

3D Printing for Beginners

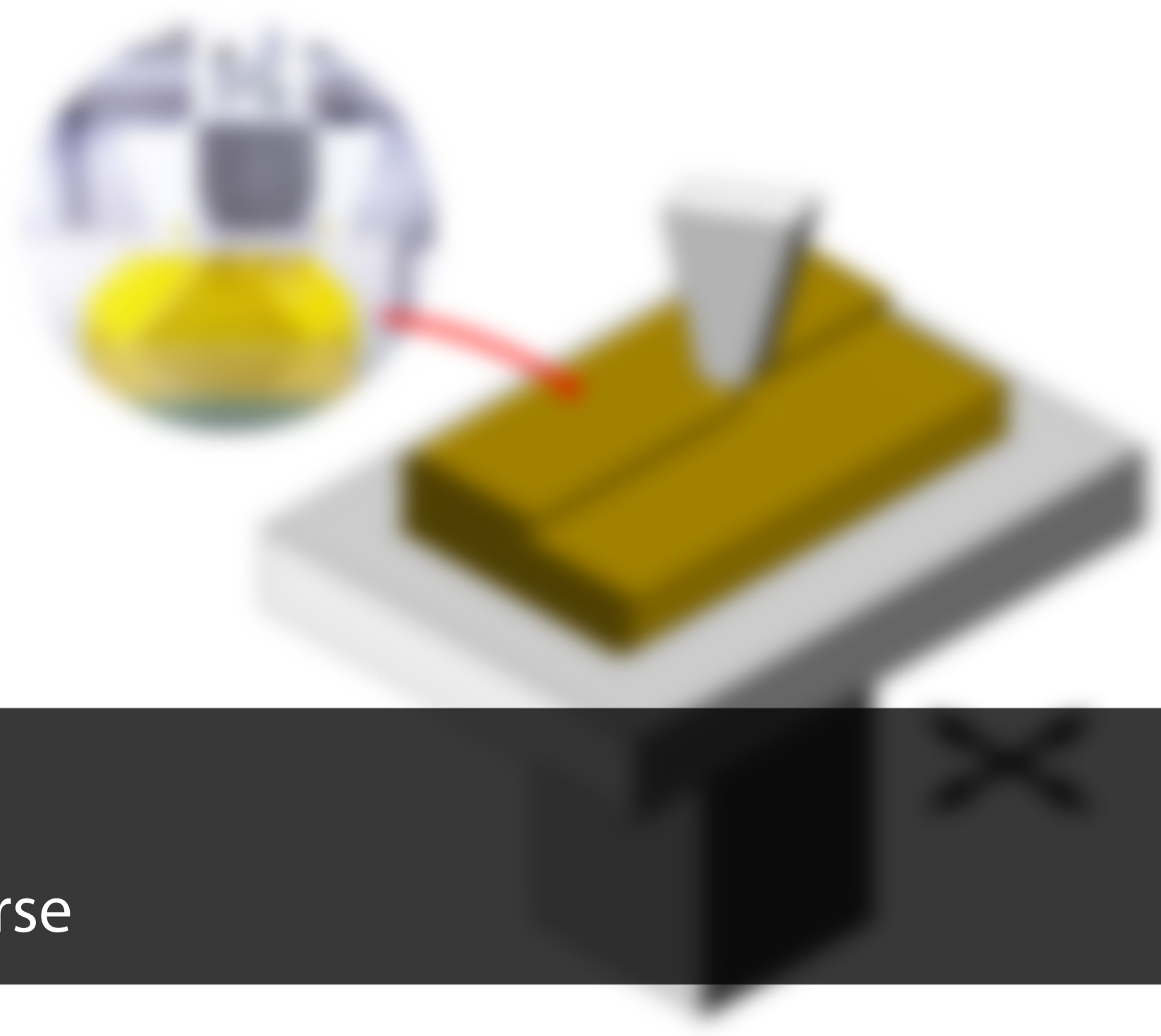
A Student User Guide



The following information is intended for first-time users new to the concept of 3D printing or new to designing around the constraints of 3D printing.

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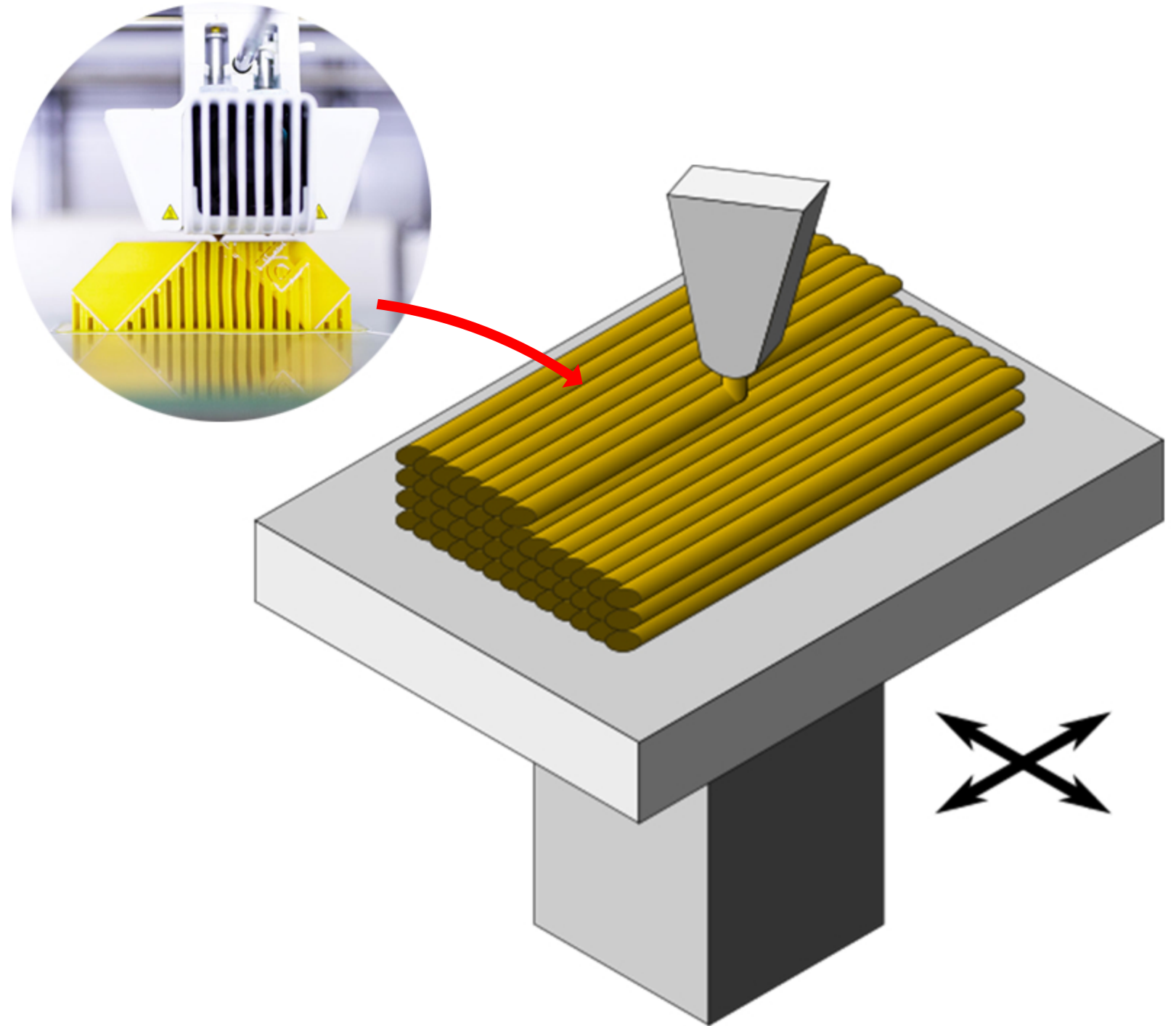


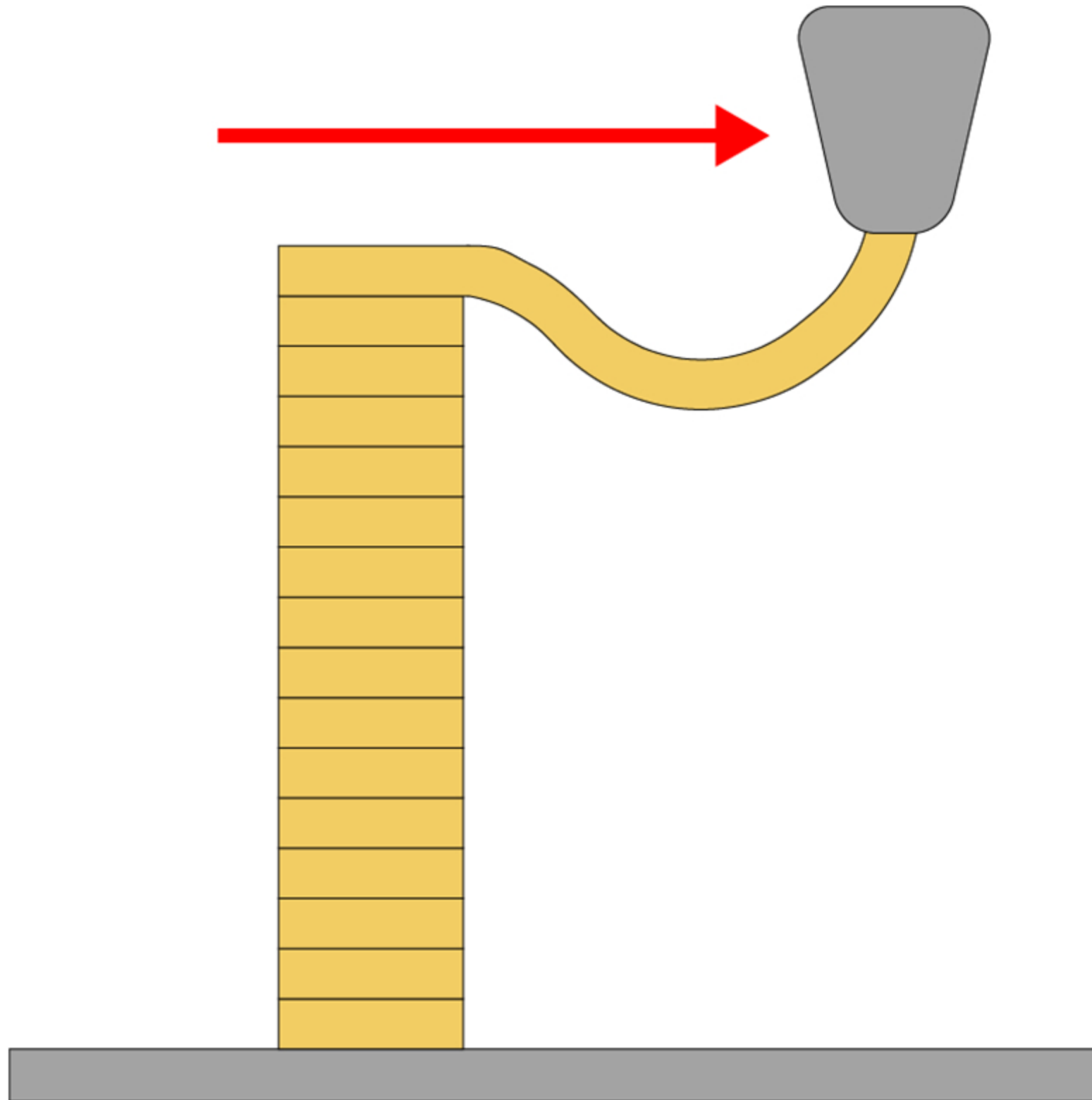
Chapter 1

3D Printing Crash Course

FDM 3D printers squeeze plastic filament through a hot nozzle, melt it, and then deposit it in thin layers onto the printer bed. These layers build up and fuse together to form the final object.

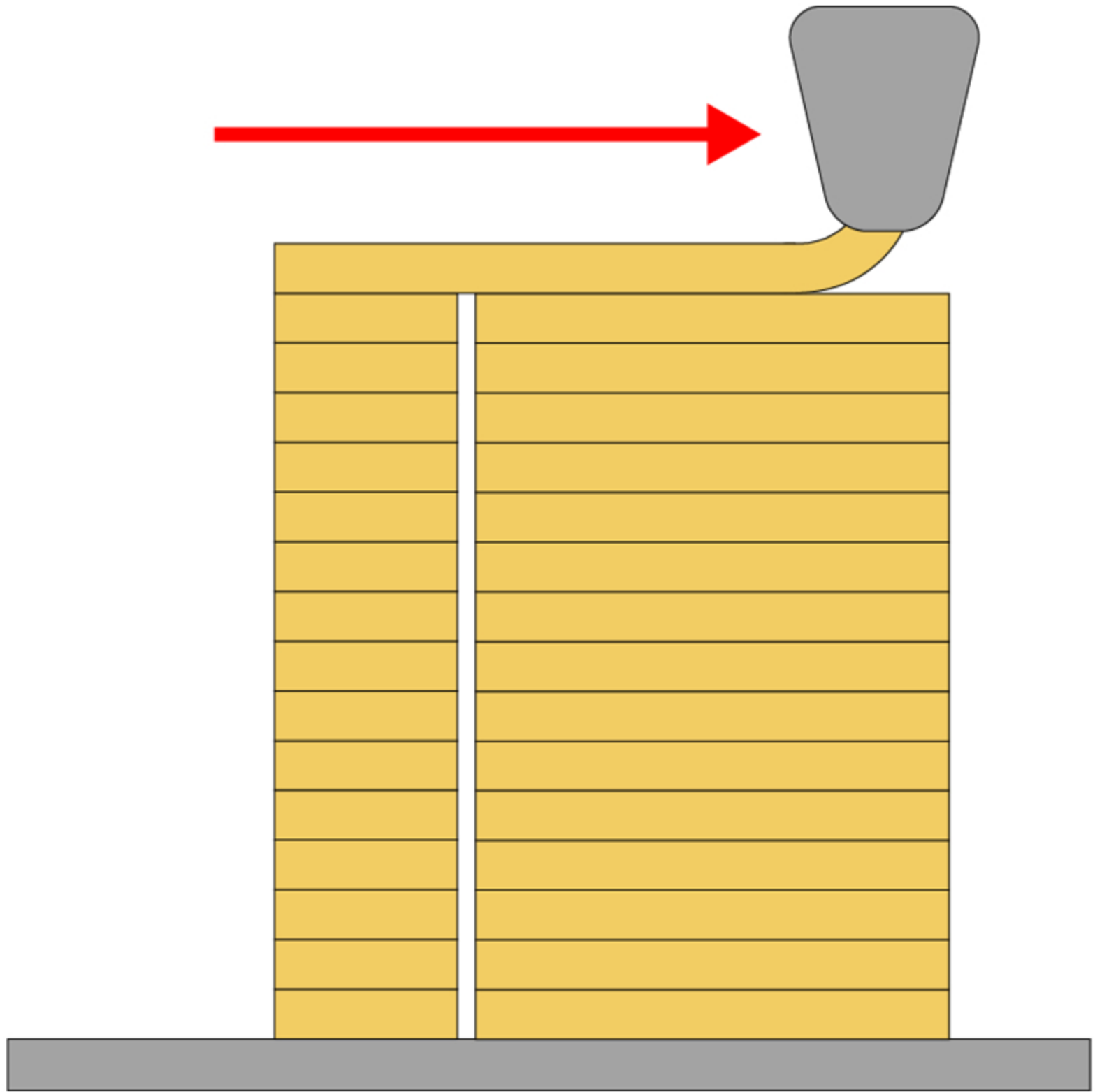
The thinner these layers are, the "finer" the resolution of the object, but the longer the job takes.





Models that have overhangs or bridges, however, face a dilemma:

How can material be dropped into thin air in order to build up an overhanging ledge?



“Support material” must be generated in the printing process to account for gravity, which will “catch” the overhanging structures when they print.

As long as an Arch315 profile is used, support material will be calculated automatically.

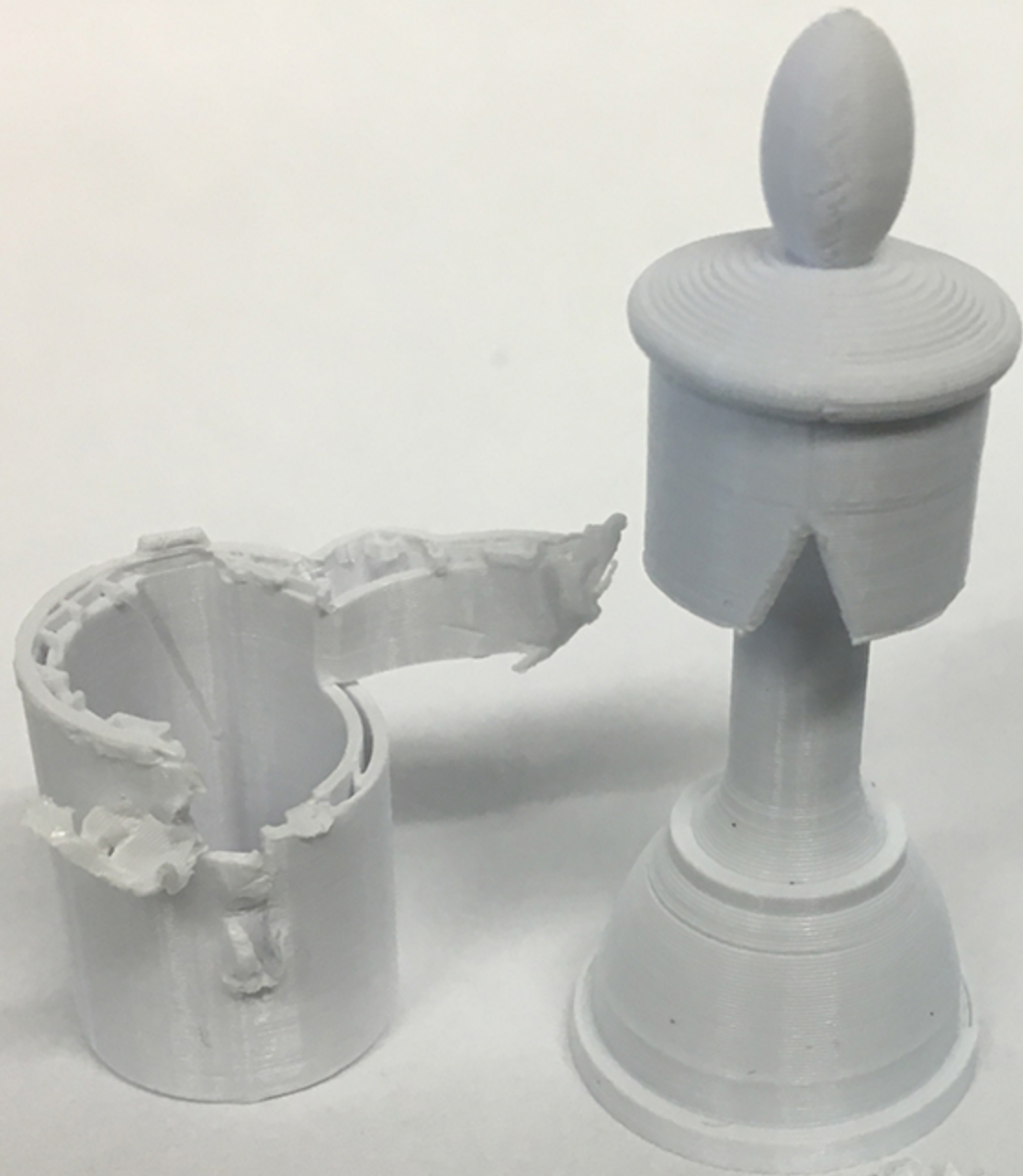
Not all overhangs need support:
mild ledges, such as the "Y" in the
example, may not generate any.



Notice how the "T" looks when the support is turned OFF though.

There was nothing to hold up the first few layers of filament during the printing process, so the bottom appears frayed as the first layers of material were dropped "mid-air".

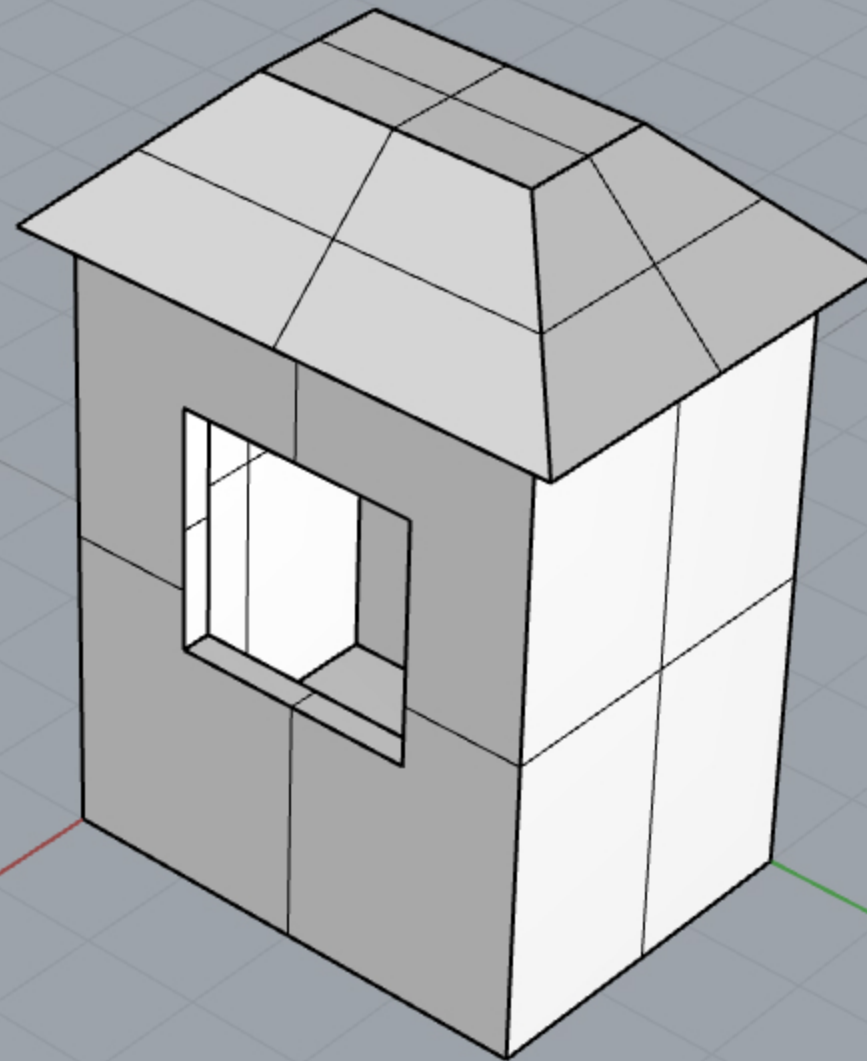




The breakaway support structures offer the fastest printing times and can be removed easily by hand after printing.

All 3D printers offer breakaway support by default.

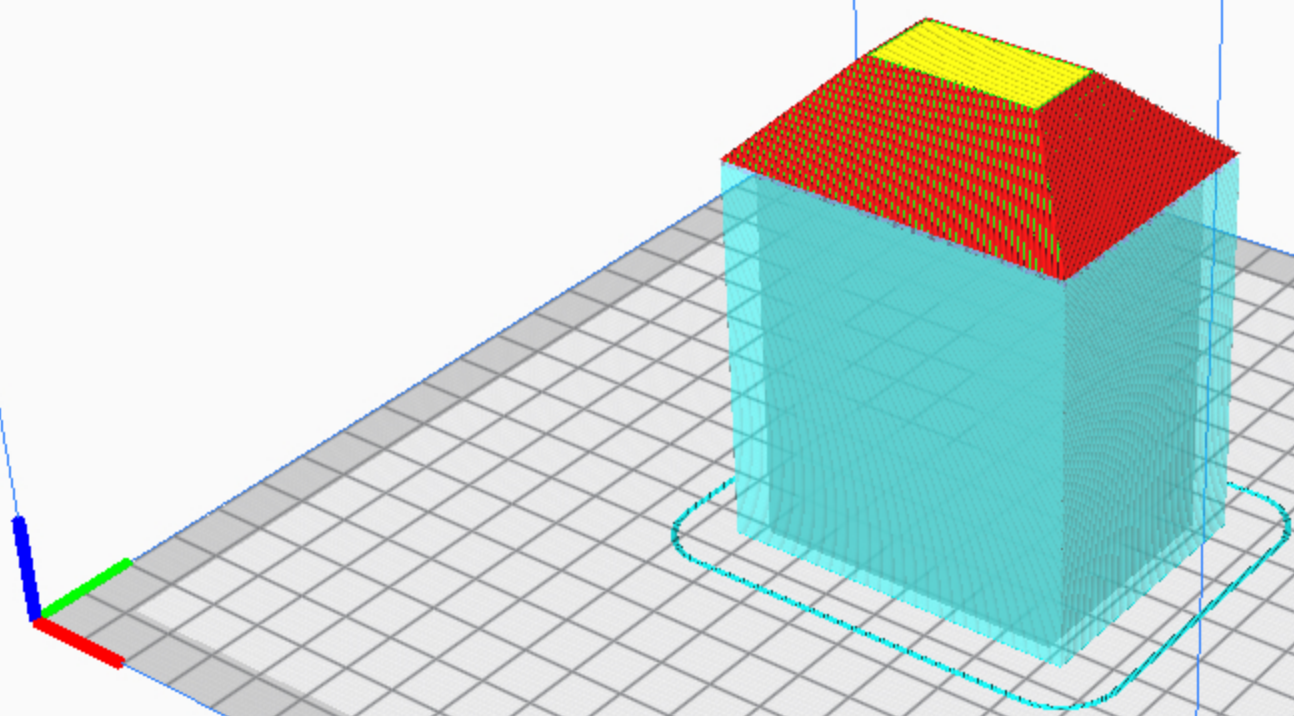




Keep in mind, however, that support structures may be a constant in how your design is 3D printed.

For example, let's try to prepare this simple house model for 3D printing in Cura. This structure was modeled in Rhino.

View type Layer view Color scheme Line Type Arch 315 Creality...d Quality - 0.2mm On Off



This is a processed 3D print in the Cura slicer.

The red and yellow parts of the model indicate the permanent model structure.

The light blue indicates support material generated by Cura.

Object list

house1_full.stl

CCR20PRO_house1_full

66.1 x 49.6 x 87.8 mm

14 hours 43 minutes

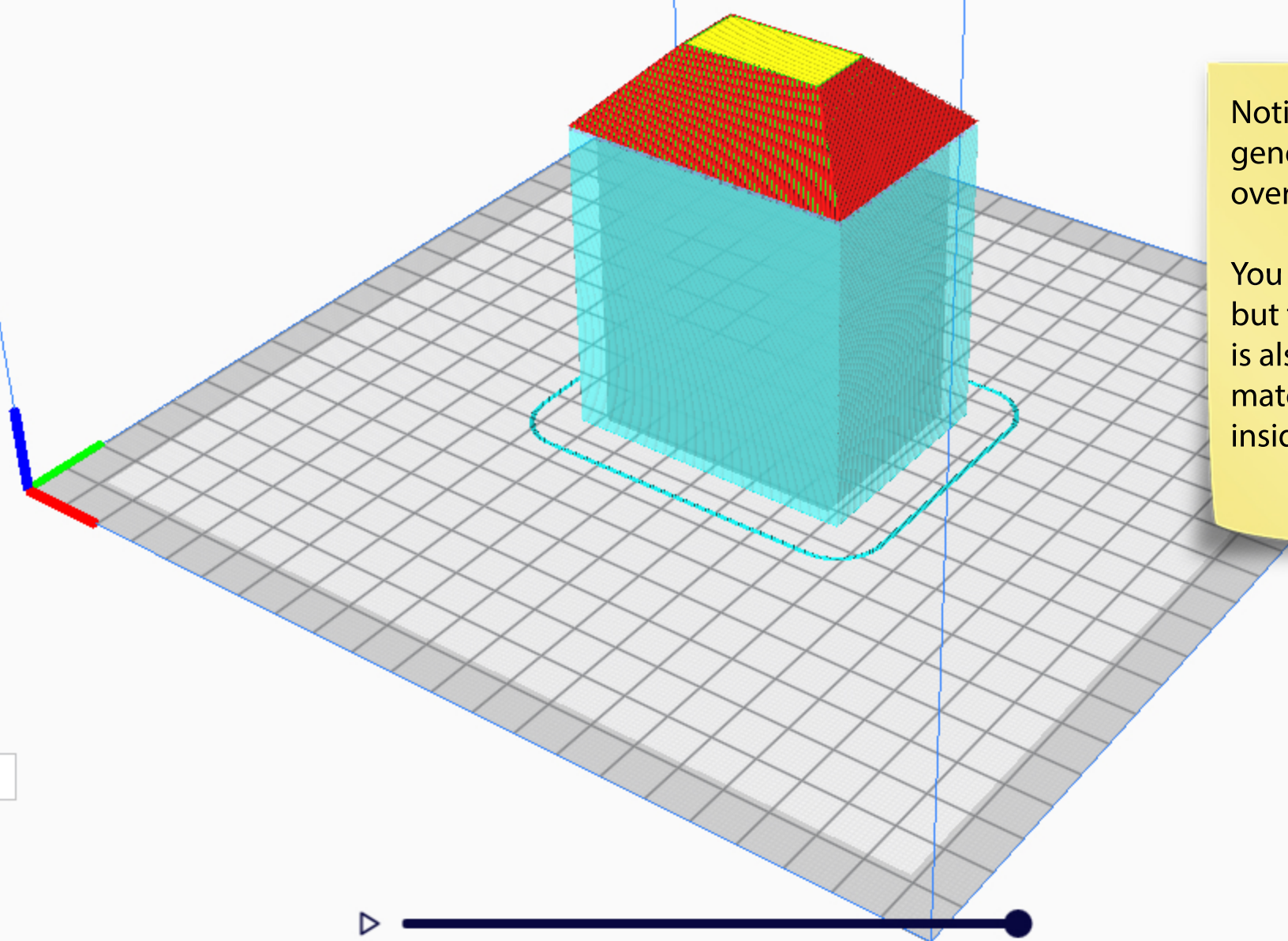
113g · 37.89m · \$ 1.70

Save to Removable Drive

View type Layer view

Color scheme Line Type

Arch 315 Creality...d Quality - 0.2mm ... On Off



Notice how support must be generated under the roof overhang.

You cannot see it in this image, but the *entire interior* of the house is also encased with support material to print the roof on the inside!

Object list

house1_full.stl

CCR20PRO_house1_full

66.1 x 49.6 x 87.8 mm



439

14 hours 43 minutes

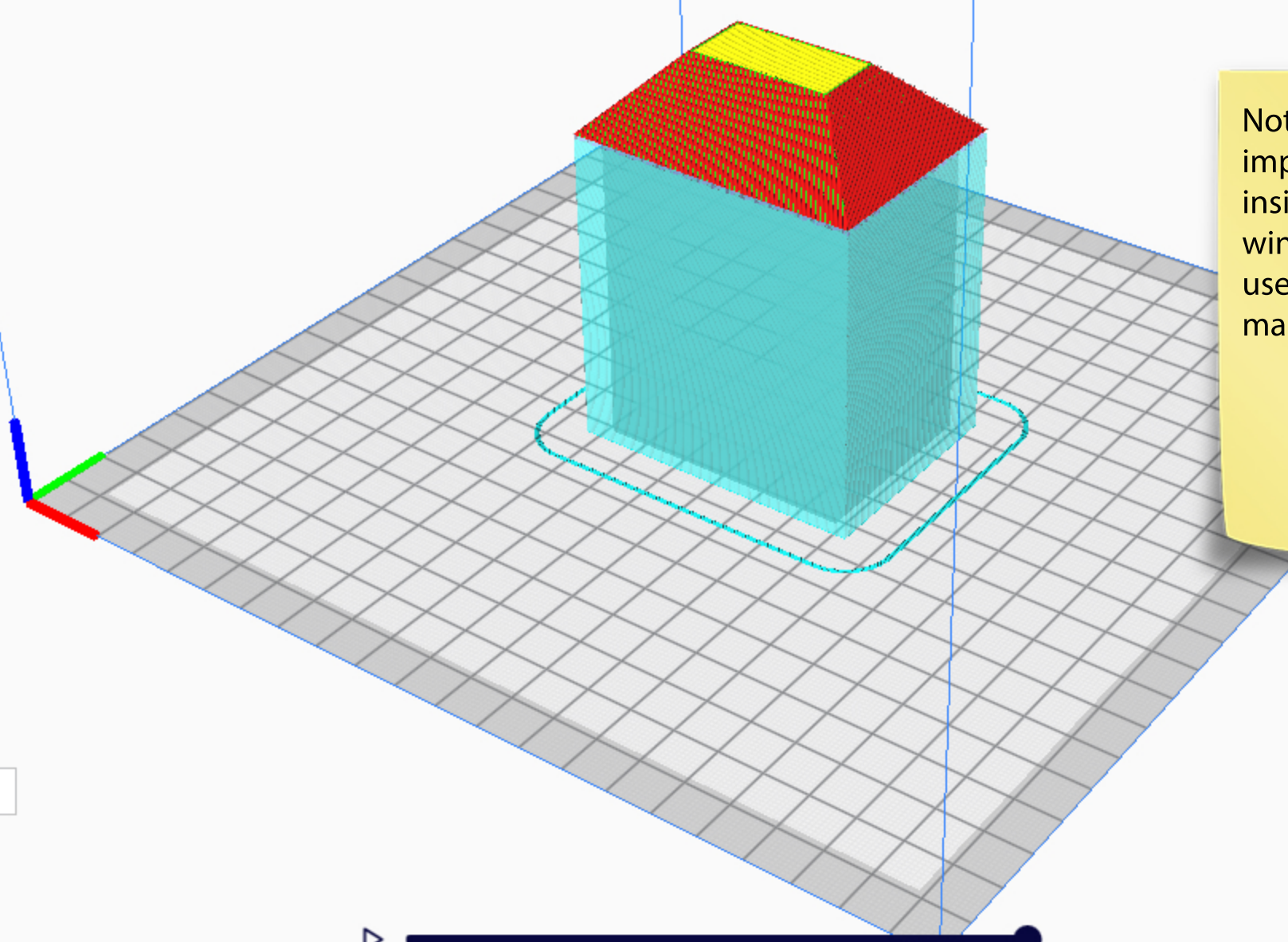
113g · 37.89m · \$ 1.70

[Save to Removable Drive](#)

View type Layer view

Color scheme Line Type

Arch 315 Crealty...d Quality - 0.2mm On Off



Not only will this support be impossible to remove from the inside through the tiny house window, but the excess materials used to print all of the support make for a long print time.

14 hours 43 minutes

113g · 37.89m · \$ 1.70

Save to Removable Drive

Object list

house1_full.stl

CCR20PRO_house1_full

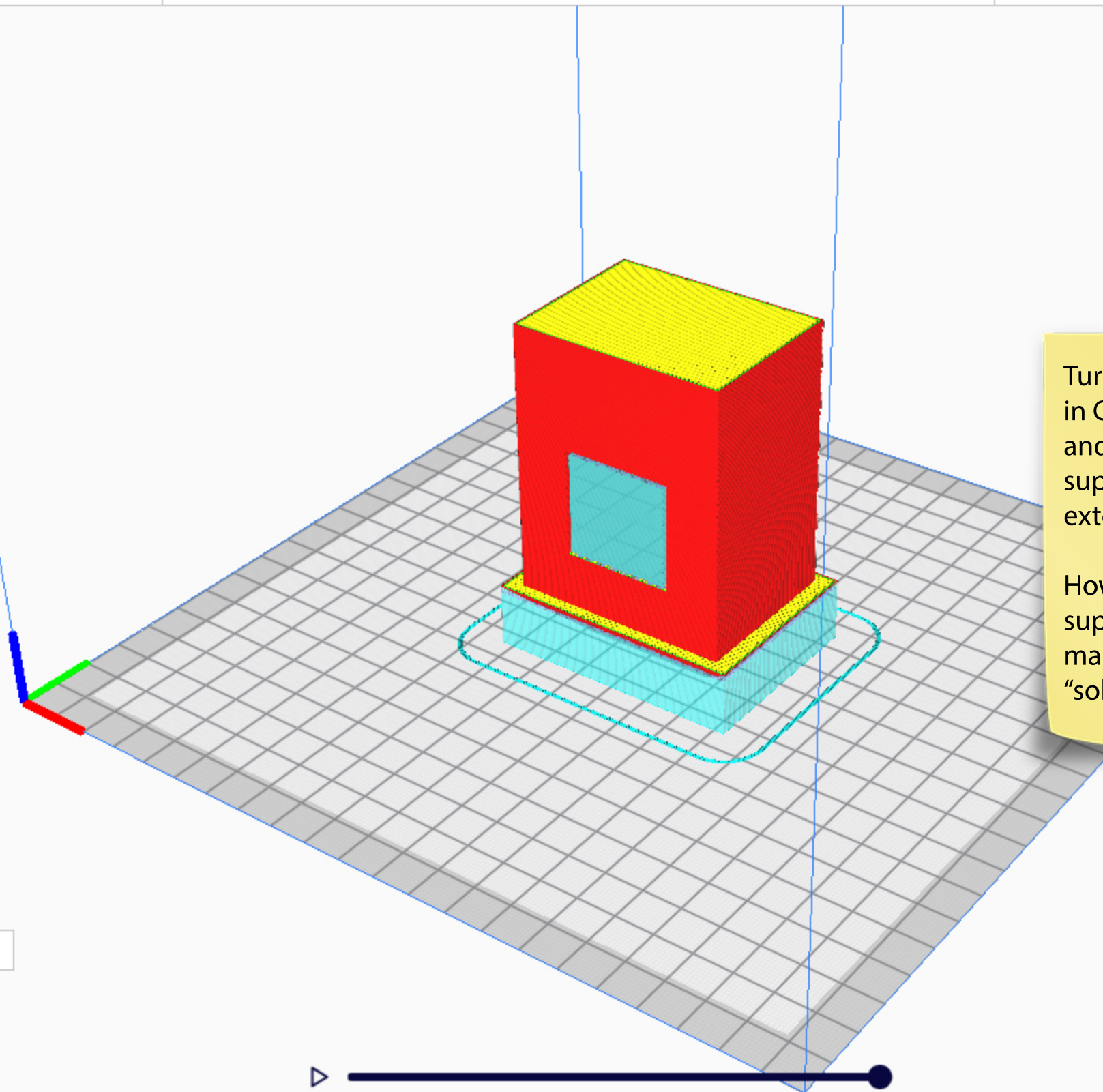
66.1 x 49.6 x 87.8 mm



View type Layer view

Color scheme Line Type

Arch 315 Creality...d Quality - 0.2mm On Off



Turning the house upside-down in Cura saves some material cost and time, since there is less support needed for the roof exterior.

However the house still has support trapped inside which will make this model unintentionally "solid".



Object list

house1_full.stl

CCR20PRO_house1_full

66.1 x 49.6 x 87.8 mm

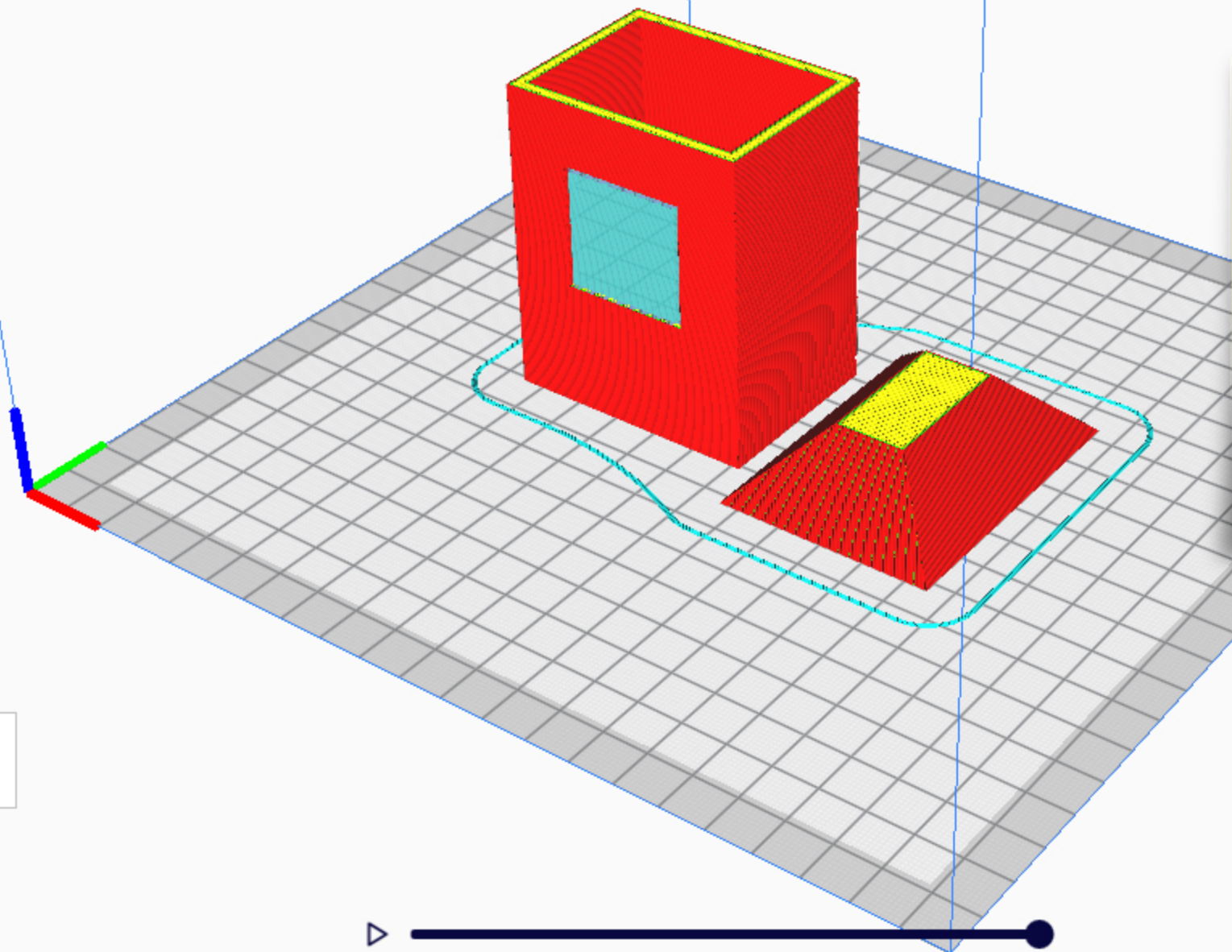
11 hours 30 minutes

88g · 29.46m · \$ 1.32

Save to Removable Drive

View type Layer view Color scheme Line Type Arch 315 Creality...d Quality - 0.2mm On Off

Navigation icons: pan, zoom, rotate, etc.



The easiest solution is to remove the roof in Rhino and print the source of the overhang separately.

The only support generated is in the window, which can be easily punched out by hand.

See how much time this also saves?

- Object list
- house2_part1.stl
- house2_part2.stl

CCR20PRO_house2_part2
110.3 x 66.1 x 71.3 mm

View orientation icons: top, front, left, right, isometric

Progress bar and play button

5 hours 48 minutes

44g · 14.62m · \$ 0.65

Save to Removable Drive

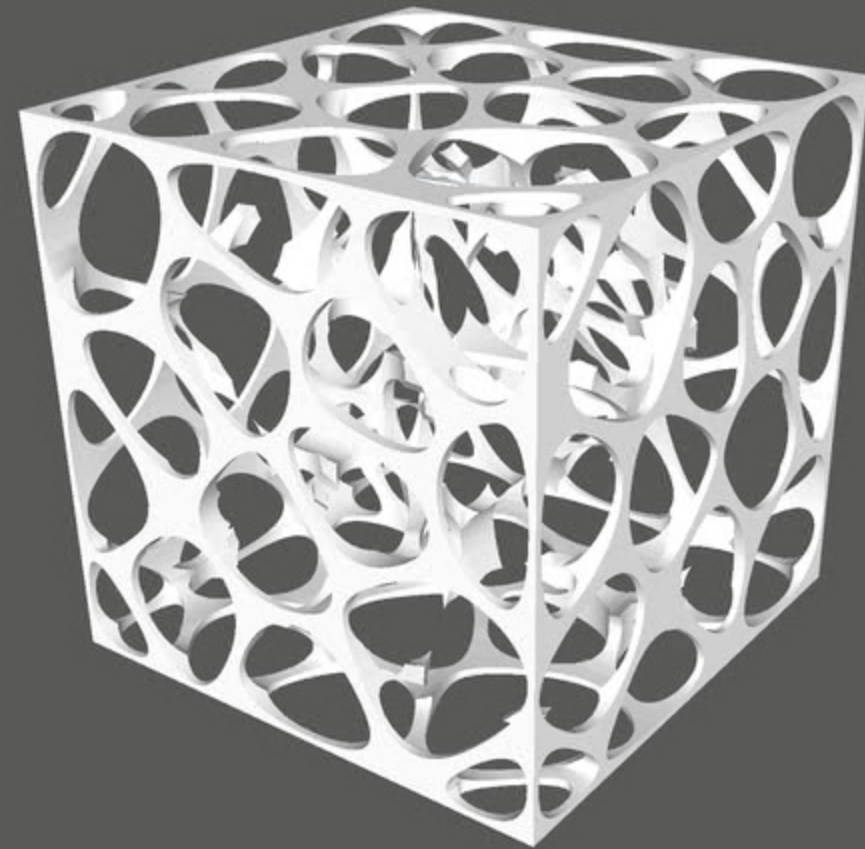
These parts are PLA plastic, and if needed, can be easily conjoined with any standard CA glue or superglue.

The roof in the prior example can be easily glued back onto the rest of the print.



There may be designs that are too complex, however, to “split apart” in a practical way to make support removal easier.

This is where the Ultimaker S5 (the larger machine) *may* come into play.



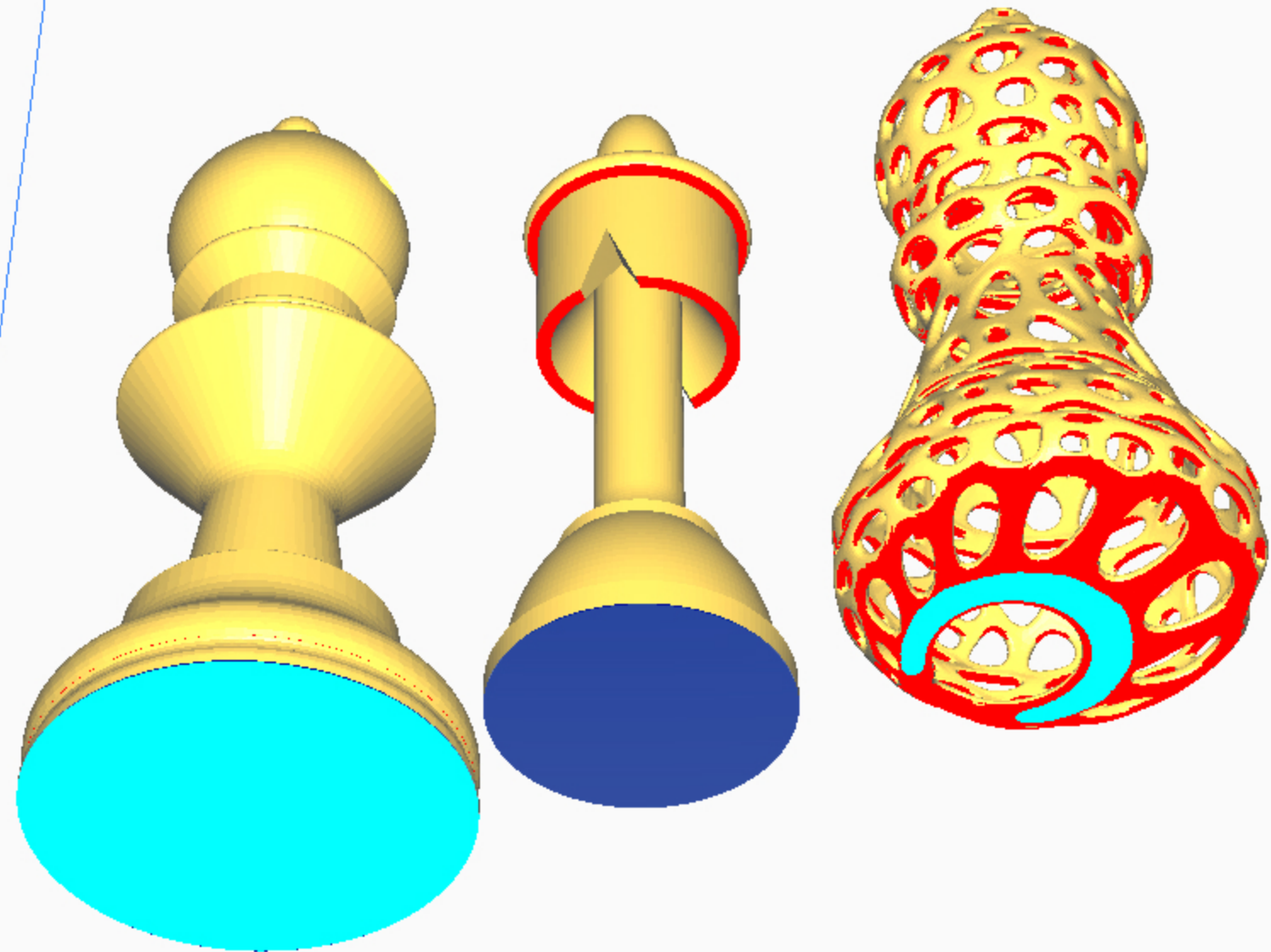
For this next example, let's take a look at what the breakaway support will look like across different models in Cura.

Notice the varying levels of complexity in these chess pieces...

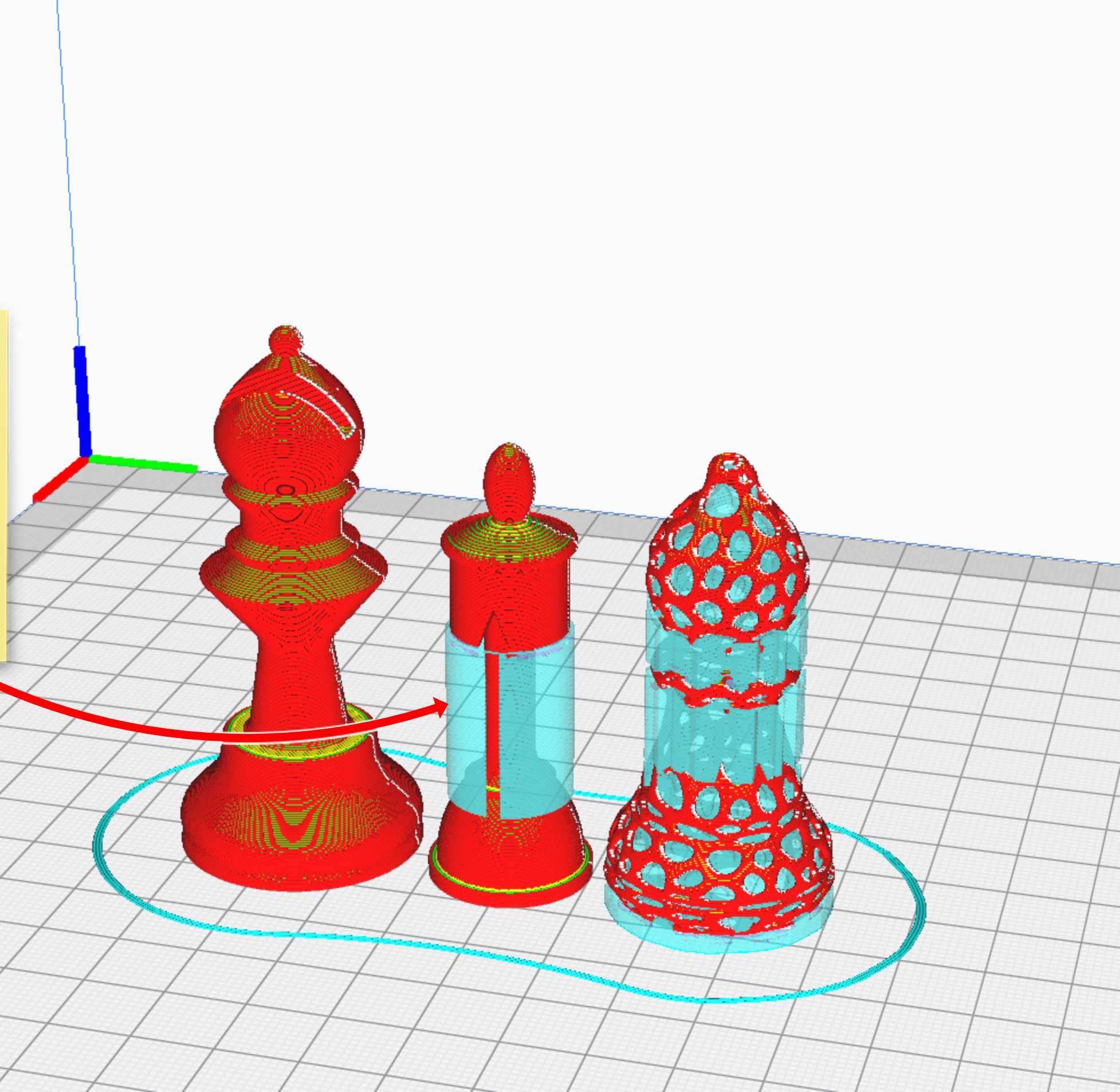


When we flip the viewport to look underneath, the red highlights indicate where support may be generated for our current Arch315 settings.

Let's see what the breakaway support will look like once generated...

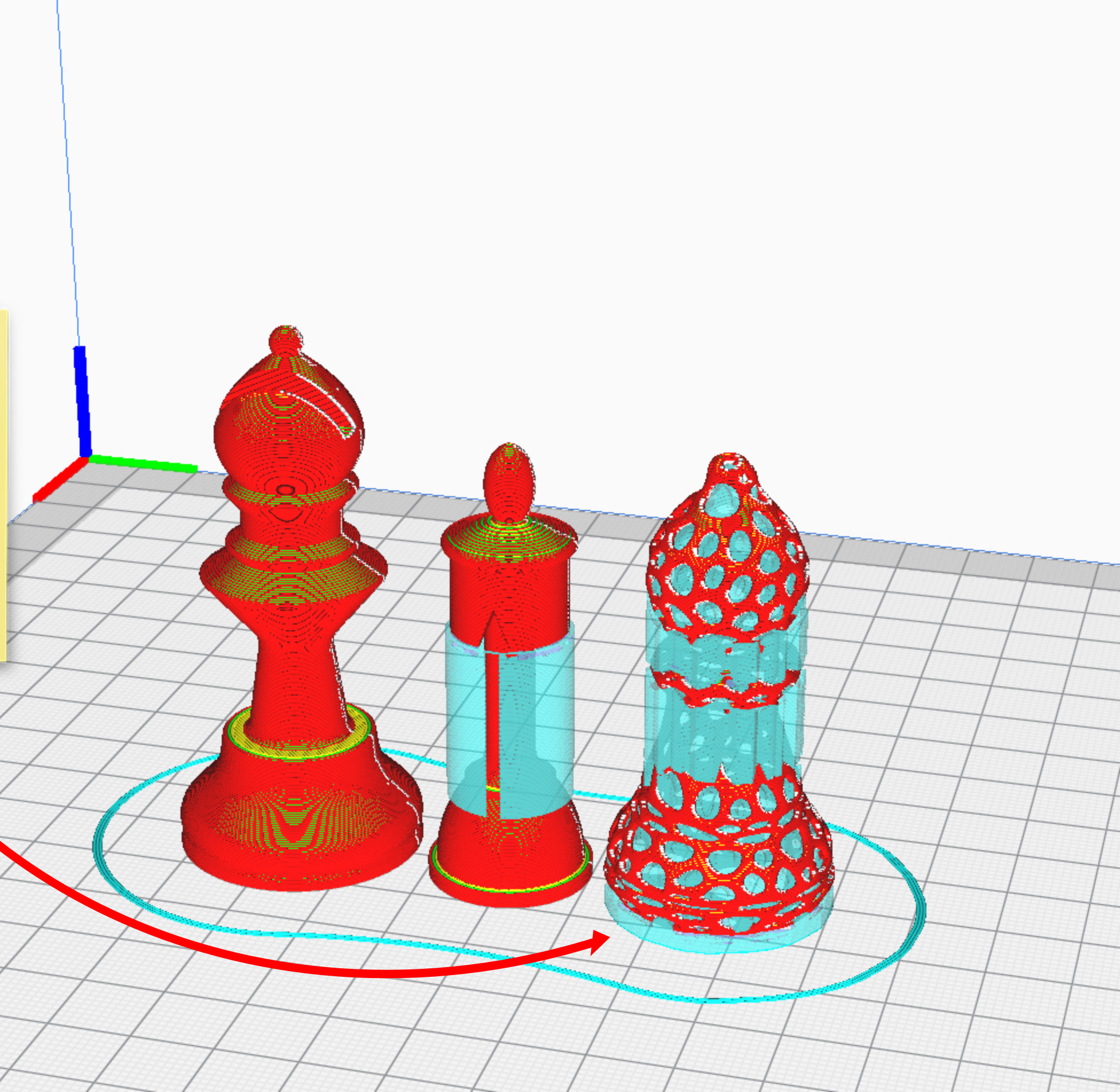


While our 1st does not need support at all, the 2nd piece generates a ring of removeable support around the object in order to print the first layers of the overhang.



The 3rd is more complex, however, and generates support both inside and outside of the voronoi structure.

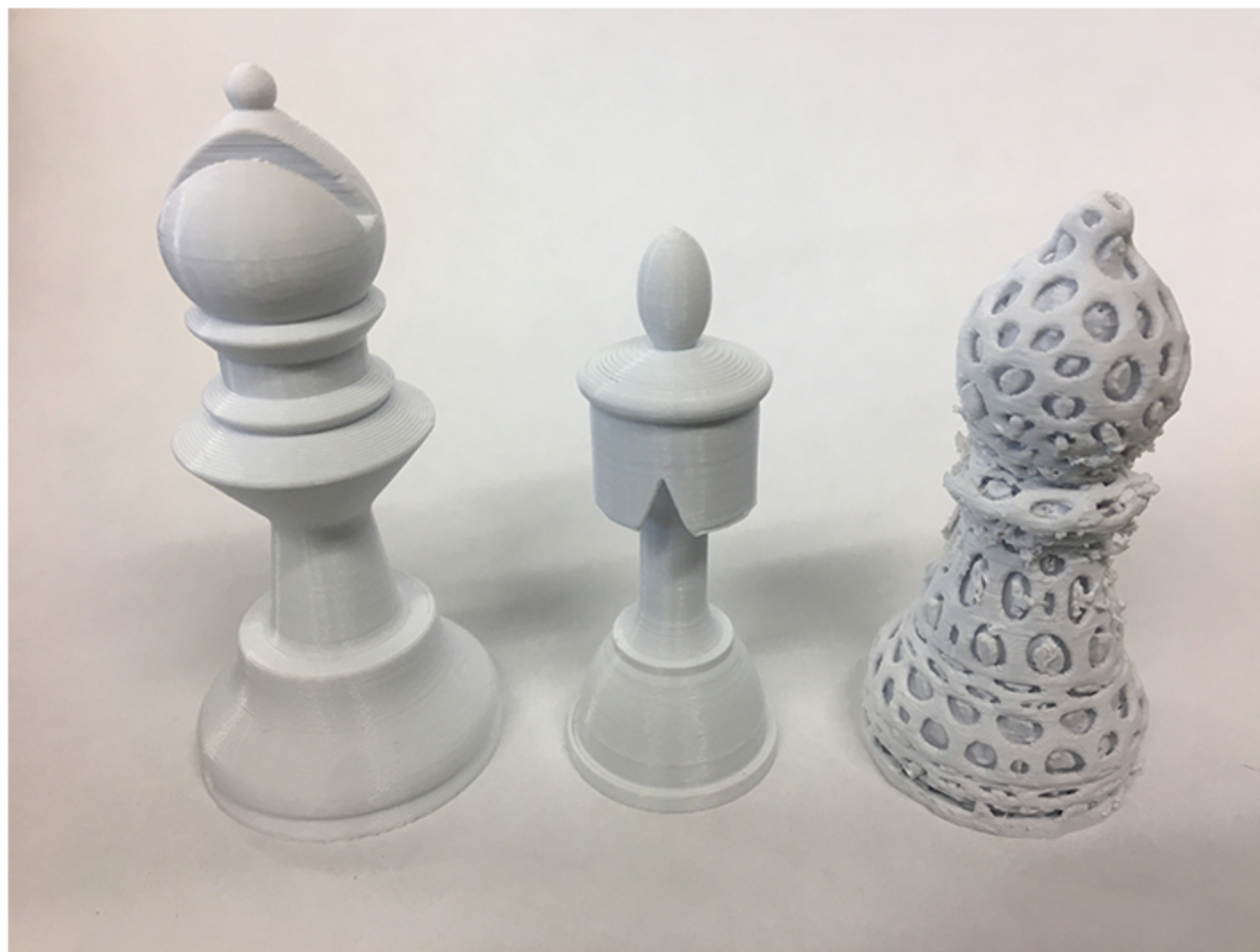
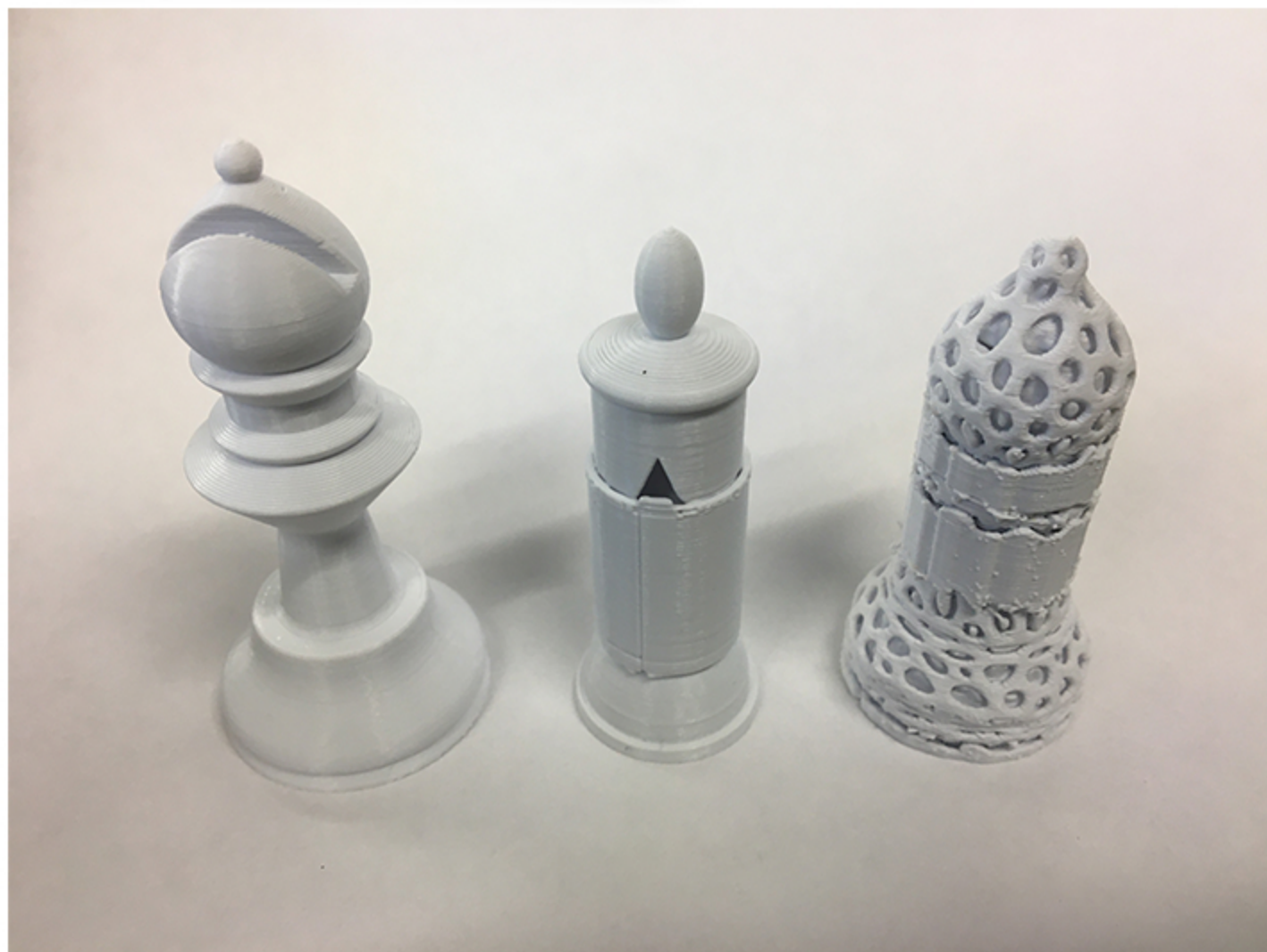
Can you guess why this particular design might be an issue for us later?

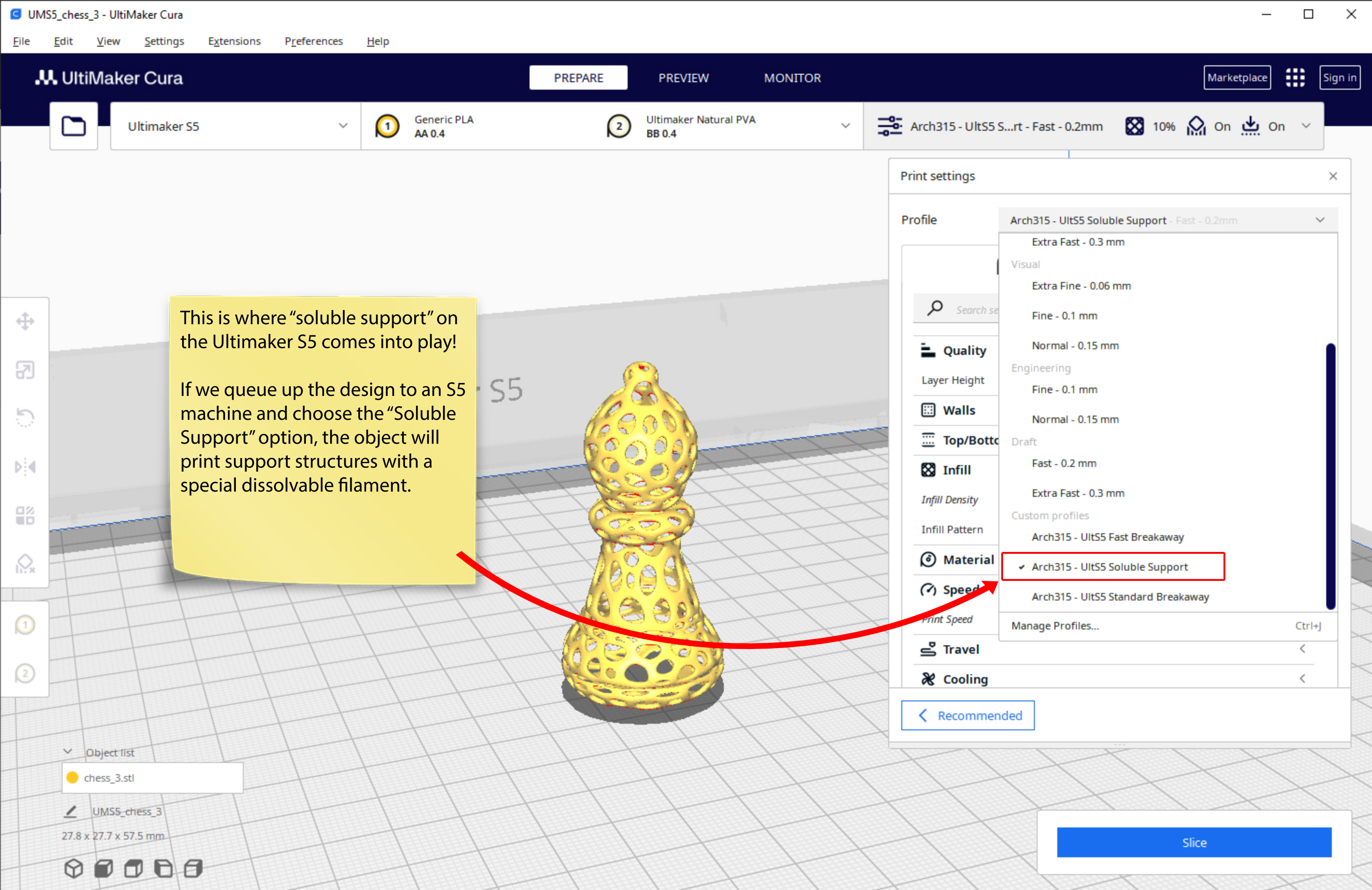


Here's the answer:

The majority of the support structure in the 3rd chess piece cannot be removed, since it's trapped inside of the design with no way to clip it out.

AKA... *it's stuck!*





This is where "soluble support" on the Ultimaker S5 comes into play!

If we queue up the design to an S5 machine and choose the "Soluble Support" option, the object will print support structures with a special dissolvable filament.

Print settings

Profile: Arch315 - UltS5 Soluble Support - Fast - 0.2mm

- Extra Fast - 0.3 mm
- Visual
- Extra Fine - 0.06 mm
- Fine - 0.1 mm
- Normal - 0.15 mm
- Engineering
- Fine - 0.1 mm
- Normal - 0.15 mm
- Draft
- Fast - 0.2 mm
- Extra Fast - 0.3 mm
- Custom profiles
- Arch315 - UltS5 Fast Breakaway
- Arch315 - UltS5 Soluble Support
- Arch315 - UltS5 Standard Breakaway
- Manage Profiles... (Ctrl+J)

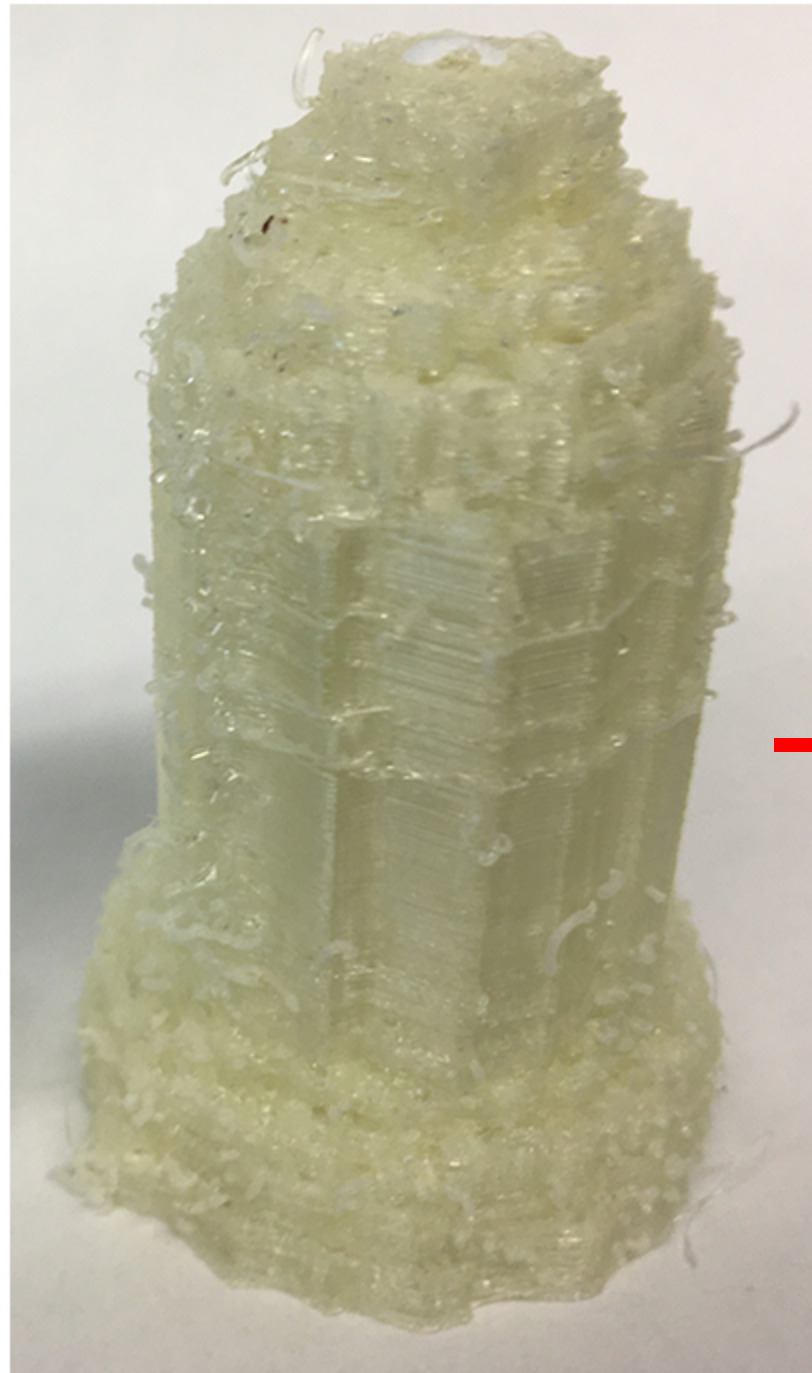
Material

Recommended

Slice

Once finished printing, place the piece into a cup of water for a couple of hours (*time will vary depending on size*).

The PVA support material is dissolved away and leaves the object behind!



The final result is not the *prettiest* and will require some mild clean-up work, however at least compared to the chess piece on the left, the right object is usable.



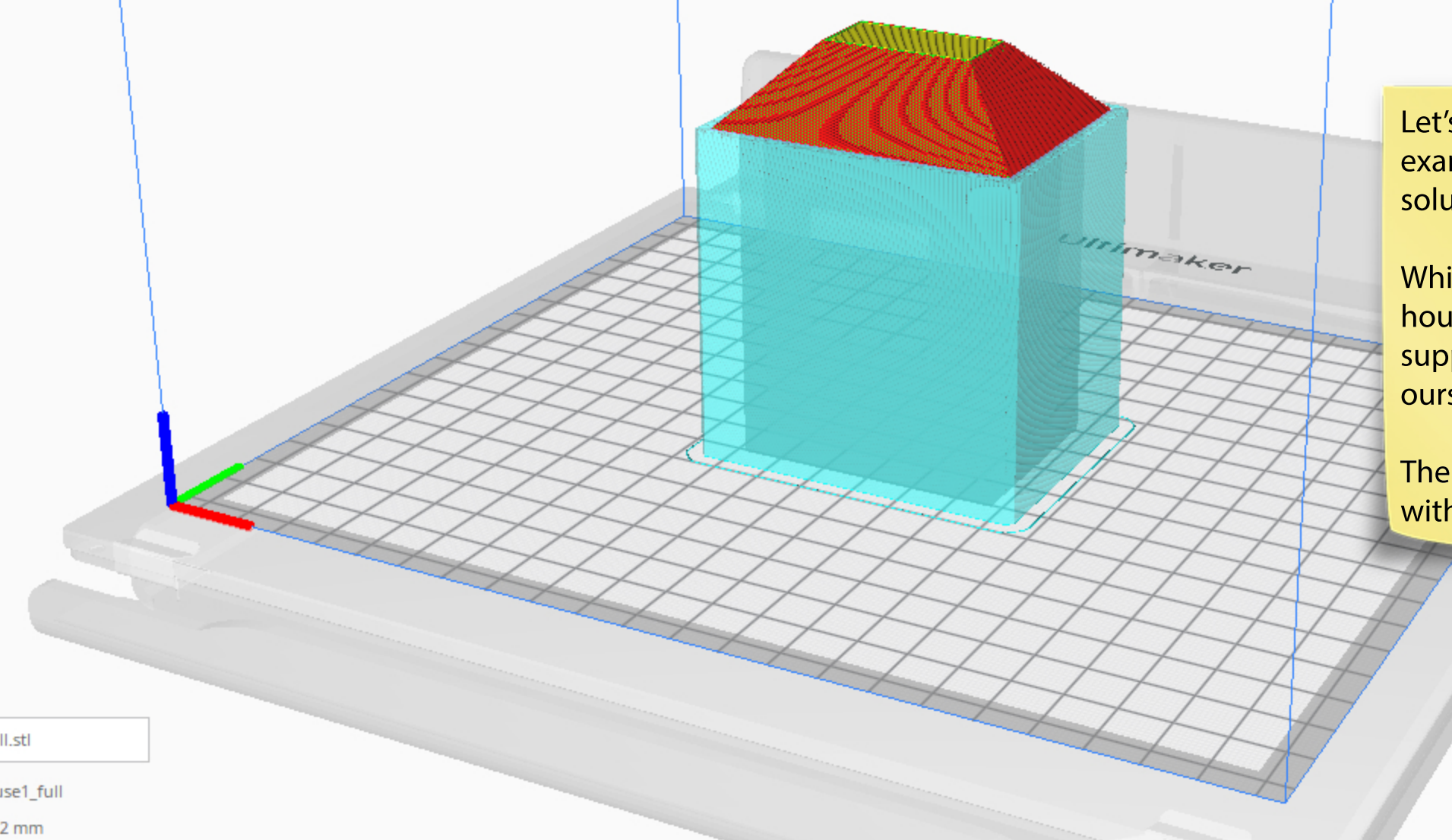
breakaway support :(



water soluble support

View type Layer view Color scheme Line Type Arch315 - Ultim...Normal - 0.15mm 10% On Off

Navigation icons: Home, Back, Forward, Stop, Play, Refresh, Undo, Redo, Close, and a numbered list (1, 2).



Let's go back to the house example and look at it with soluble support now.

While we *could* slice the entire house on the S5 using soluble supports, we're only slowing ourselves down.

The house would still print best with the roof removed.

Object list

- house1_full.stl

UMS3_house1_full
64.9 x 48.7 x 86.2 mm

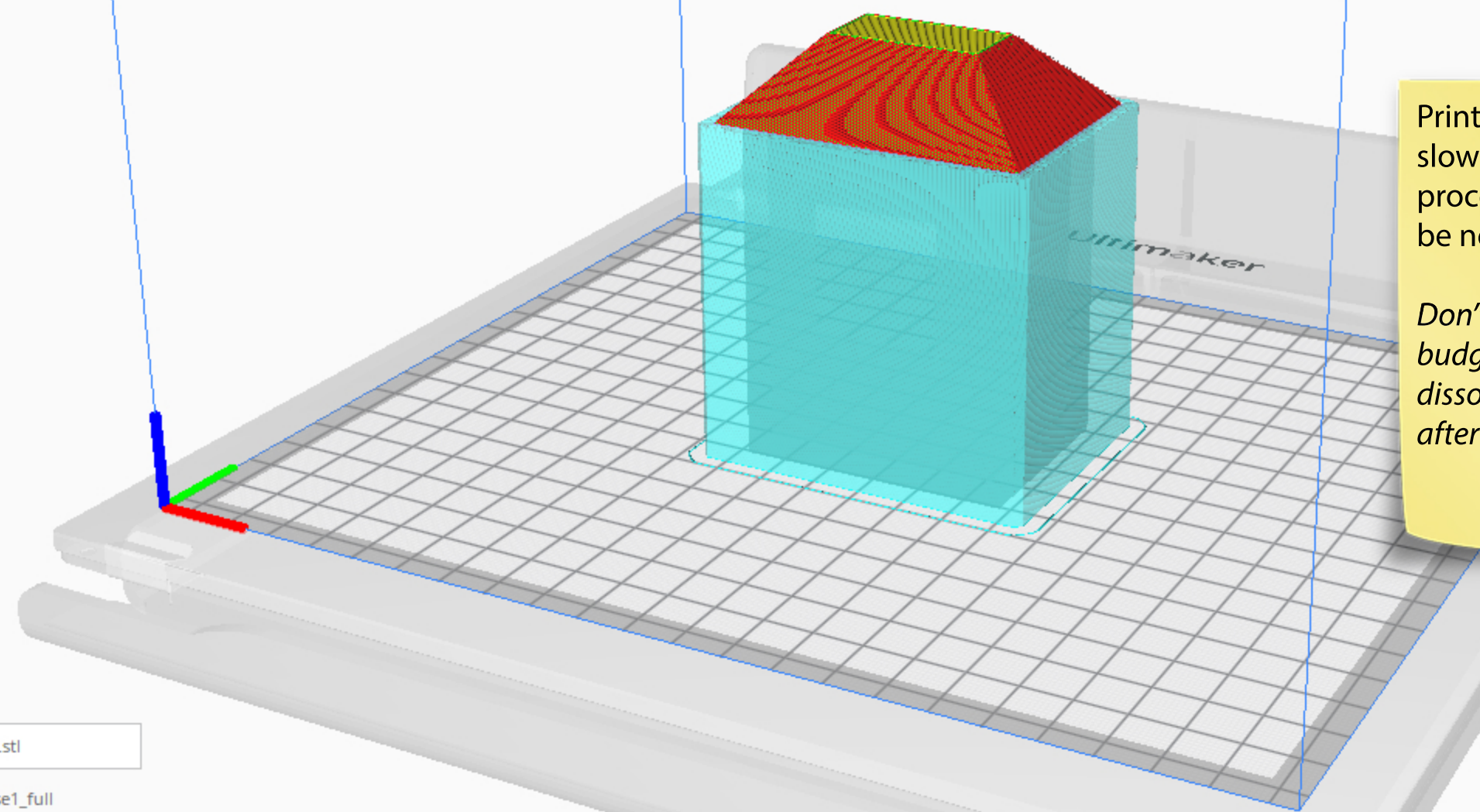
14 hours 28 minutes

107g · 13.50m · \$ 4.06

Save to Removable Drive

View type Layer view Color scheme Line Type Arch315 - Ultim...Normal - 0.15mm 10% On Off

- Navigation icons: pan, zoom, rotate, etc.
- Object list: 1, 2



Printing with soluble supports is a slower and more expensive process in general, however may be necessary for complex objects.

Don't forget that you must also budget for additional time to dissolve the support filament away after the printing process.

Object list

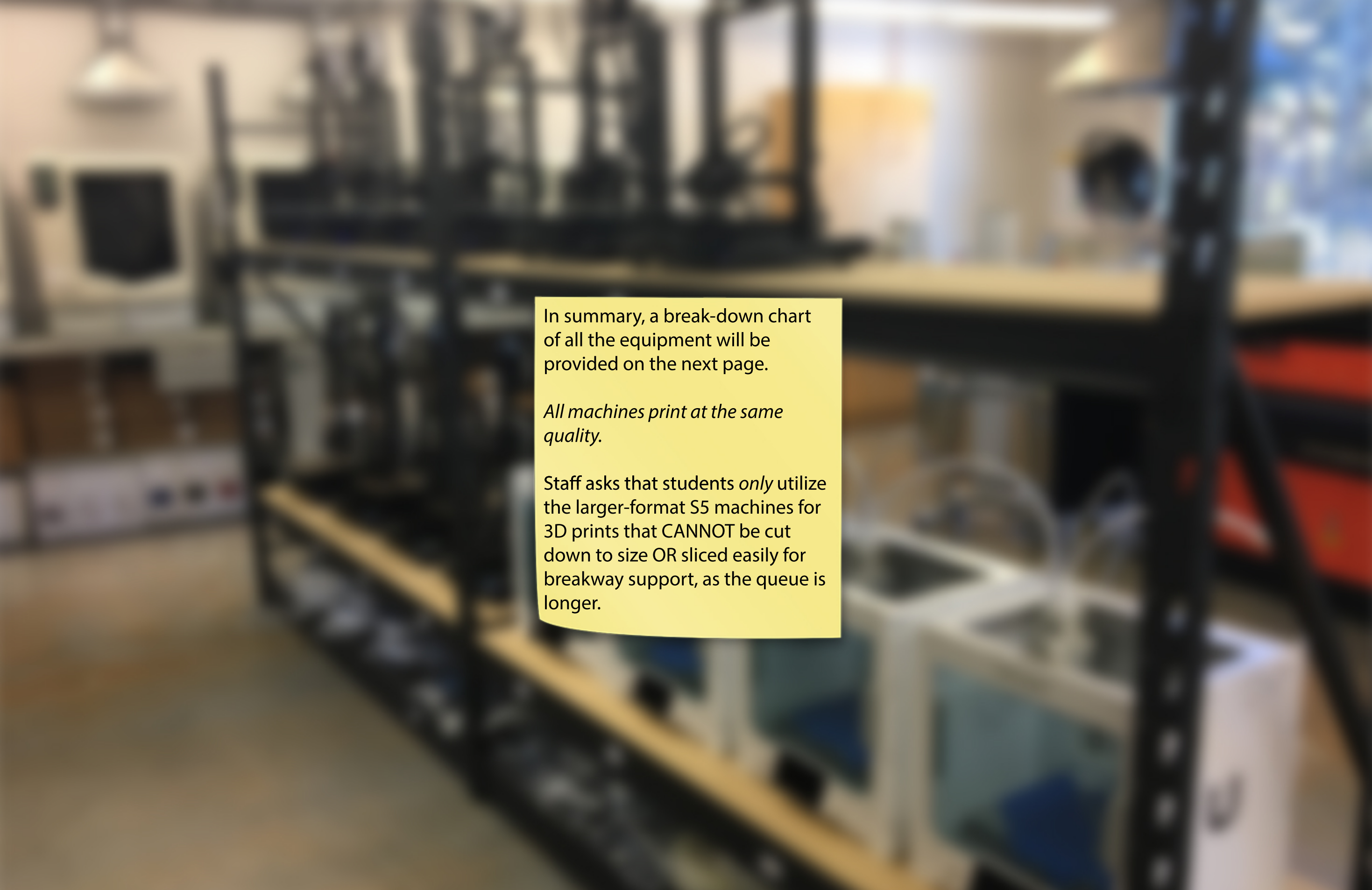
- house1_full.stl

UMS3_house1_full
64.9 x 48.7 x 86.2 mm

14 hours 28 minutes

107g · 13.50m · \$ 4.06

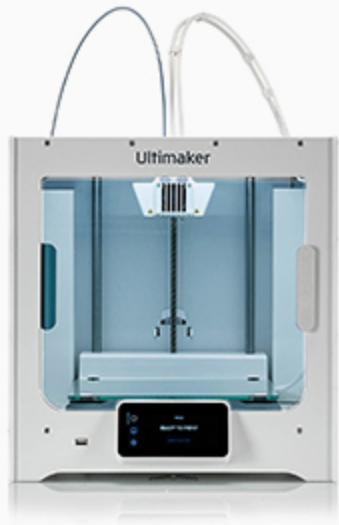
Save to Removable Drive



In summary, a break-down chart of all the equipment will be provided on the next page.

All machines print at the same quality.

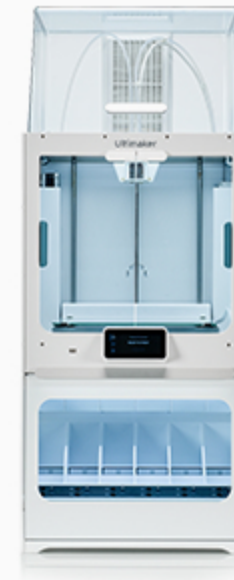
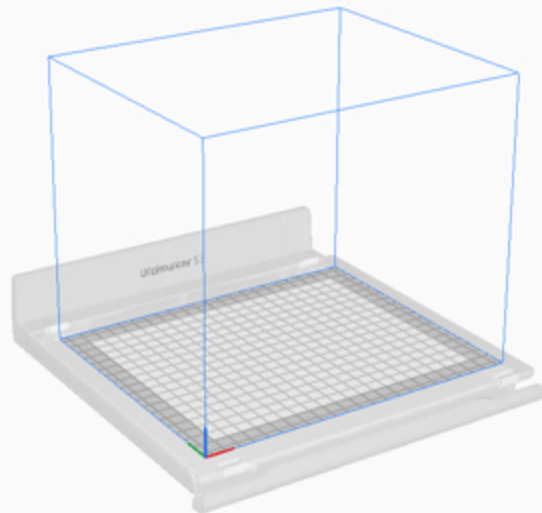
Staff asks that students *only* utilize the larger-format S5 machines for 3D prints that CANNOT be cut down to size OR sliced easily for breakway support, as the queue is longer.



Ultimaker S3

- (230 x 190 x 200mm)
(9.0 x 7.4 x 7.8in)

- PLA plastic filament (white & black) ○●
- Breakaway support (hand-removal)



Ultimaker S5

- (330 x 240 x 300mm)
(13.0 x 9.4 x 11.8in)

- PLA plastic filament (white only) ○
- Breakaway OR soluble support (dissolvable)

