object on the first layer, but not connected to the object. This helps prime the extrusion nozzle and can be an additional check for bed leveling before the print begins.