



Designing Models for 3D Printing

Beets Limited

beets3d.com



Image Credit: thoughtco.com

Consideration

- Limitations of Technology
- Difficulty
- Printing Cost and Time
- Appearance
- Structural Strength and Weakness

Fusion Deposition Modelling - FDM

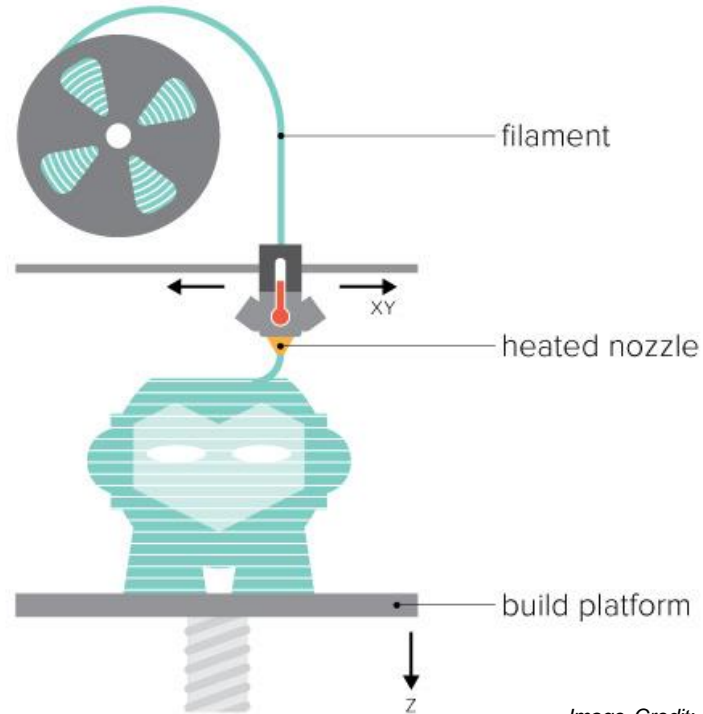


Image Credit: rookieelectronics.com

Topics

- Overhang and Support
- Wall Thickness
- Vertical Pins
- Vertical Holes
- Warping
- Elephant Foot
- Snap-fit Joints
- Build Orientation

Overhang and Support

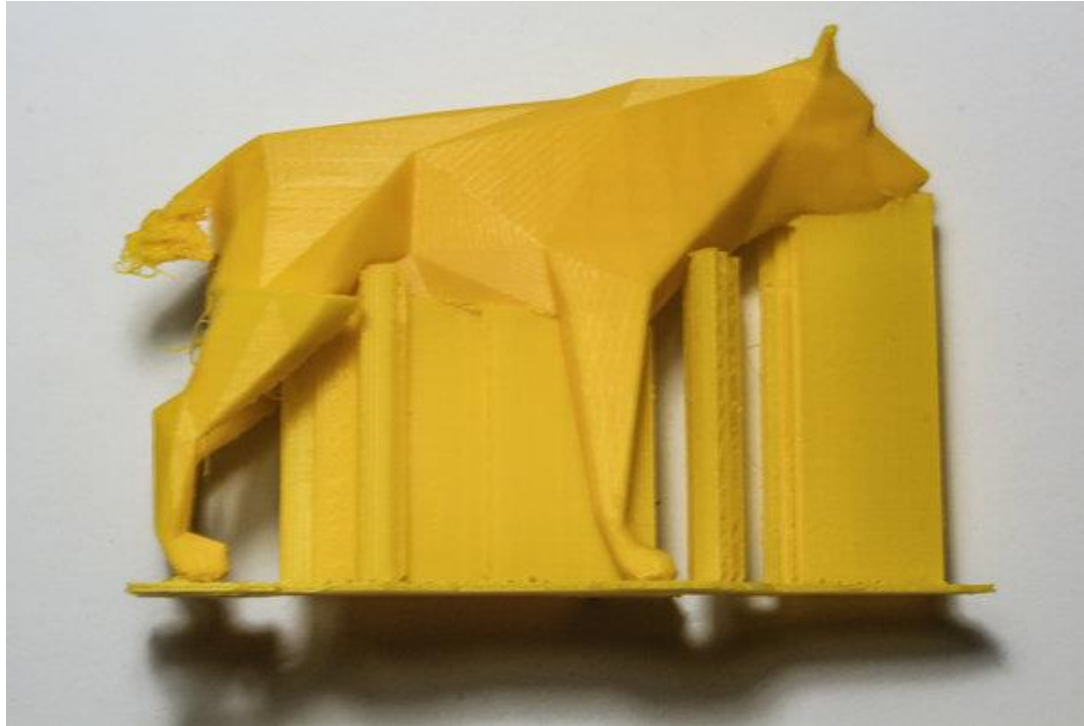
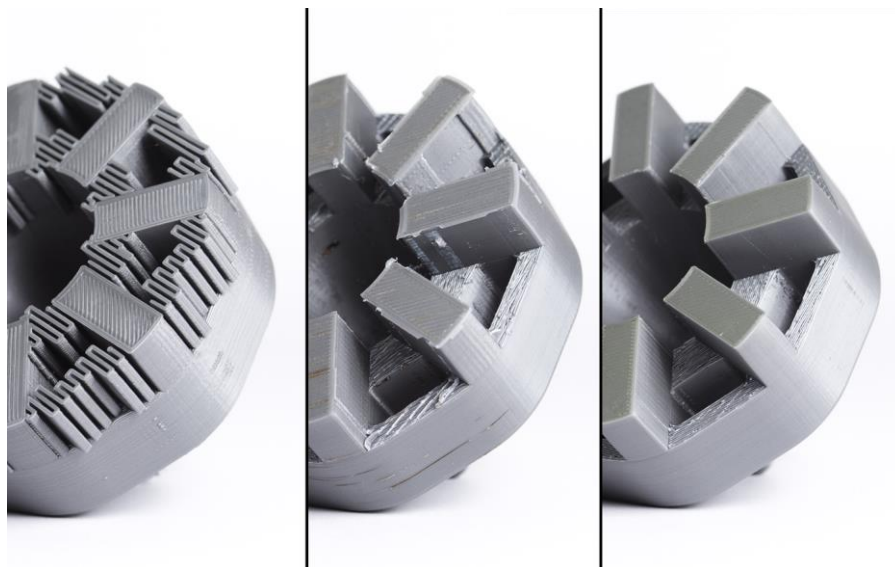


Image Credit: <https://pinshape.com/>

Why Support is bad?

- Waste of materials and printing time
- After print post-processing
- Bad appearance



The “YHT” of Support



Image Credit: <https://3dhubs.com/>

Overhang and Support - General Design Rule



- 45° overhang
- Bridging: 10-20mm (depending on materials and printer)
- Consider appearance and print direction (let's revisit later)

Wall Thickness

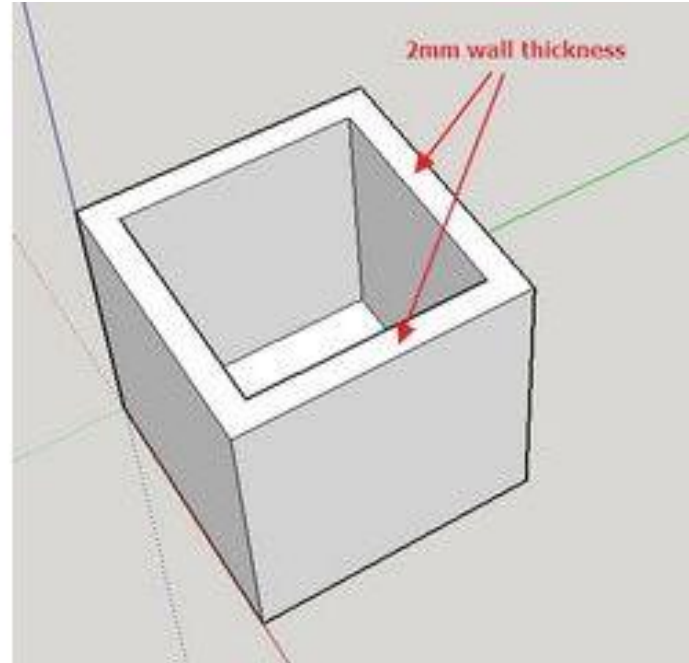
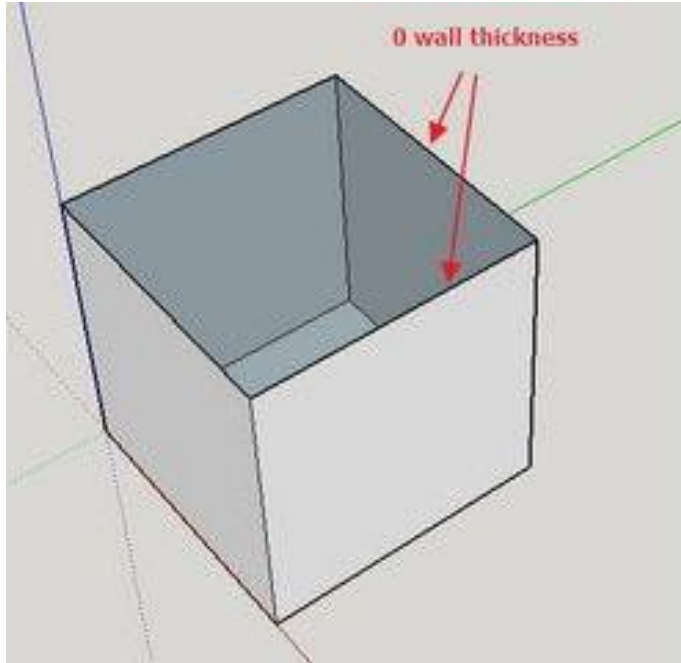


Image Credit: <https://fabacademy.org/>

Rule of Thumb



- Minimum wall thickness:
 - FDM - 0.8mm
 - SLA/DLP - 0.5mm
- Wall thickness = Multiple of nozzle diameters (see next slide)

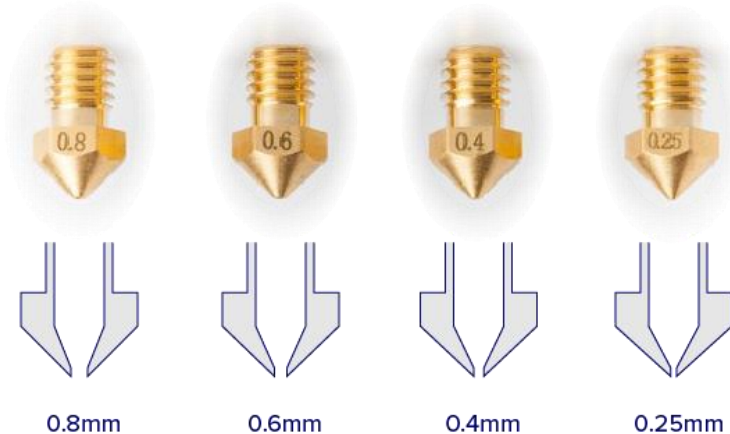


Image Credit: <https://my3dconcepts.com/>

The Thin Wall Problem



Image Credit: <https://simplify3d.com/>

Vertical Pins



Image Credit: <https://3dhubs.com/>

Problems with Vertical Pins

Small Vertical Pins (Diameter < 5mm)

- Weak with no infill.
- Bad print quality
- May not get printed at all

Solution:

- Print very slowly
- Use nozzle with smaller diameter
- Use SLA/DLP Printer
- Design a hole and insert a real pin

Vertical Holes

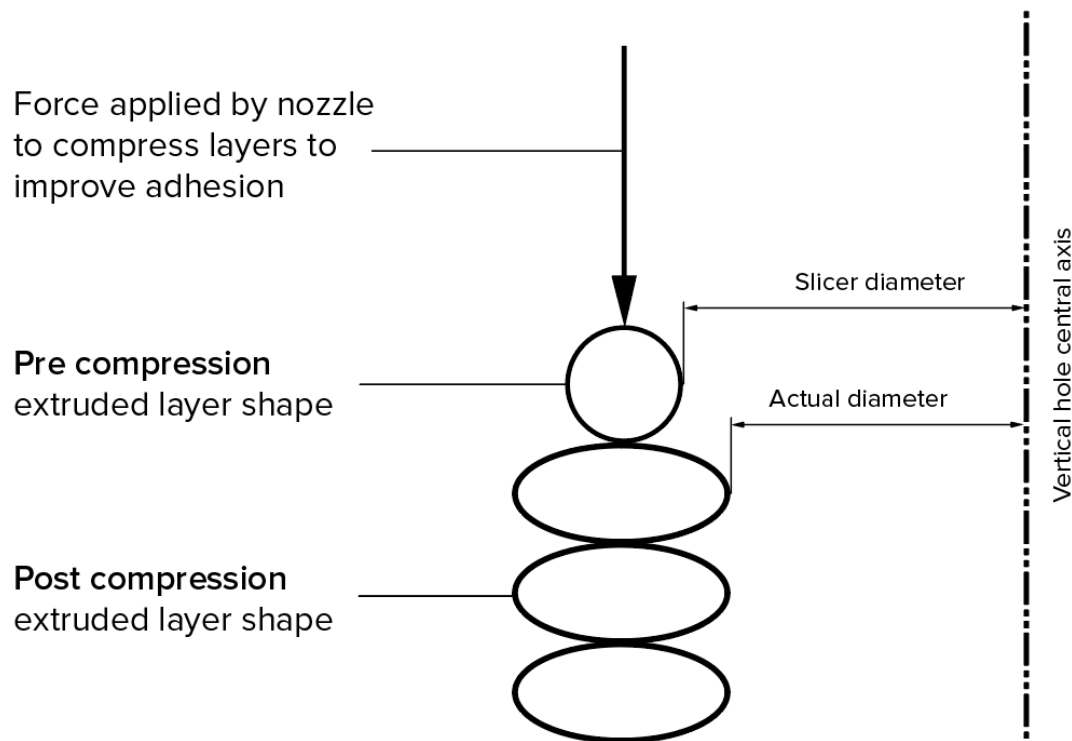


Image Credit: <https://3dhubs.com/>

Warping



Image Credit: <https://3dhubs.com/>

Cause of Warping



As newly deposited layers cool they shrink, pulling the underlying layer upward resulting in warping

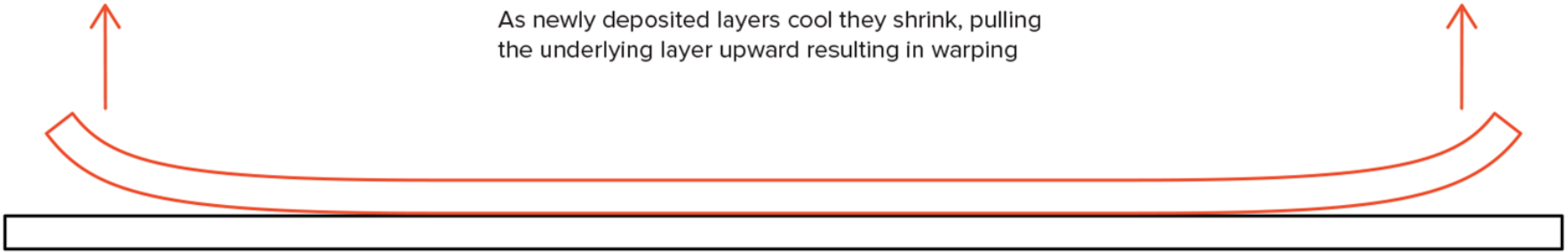
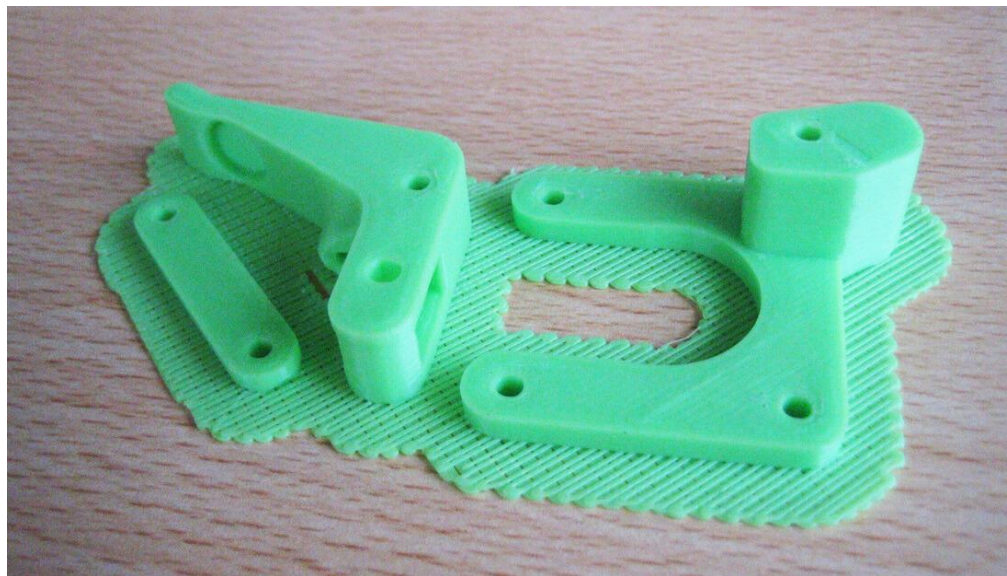


Image Credit: <https://3dhubs.com/>

Printing tips to avoid warping

- Print with heated build platform
- Use Blue Tape
- Print with PLA
- Add a raft/brim



Design tips to avoid warping

- Avoid large and flat surface. Split them
- Avoid sharp corners - add fillet or chamfer



Edge



Chamfer



Fillet

Image Credit: <https://engineering.com/>

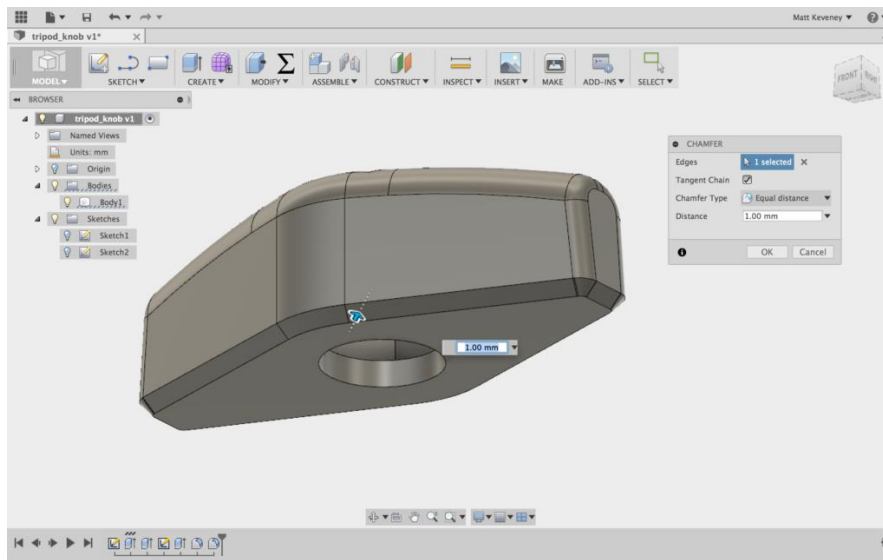


Image Credit: <https://acemonstertoy.org/>

Elephant Foot

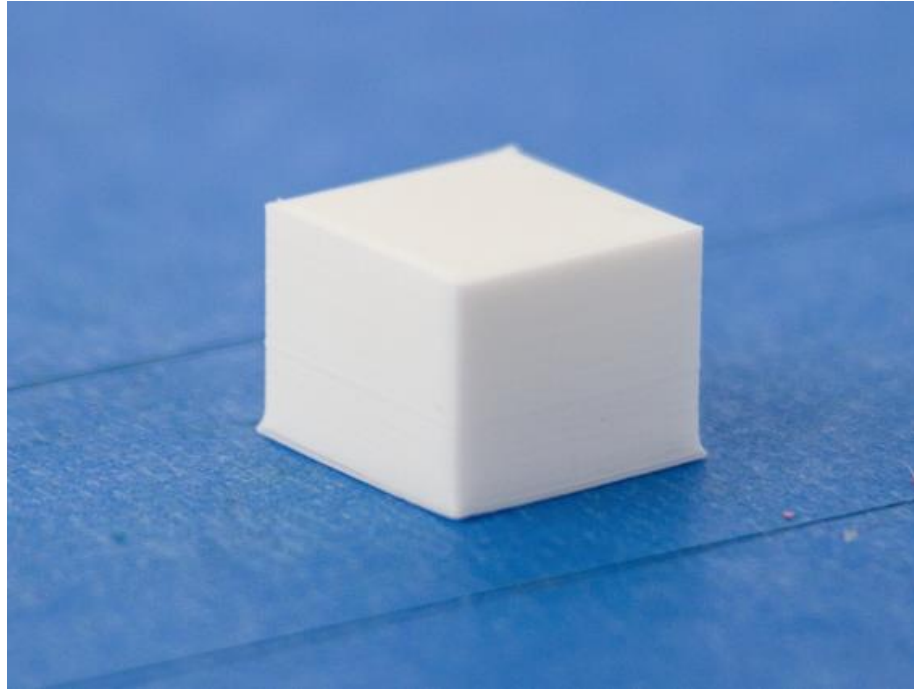


Image Credit: <https://matterhackers.com/>

Elephant Foot Solution - Chamfer

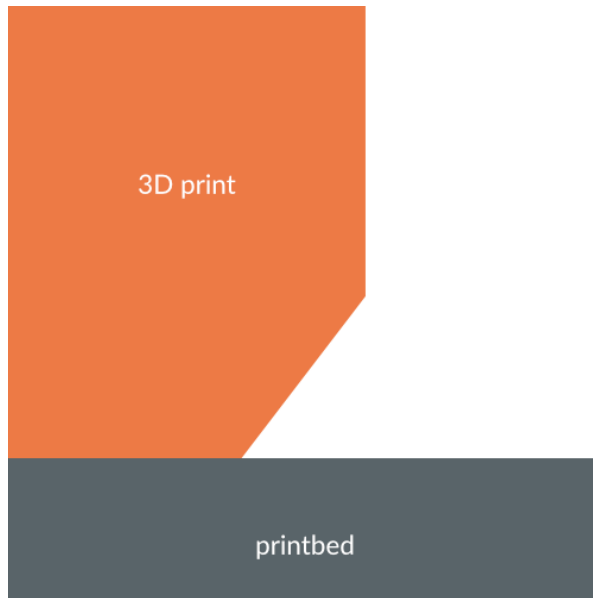


Image Credit: <https://aprintapro.com/>

Snap-fit Joints



Image Credit: <https://3dhubs.com/>

Snap-fit Joints



Cantilever

- Easy to design
- Easy to assembly
- No glues needed
- Lock securely and accurately

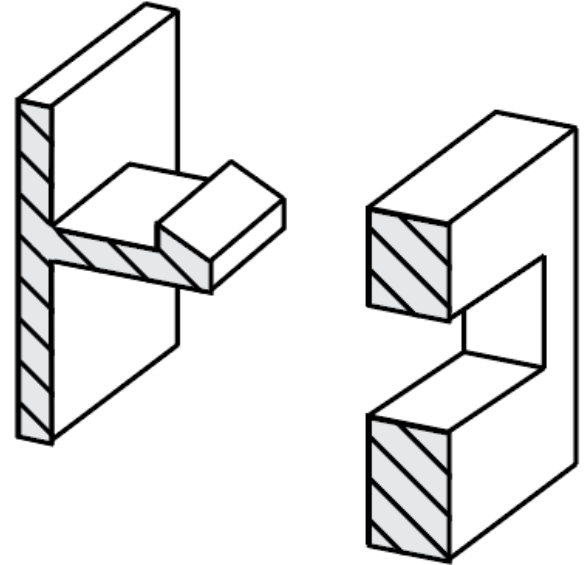
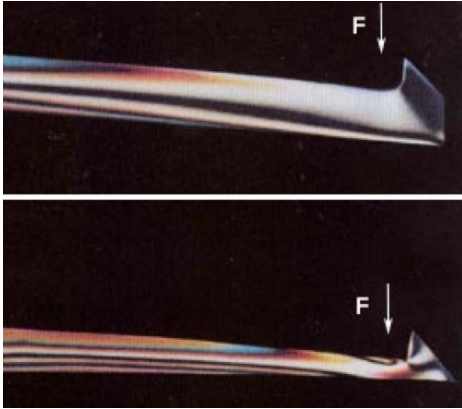
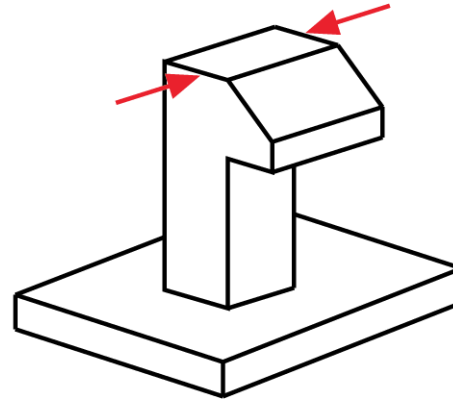


Image Credit: <https://3dhubs.com/>

Designing Snap-fit Joints

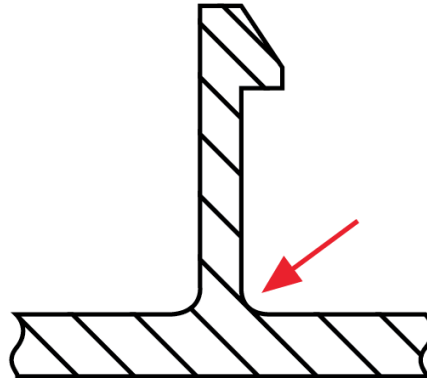


Tapering



Increase Width

Add Fillet



Positioning

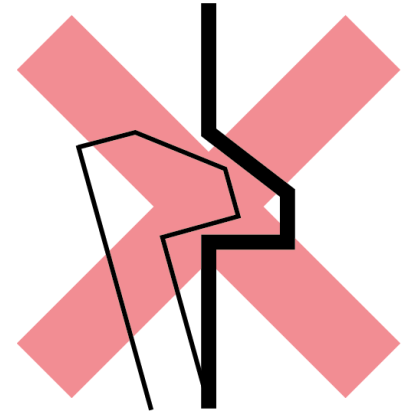


Image Credit: <https://3dhubs.com/>

Build Orientation

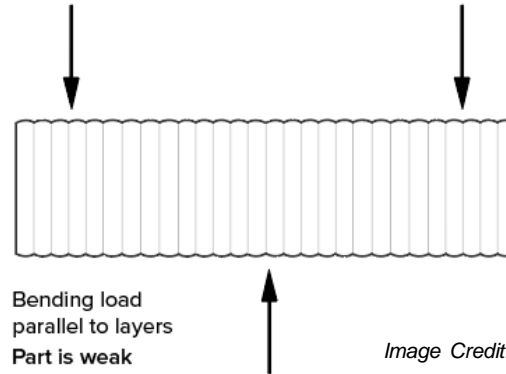
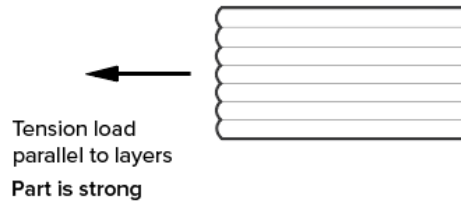
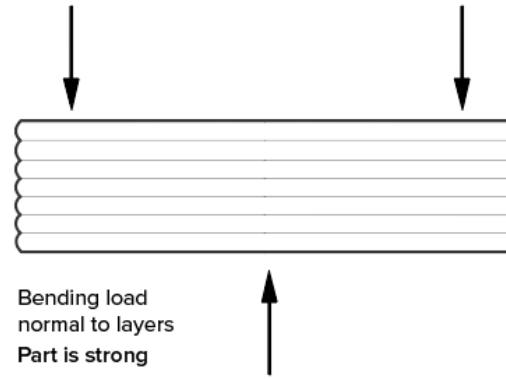
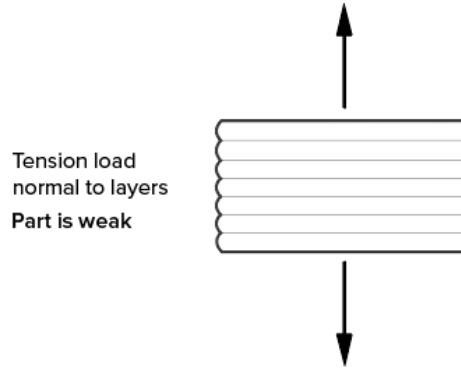
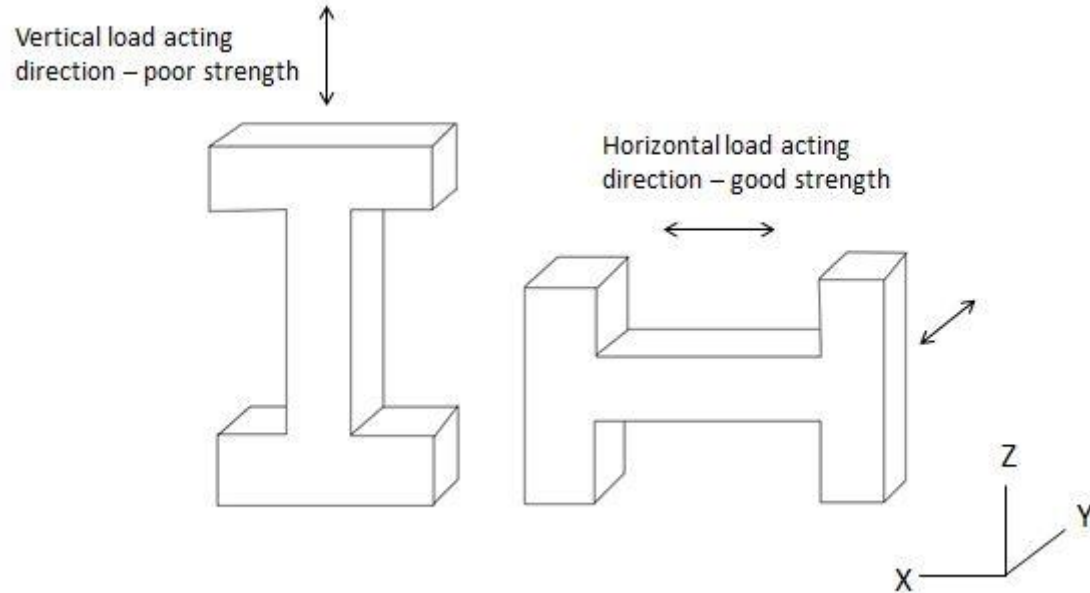


Image Credit: <https://3dhubs.com/>

Build Orientation



Build Orientation



MakerBot
MakerWare 2.3

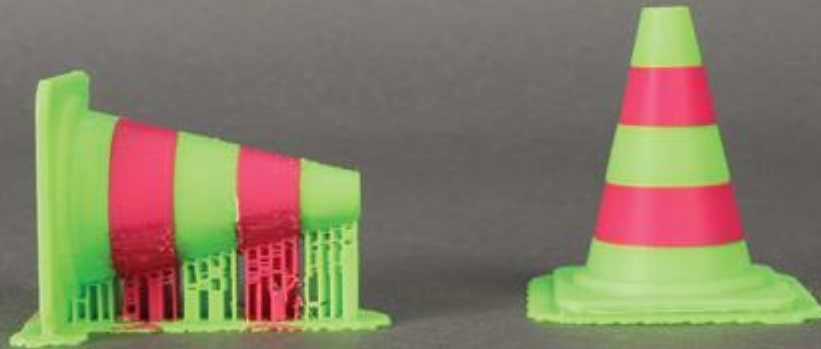
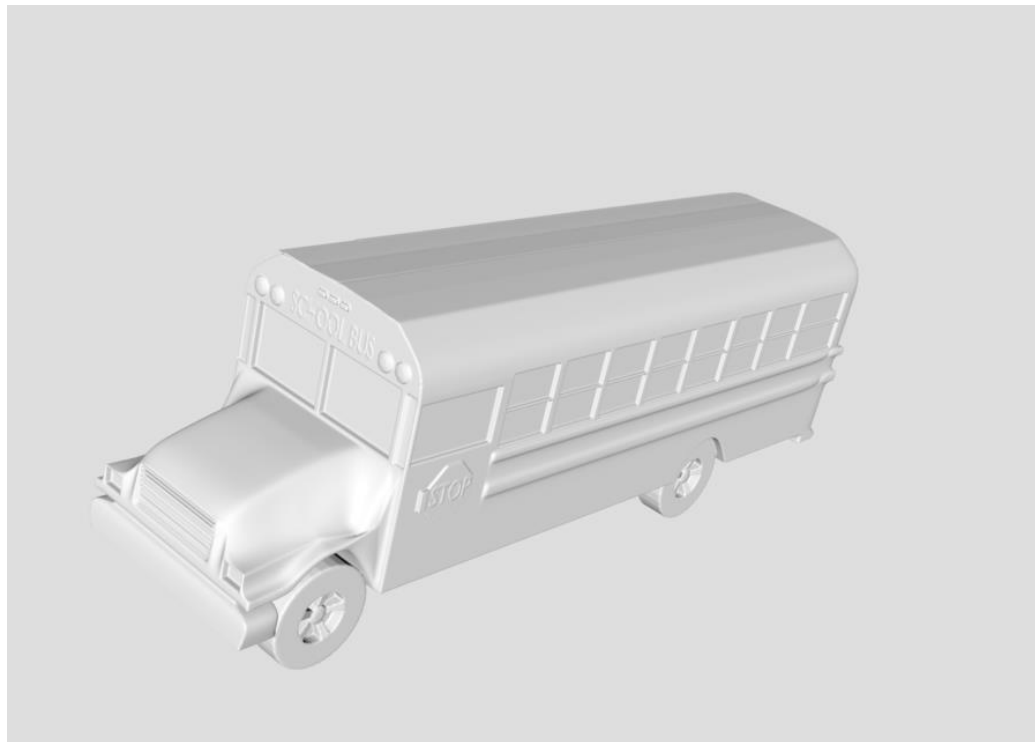
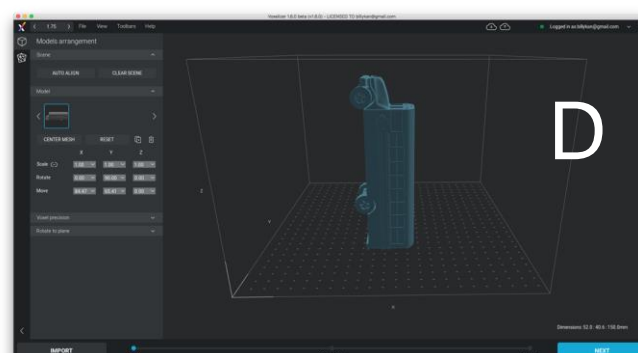
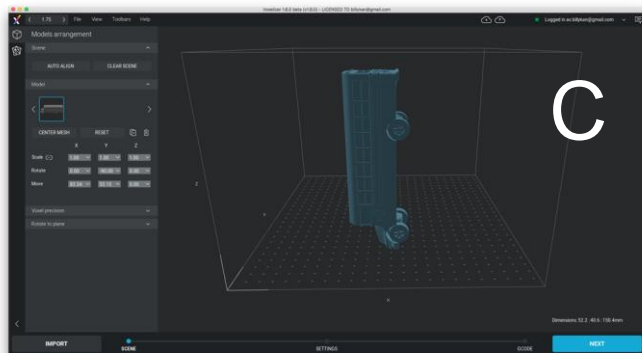
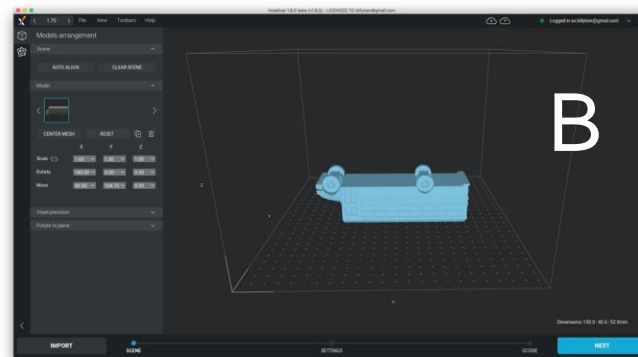
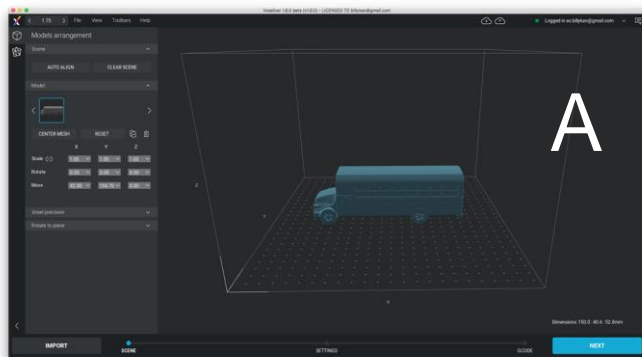


Image Credit: <https://tufts.makernetwork.org/>

Build Orientation - A Quiz



What's the best build orientation?





Build Orientation Considerations

- Strength
- Overhang and Support
- Appearance



More Resources

3D Hubs Knowledge Base

<https://www.3dhubs.com/knowledge-base>

Print Quality Troubleshooting Guide

<https://www.simplify3d.com/support/print-quality-troubleshooting/>

The 3D Printing Handbook

<https://www.amazon.com/3D-Printing-Handbook-Technologies-applications/dp/9082748509>

3D Hubs “Printability” Test



The screenshot shows the 3D Hubs website interface. At the top, there's a navigation bar with the 3D Hubs logo, links for Services, Resources, and How it works, and buttons for Sign Up, Log In, and Order custom parts. The main content area features a 3D model of a mechanical part, 'superstresstest_f_scale...', with dimensions 44.9 x 50.0 x 31.3 mm. The model is shown in a wireframe view with yellow highlights indicating areas of concern. A sidebar on the right displays the printability analysis results, including a list of issues and a section for 'Printability by process'.

superstresstest_f_scale...
44.9 x 50.0 x 31.3 mm
[Review printability warnings](#)

Hard to Remove Support **Reset camera**

543 Intersecting faces
No non-manifold edges found.
[Read more about mesh integrity rules.](#)

Printability by process

FDM **SLA** **SLS**

Wall Thickness analysis passed. [Show](#)
10% of your part is thinner than 1 mm. We consider a part to be printable if no more than 15% of its walls are thinner than 1 mm.

Intricate Details issues detected. [Show](#)
19% of your part contains details that may not be printed accurately with FDM.

Hard to Remove Support issues detected.
This part has hard to remove support with FDM.
[Read more about FDM design rules.](#)

Hard to Remove Support issues

[Select files](#)
We accept .stl and .obj file formats

3D Hubs secures your files, protecting your intellectual property



Thanks and Good Luck!