

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

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3D Printer vs. Laser Cutter

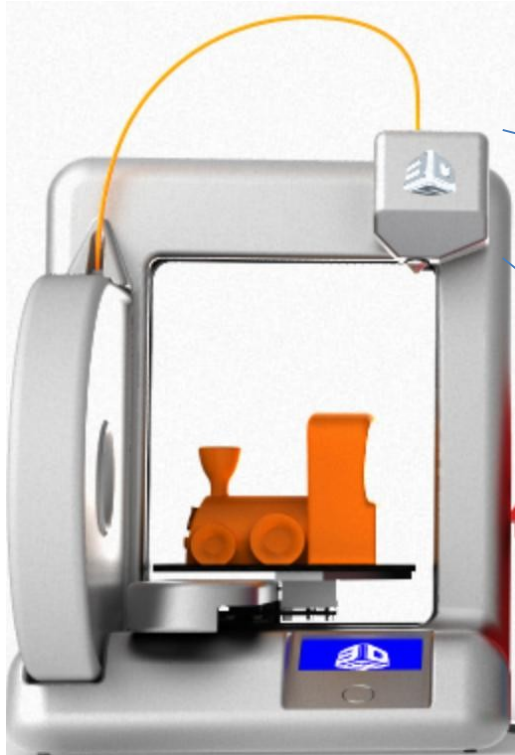
- ✗ Slower
- ✗ Less precise
- ✗ More expensive
- ✗ Limited materials
- ✗ Support material may be required
- ✓ Complex 3D structures!



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

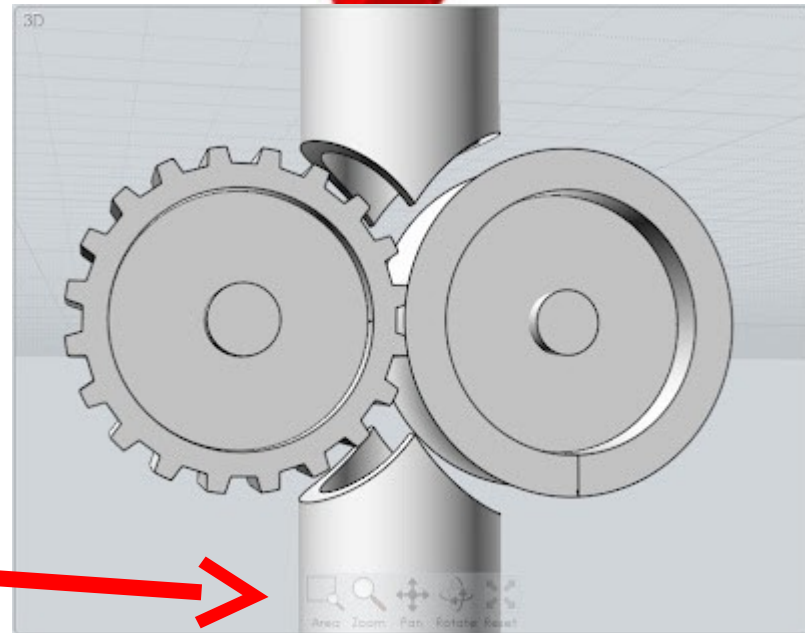
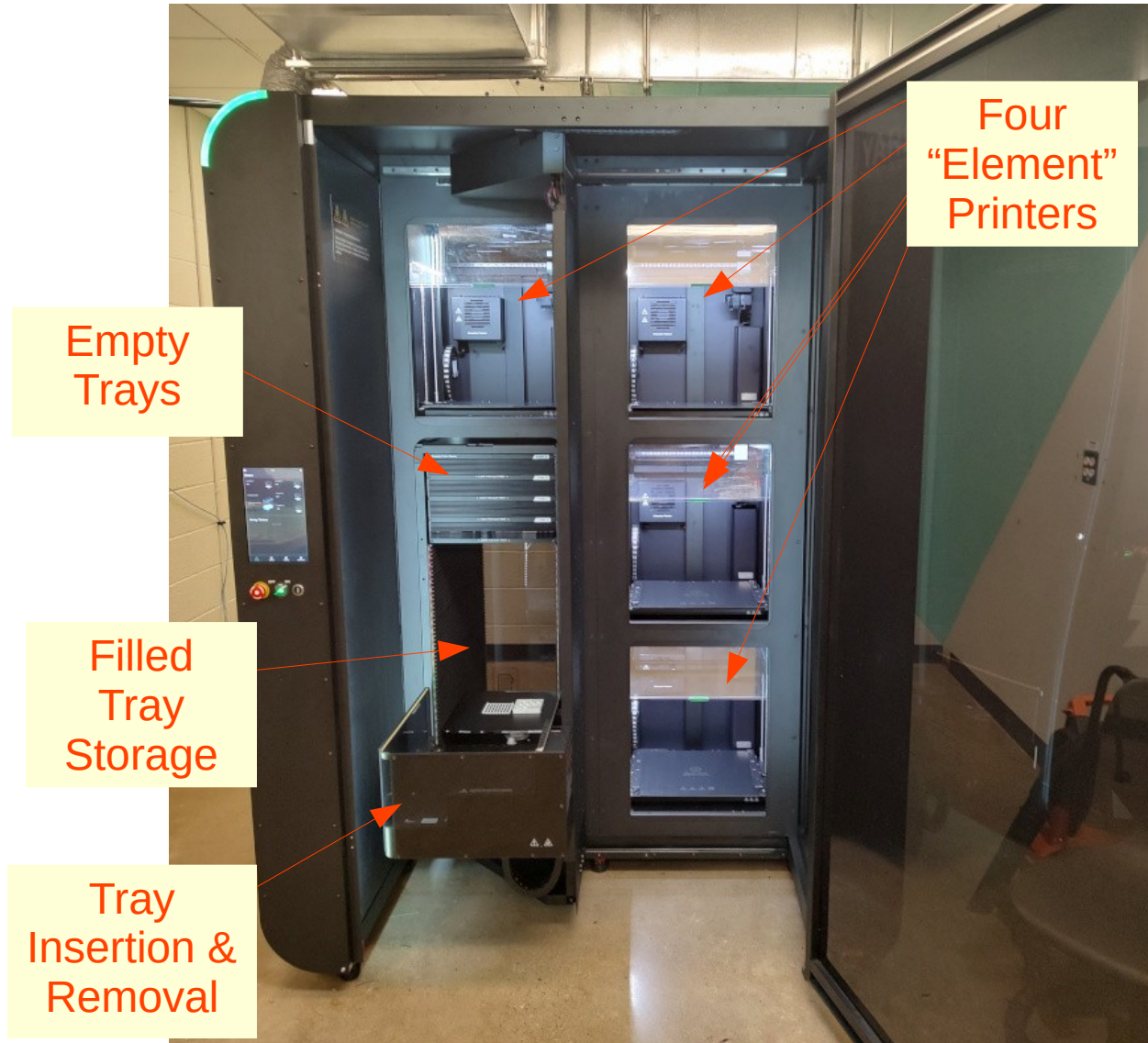


Image from cubifyfans.blogspot.com

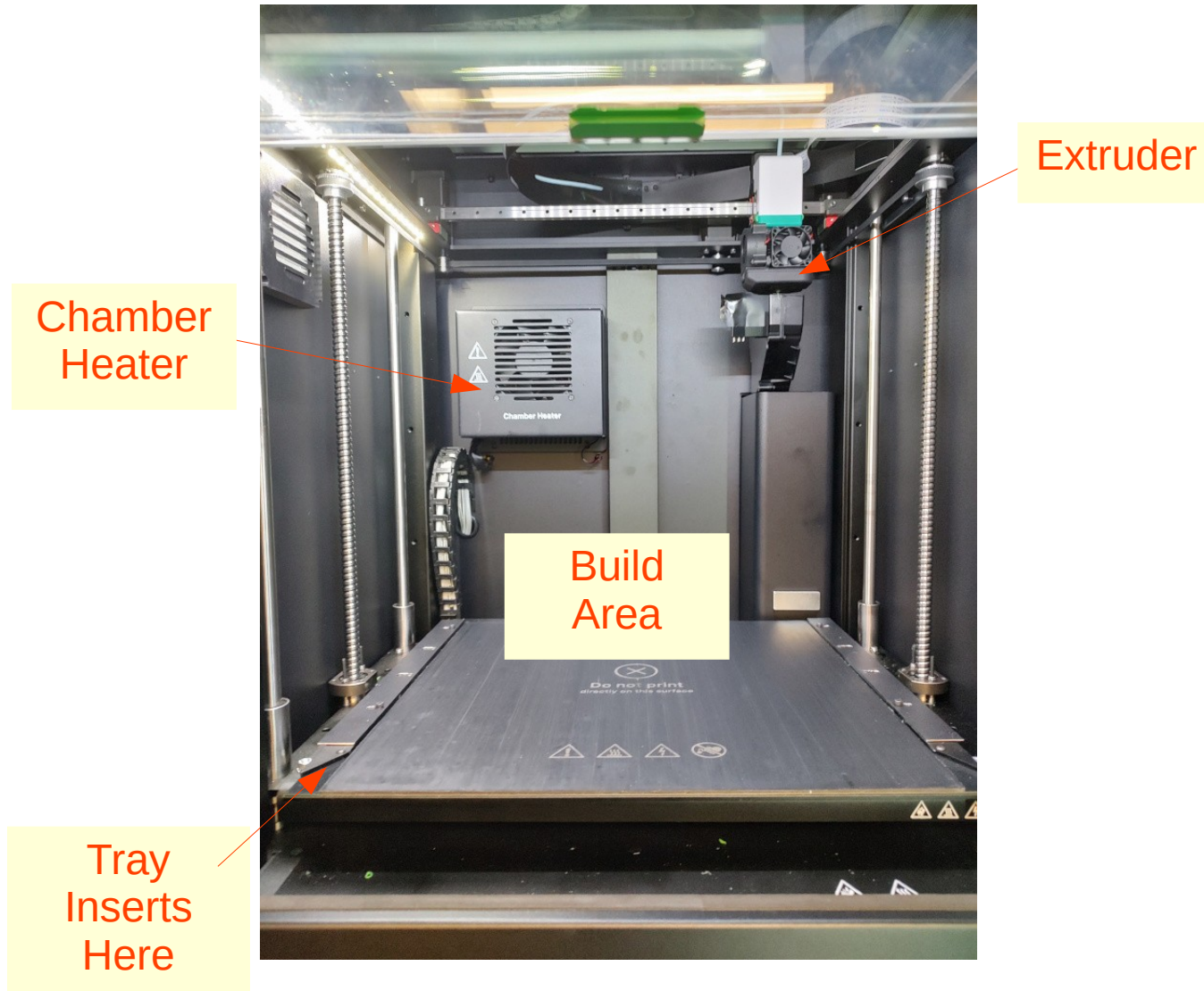
Mosaic's 3D Printer Array



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

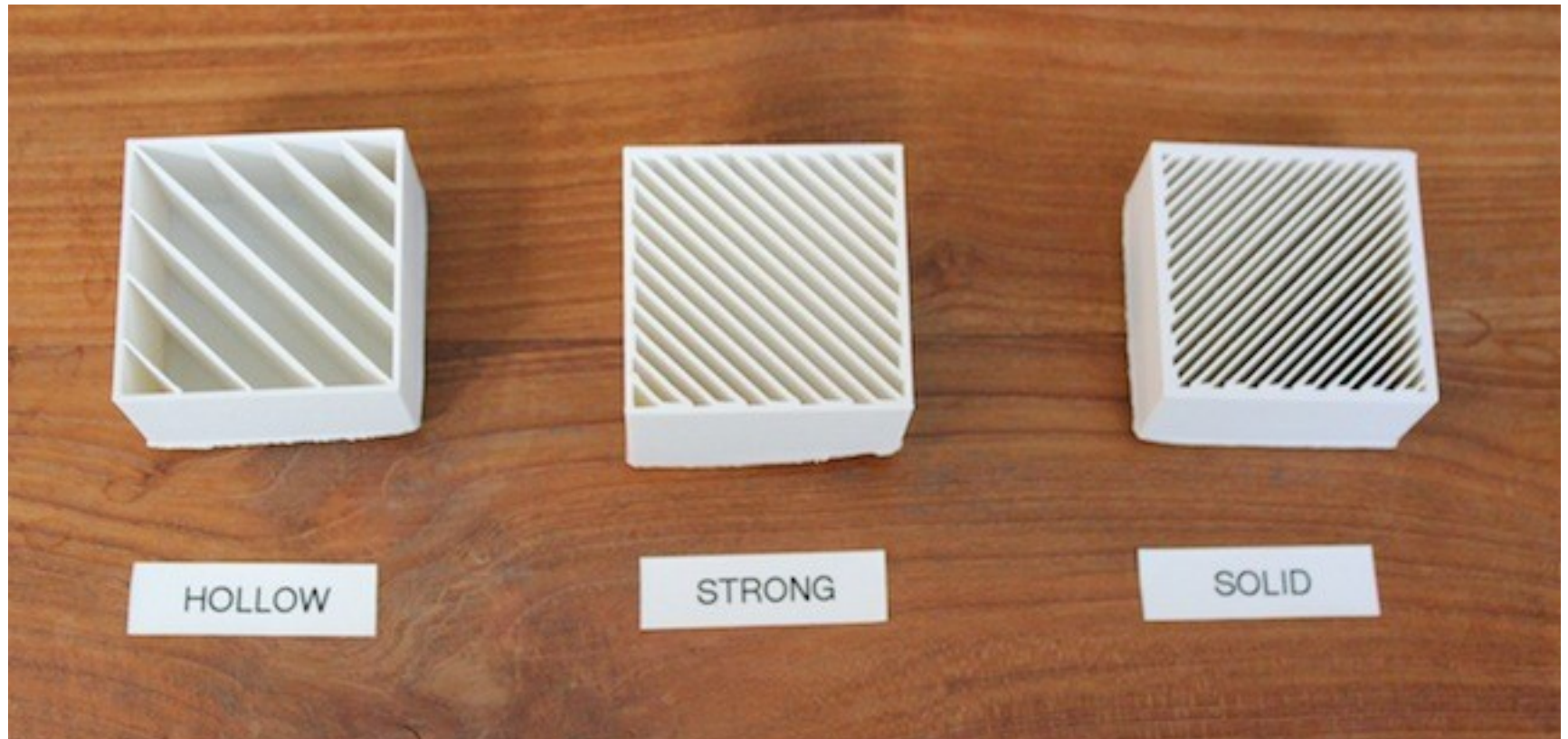
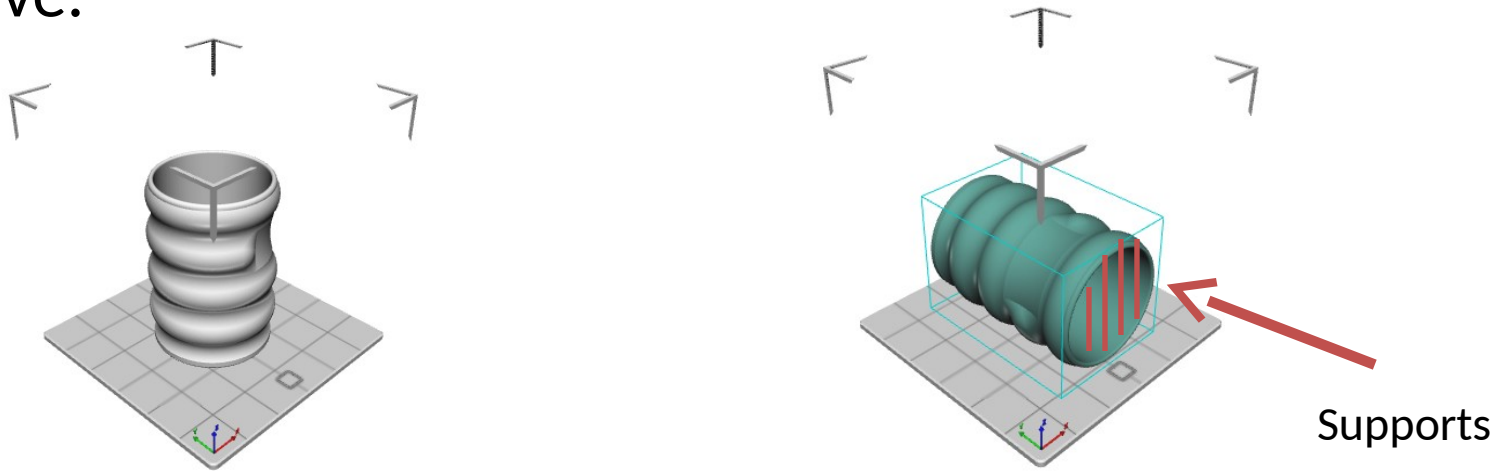


Image from cubify.com

Part Orientation

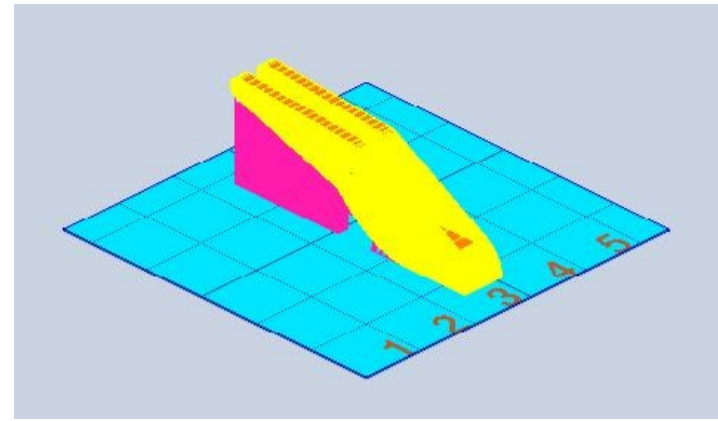
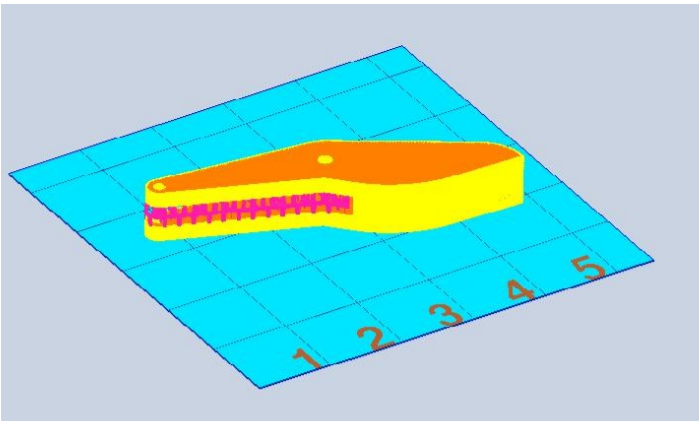
- Choose your part orientation to avoid the need for supports if possible.
- Don't put supports where they will be difficult to remove.



- 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 “3D Printing Service” link and upload your file into the Submissions subfolder.
3. Cody will print your job on a Bambu P1S printer.
4. Wait a day, then check the In Progress or Completed folders to monitor the status of your print.
5. Problems? Email help@ideate.cmu.edu.

Bambu P1S Printer: Bambu Lab



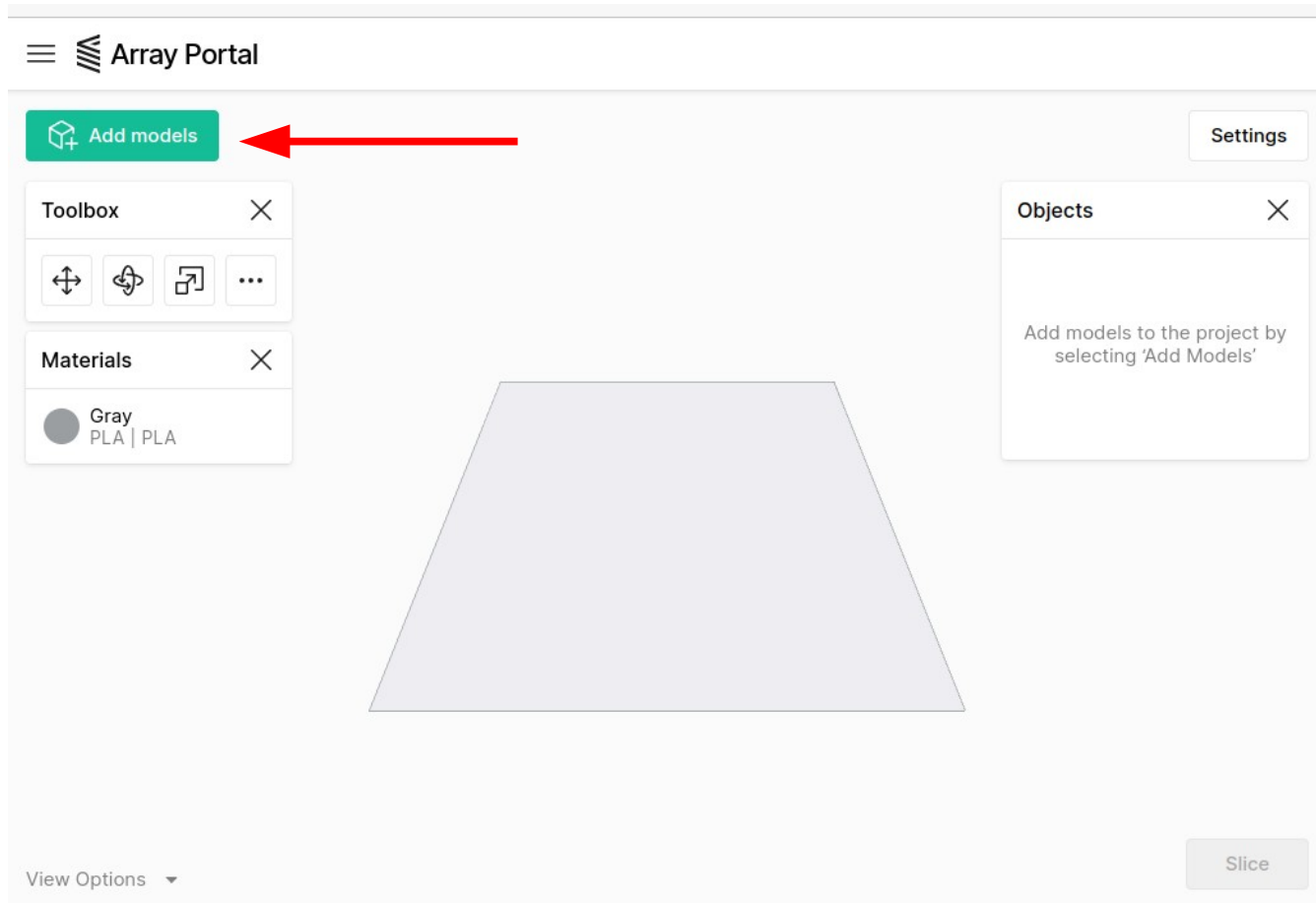
We just received two of these high speed FDM printers.

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

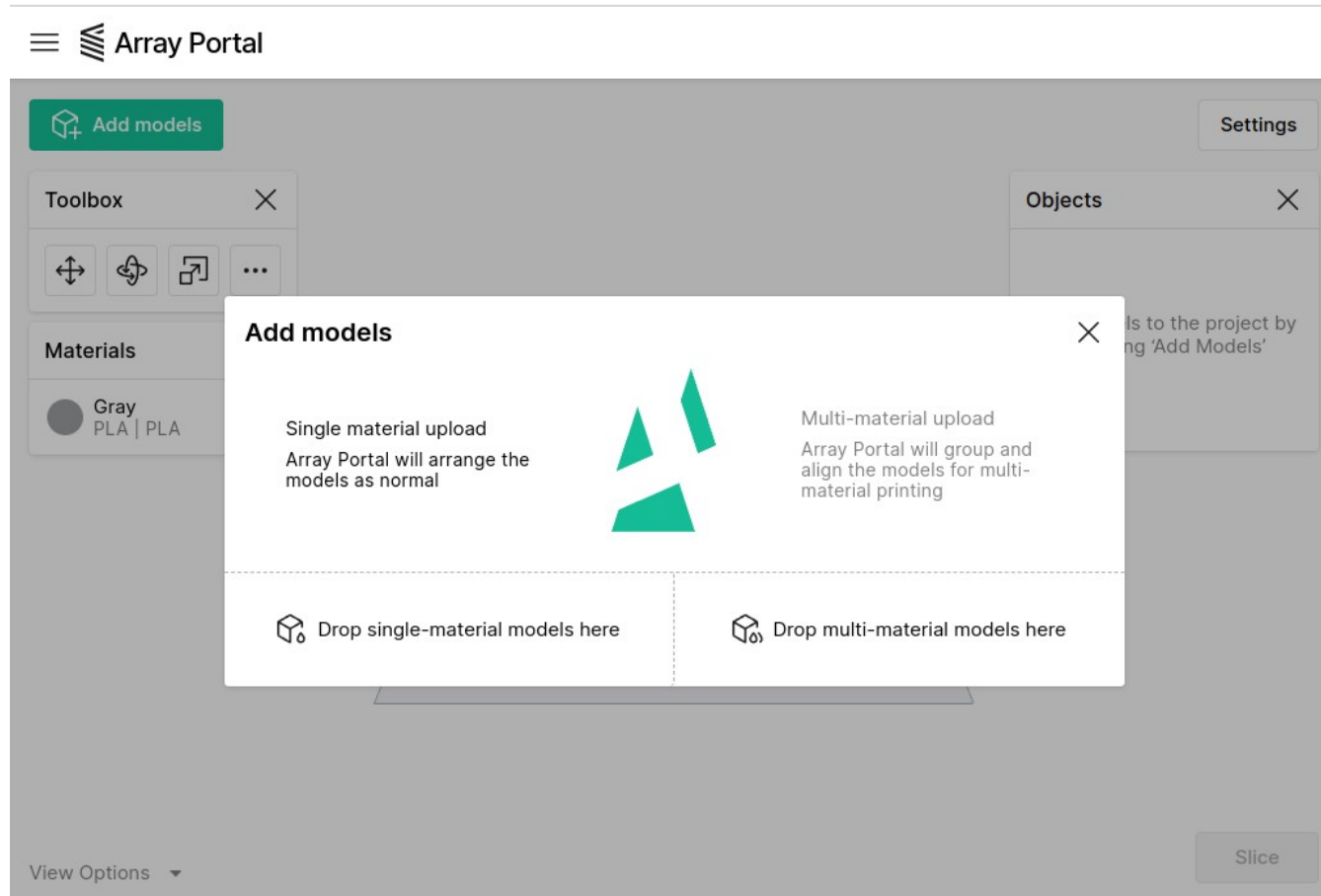
The Array Portal

- This is a quick tour of the Array Portal user interface.
- We will not be using the Array for the molecule assignment, but we might use it for the duck.

Click on “Add models”



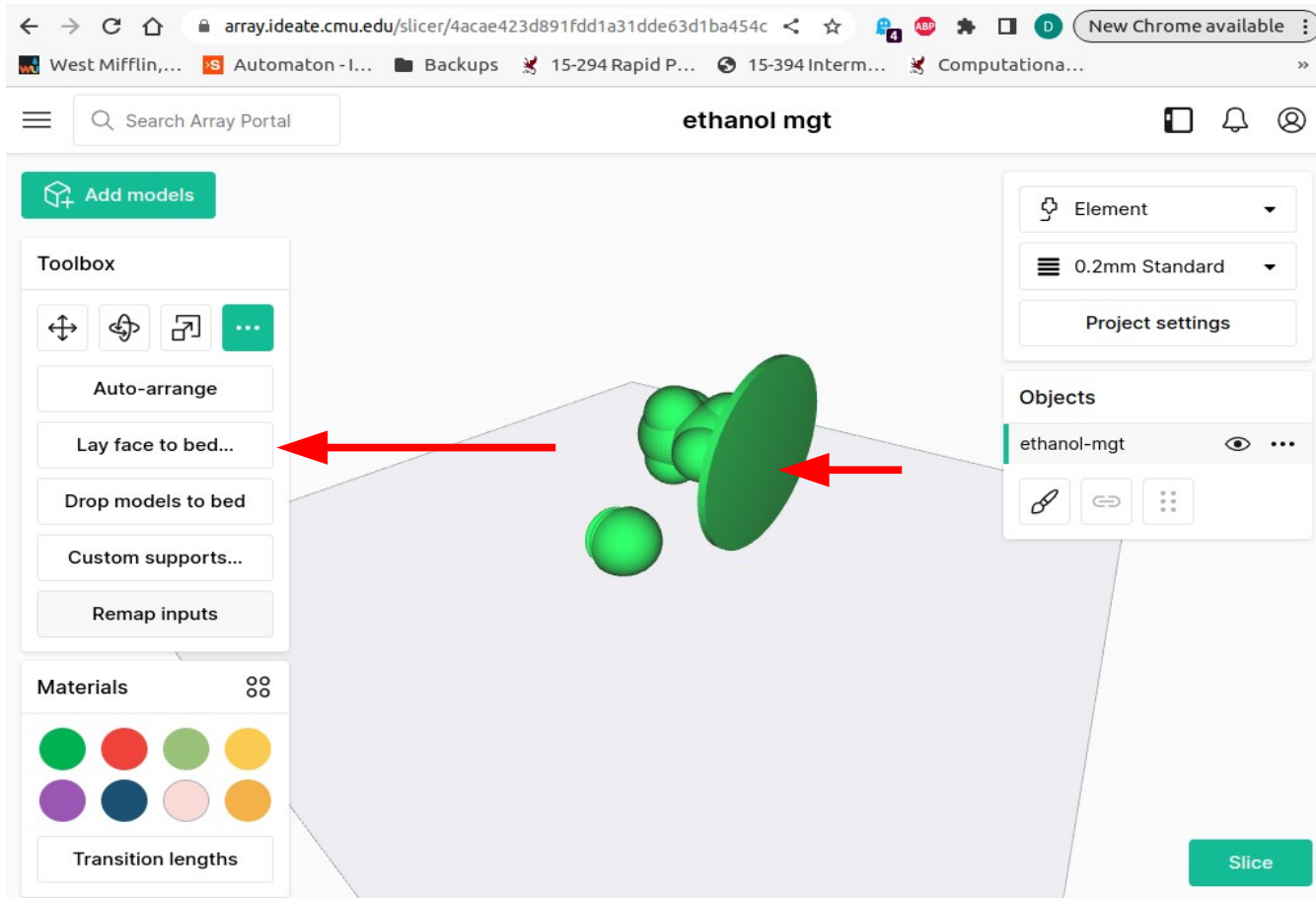
Upload Your STL File



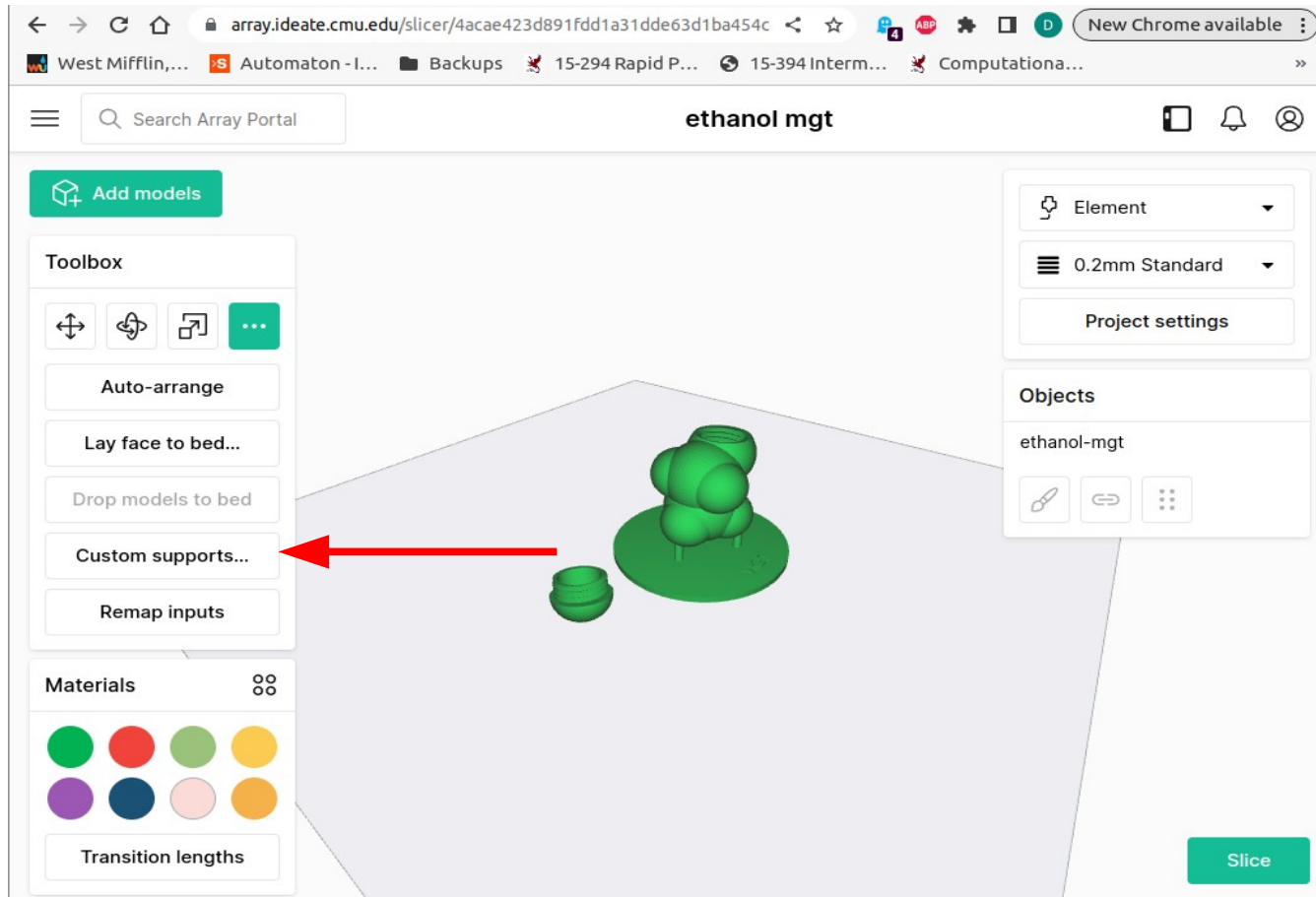
Open the Toolbox



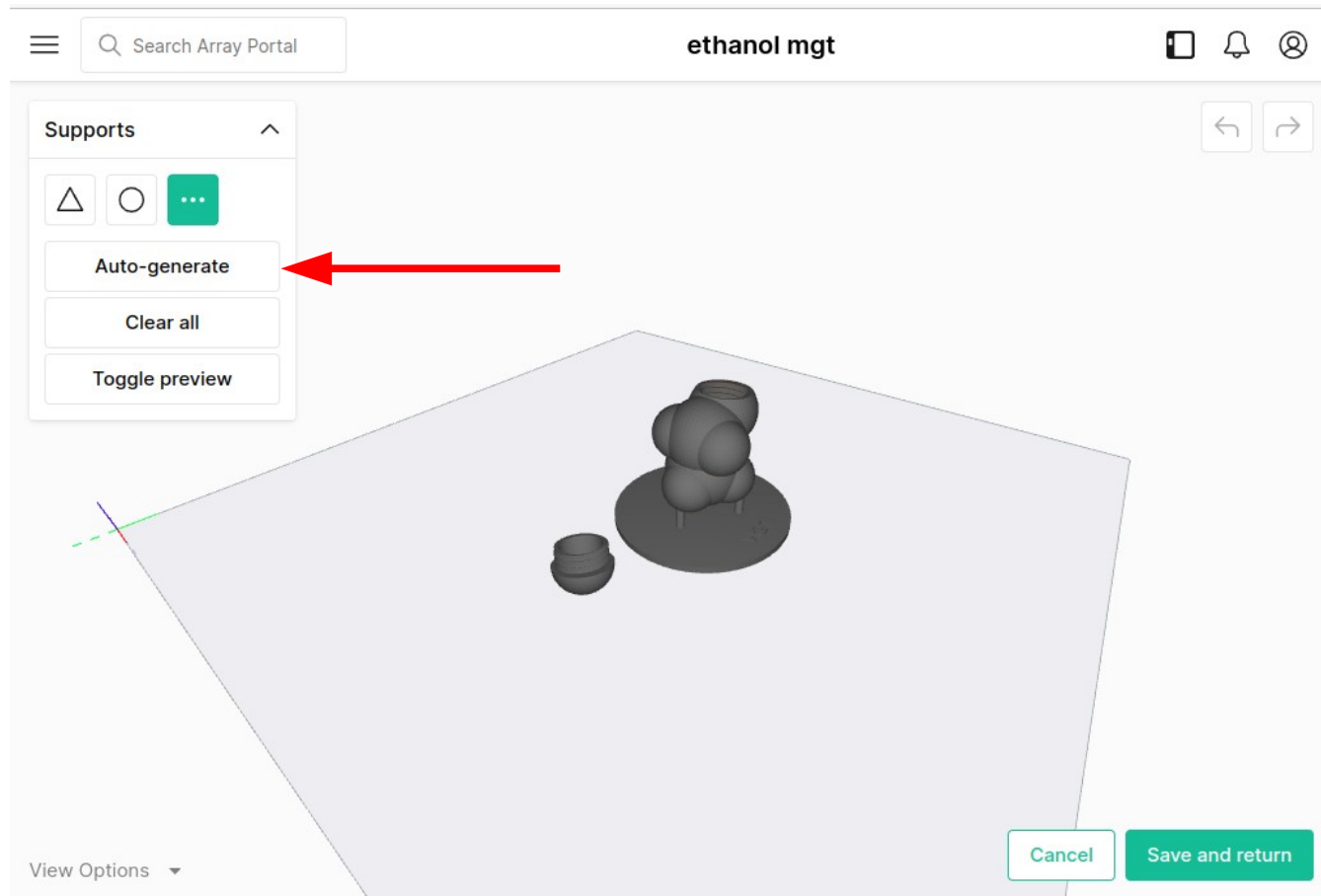
Click on “Lay face to bed”



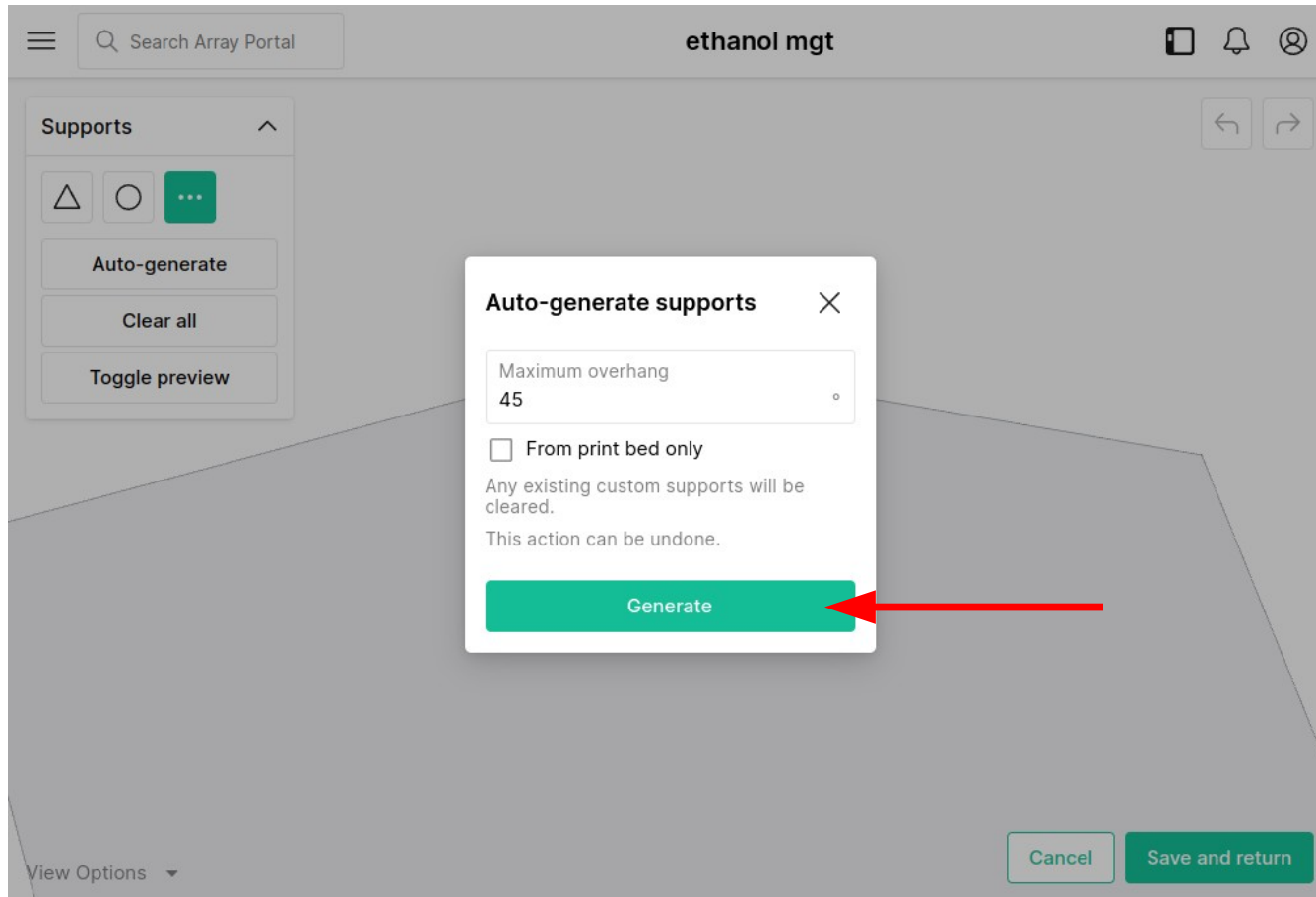
Click on “Custom supports...”



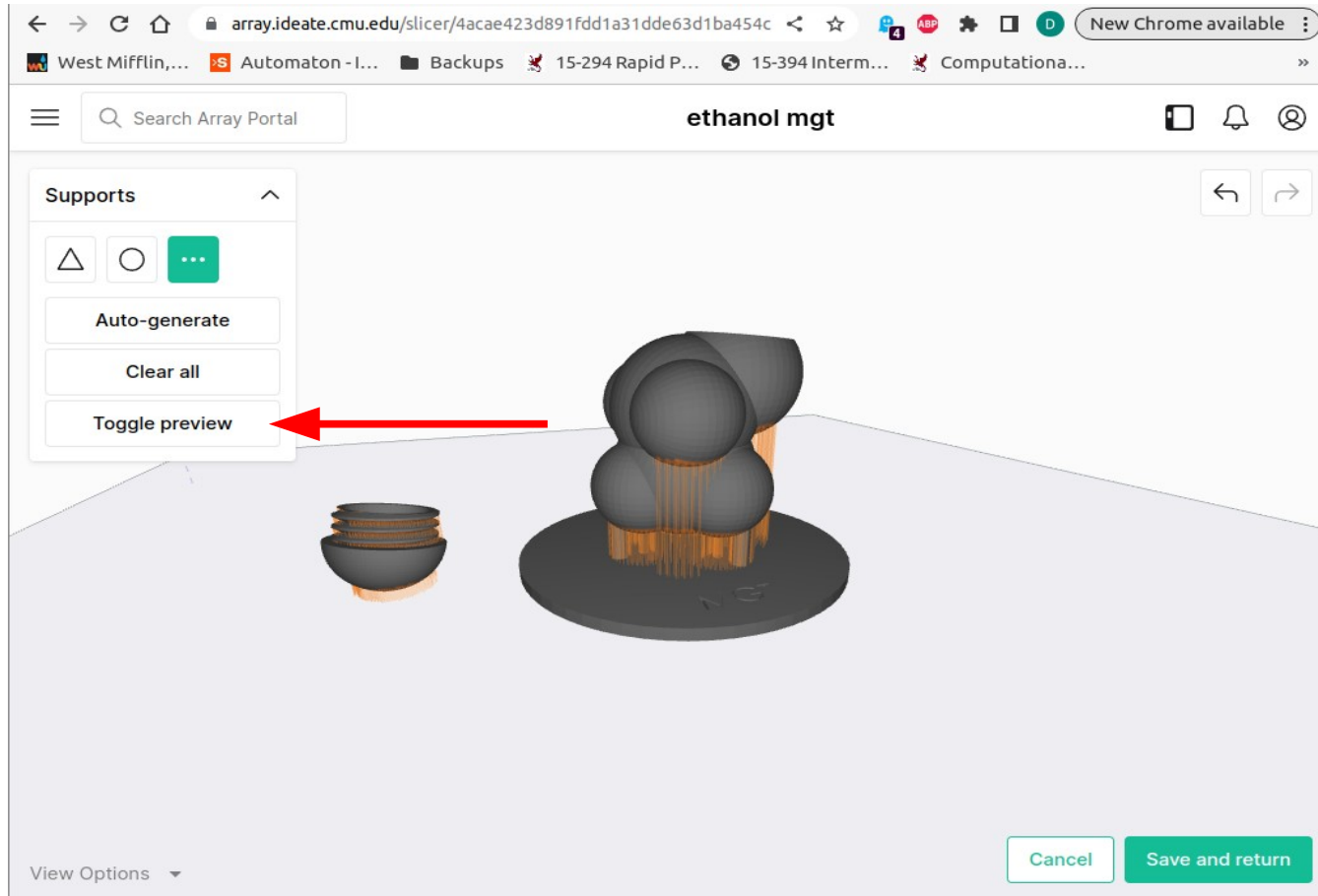
Click on “Auto-generate”



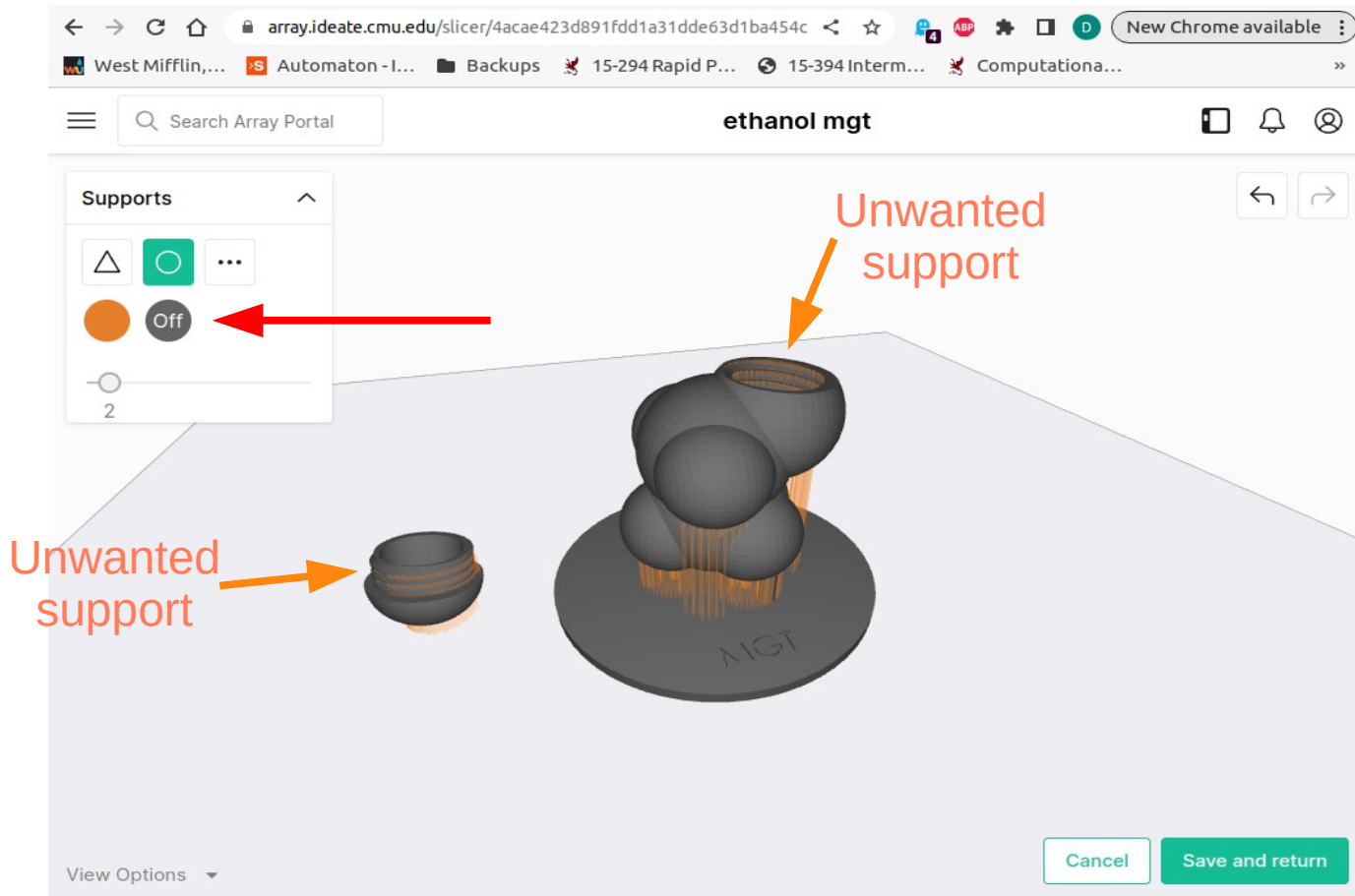
Click on “Generate”



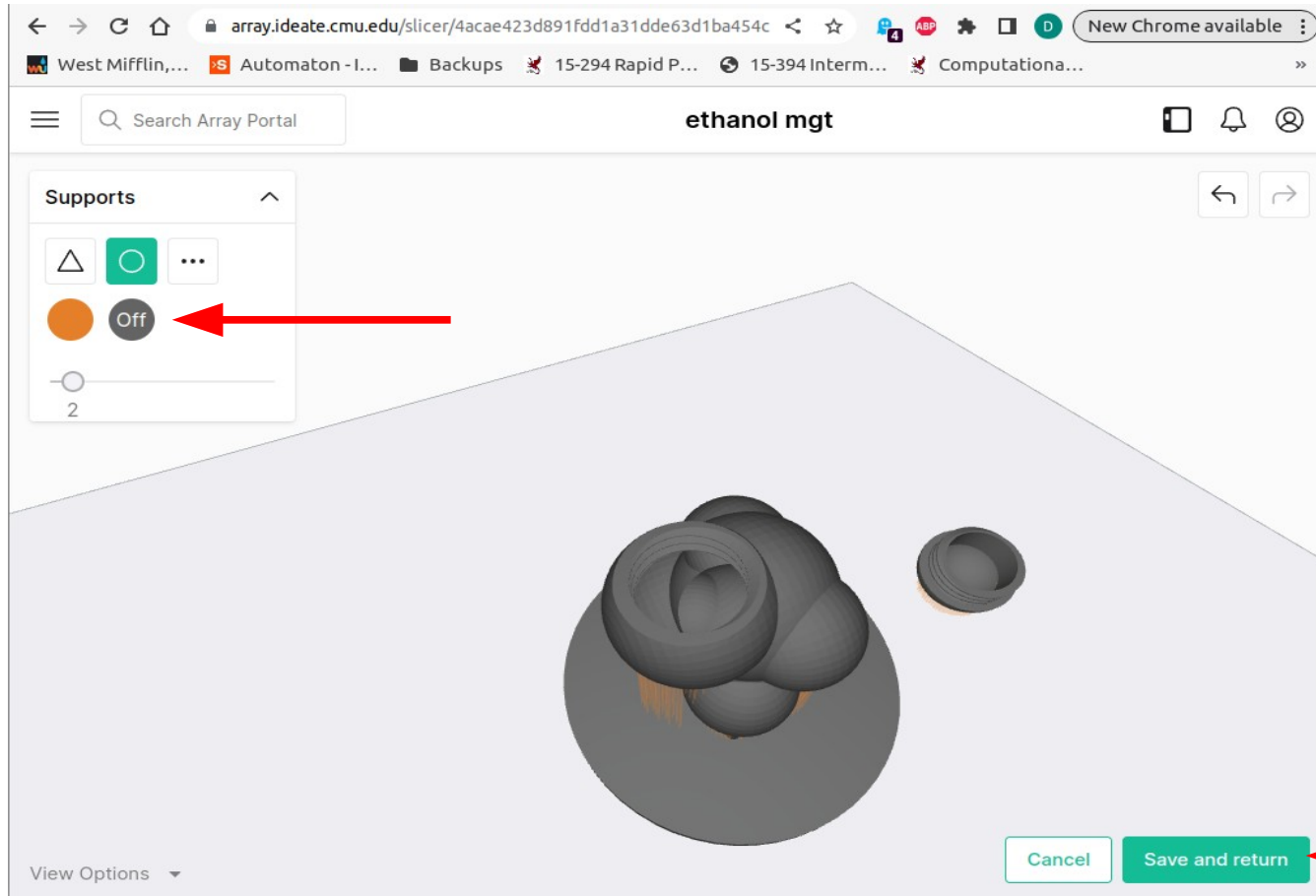
Click on “Toggle preview”



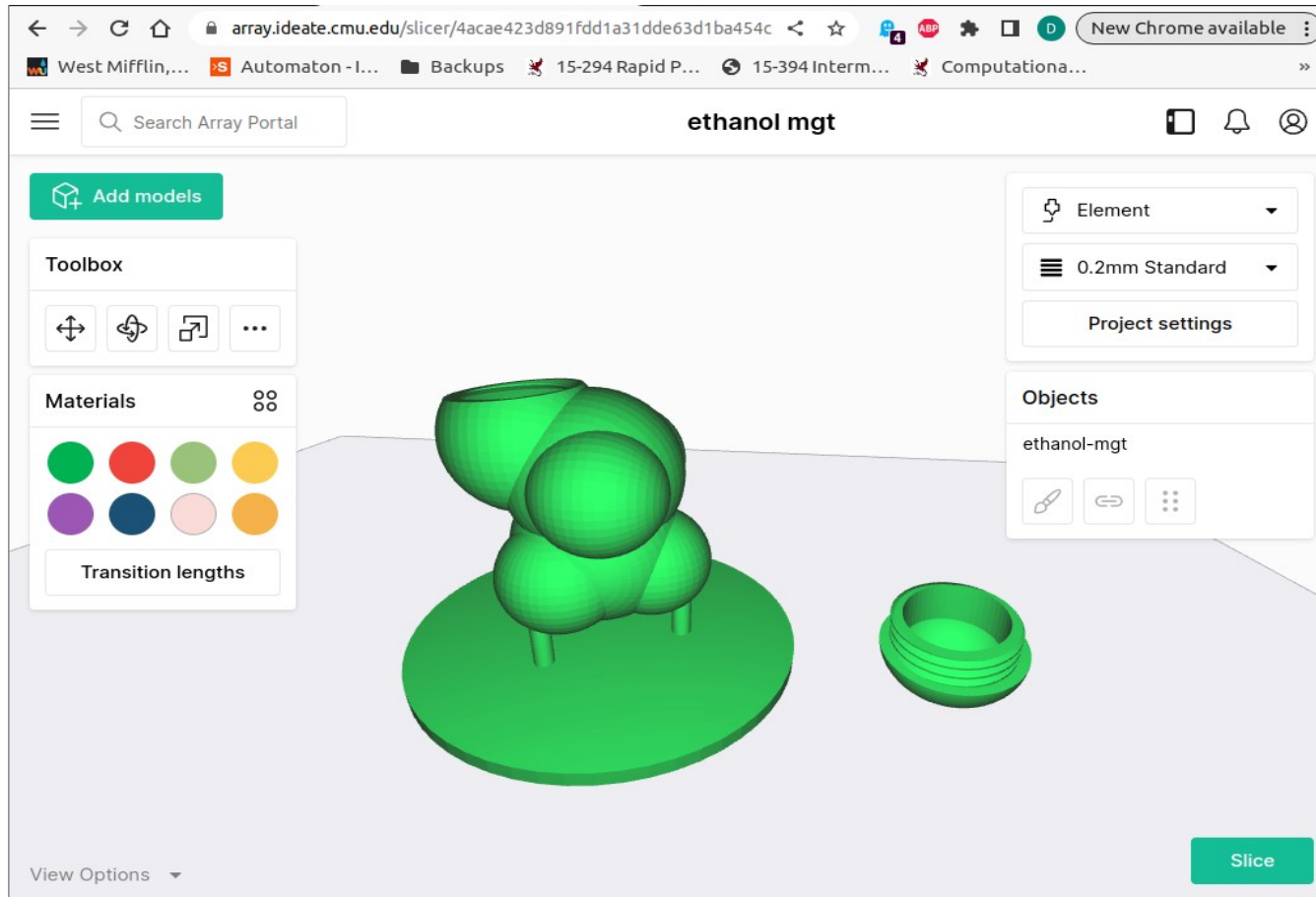
Set brush to "Off"



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



Click on “Slice”



Click on “Send to Array”

The screenshot shows the IDEATe Slicer web 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: [dropdown]

- 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 Dialog:

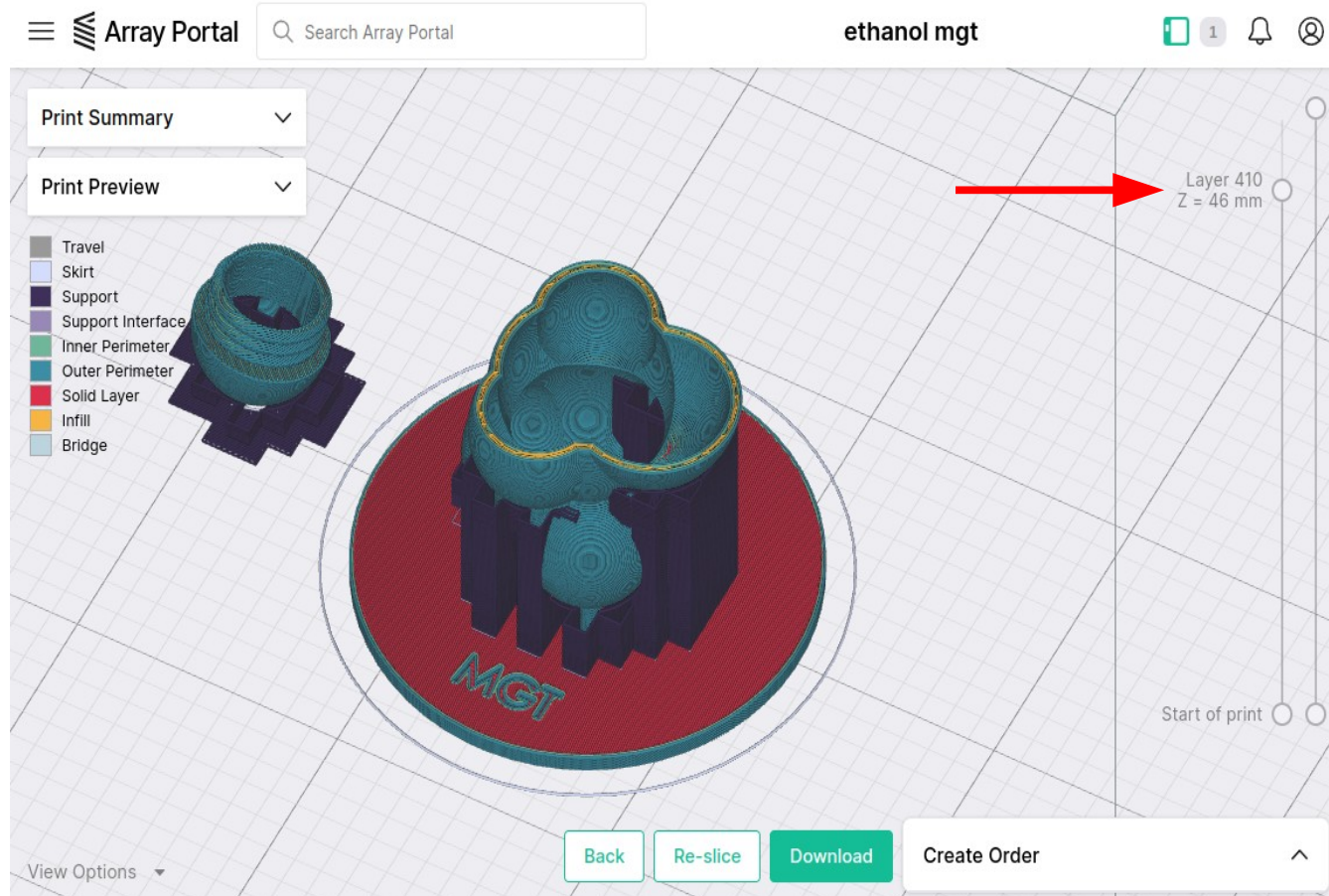
- IDEATe Array: 1 [dropdown]
- Order Name: ethanol mgt
- Quantity: 1
- Bed Type: Type I [dropdown]
- Send to Array** [button]

At the bottom of the interface, there are buttons for "Back", "Re-slice", and "Download". A red arrow points to the "Send to Array" button in the "Create Order" dialog.

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, on the left, there is a legend with various colored squares corresponding to different parts of the 3D model: 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 circular object with a red solid layer and a teal outer perimeter. A white dialog box is centered over the model with the title 'Order received' and the text 'Array has received and queued this order.' Below the text are two buttons: 'Close' and 'Go to device'. On the right side, there is a 'Create Order' panel. It includes a dropdown menu for 'IDeATe Array: 1', a text input for 'Order Name' containing 'ethanol mgt', a text input for 'Quantity' containing '1', and a dropdown menu for 'Bed Type' containing 'Type I'. At the bottom of this panel is a green button labeled 'Send to Array', which is highlighted by a red arrow pointing from the right. At the bottom of the main interface, there are three buttons: 'Back', 'Re-slice', and 'Download'. In the bottom left corner, there is a 'View Options' dropdown menu. In the top right corner of the main area, there is a vertical scale indicator showing 'Layer 474' and 'Z = 58.8 mm'.

Use Slider to View Layers

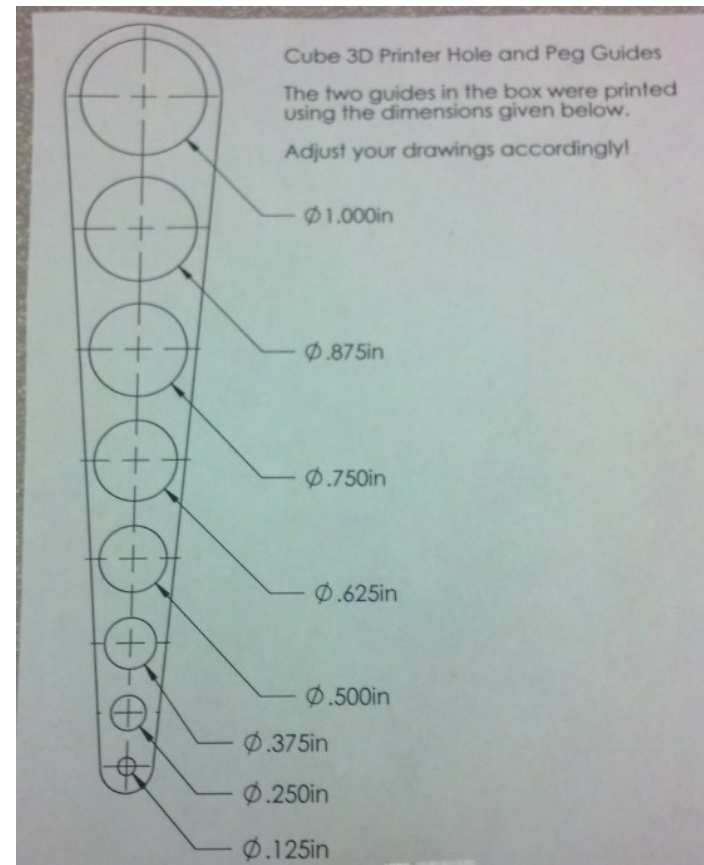


Post-Processing Steps

- 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



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.