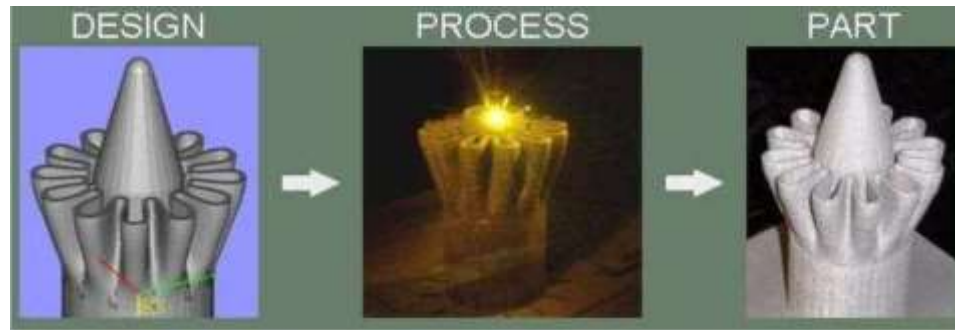


Features of 3D print of shaped surfaces

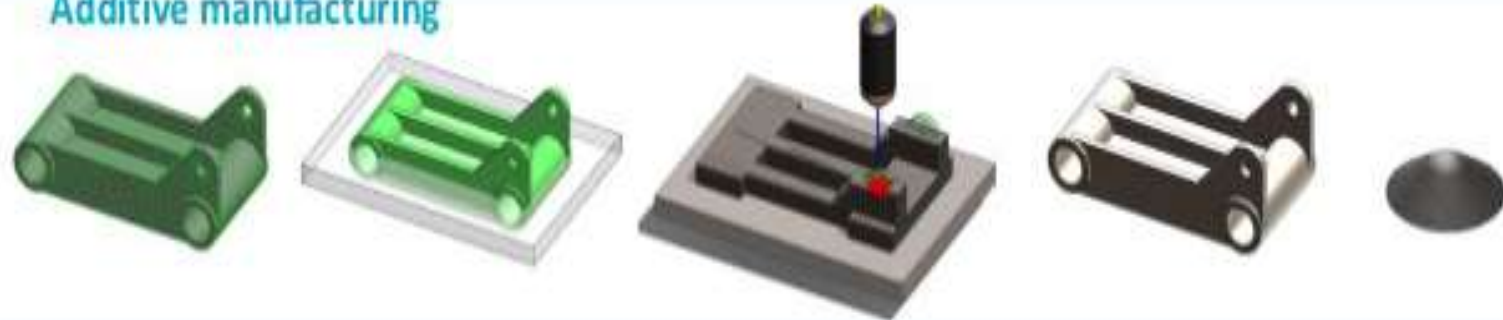
Additive manufacturing



(source: extxe.com)

Difference between Additive manufacturing and Subtractive manufacturing

Additive manufacturing

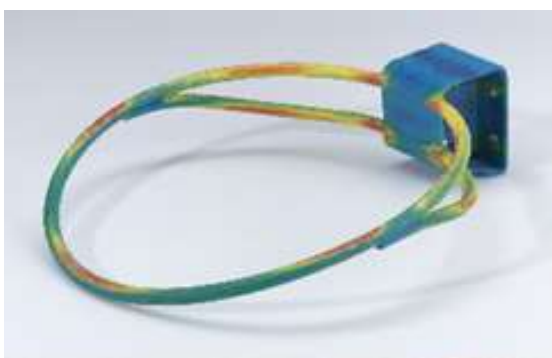
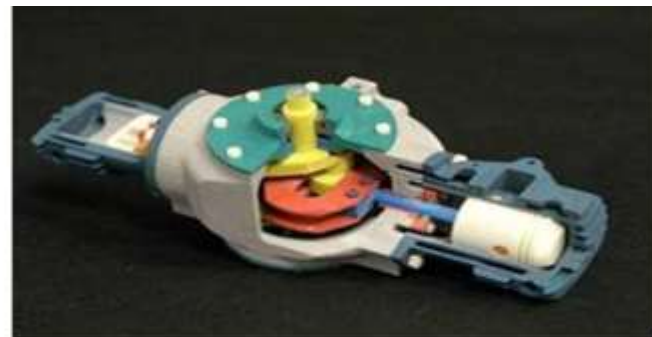
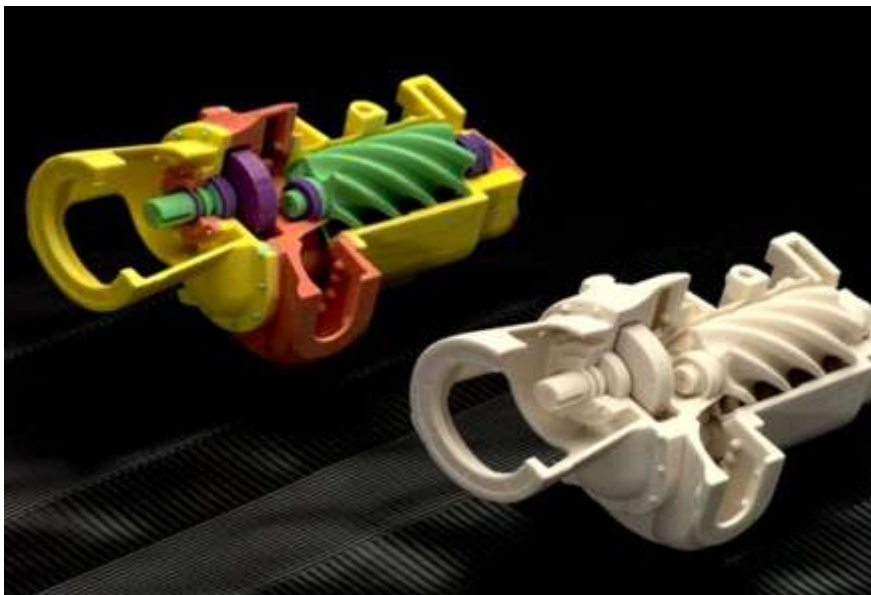


Subtractive manufacturing

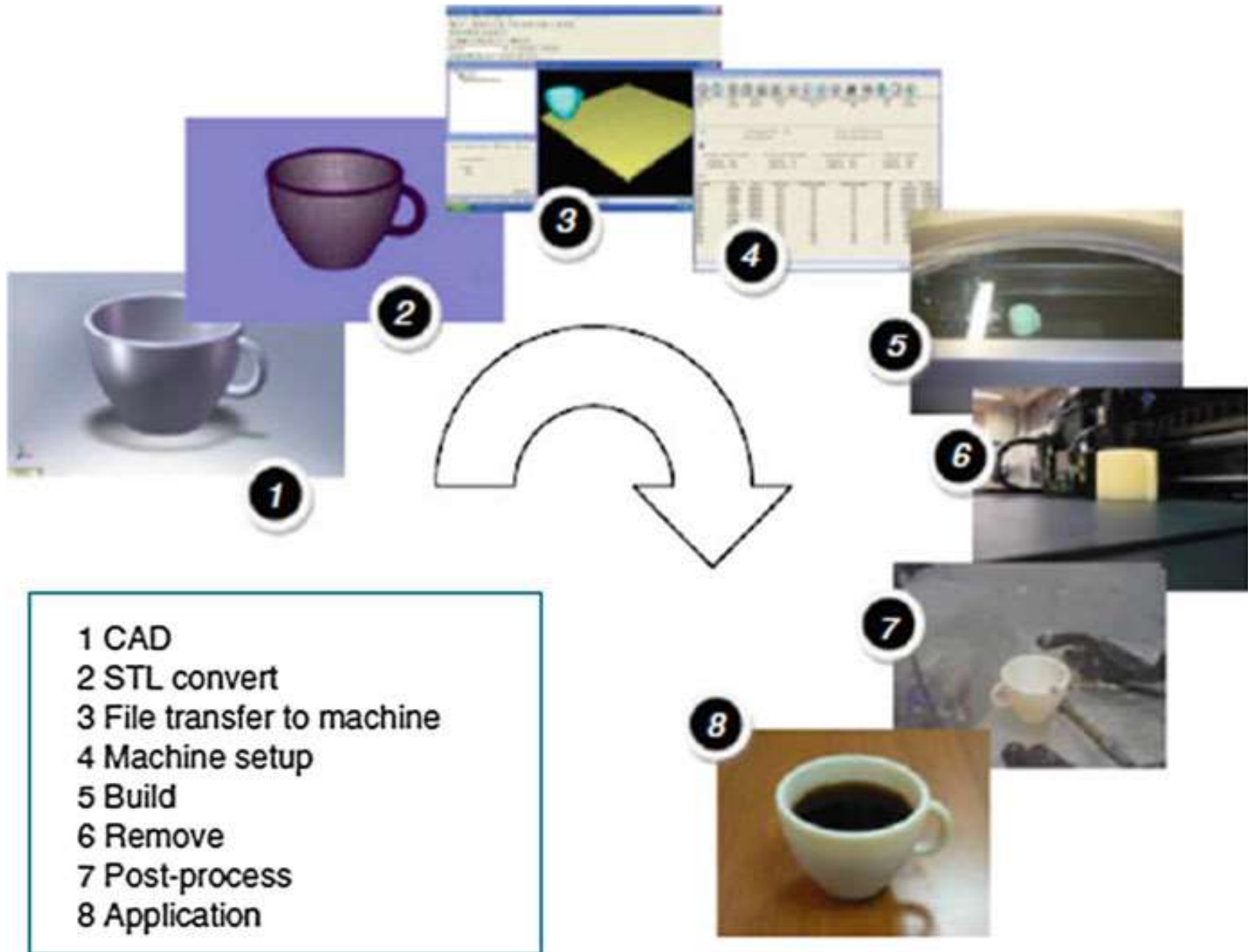


(source: bastiendesign.com)

Products of Additive manufacturing



The Generic AM Process

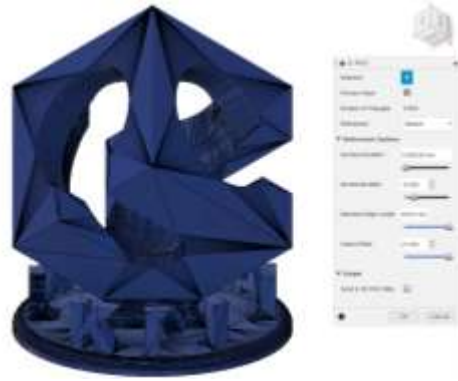


(source: Ian Gibson. Additive Manufacturing Technologies)

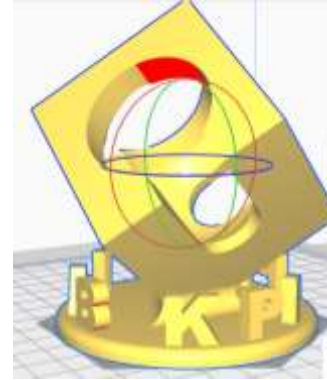
Example of an AM Process



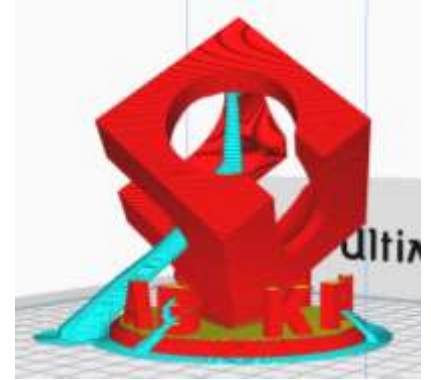
CAD



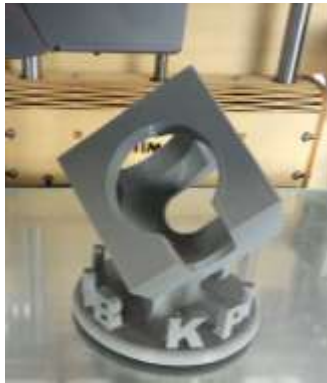
STL Convert



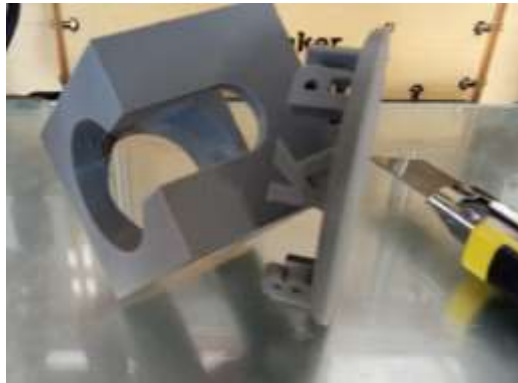
File transfer to machine



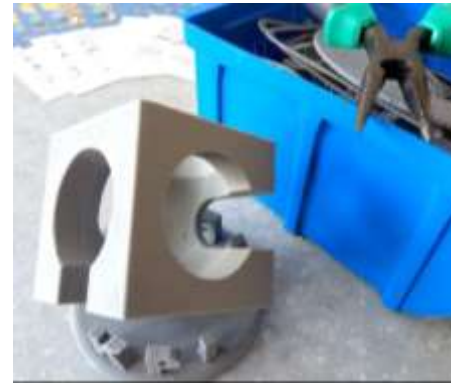
Machine setup



Build



Remove



Post-process



Application

Support Generation

Support structures are considered to be a necessary evil in 3D printing. On the one hand, they are absolutely necessary for models with nasty overhangs or bridges. On the other hand, they increase material costs, add more post-processing work and can damage the model's surface. Getting the 3D printing support structures right is, therefore, a very important aspect of 3D printing complicated models.

3D printing support structures



(source: amfg.ai)

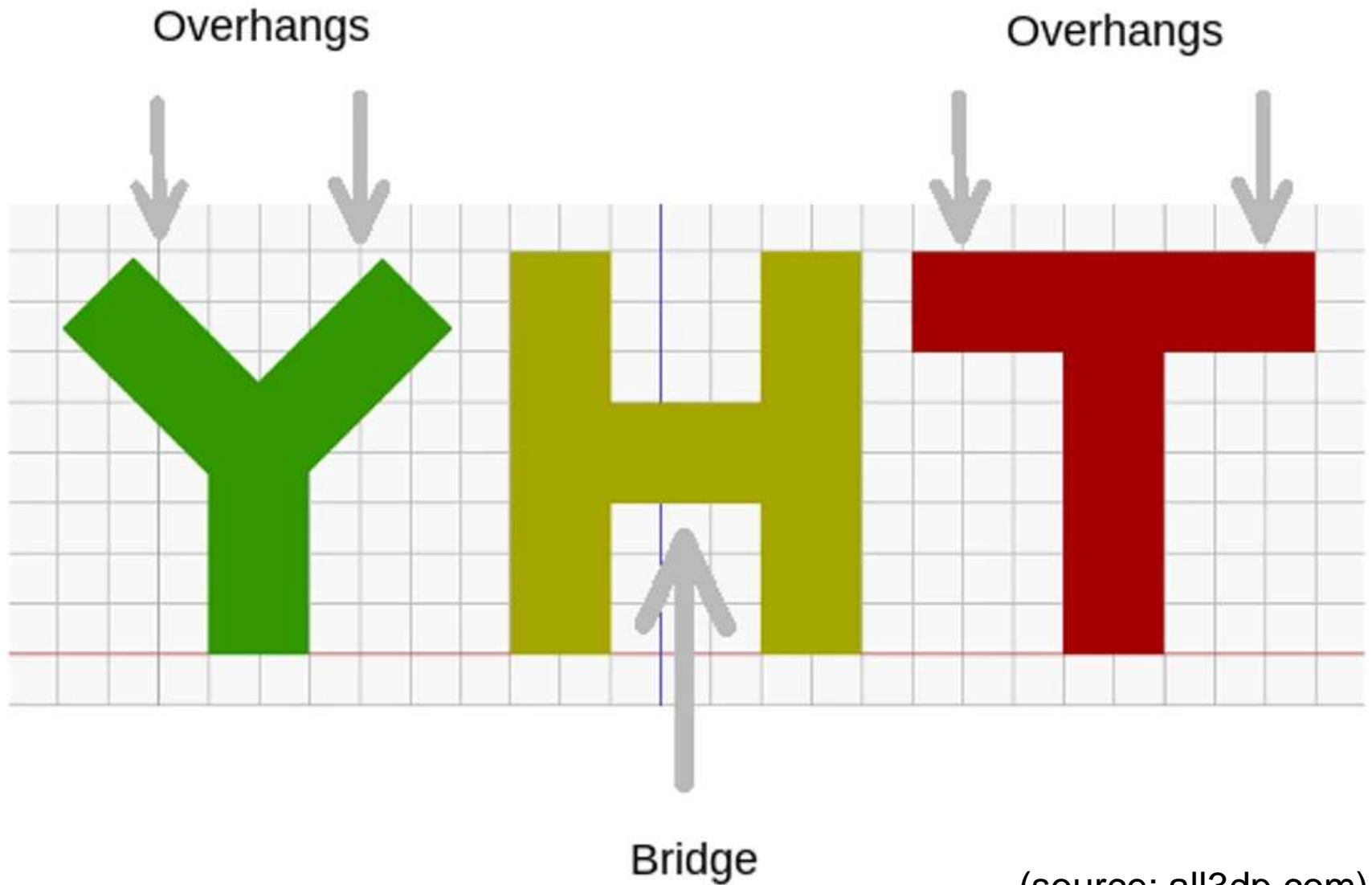


(source: amerilabs.com)



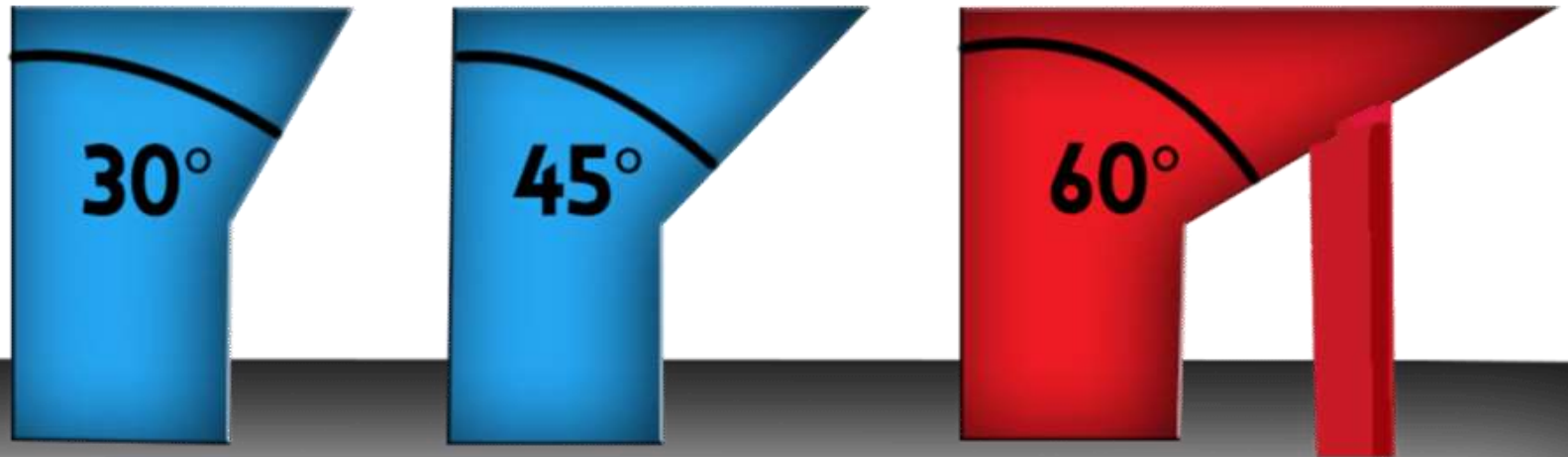
(source: pick3dprinter.com)

WHEN DO YOU NEED THEM?



(source: all3dp.com)

Not all overhangs need supports - **the 45 degrees rule**



Overhangs at an angle of more than 45 degrees from the vertical require 3D printing support structures

(source: all3dp.com)



Without 3D printing support structures, the letter T won't print properly (source: 3DHubs)

The overhangs in the letter Y do not require 3D printing support structures. The ones in the letter T do require them. (source: 3DHubs)



Not all bridges require support - **the 5 mm rule**



Bridges longer than 5mm can't be printed without 3D printing support structures. Notice how they warp and deform. (source: all3dp.com)



The massive overhang test in Thingiverse (source: all3dp.com)

Downsides:

- 1. Increased material cost**
- 2. Increased Printing Duration**
- 3. Added post processing work**



Support structures require additional material and they are removed and discarded after printing. (source: all3dp.com)



Support structures add to post processing work. (source: Formlabs)

DOWNSIDERS:

4. Risk of damaging the model



Print with support.



Support removal caused damage.

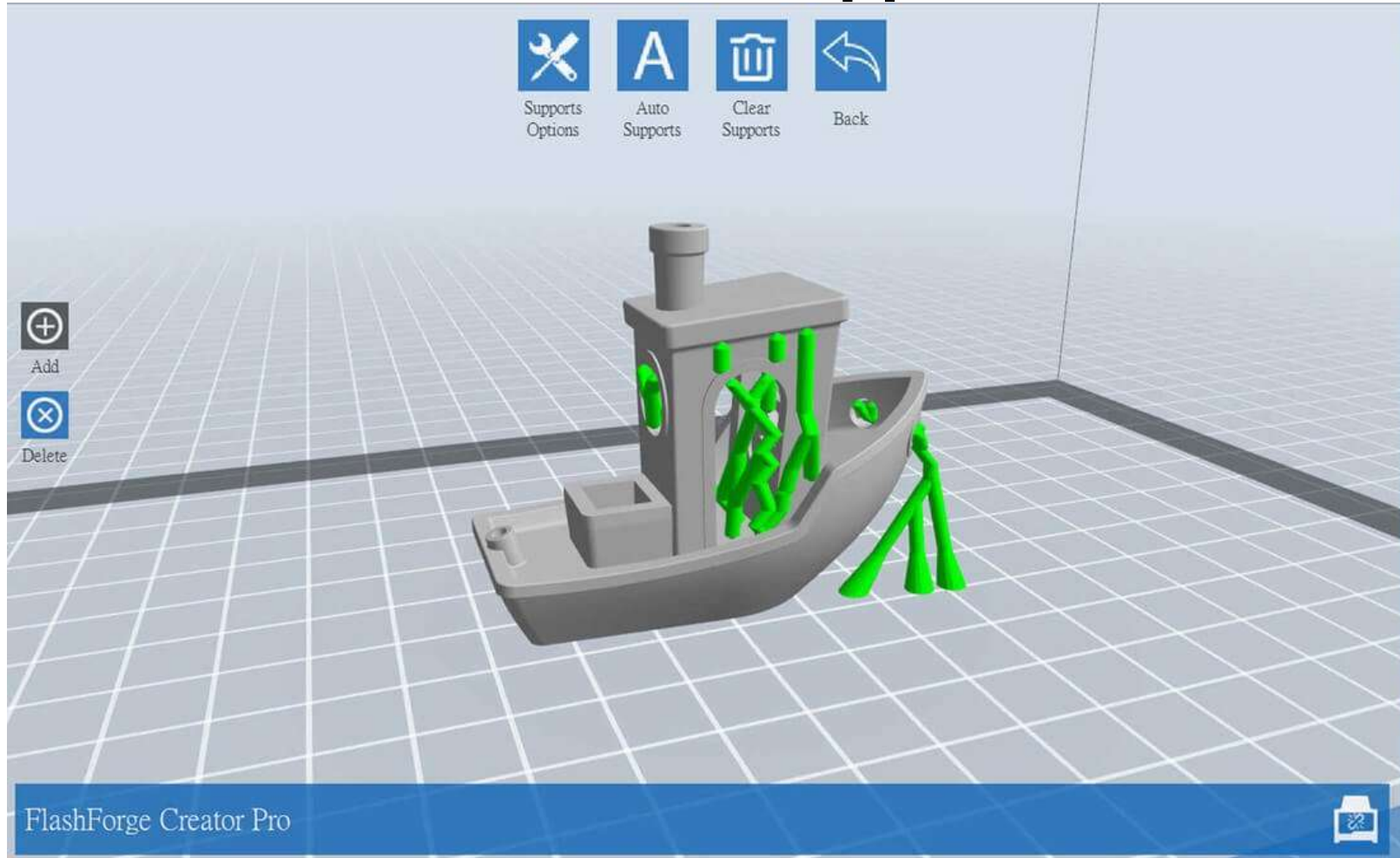


Support removed without much damage.

(source: 3DHubs)

SUPPORT STRUCTURE GEOMETRY:

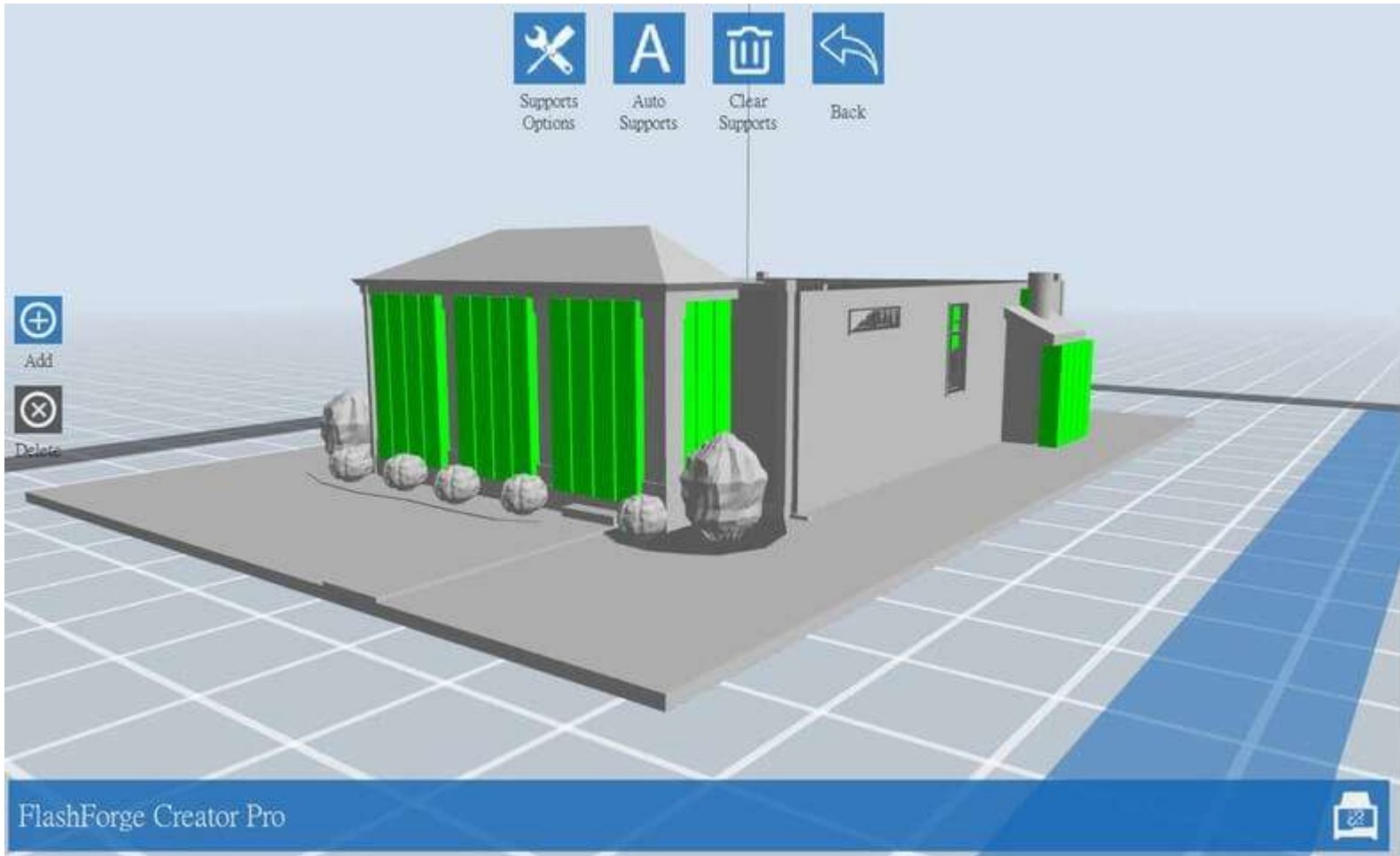
1. Tree-like support



Tree-like 3D printing support structures (source: Flashforge)

SUPPORT STRUCTURE GEOMETRY:

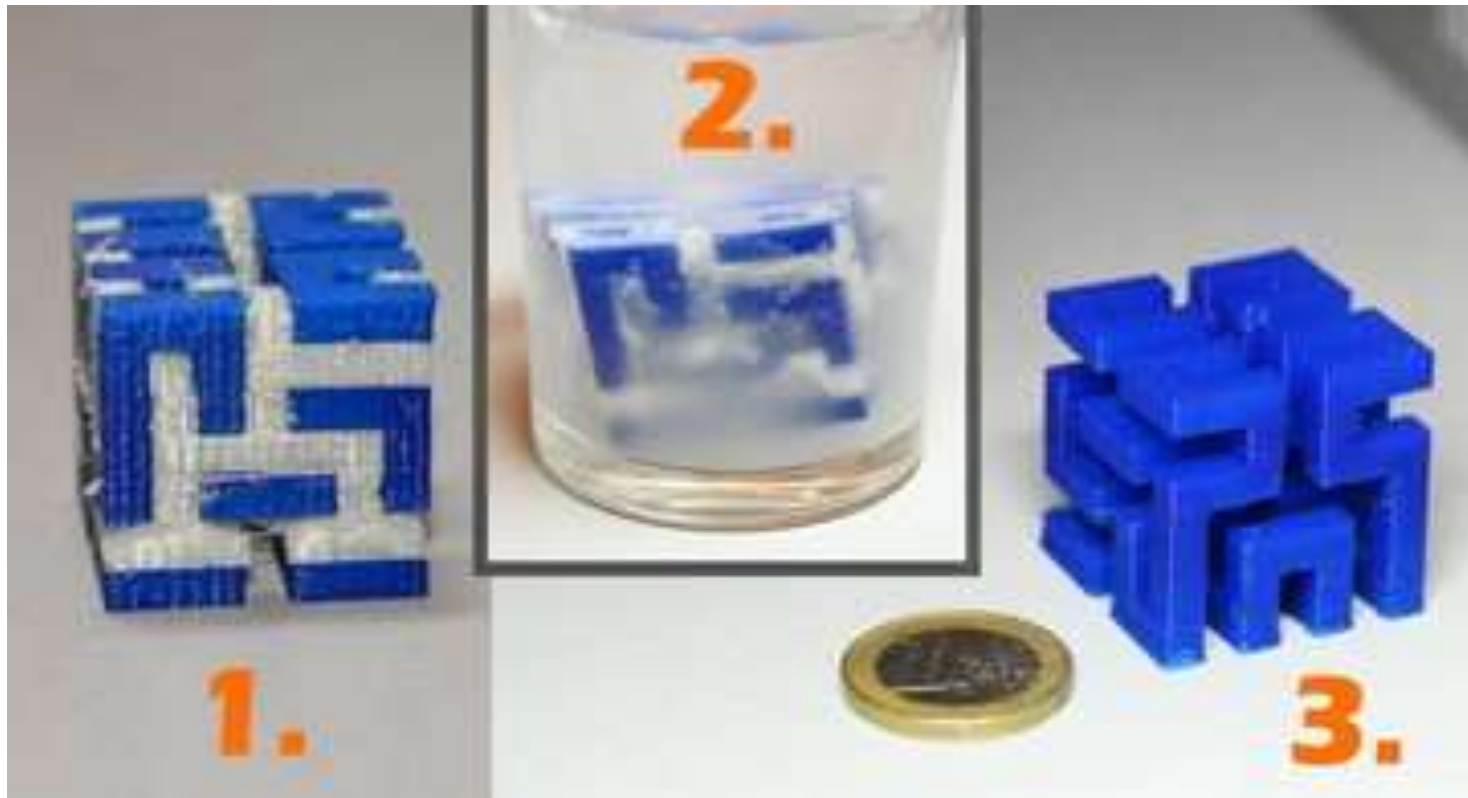
2. Linear or Accordion Support



Linear 3D printing support structures (source: Flashforge)

TYPES OF SUPPORT BY EASE OF REMOVAL:

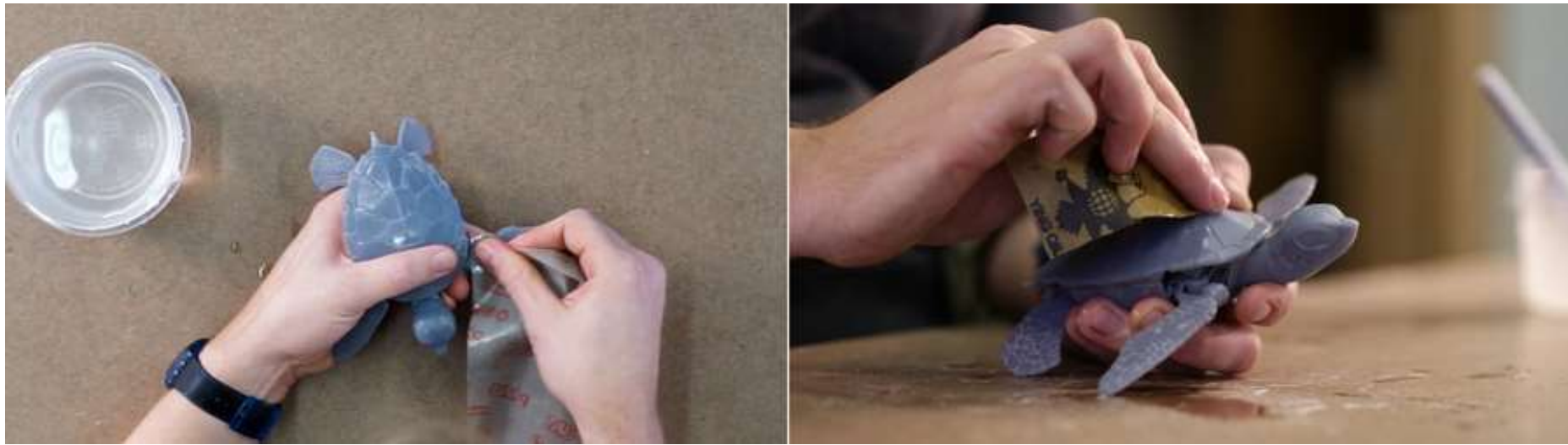
1. Break-away 3D printing support structures
2. Dissolvable 3D printing support structures



Dissolvable support structures are easier to remove, but require a dual extruder printer.

(source: all3dp.com)

HOW TO REMOVE BREAKAWAY 3D PRINTING SUPPORT STRUCTURES?



You can use wet sanding to remove the last bits of 3D printing support structures and polish the model surface (Source: Formlabs)

MINIMIZE 3D PRINTING SUPPORT STRUCTURES BY CLEVER DESIGN:

1. Integrate 3D printing supports into the model



Venus Vitrix by Antonio Canova

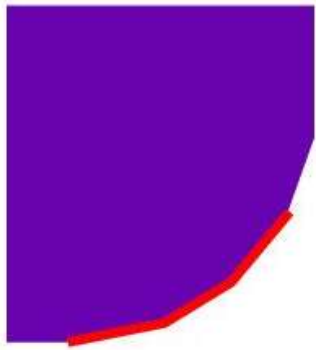
(source: all3dp.com)

The Guardian by @fantasygraph illustrates how supports can be integrated into a model.



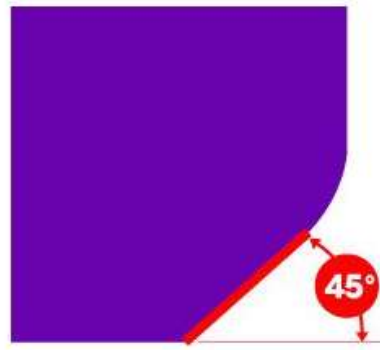
MINIMIZE 3D PRINTING SUPPORT STRUCTURES BY CLEVER DESIGN:

2. Chamfers

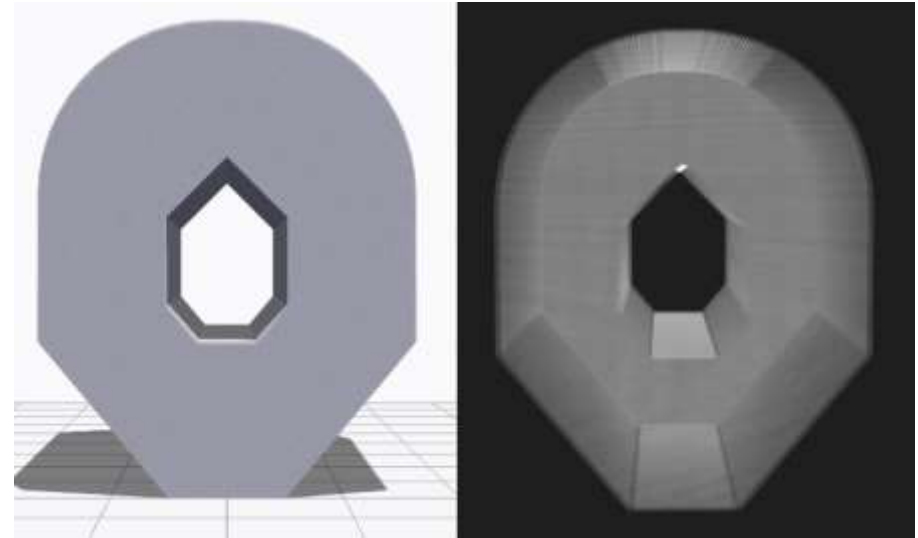


A gradually rounding edge which requires support

(source: Rigid Ink)

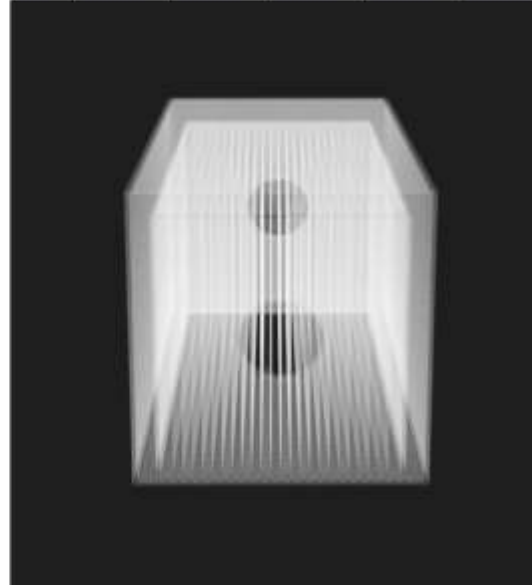
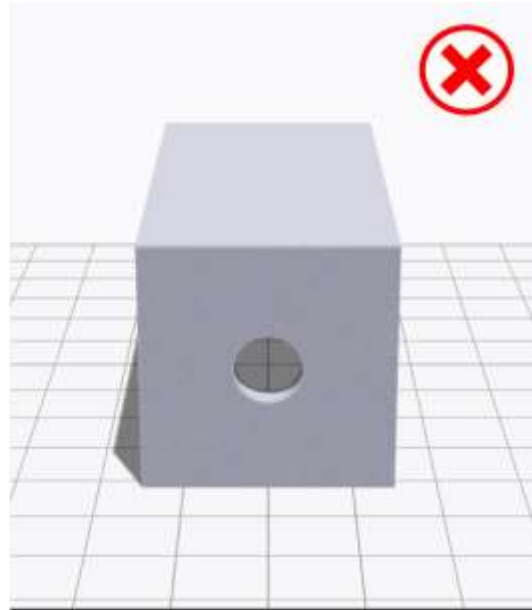
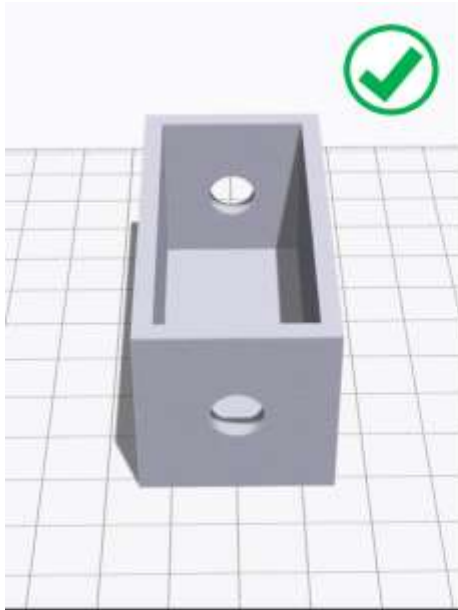


Chamfered edge which can be printed without 3D printing support structures



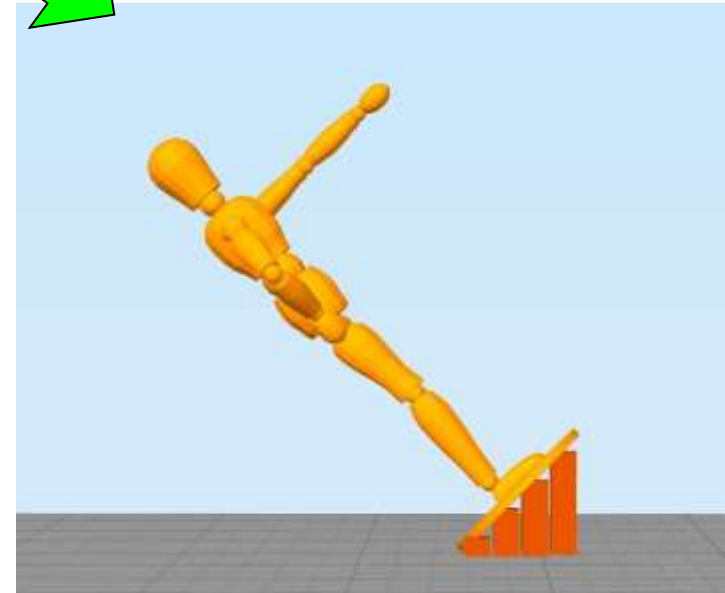
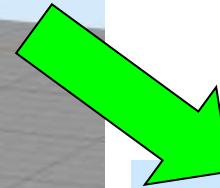
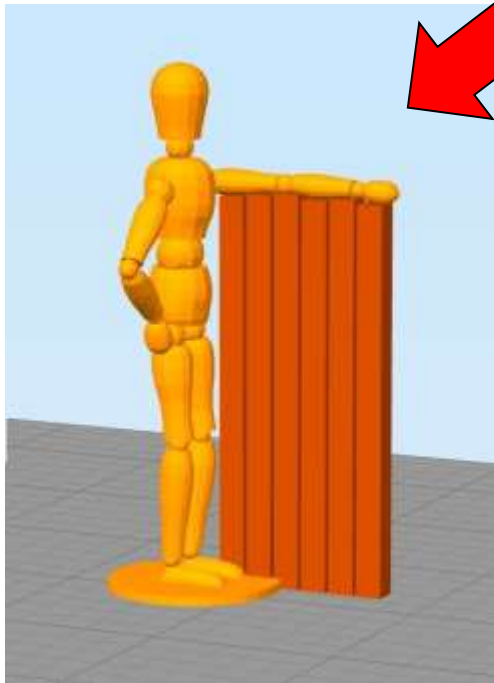
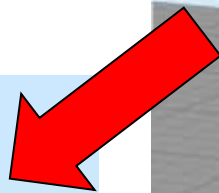
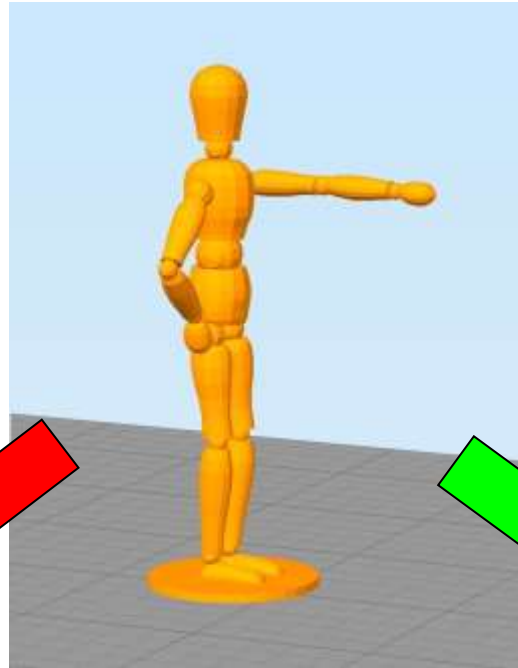
Chamfered hole in the shape of a teardrop (source: Markforged)

MINIMIZE 3D PRINTING SUPPORT STRUCTURES BY REORIENTATION



You can often minimize the use of 3D printing support structures by cleverly reorienting the model on the build plate (source: Markforged)

MINIMIZE 3D PRINTING SUPPORT STRUCTURES BY REORIENTATION



(source: @fantasygraph)

PRINTING OVERHANGS AND BRIDGES WITHOUT 3D PRINTING SUPPORT STRUCTURES

- optimal condition of your 3D printer;
- cooling your printing material as rapidly as possible;
- lower printing temperatures;
- reducing printing speed;
- lowest layer thickness.

CURA SUPPORT STRUCTURE SETTINGS

Slicer software expose a lot of different settings that control the following aspects of 3D printing support structures:

- placement of 3D printing support structures
- strength of 3D printing support structures
- ease of removal after printing
- damage to the print surface

CURA SUPPORT STRUCTURE SETTINGS

1. Turn on auto-generated 3D printing support structures for unstable models
2. Select between tree-like support or linear support



Tree like support structures in Cura

(source: all3dp.com)

CURA SUPPORT STRUCTURE SETTINGS

3. Control placement of 3D printing support structures



Two types of support structure placement in Cura
: Everywhere and Touching Build plate

(source: all3dp.com)

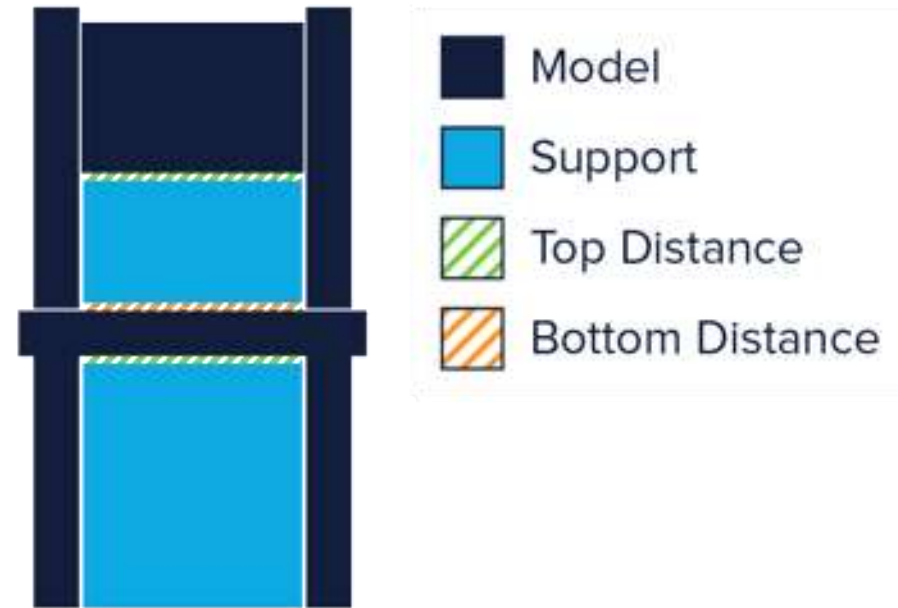
4. The Enable Support Roof can improve the surface finish of overhangs but at a cost

CURA SUPPORT STRUCTURE SETTINGS

5. Prevent 3D printing support structures from damaging the model's outer walls by using the Support X/Y Distance setting



6. The Z Distance setting can help make the 3D printing support structures easier to remove



(source: all3dp.com)

CURA SUPPORT STRUCTURE SETTINGS

7. Select the proper 3D printing support structure for the right balance between strength and ease of removal

Concentric



Grid



Lines



Triangle



Zig Zag



Basic support patterns in Cura

Conclusion

You need support structures to print difficult overhangs and bridges in your model. But when you can't use dissolvable 3D printing support structures, it's a good idea to try to minimize your use of them. We discussed situations where you don't need 3D printing support structures and mentioned several creative tricks to print without them.

But often, you would have an overhang or bridge that's so bad that you must use support. In this case, you need to play with your slicer settings to ensure that you don't waste too much material or damage the model during removal. We talked about how to choose correct slicer settings to get the best results and shared some tricks on how to remove 3D printing support structures the right way.