Tips for Designing 3D Printed Parts that can be Assembled Using Screws, Inserts, Threads, and Fasteners

Prepared By:

Crystal Atoz, Lead Lab Technician

CLV 3D Maker Center

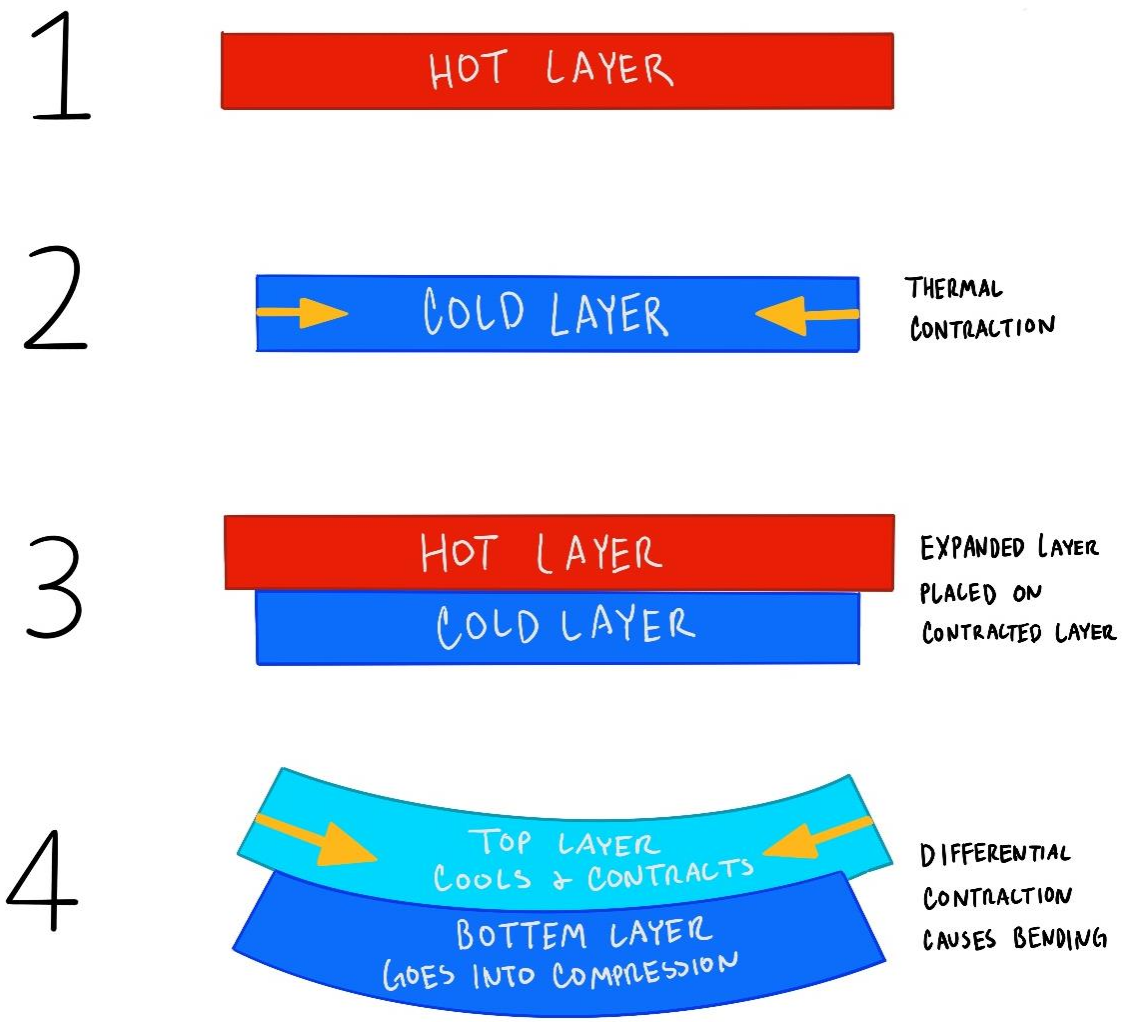
300 S. 4th St. Suite 180

Las Vegas, NV 89101

Created: 2024

Tolerances

The most important factor to consider when you are designing, is tolerance. Particularly in FDM 3D printing, there are deviations from the actual dimensions. These can be resulted from material shrinkage or layer thickness. Shrinkage happens almost immediately as the material starts cooling as it is laid onto the build plate.



±0.5mm is the suggested tolerance

Clearance

Any joint needs a little bit a space in order for the parts to fit together, called clearance. This is a trial-and-error design process that depends on the situation. To test the clearance of your design, try printing out only the parts around the joint. This way you can easily adjust without wasting filament.

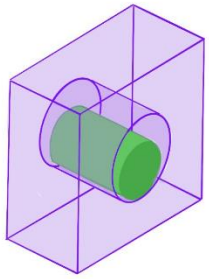
Design Tips

- Make your joints print parallel to your layers to increase strength
- Break in the joints to loosen
- If you scale your model, remember that the clearances scale too

Types of Fits

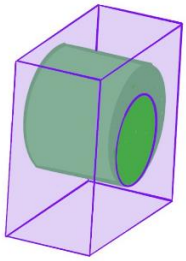
Clearance Fit

The hole is larger than the shaft. Parts can rotate or slide relative to the other.



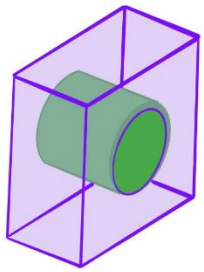
Interference Fit

The hole is smaller than the shaft. A lot of force or heat is needed to assemble or disassemble the parts.



Transition Fit

The hole is slightly smaller than the shaft and only a small amount of force is needed to assemble/ disassemble the parts.



Threaded Fasteners

As a rule of thumb the minimum wall thickness around a thread should match the diameter of the fastener (e.g. an M5 fastener requires a minimum of 5mm wall thickness around the threaded hole).

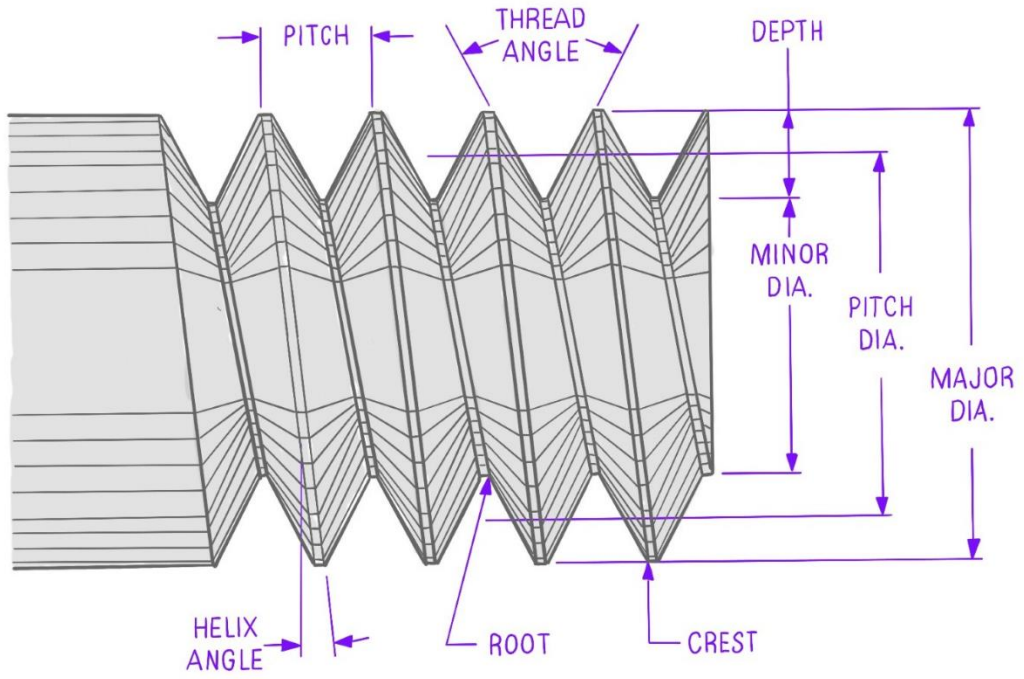
If the wall thickness is too low, the parts can distort or fracture due to the added stress.

For a more accurate hole, consider drilling the hole after printing rather than printing the part. This can result in better accuracy.

Threads

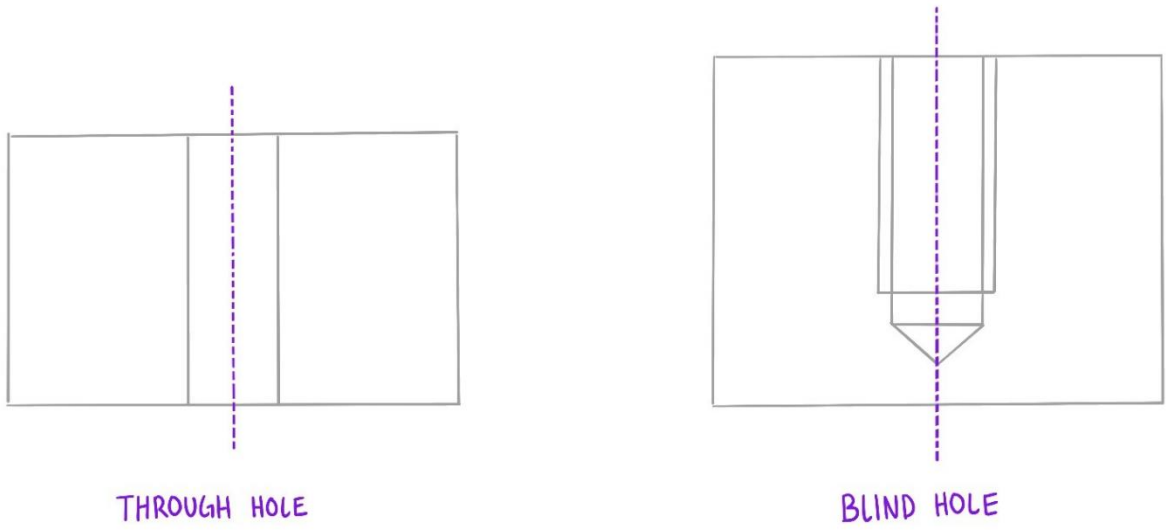
It is better to incorporate threaded inserts/nuts rather than printed threads. Threaded fasteners, such as screws, are a popular method of securing 3D-printed parts together.

Main Parameters of Threads



Blind Holes VS. Through Holes

Blind Holes do not go all the way through the part and thus you need to specify the depth. On the other hand, a through hole goes all the way through the surface of your part. Its depth will share the thickness of the wall it cuts through.



Snap Fits

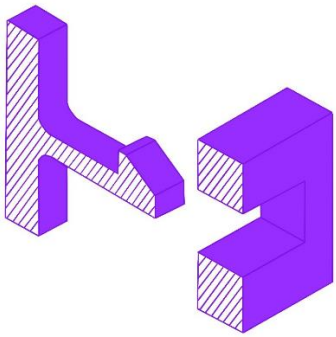
A quick and easy way of connecting two 3D printed components using interlocking features that click into place to create a connection.

Common Types

Cantilever Snap-fit Joints

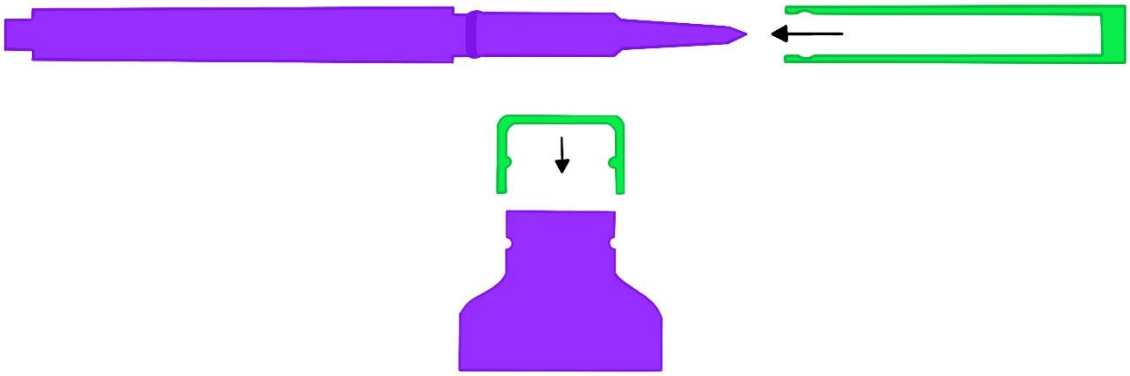
This is the most common that consists of a protrusion (bead or hook) on one end of the component and a structural support feature at the other end. This protrusion is placed into an opening and bends back to lock the connection in place.

They are very easy to design and intuitive for assembly and disassembly.



Annular snap-fit Joints

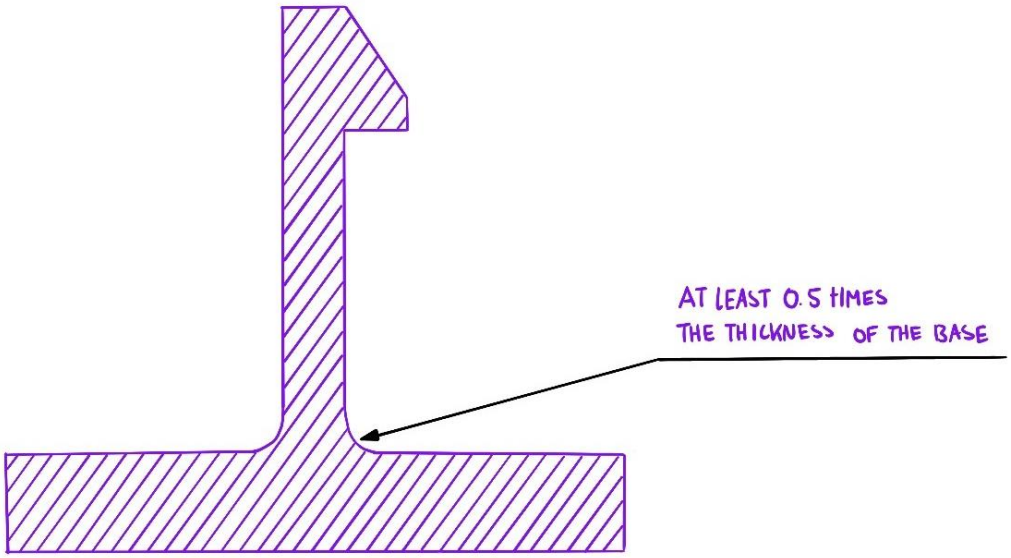
Uses a hoop strain to hold a pressed part in place. Common examples are bottom and pen caps. While using this, it is possible to create a waterproof seal around the joint.



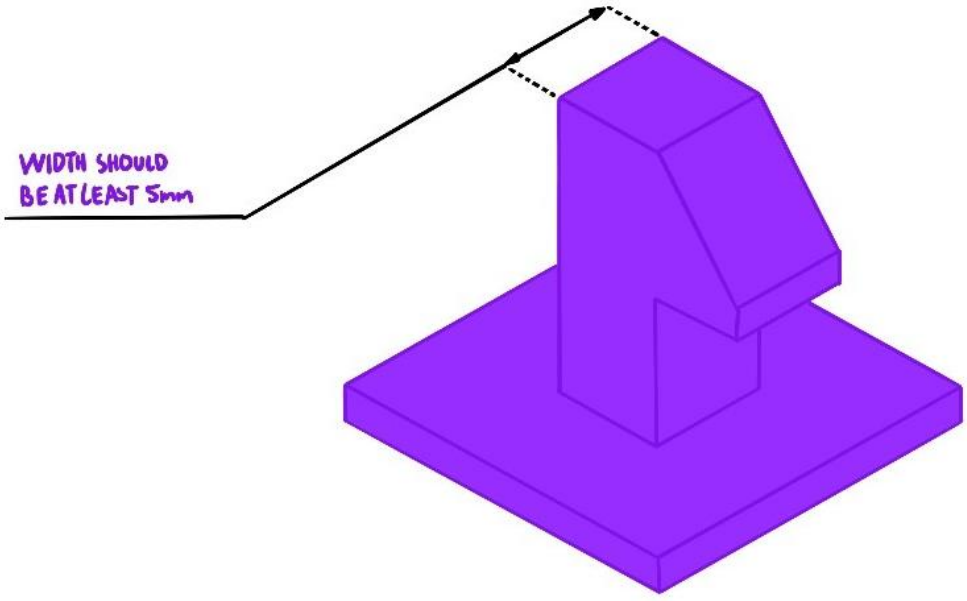
Best Practices for designing snap fits

It is important to consider features that will reduce the stress and strain on the assembly.

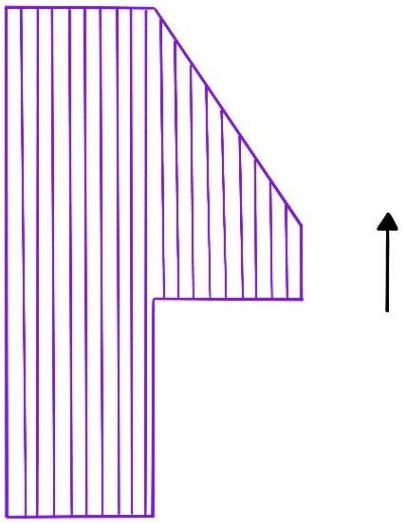
- Increase the base of the cantilever



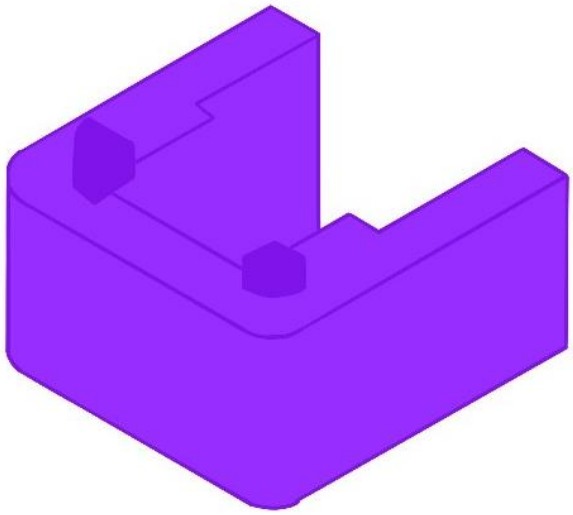
- Increase the width of the clip to make it stronger



- Consider the build direction. Avoid designing snap-fit cantilevers that are built up vertically because they are inherently weaker.



- Add lugs to assist with the alignment of your components



Common Problems

There are a few common problems associated with designing snap-fit designs.

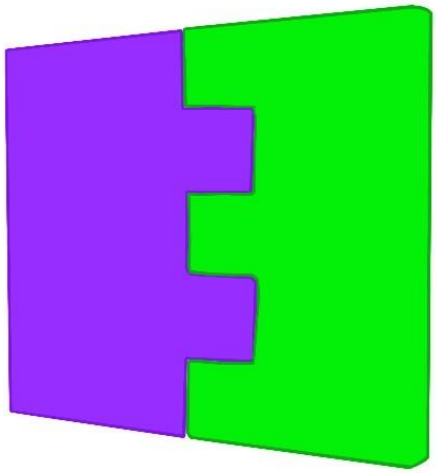
- Sharp corners may add stress and increase the probability of the joint breaking off
- Misplaced gaps in parts will cause tolerance issues
- The more you assemble and disassemble, the more likely the part with weaken

Remember that a well-designed snap-fit design can be used many times without any noticeable wear.

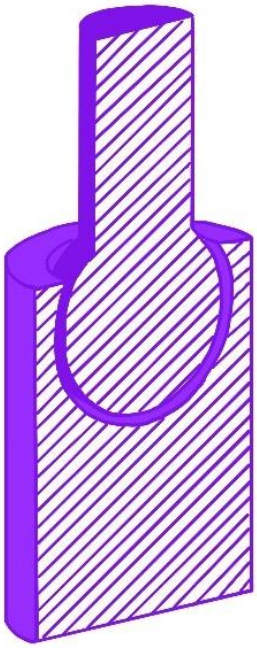
Joints

Any structure that joins two pieces together to connect parts or allow movement.

Interlocking Joints

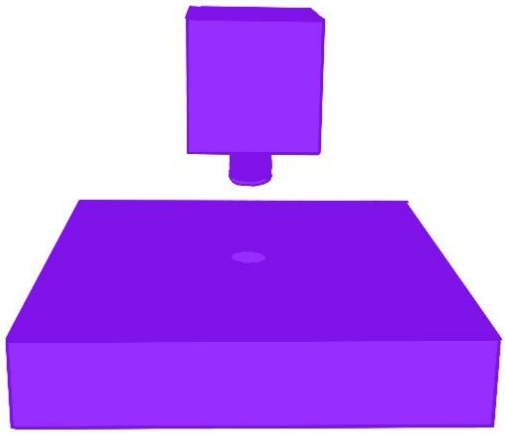


Ball-and-Socket Joints

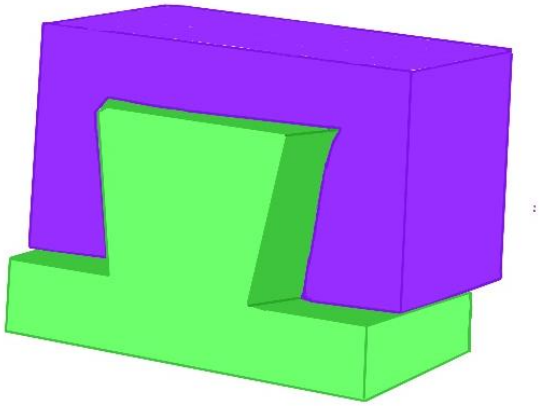


Peg Joints

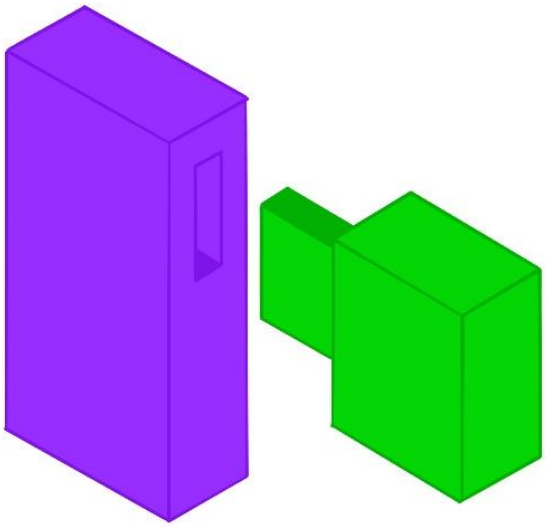
All you do is add a peg to one piece and make an appropriately sized hole in the other one. Once your parts are printed just push the peg into the hole, and if you've got the tolerances right (I'll cover that later) the friction between peg and hole will keep the two pieces together.



Dovetails



Mortise and Tenon



Tongue and Groove