

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

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3D Printer vs. Laser Cutter

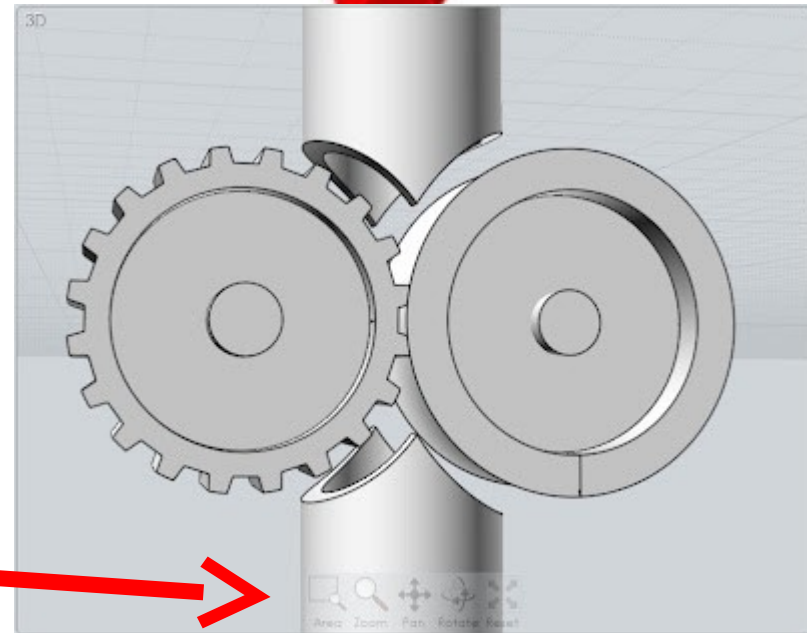
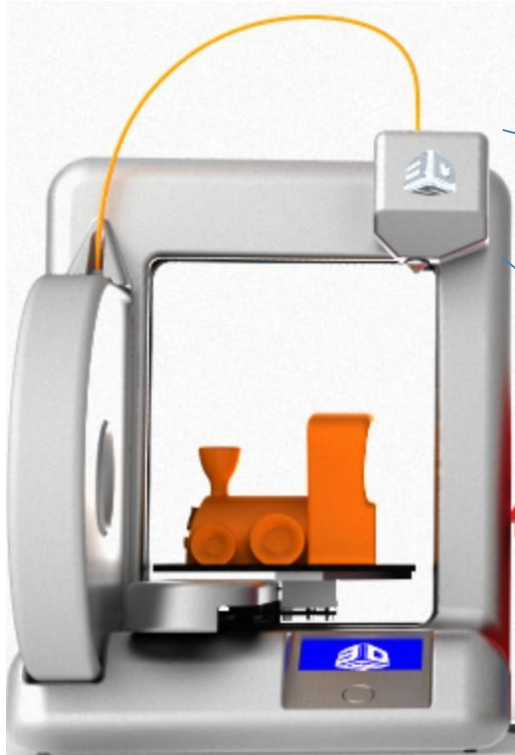
- ✗ Slower
- ✗ Less precise
- ✗ More expensive
- ✗ Limited materials
- ✗ Support material may be required
- ✓ Complex 3D structures!



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



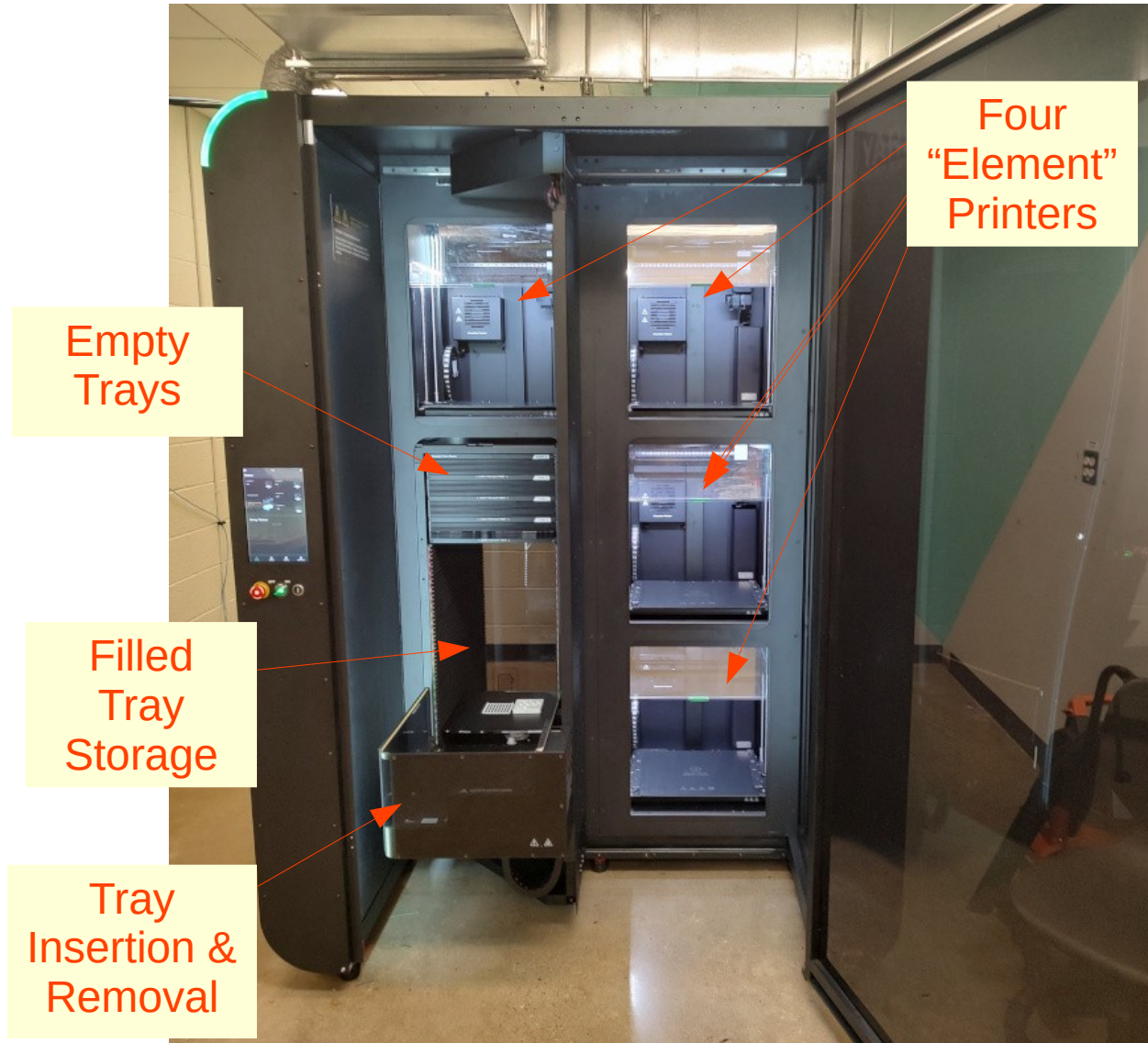
Heated section

Image from cubifyfans.blogspot.com

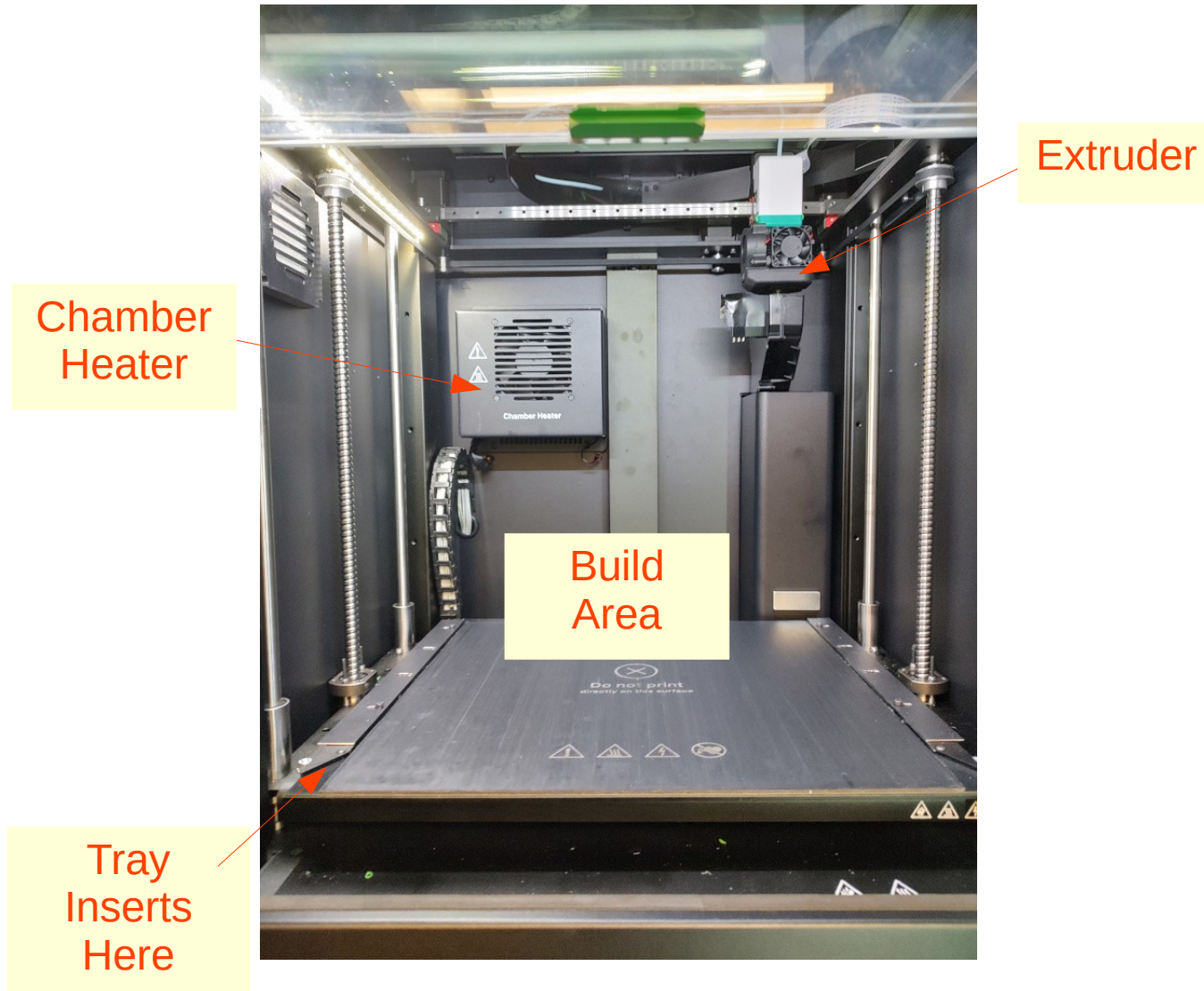
Mosaic's 3D Printer Array



Mosaic's 3D Printer Array



An “Element” Printer



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

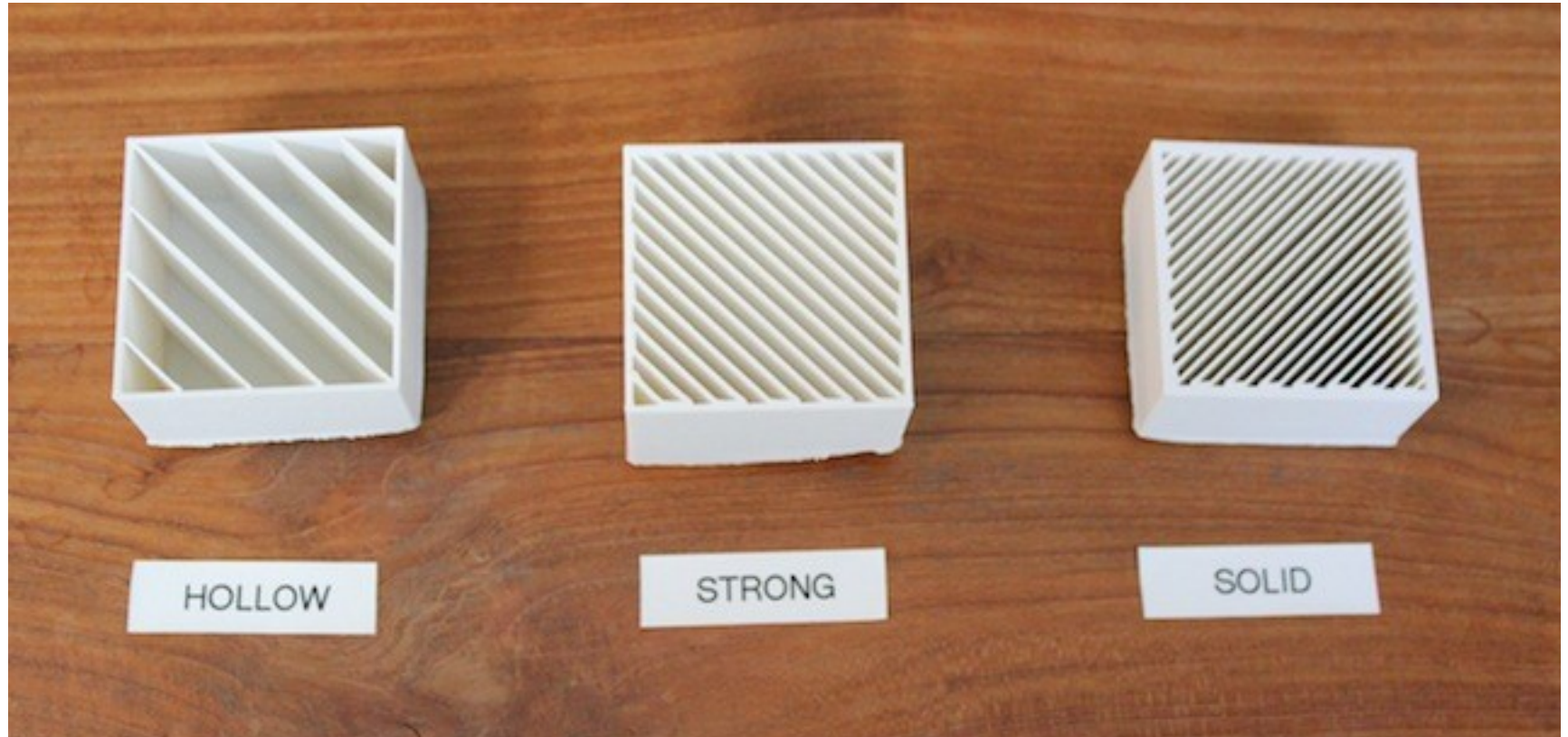
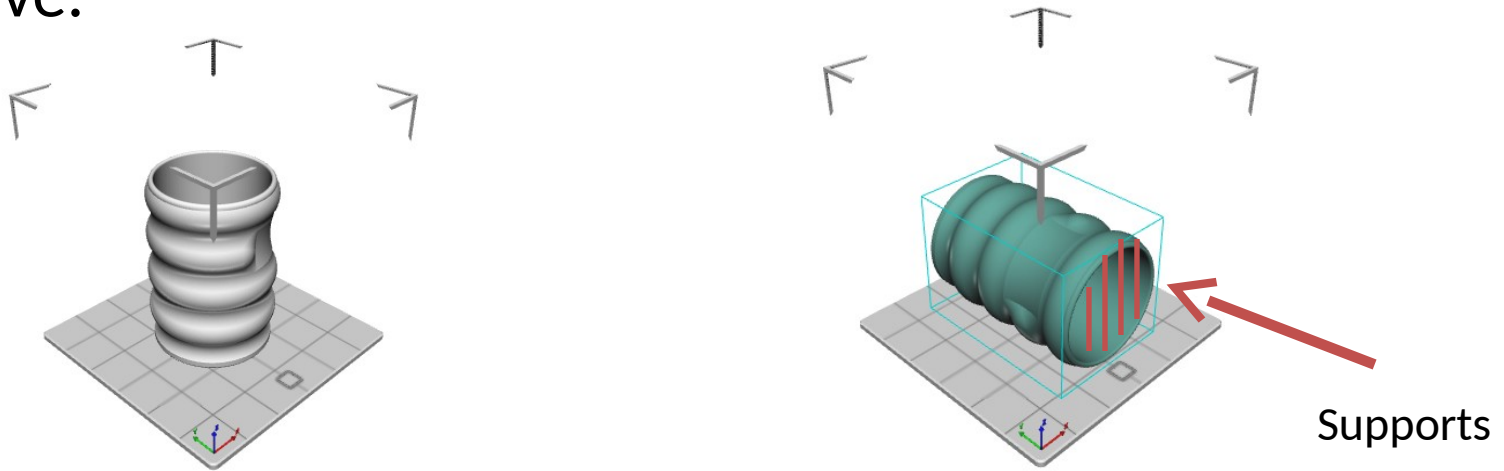


Image from cubify.com

Part Orientation

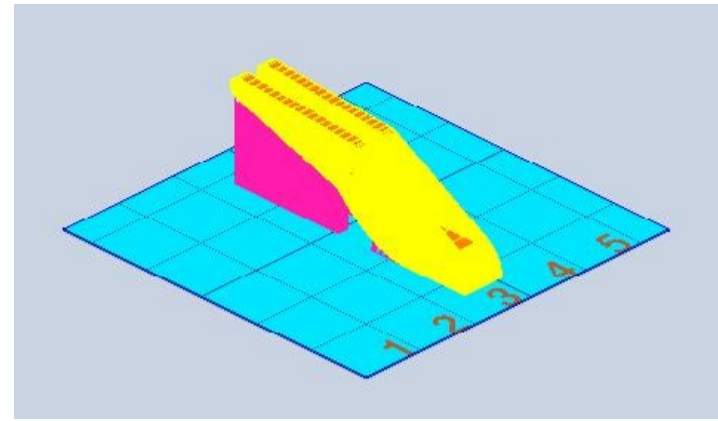
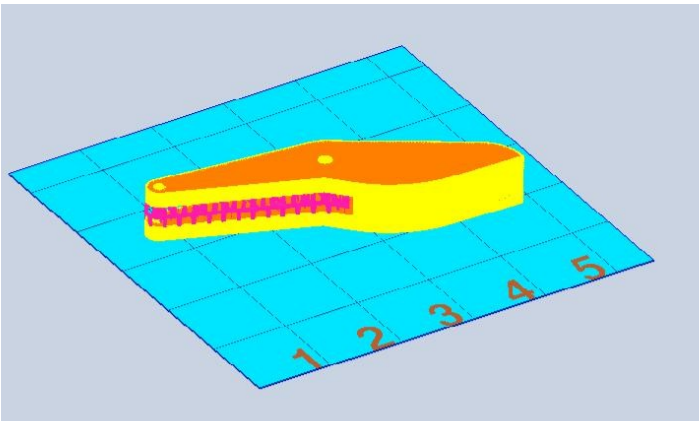
- Choose your part orientation to avoid the need for supports if possible.
- Don't put supports where they will be difficult to remove.



- 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) +

Toolbox





Materials

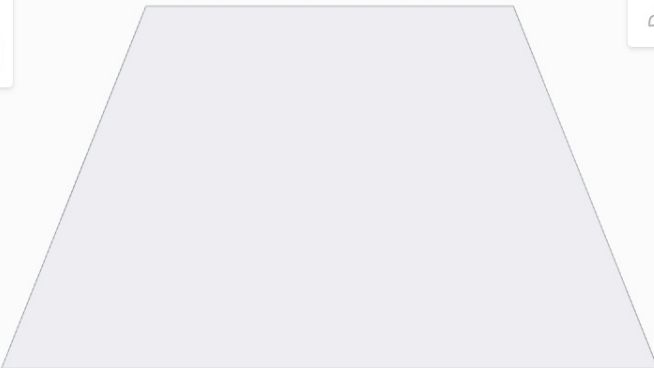
- PLA
- Dissolve LT

Transition lengths

Settings

Objects  

Add models by dragging into the page or clicking the button above

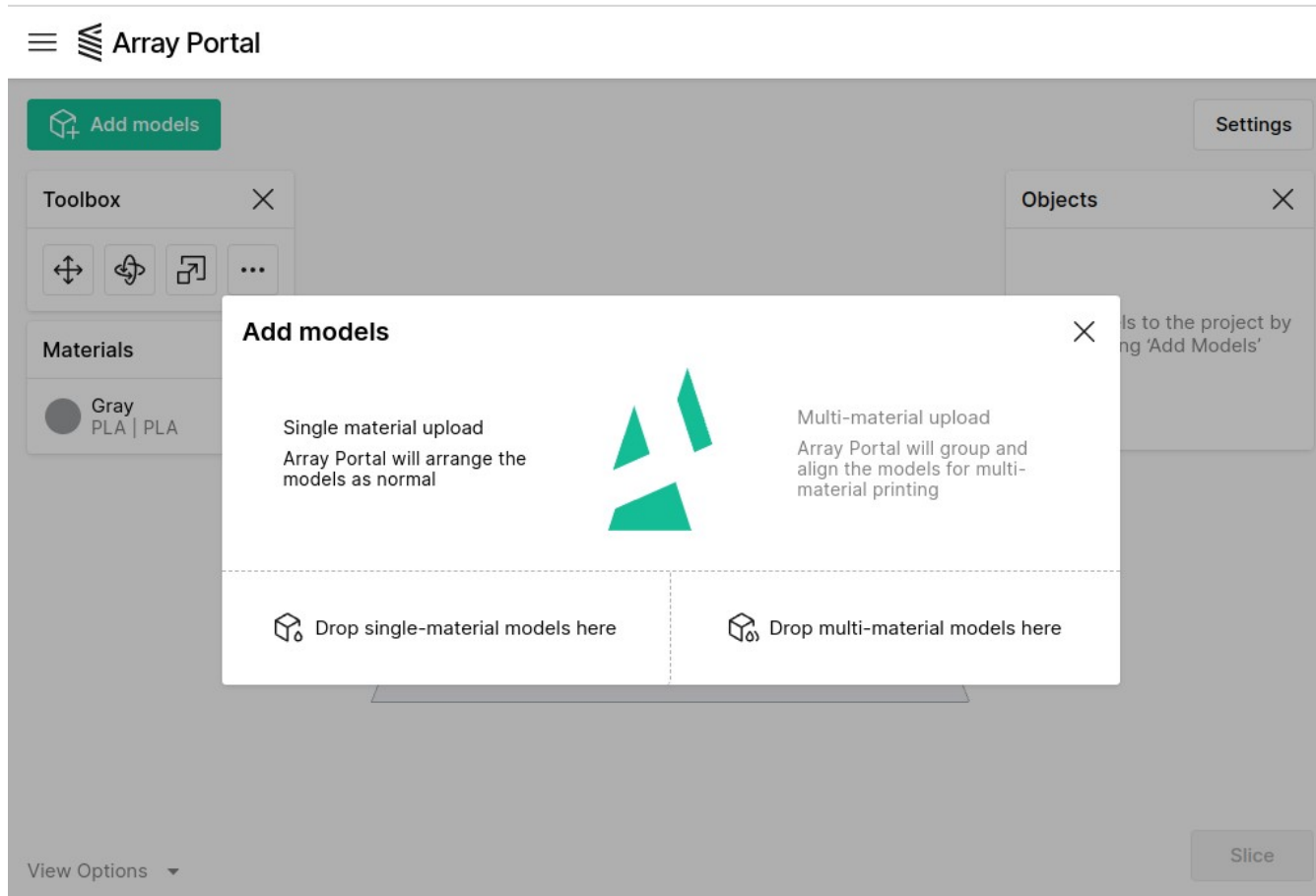


[Slice](#)

View Options ∨

[Submit](#)

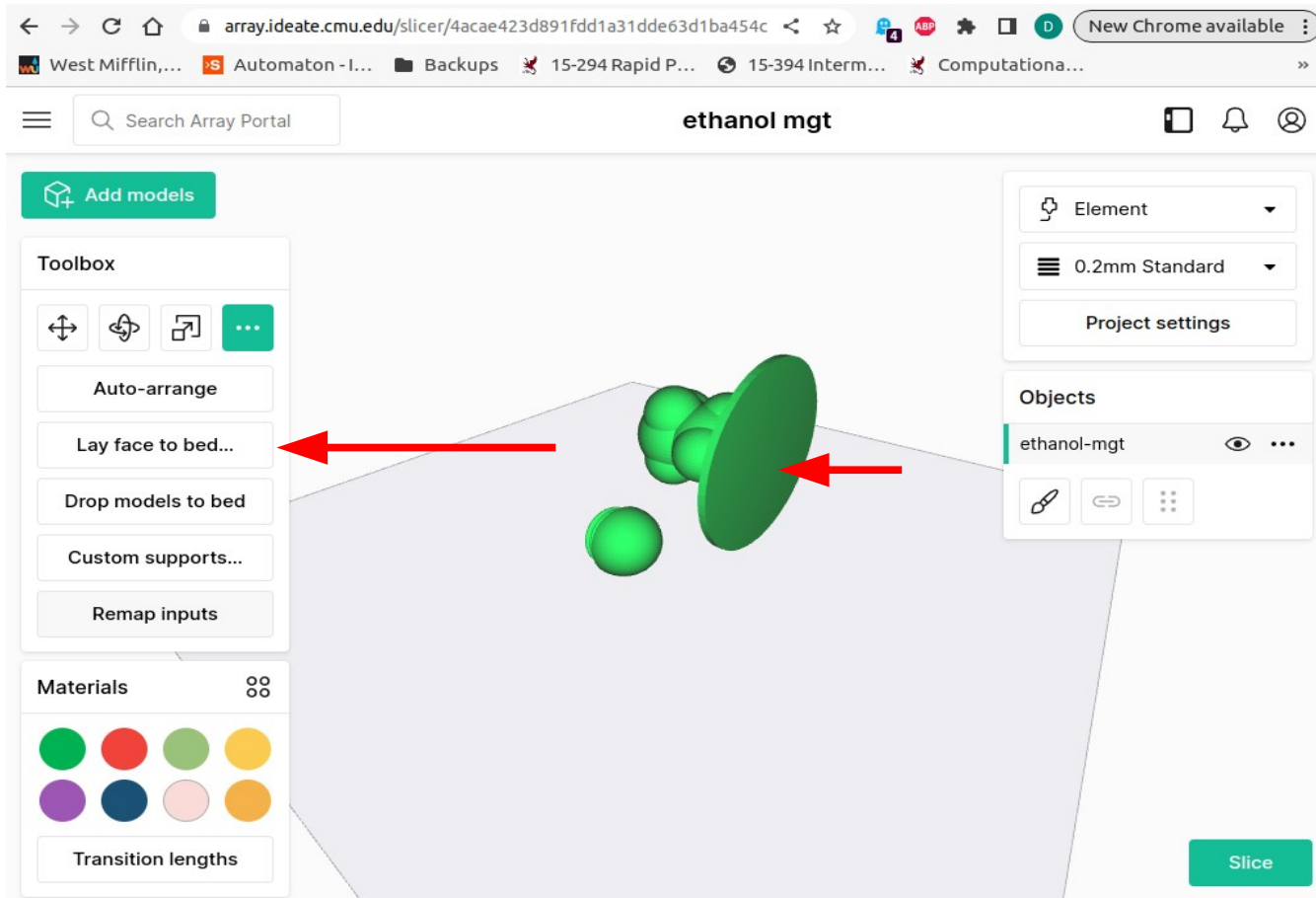
Upload Your STL File



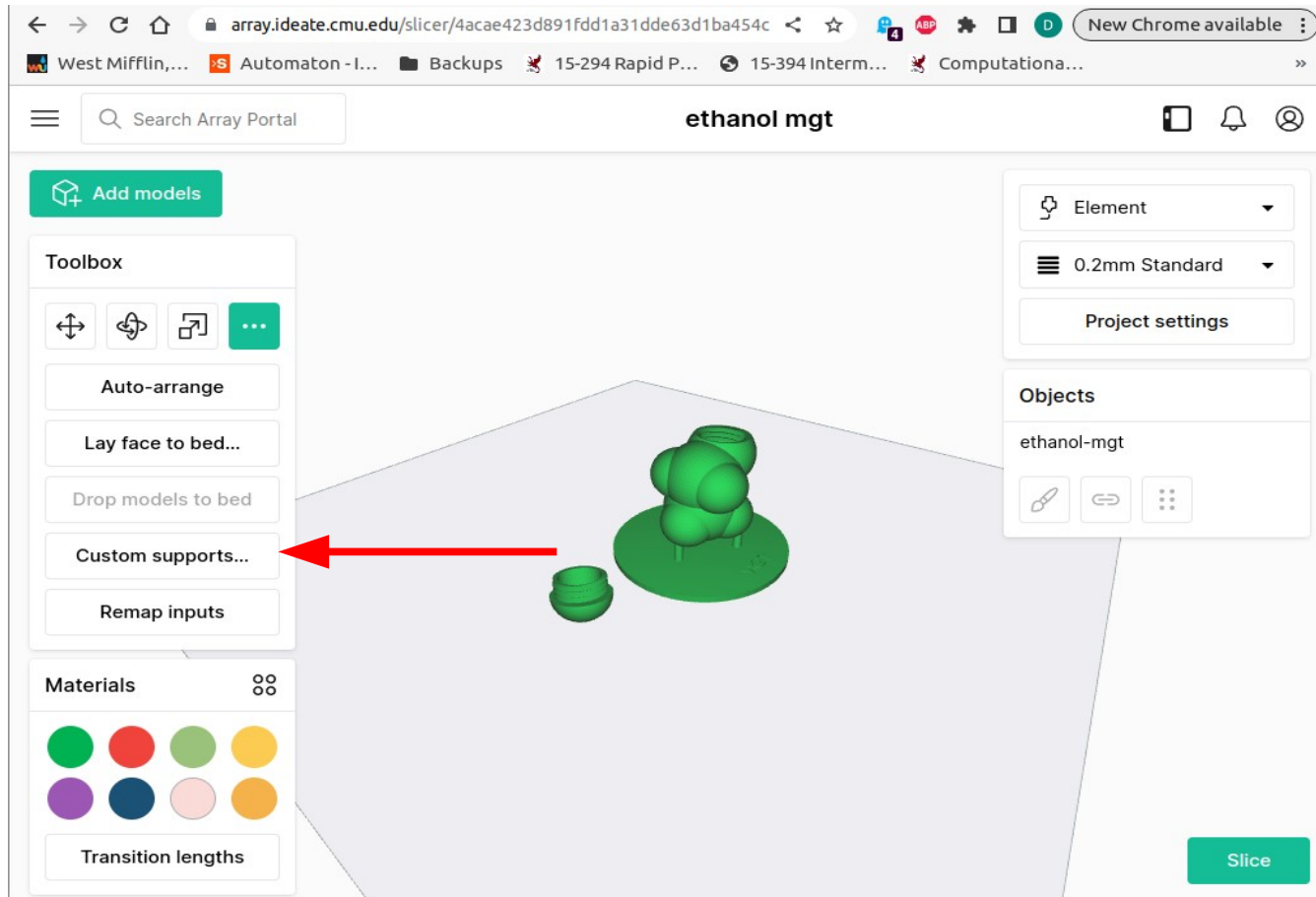
Open the Toolbox



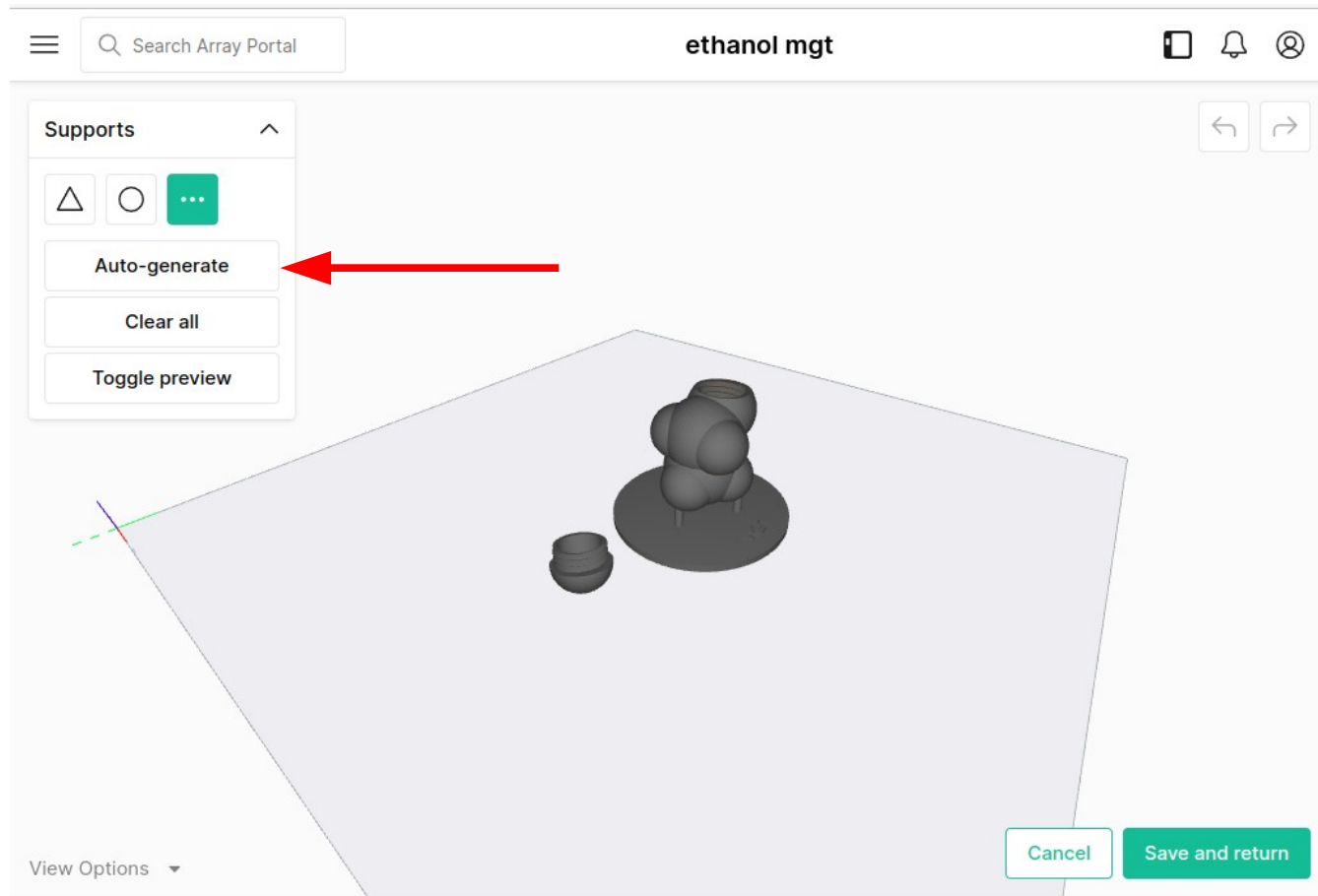
Click on “Lay face to bed”



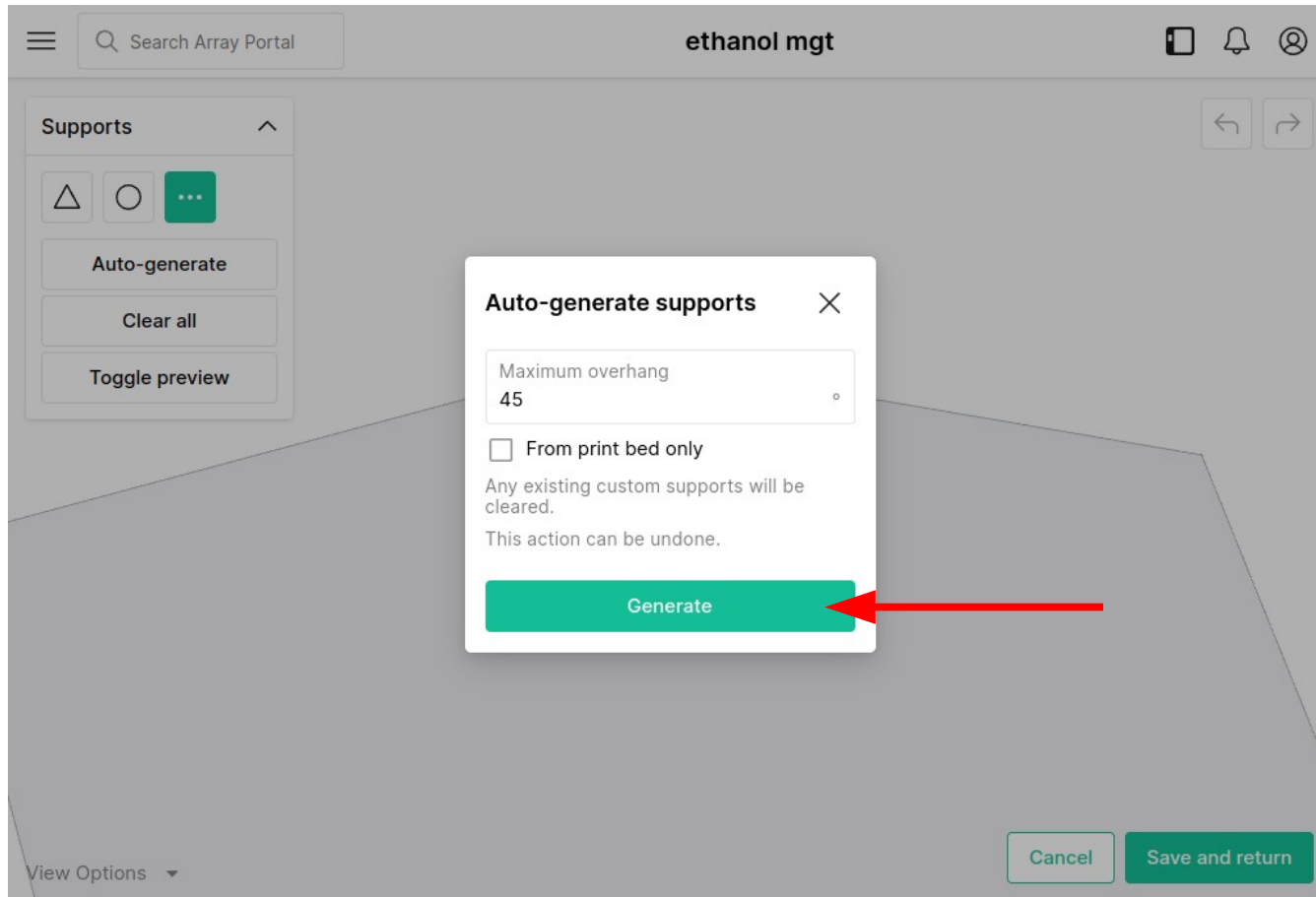
Click on “Custom supports...”



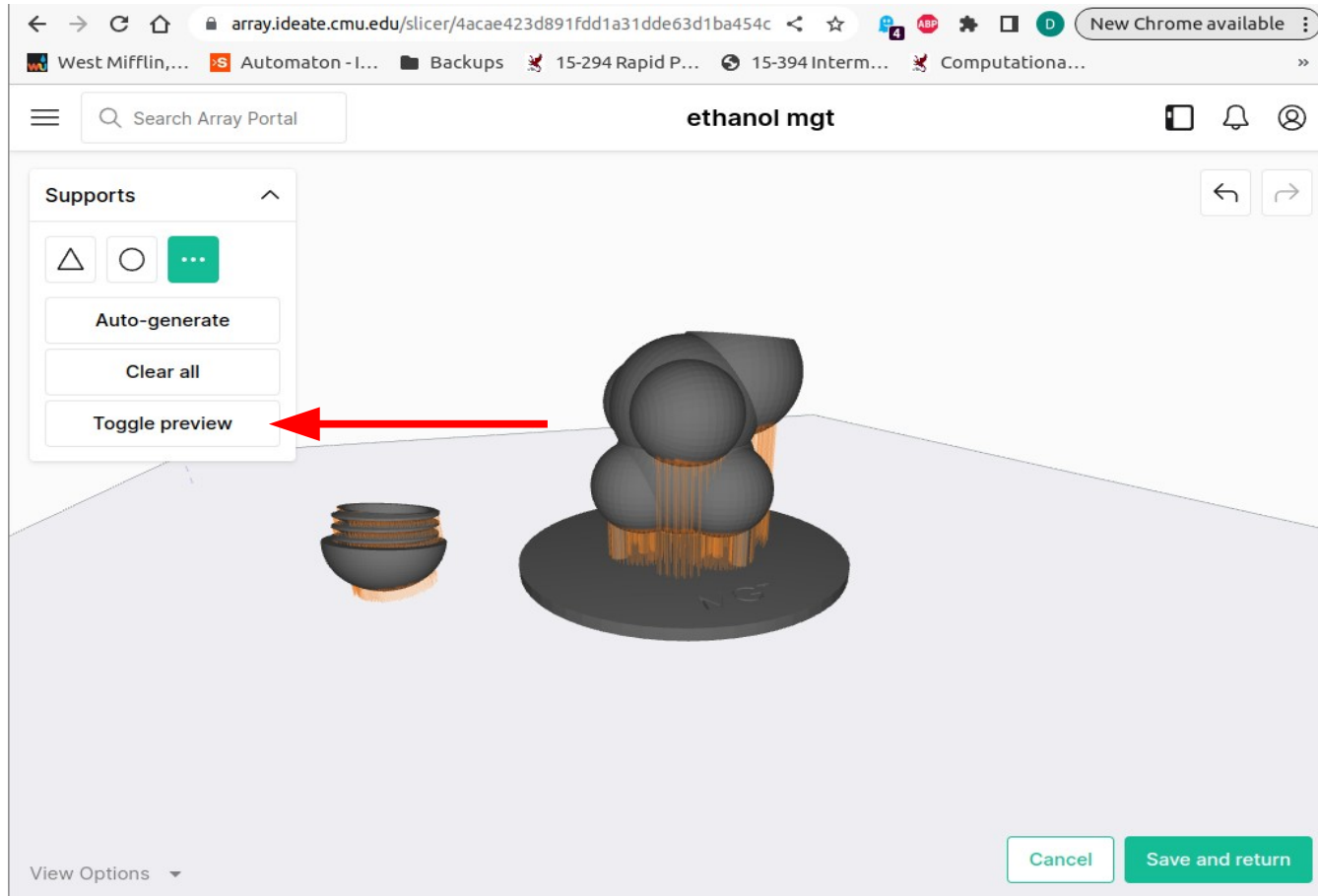
Click on “Auto-generate”



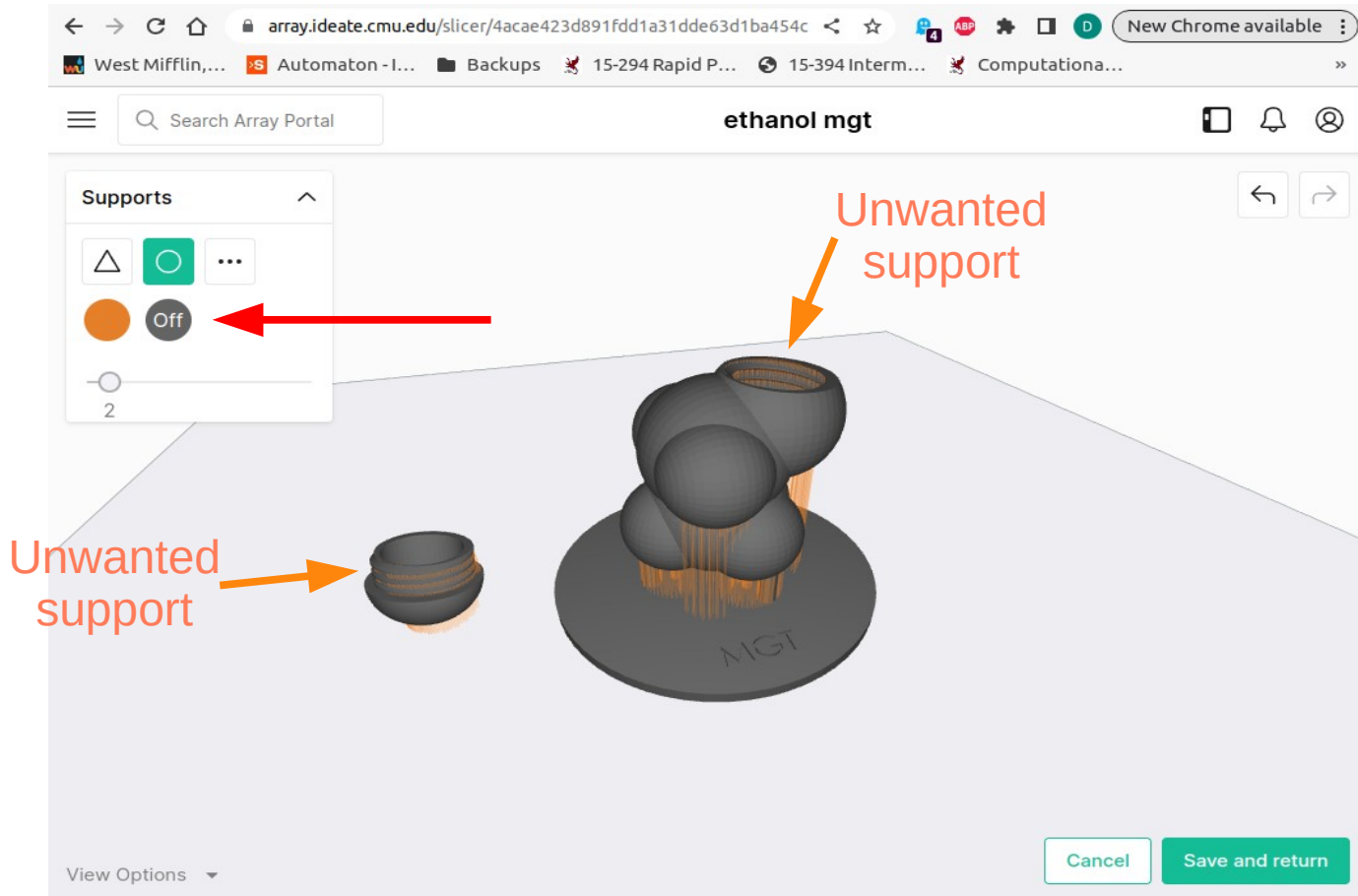
Click on “Generate”



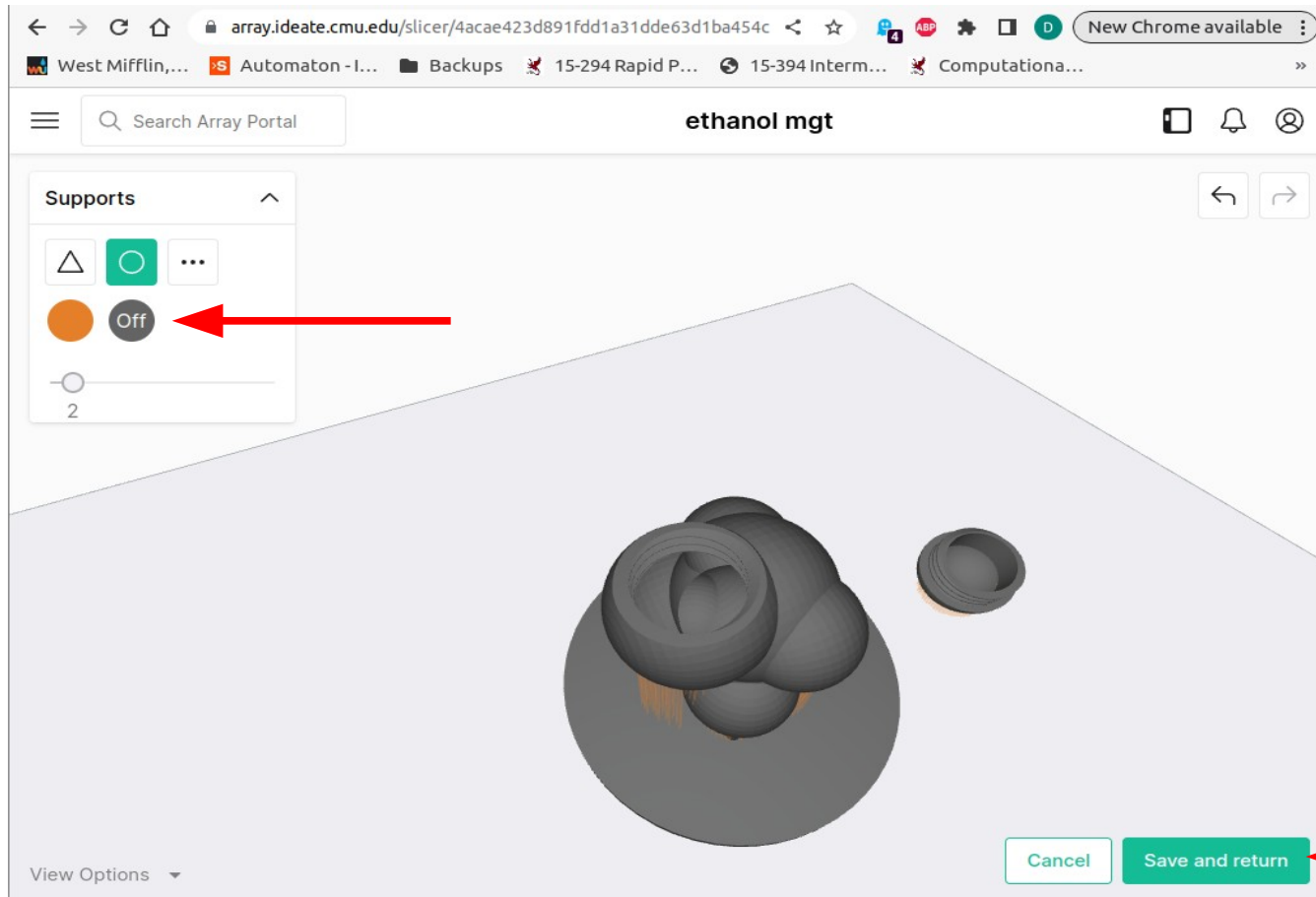
Click on “Toggle preview”



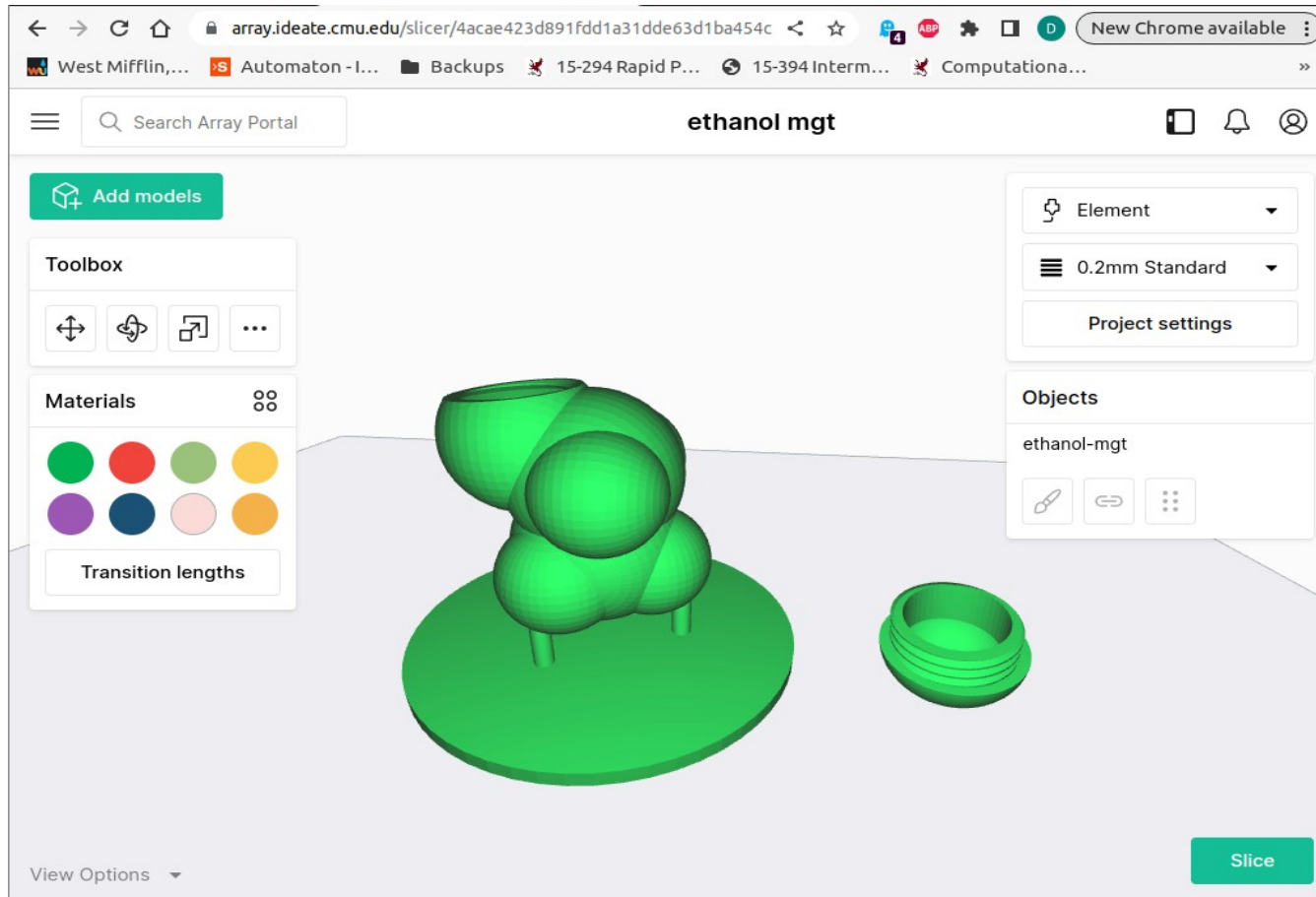
Set brush to "Off"



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



Click on “Slice”



Click on “Send to Array”

The screenshot shows the IDEATe slicer interface. The browser address bar displays the URL: `array.ideate.cmu.edu/slicer/4acae423d891fdd1a31dde63d1ba454c`. The page title is "ethanol mgt".

Print Summary

- Size: 81.3 × 120.1 × 58.9 mm
- Time: 3 hr 3 min
- Cost: \$1.24
- Filament Length: 11.05 m

Print Preview

Path type

- Show travel movement
- Show retract points
- Show restart points

Legend

- Travel
- Skirt
- Support
- Support interface
- Inner Perimeter
- Outer Perimeter
- Solid Layer
- Infill
- Bridge

Create Order

- IDEATe Array: 1
- Order Name: ethanol mgt
- Quantity: 1
- Bed Type: Type I

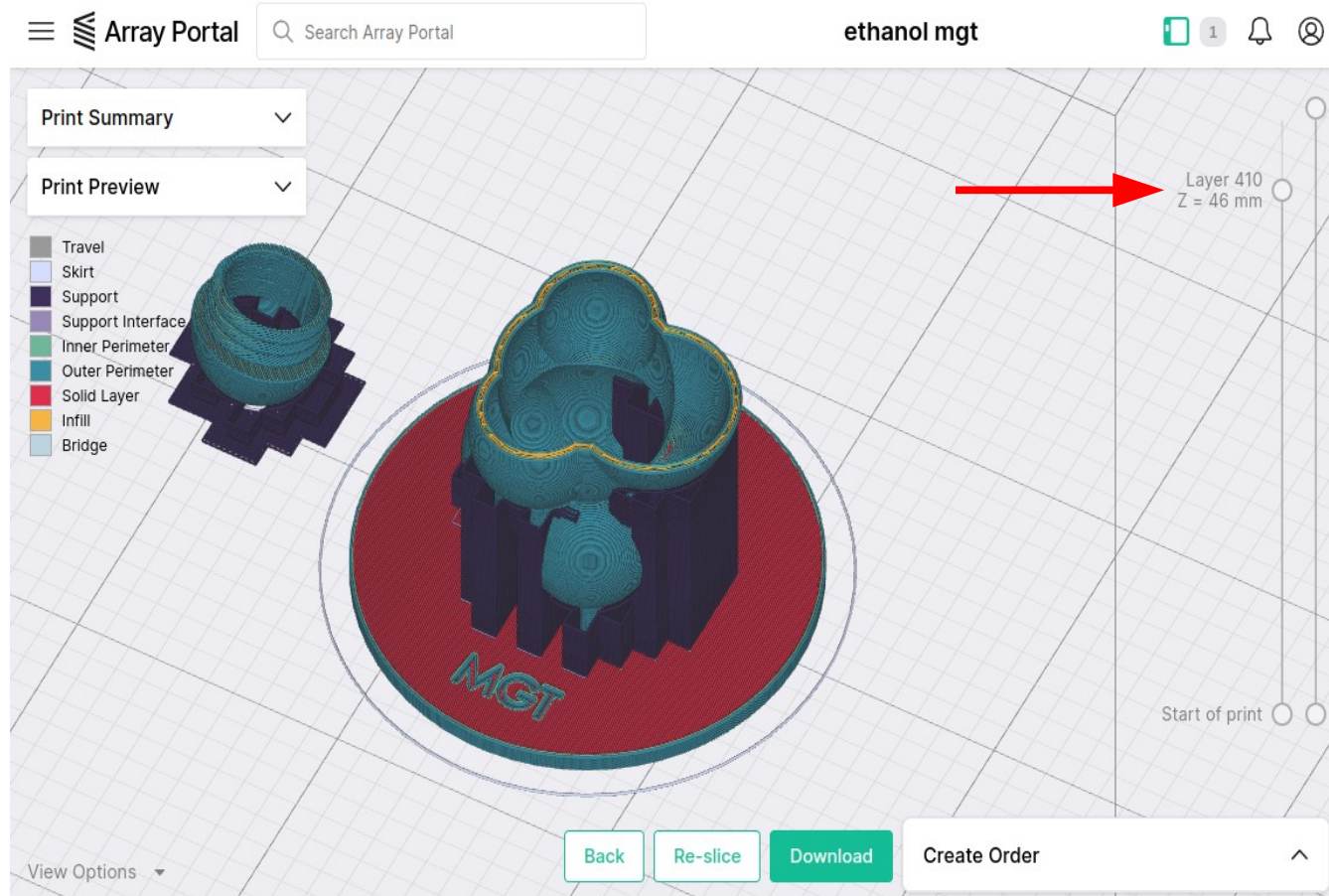
Buttons: Back, Re-slice, Download, **Send to Array** (highlighted with a red arrow)

Layer 474
Z = 58.8 mm

Click on “Send to Array”

The screenshot displays the 'ethanol mgt' software interface. At the top, there is a search bar labeled 'Search Array Portal' and the title 'ethanol mgt'. On the right side of the top bar, there are icons for a mobile device, a notification bell, and a user profile. Below the top bar, there is a legend on the left with categories: Travel (grey), Skirt (light blue), Support (dark blue), Support Interface (purple), Inner Perimeter (green), Outer Perimeter (teal), Solid Layer (red), Infill (yellow), and Bridge (light blue). The main area shows a 3D model of a printed part with a red solid layer. A modal window titled 'Order received' is centered, containing the text 'Array has received and queued this order.' and two buttons: 'Close' and 'Go to device'. On the right side, there is a 'Create Order' panel with a dropdown menu set to 'IDeATe Array: 1'. Below this, there are input fields for 'Order Name' (ethanol mgt), 'Quantity' (1), and 'Bed Type' (Type I). At the bottom right of the 'Create Order' panel, there is a green button labeled 'Send to Array', which is highlighted by a red arrow pointing from the right edge of the screen.

Use Slider to View Layers

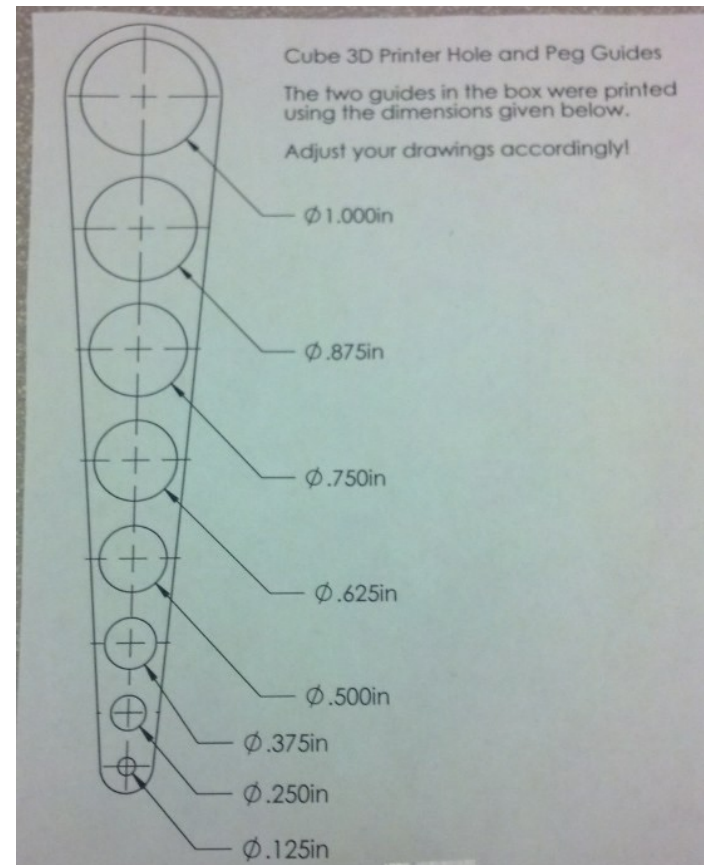


Post-Processing Steps

- 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.