15-294 Rapid Prototyping Technologies:
Molecule Exercise and
3D Printer Intro

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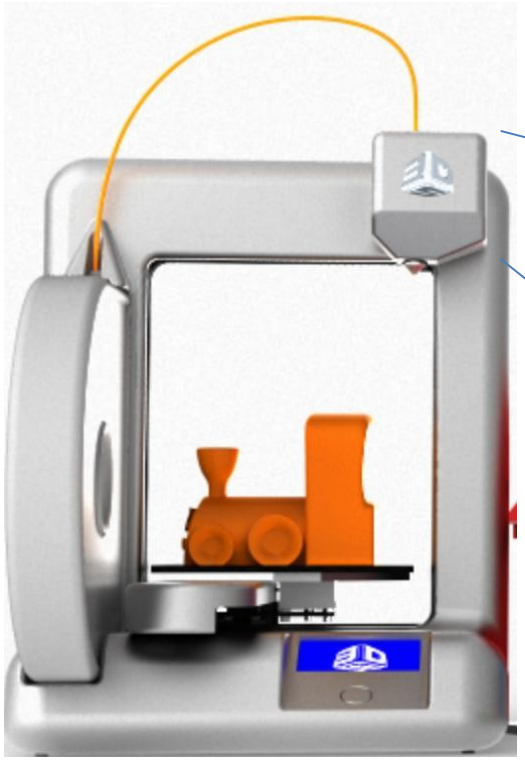
3D Printer vs. Laser Cutter

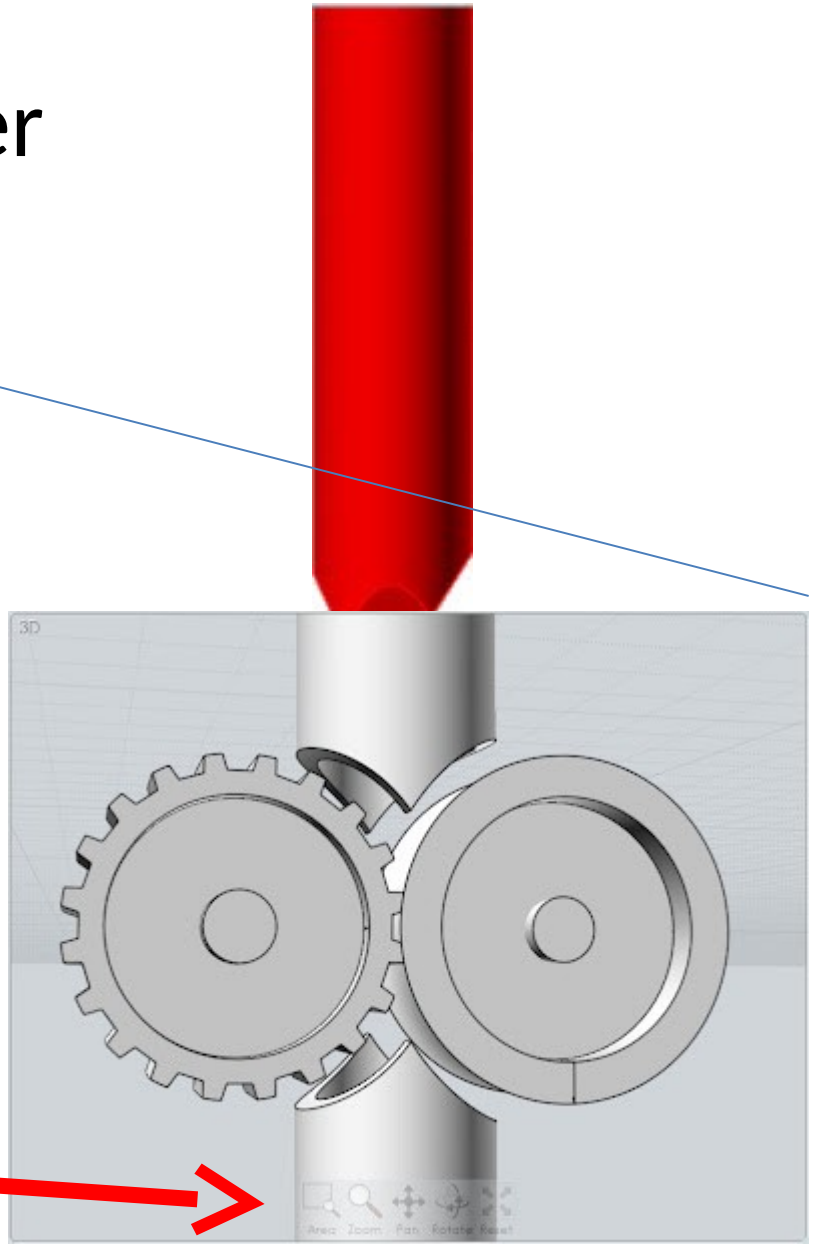
- x Slower
- x Less precise
- x More expensive
- x Limited materials
- x Support material may be required
- ✓ Complex 3D structures!

Low Cost 3D Printers

- RepRap: 2005 onward
  - Adrian Bowyer, University of Bath (UK)
  - Goal: open source 3D printer that can replicate itself
  - 4 generations: Darwin, Mendel, Prusa Mendel, Huxley
  - Spawned many start-ups
- Makerbot
  - Evolved from RepRap; initially was open source
  - Cupcake, Thing-o-Matic, Makerbot2, Replicator
- Solidoodle ($500)
- Zortrax M-200
- Many, many more…

The Cube 2 Extruder



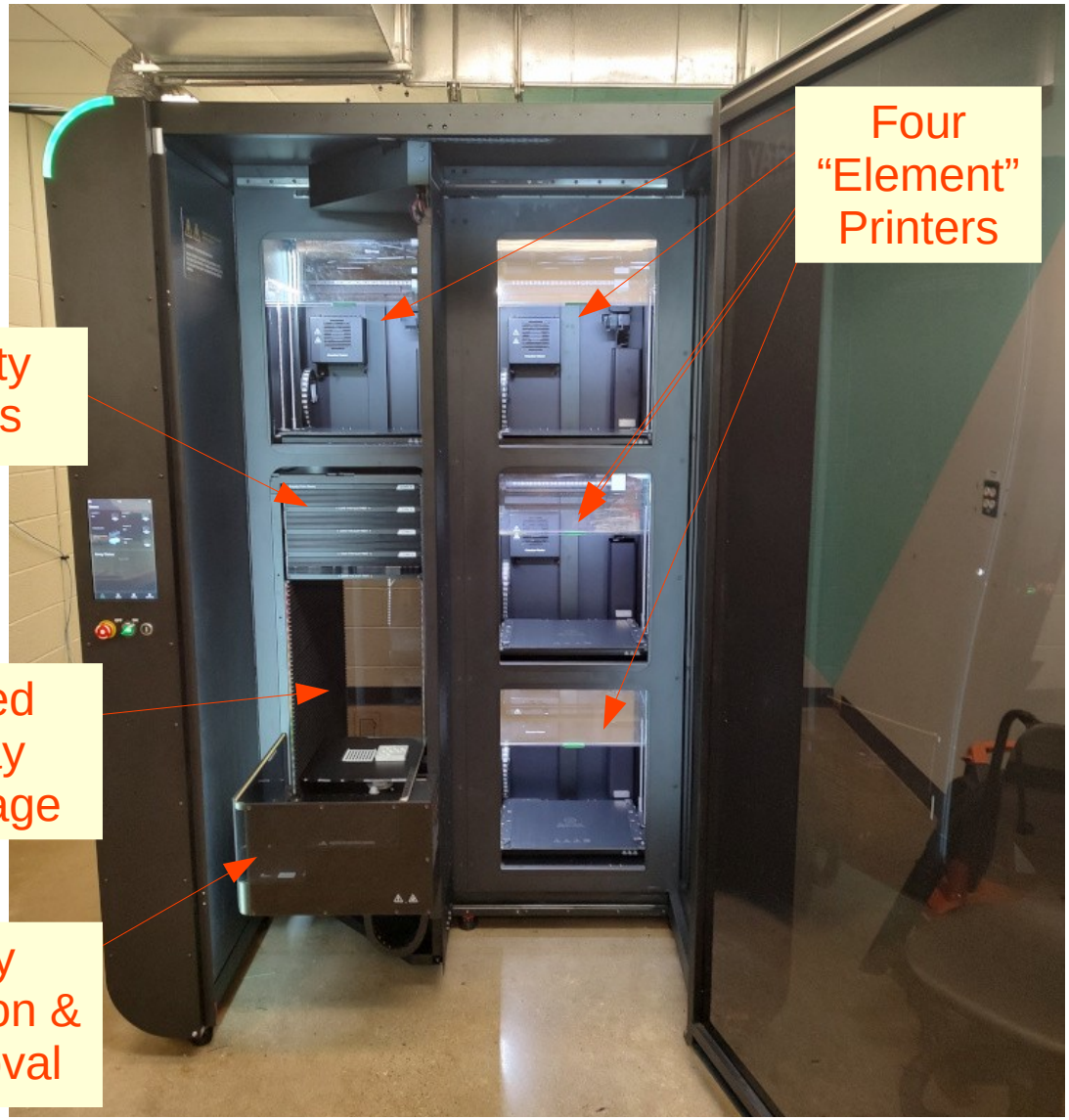


Heated section

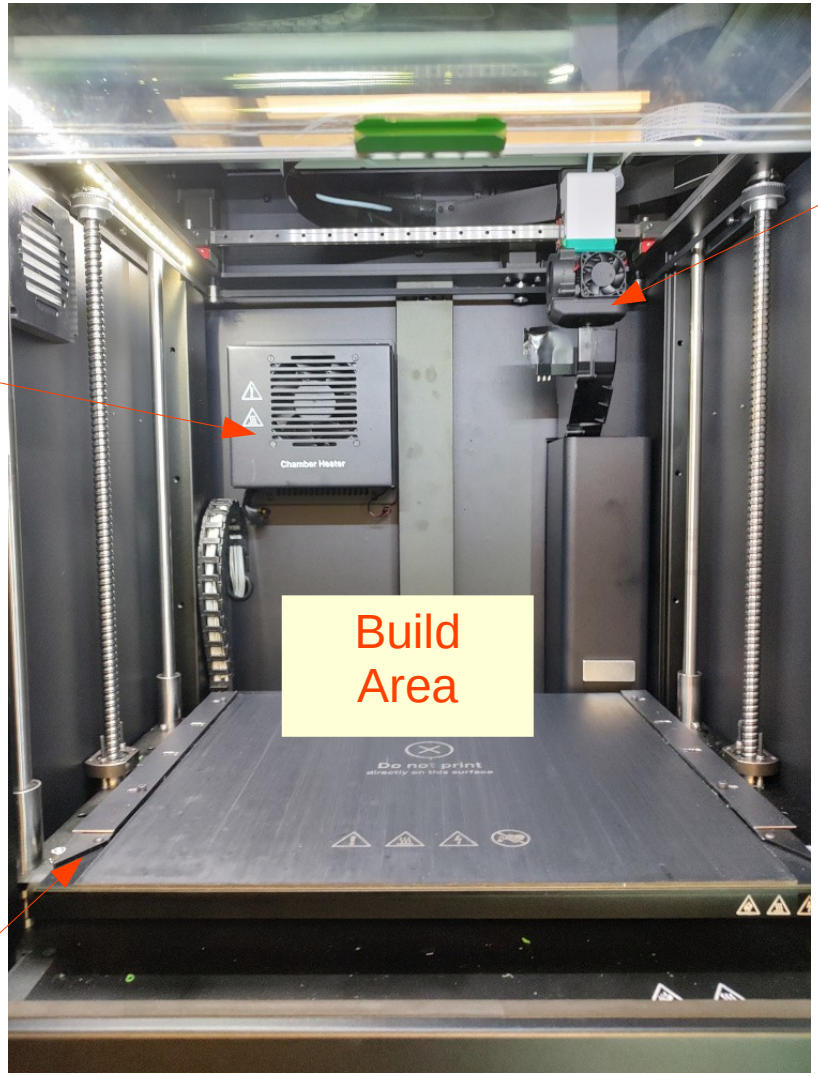
Image from cubifyfans.blogspot.com

Mosaic’s 3D Printer Array

Mosaic's 3D Printer Array



An “Element” Printer



Extruder

Chamber Heater

Build Area

Tray Inserts Here

Coarse vs. Fine STL Triangulation

- Too coarse can lose detail, but too fine can also cause features to be lost.
  - SolidWorks “fine” (under “Options” when you save an STL file) seems to be okay, but don’t go to “custom” and crank up resolution to the max.

Changing the Amount of Infill

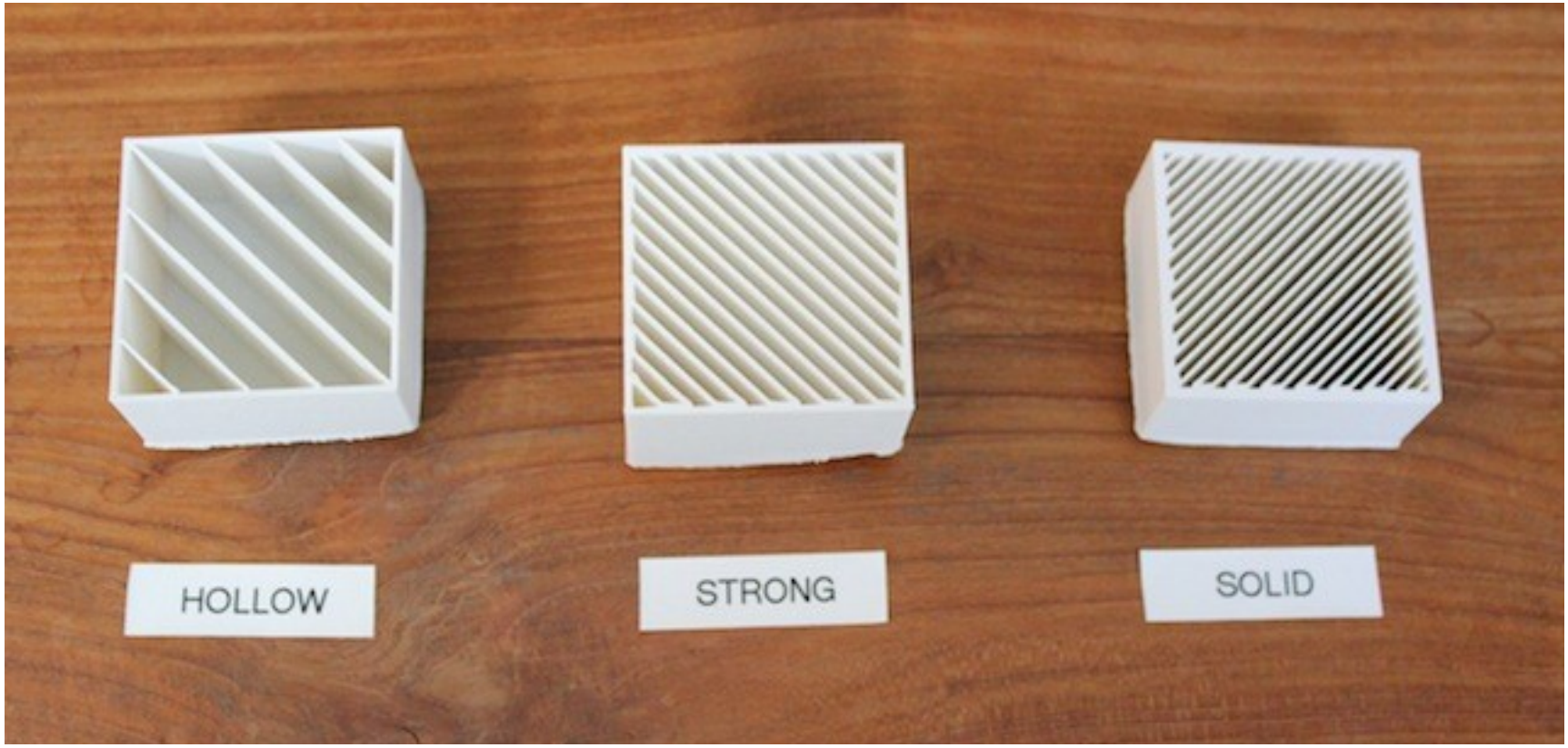
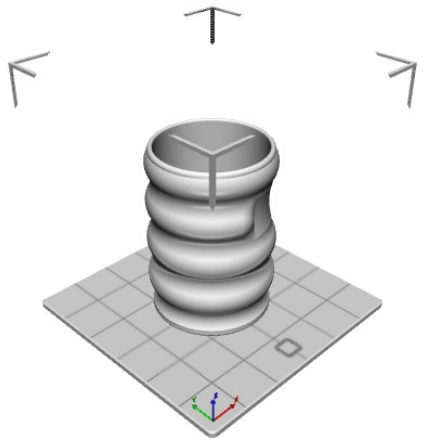
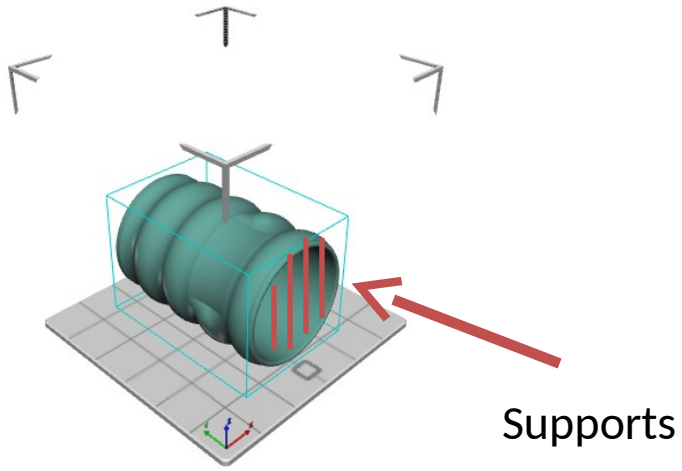


Image from cubify.com

Part Orientation

- Choose your part orientation to avoid the need for supports if possible.
- Don’t put supports where they will be difficult to remove.

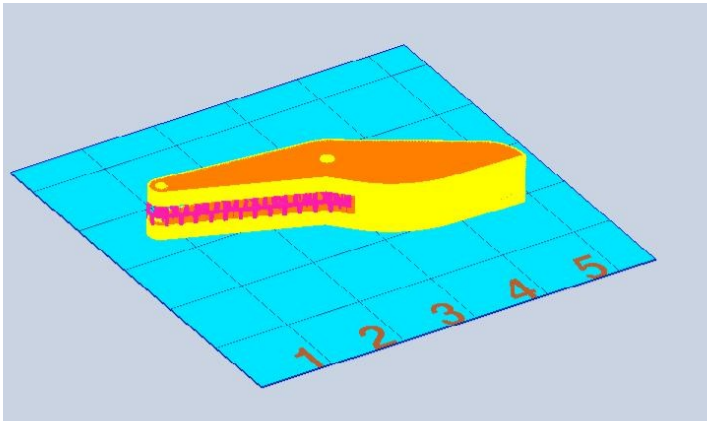


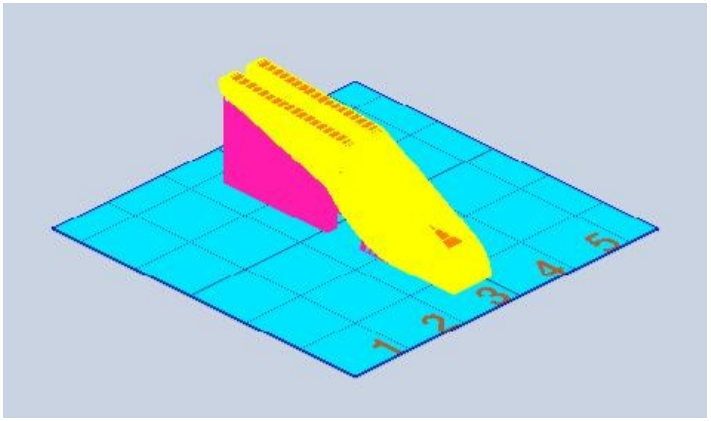


- Remember: supports leave a rough surface.

Part Orientation

- Sometimes the use of support material is unavoidable.
- Don’t put supports where they will be difficult to remove.

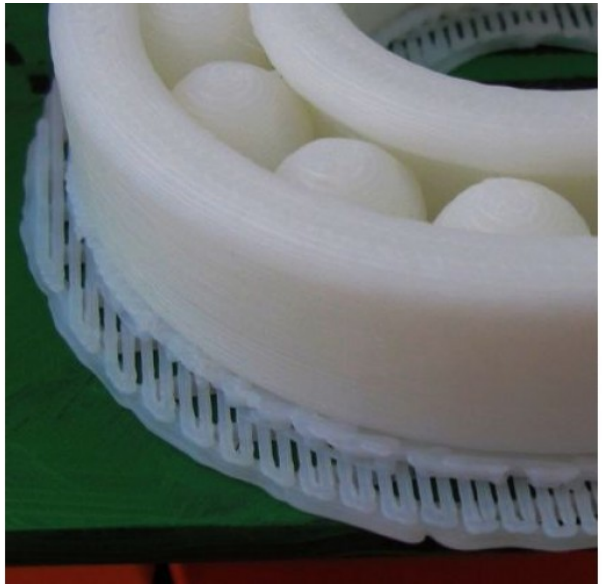




- Remember: supports leave a rough surface.

Use of a Raft

- Why use a raft?
  - Stable base of support for tall, skinny parts.
  - Prevents warping of big smooth parts (like cases) by reducing surface contact with heated bed (1st gen. Cubes only).
- Why avoid a raft?
  - Ruins the part finish (get out your sandpaper).
  - Takes more time and more plastic to print.



How to Print Your Molecule

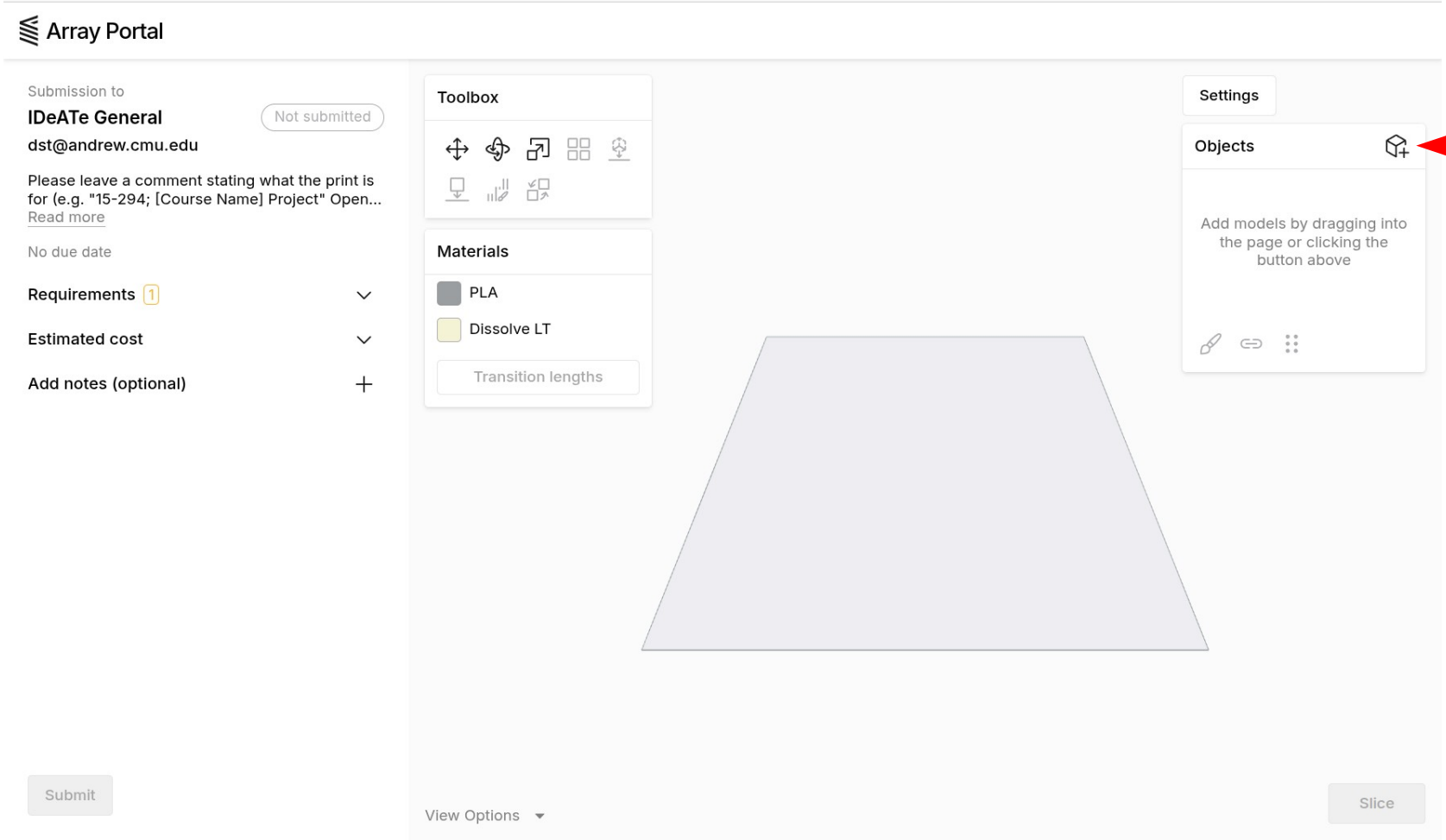
1. Create an STL file in SolidWorks. Name it like this:
   *andrewid*_molecule_v1.stl
2. From the course home page, click on “IdeATe Array Portal” and then click to generate a new print request.
3. You’ll receive an email with a submission link. Click on it.
4. Upload your STL file, then slice it, add a comment saying “15-294 molecule”, then click Submit.
5. Wait a day, then check 3D Print Pickup cart for your print.
6. Problems? Email help@ideate.cmu.edu.

Where to Pick Up Your 3D Print

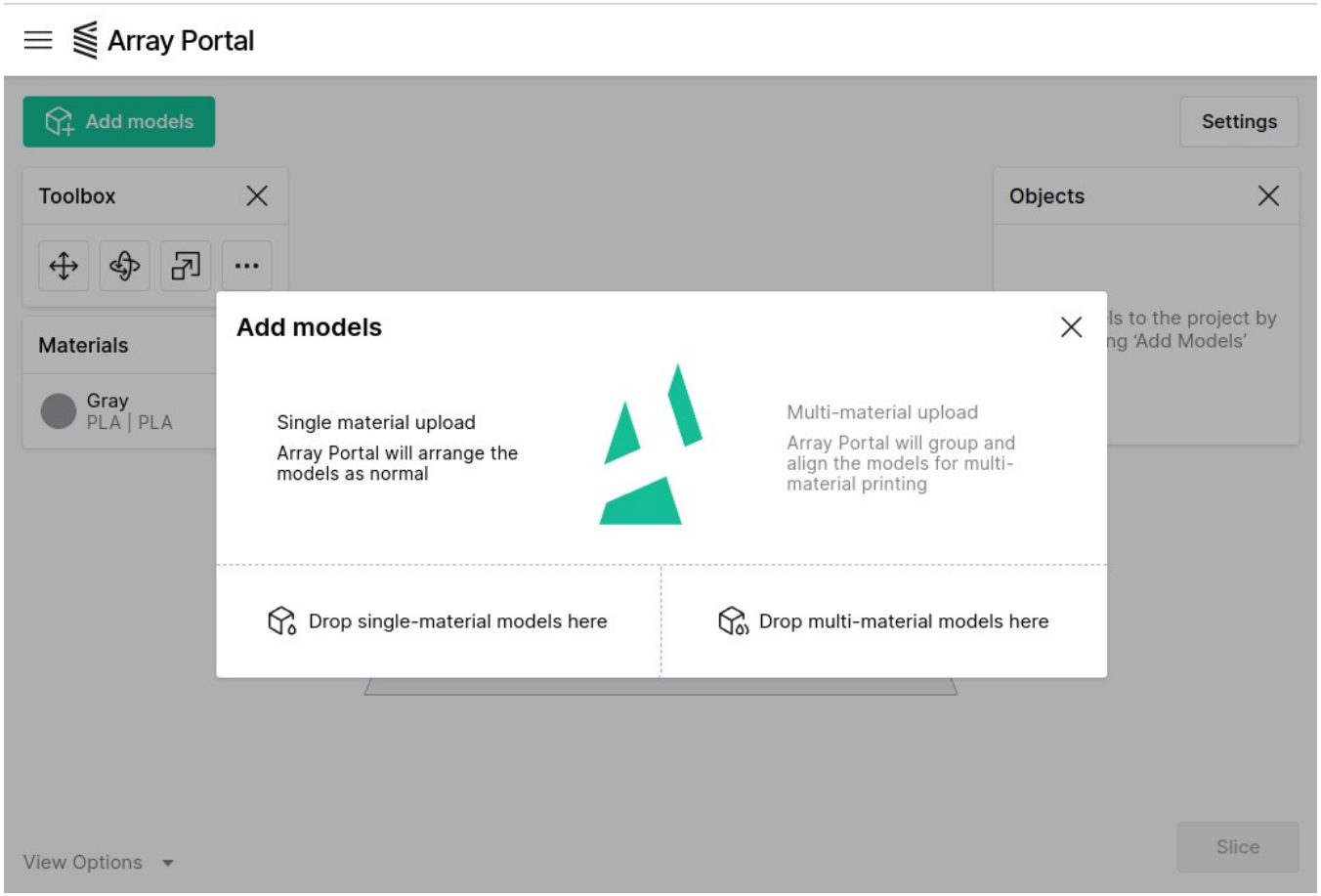
The Array Portal

- This is a quick tour of the Array Portal user interface.
- You access it via a separate email link for each submission. Don’t lose the link!

Add a model

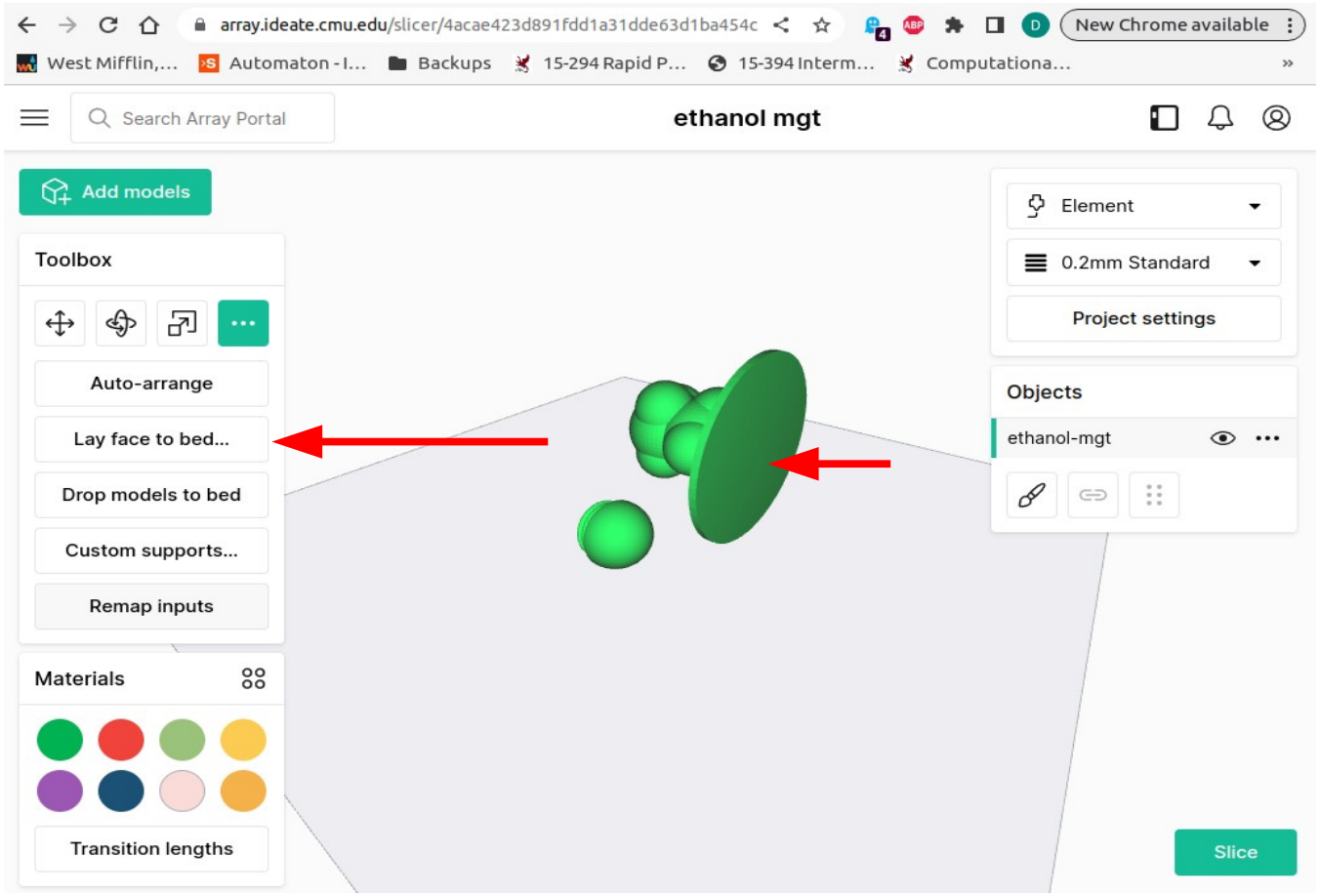

Array Portal
Submission to
IDeATe General
Not submitted
dst@andrew.cmu.edu
Please leave a comment stating what the print is for (e.g. "15-294; [Course Name] Project" Open...
Read more
No due date
Requirements 1
Estimated cost
Add notes (optional)
Submit
Toolbox
Materials
PLA
Dissolve LT
Transition lengths
Settings
Objects
Add models by dragging into the page or clicking the button above
View Options
Slice

Upload Your STL File

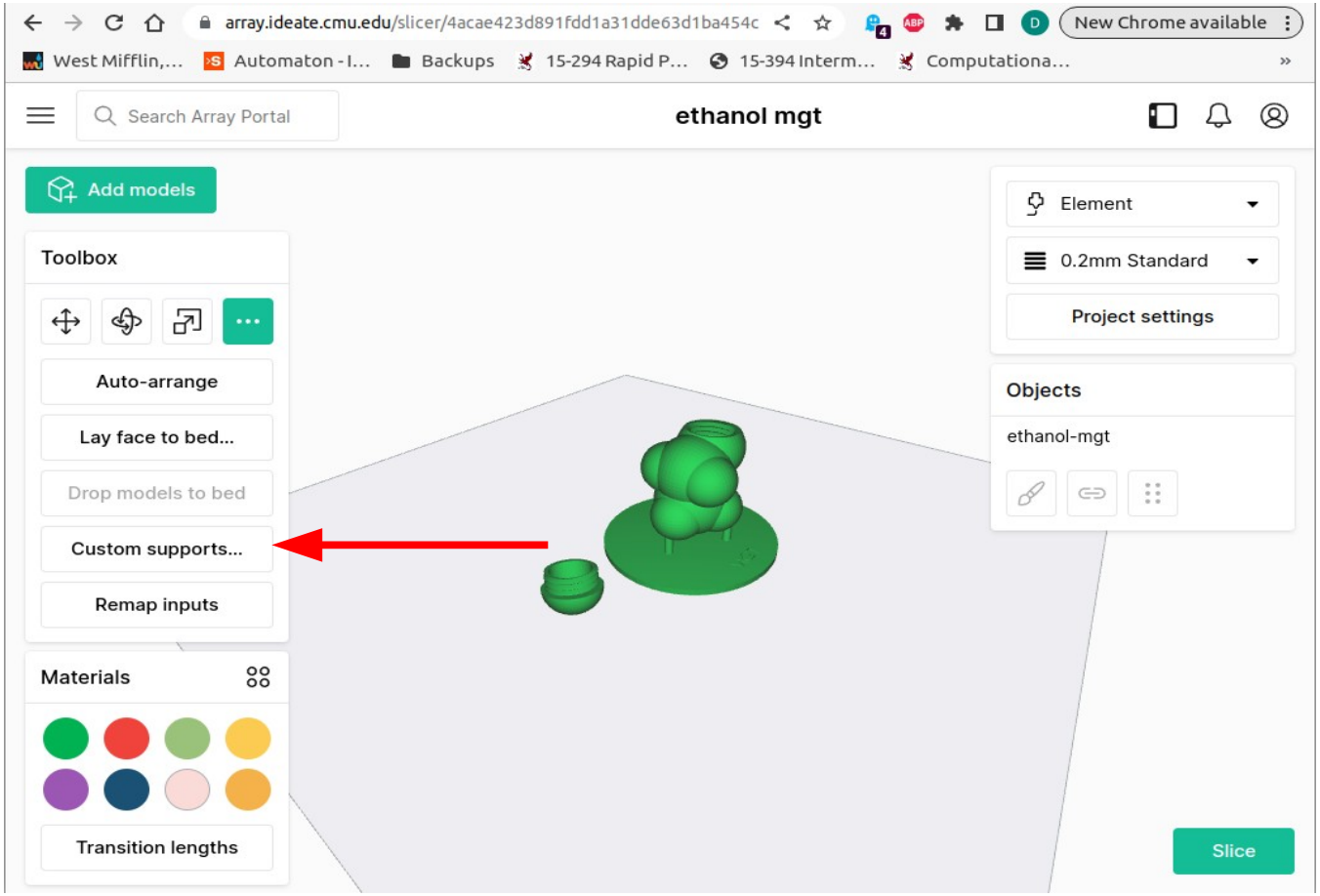


Open the Toolbox

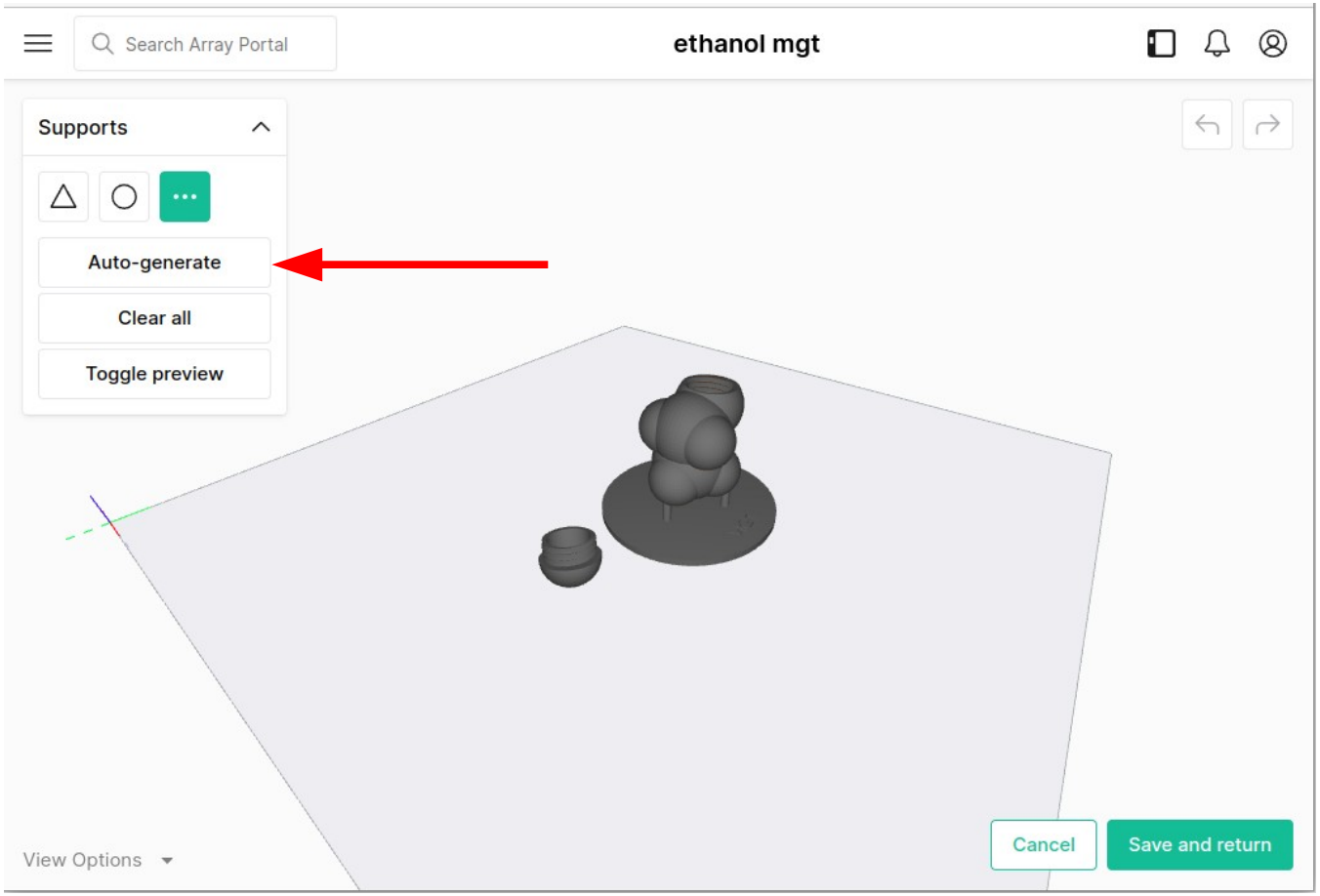
Click on “Lay face to bed”



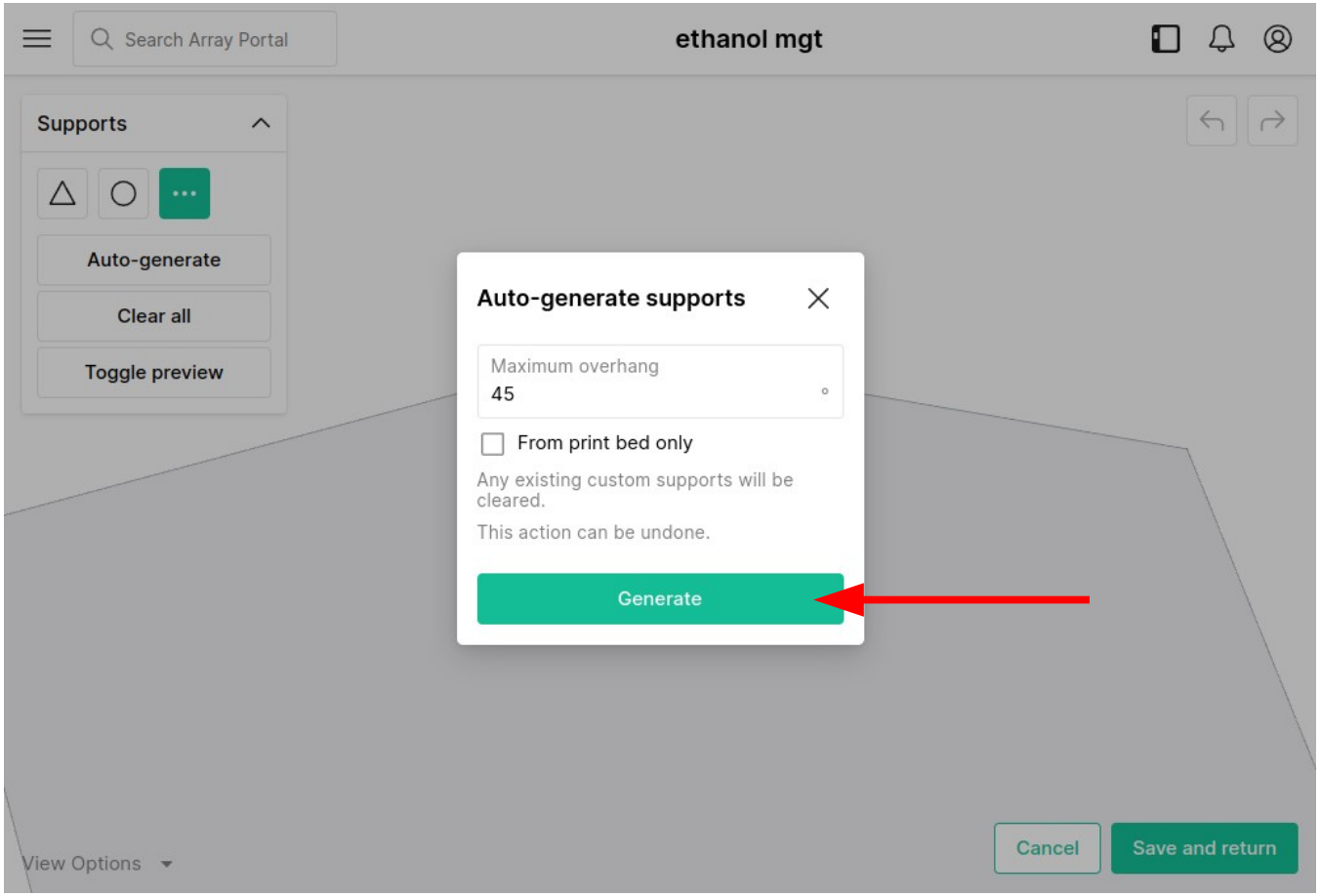
Click on “Custom supports…”



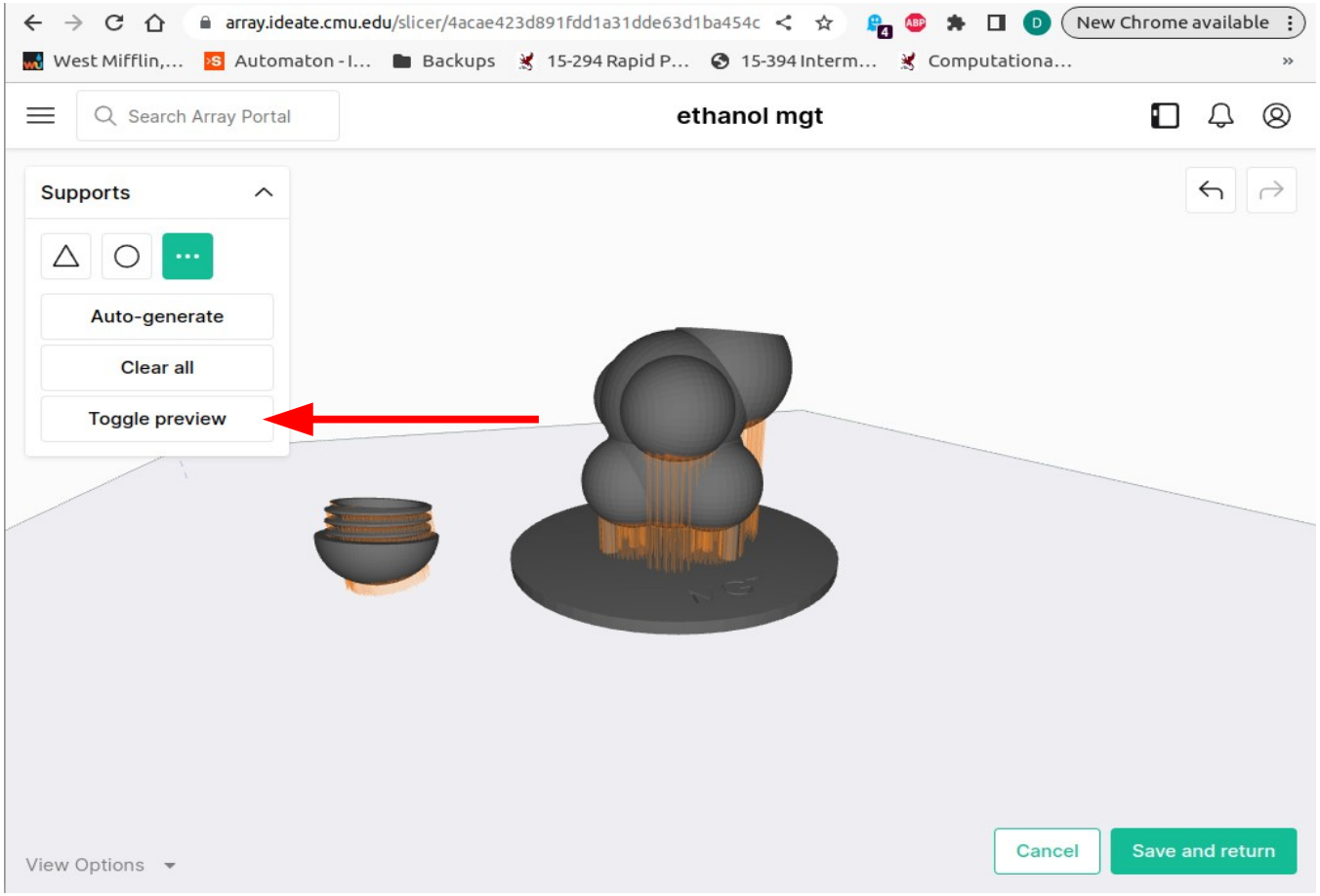
Click on “Auto-generate”



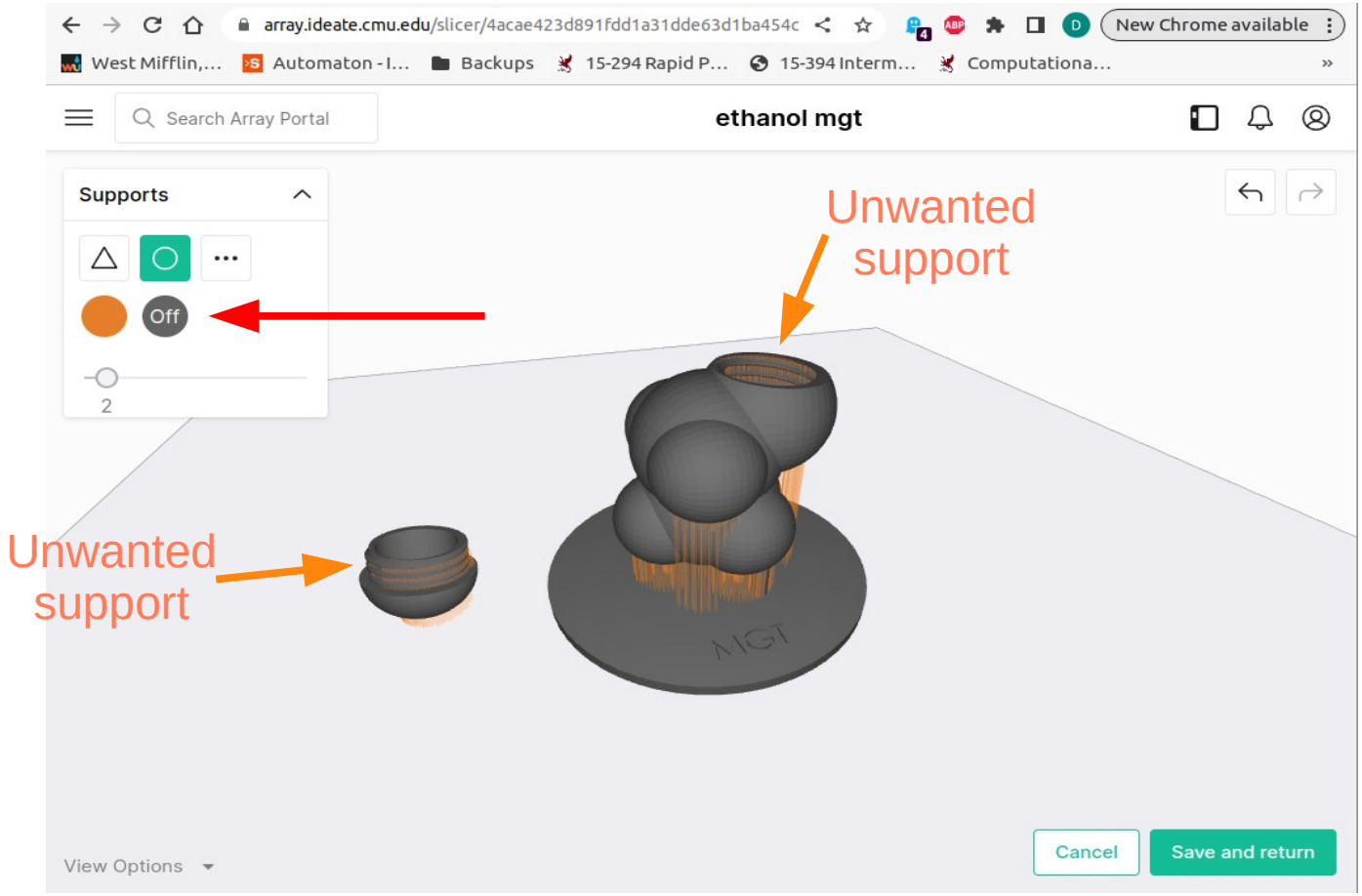
Click on “Generate”



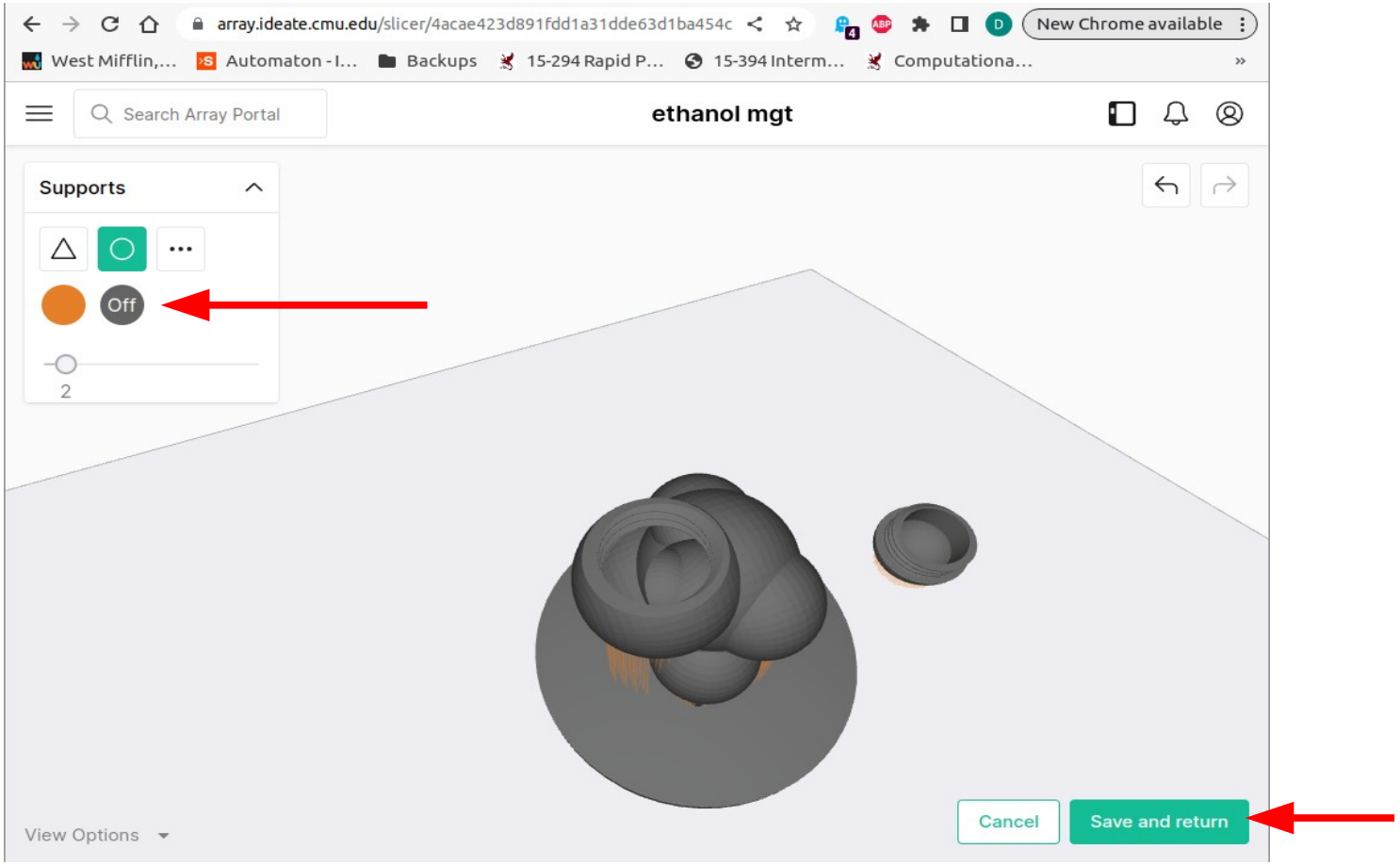
Click on“Toggle preview”



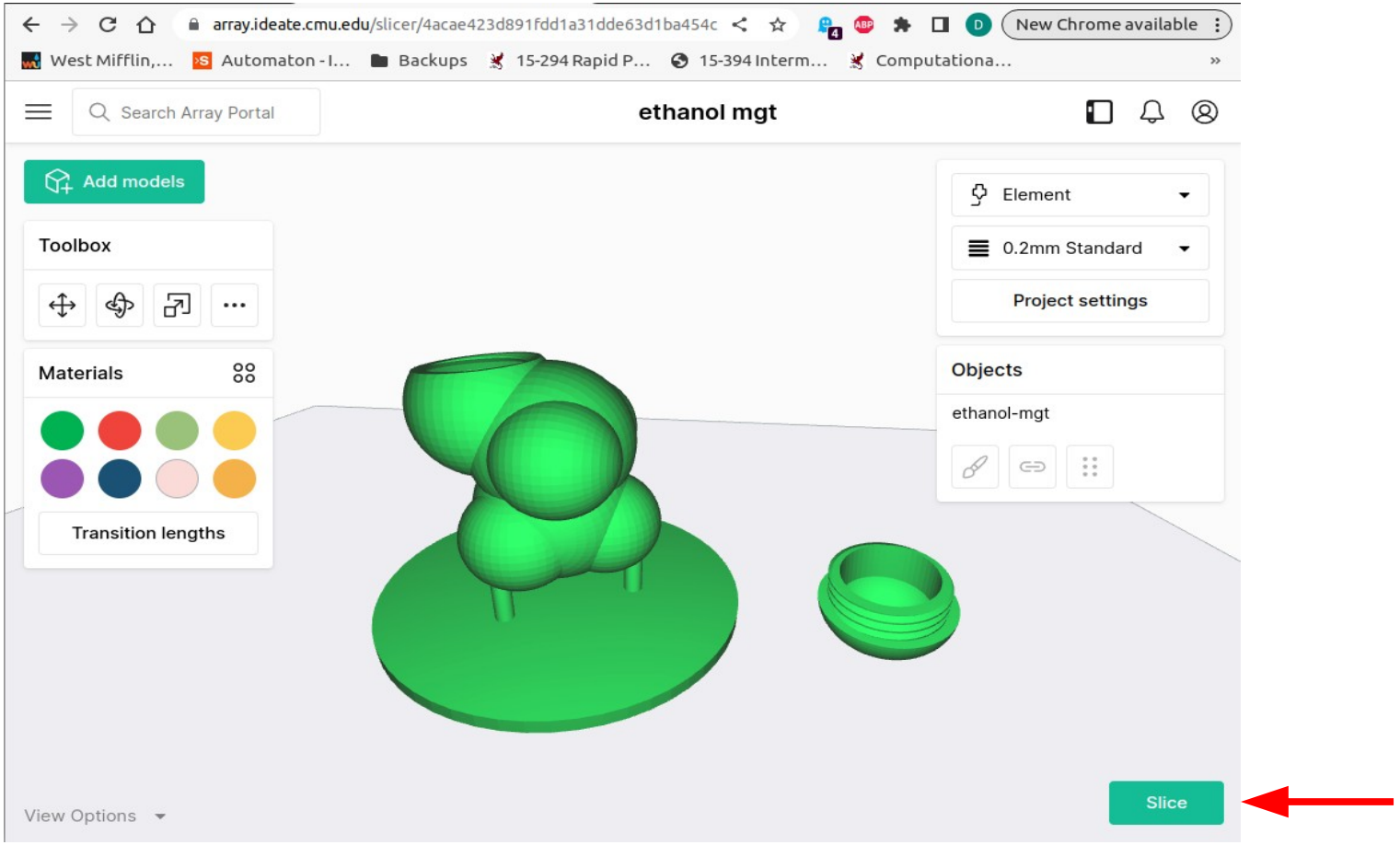
Set brush to “Off”



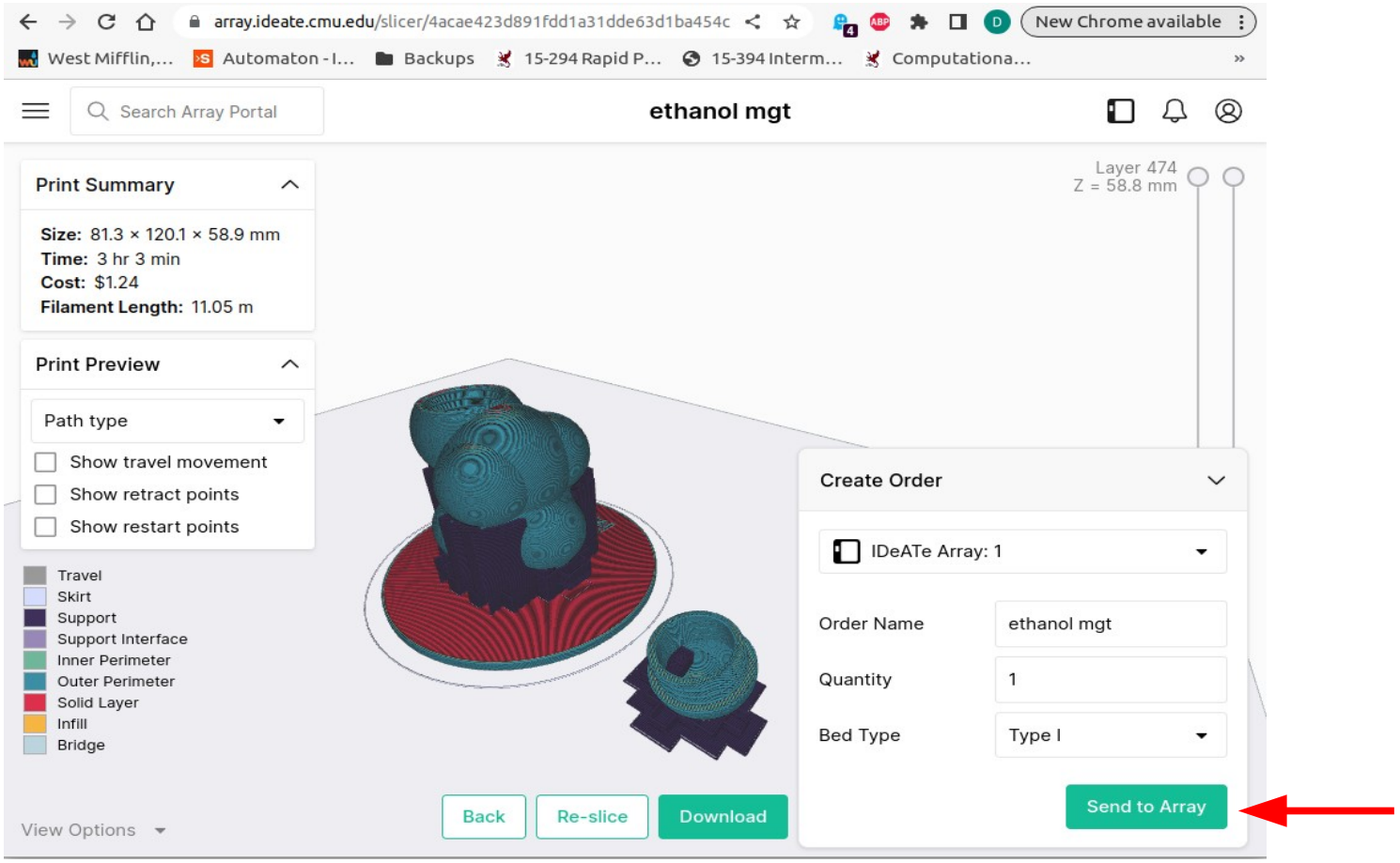
Click and drag to erase unwanted support (need clean threads)



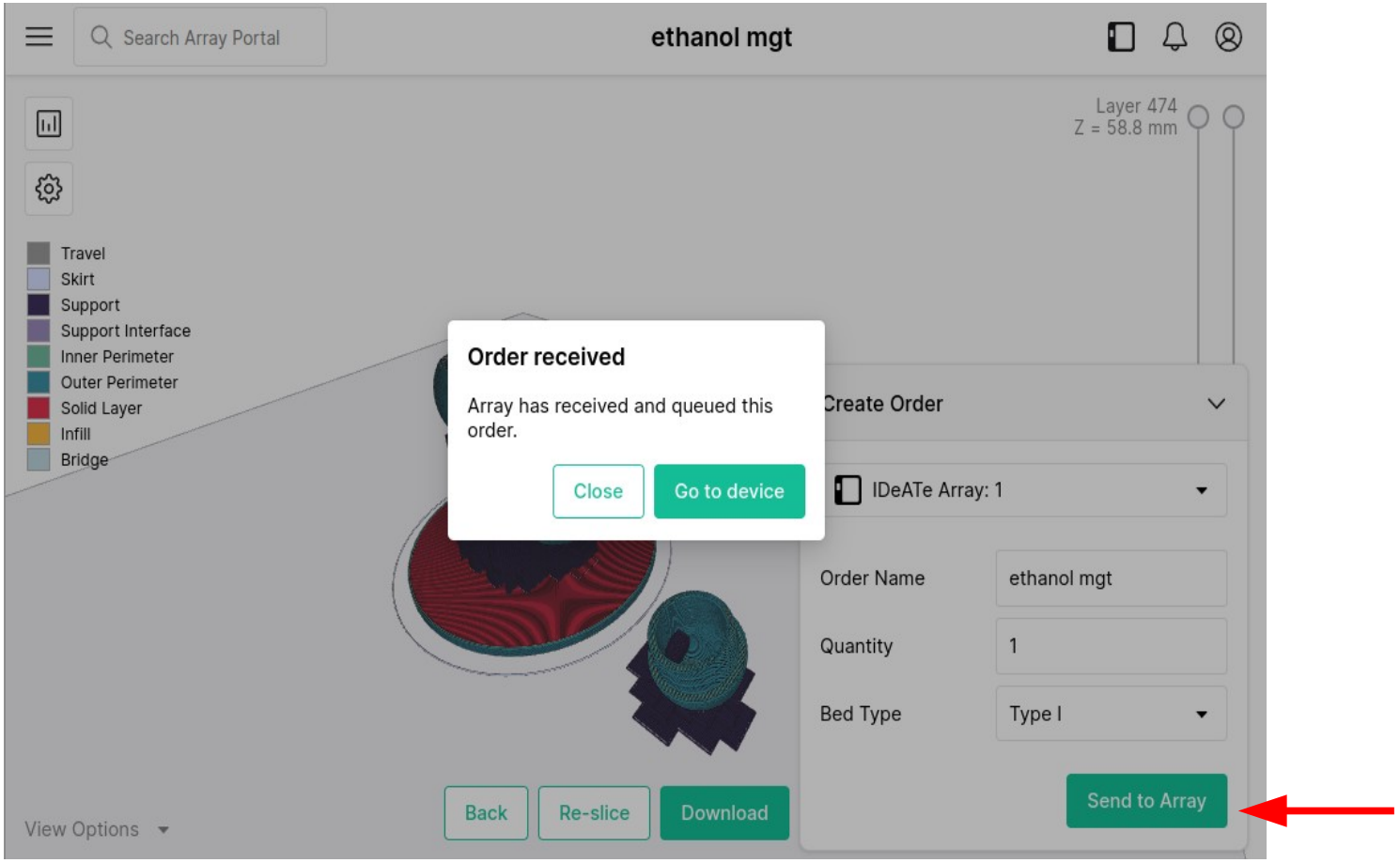
Click on “Slice”



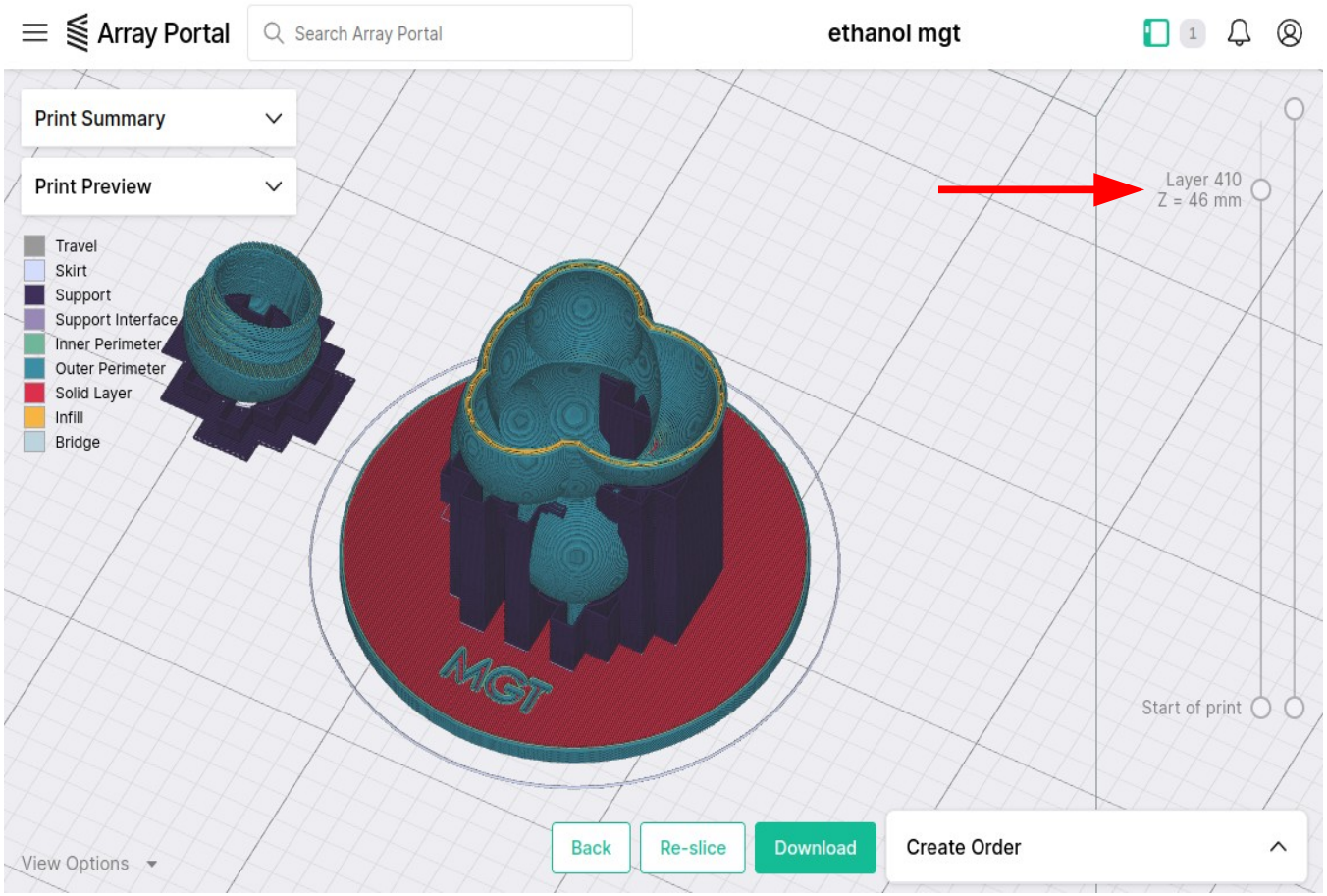
Click on “Send to Array”



Click on “Send to Array”



Use Slider to View Layers

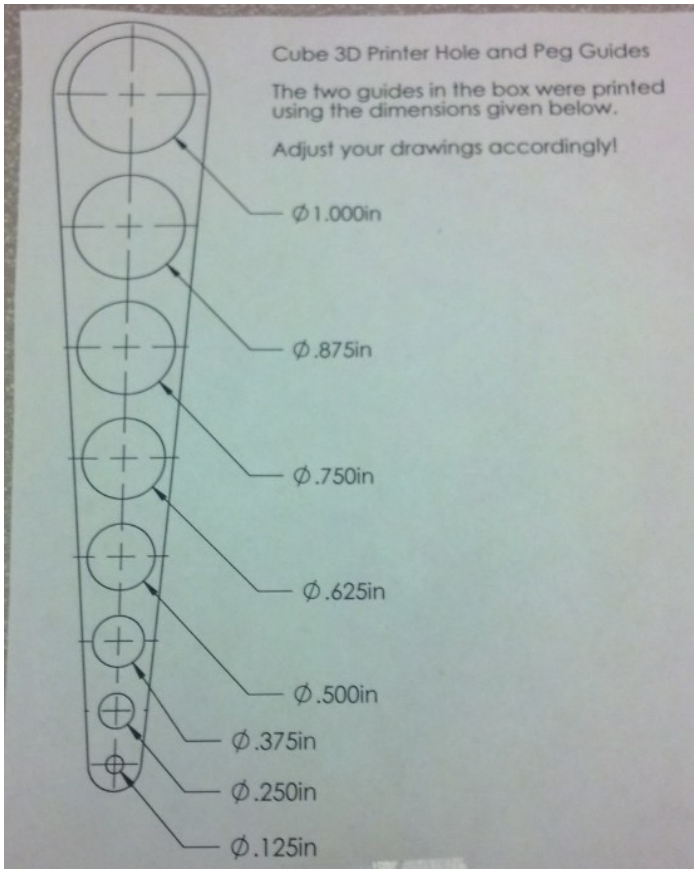


Post-Processing Steps

- Snap off any supports or raft.
  - A pliers works well.
- Sanding or filing might also be helpful.
- Machining? Painting? Gluing? Fake fur?
  - It’s up to you!

Test Object (Mike Taylor)

- Compare requested size vs. actual.

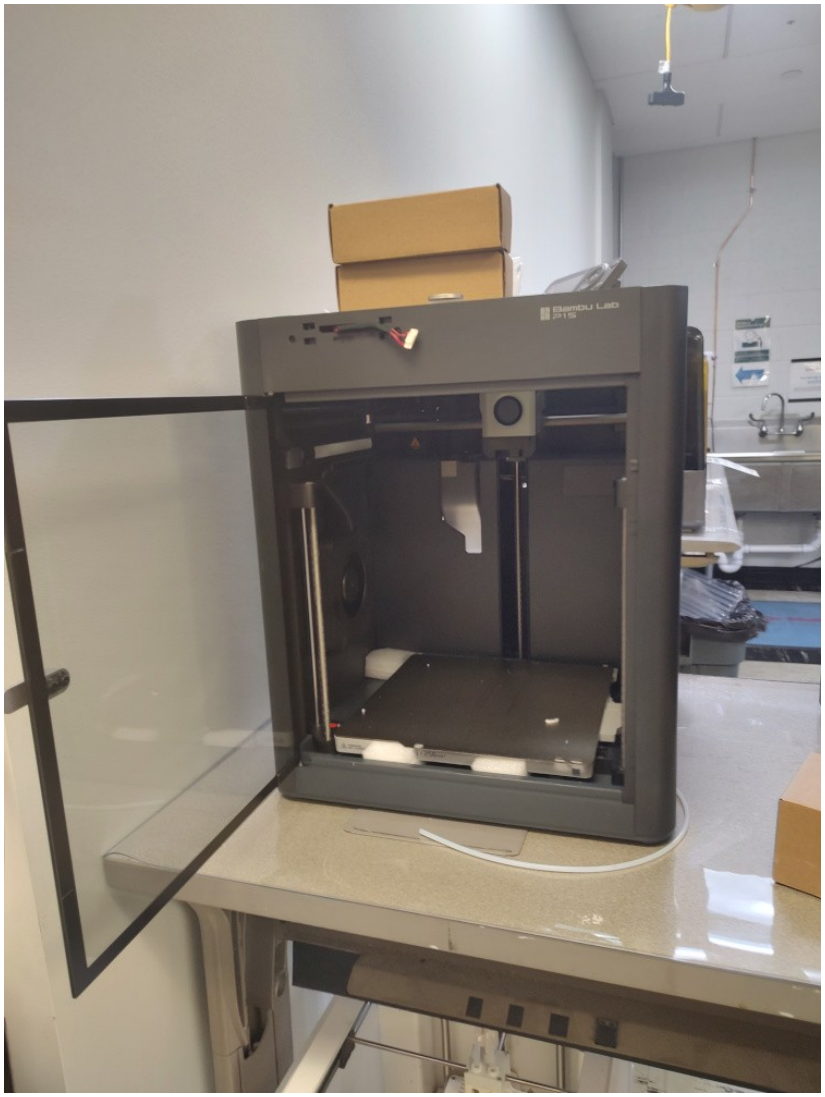


Design Rules

- Shafts will be slightly **thicker** than intended.
- Holes will be **narrower** than intended.
- Do you want a 2.5 mm hole? On a 1st generation Cube:
  - Use 3.0 mm for a horizontal hole.
  - Use 3.7 mm for a vertical hole.
- Minimum widths for walls?

When Things Go Wrong

Bambu P1S Printer: Bambu Lab



We have a collection of these high speed FDM printers.

The are located in room A5, around the corner from the laser cutters.

Alternative Printing Choices

- Objet printer at Tech Spark.
  - Finer resolution, smoother finish.
  - Can print dissolvable support material.
  - Pay by the cubic centimeter.
- Stereolithography facility at Pitt.
- Shapeways
  - High end 3D printing service; many materials. e.g., ceramics.
  - Library of models and applications.
  - 8 day turn-around; fast shipping.