



Physics 524
Survey of Instrumentation and Laboratory Techniques
2024

University of Illinois at Urbana-Champaign

Unit 4a: 3D structure modeling: TinkerCad, Cura

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Goal for this unit

- Use Tinkercad to create simple stereolithography files
- Use Cura to create the instruction file for an Ultimaker 2+ 3D printer

Introduction to Tinkercad

From Wikipedia:¹

Tinkercad is a free-of-charge, online 3D modeling program that runs in a web browser. Since it became available in 2011 it has become a popular platform for creating models for 3D printing as well as an entry-level introduction to constructive solid geometry in schools.

Tinkercad was founded by former Google engineer Kai Backman and his cofounder Mikko Mononen, with a goal to make 3D modeling, especially the design of physical items, accessible to the general public, and allow users to publish their designs under a Creative Commons license. In 2011, the tinkercad.com website was launched as a web-based 3D modeling tool for WebGL-enabled browsers, and in 2012 the company moved its headquarters to San Francisco. By 2012, over 100,000 3D designs had been published by users.

In May 2013, Autodesk announced at a Maker Faire that they would acquire Tinkercad.

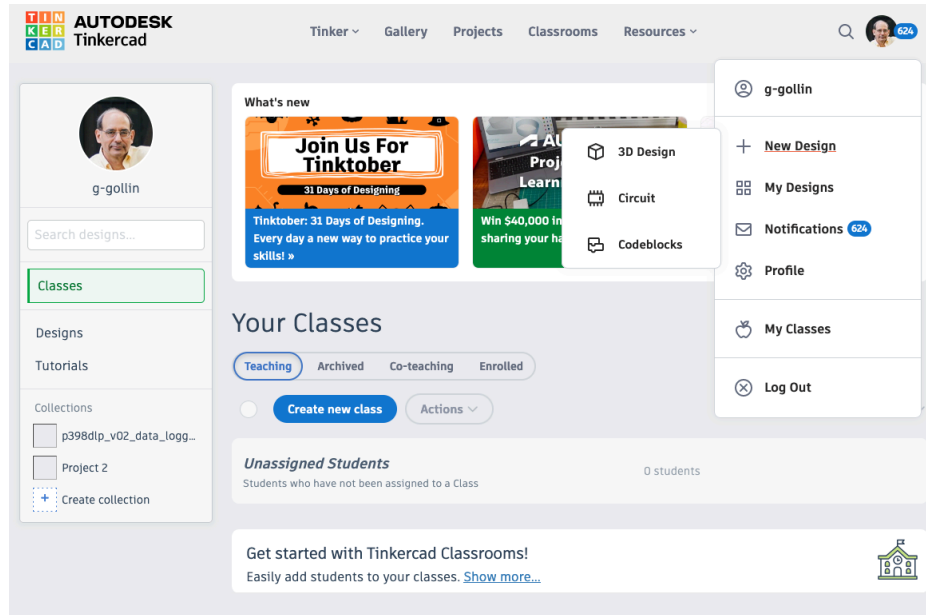
Tinkercad is easy to use; the more experience you have with it, the more sophisticated your designs will become, perhaps obviating the need for use a more powerful (and more esoteric) modeling tool in your design work.

Making a cute little box

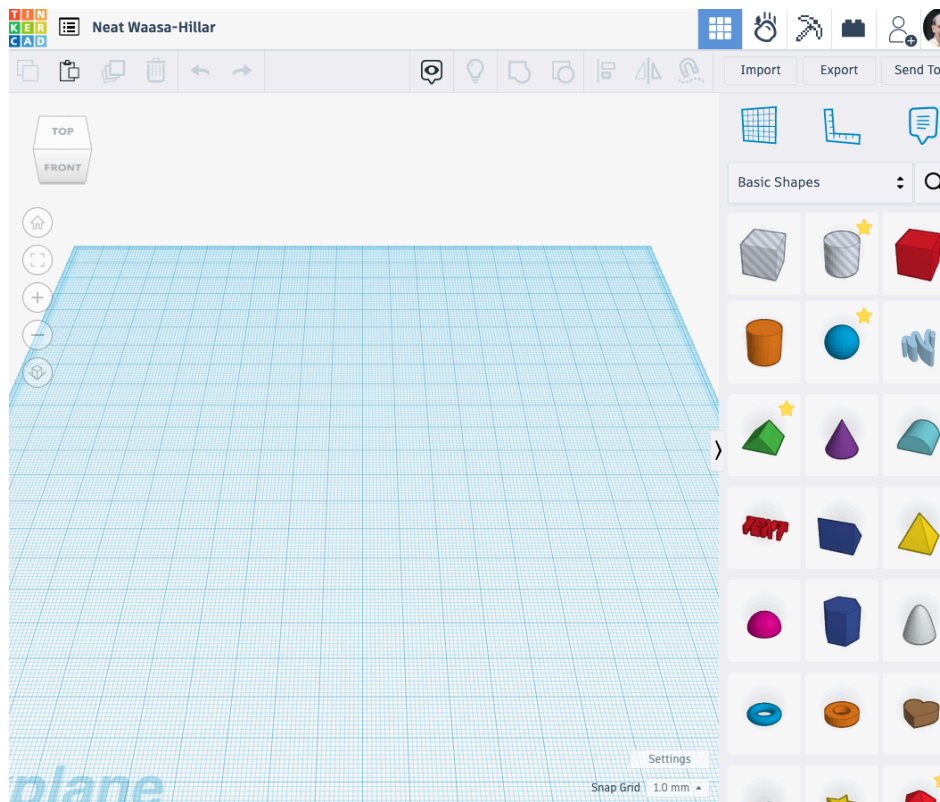
Open up Tinkercad (<https://www.tinkercad.com/>) and log in using your Autodesk account. We'll design a small rectangular box with a removeable lid. We'll set the overall exterior size, including the lid, to be an 18 mm cube with walls that are 2 mm thick.

Find the user menu and click "New Design" and then "3D Design."

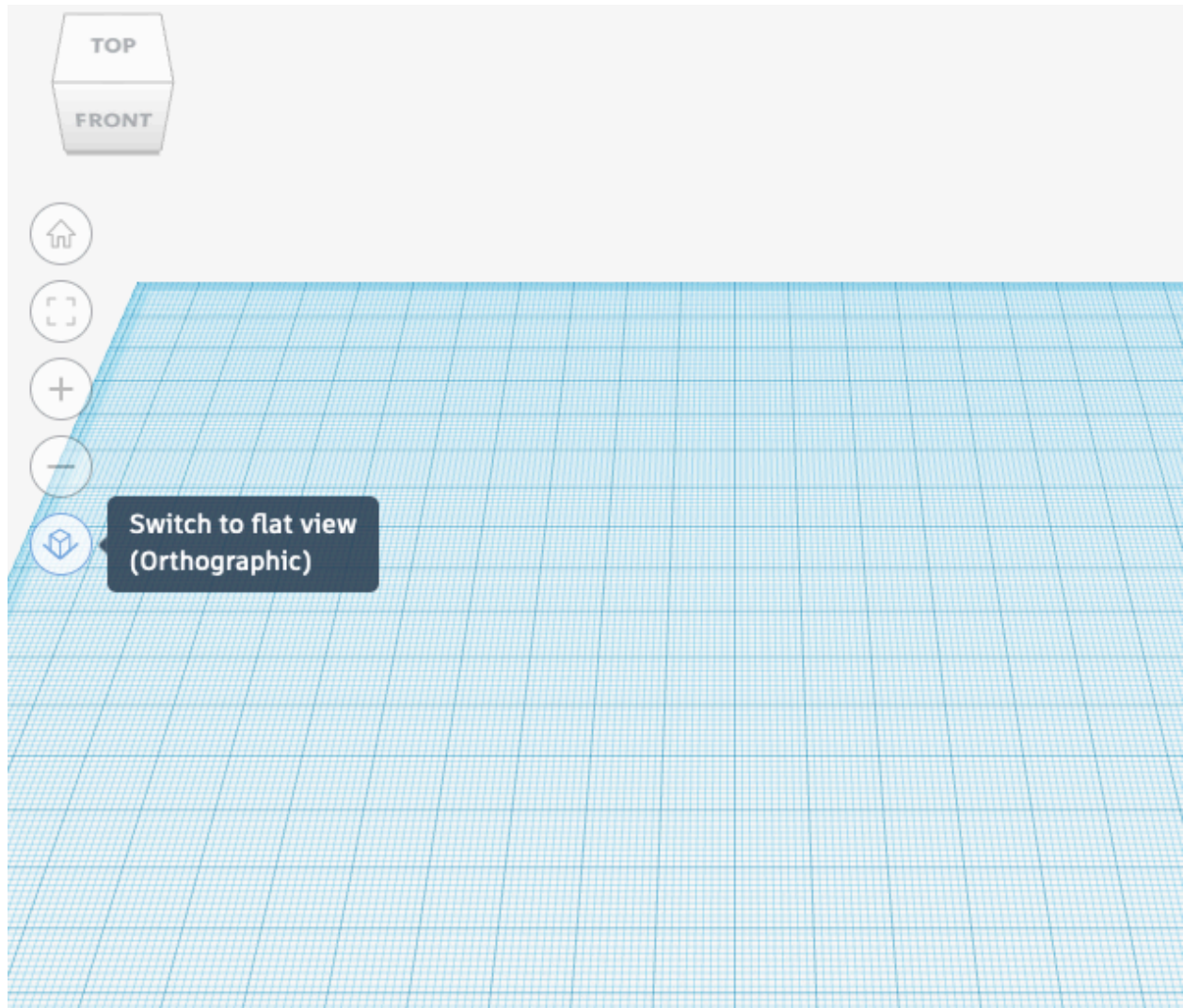
¹ <https://en.wikipedia.org/wiki/Tinkercad>



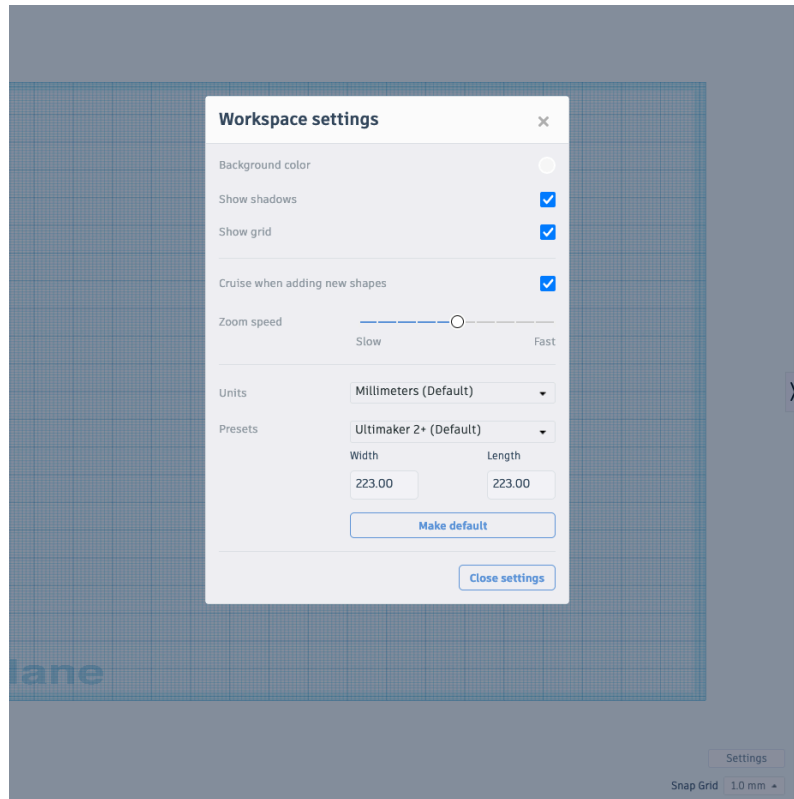
Change the name of your design to something more descriptive than “Neat Waasa-Hillar.”



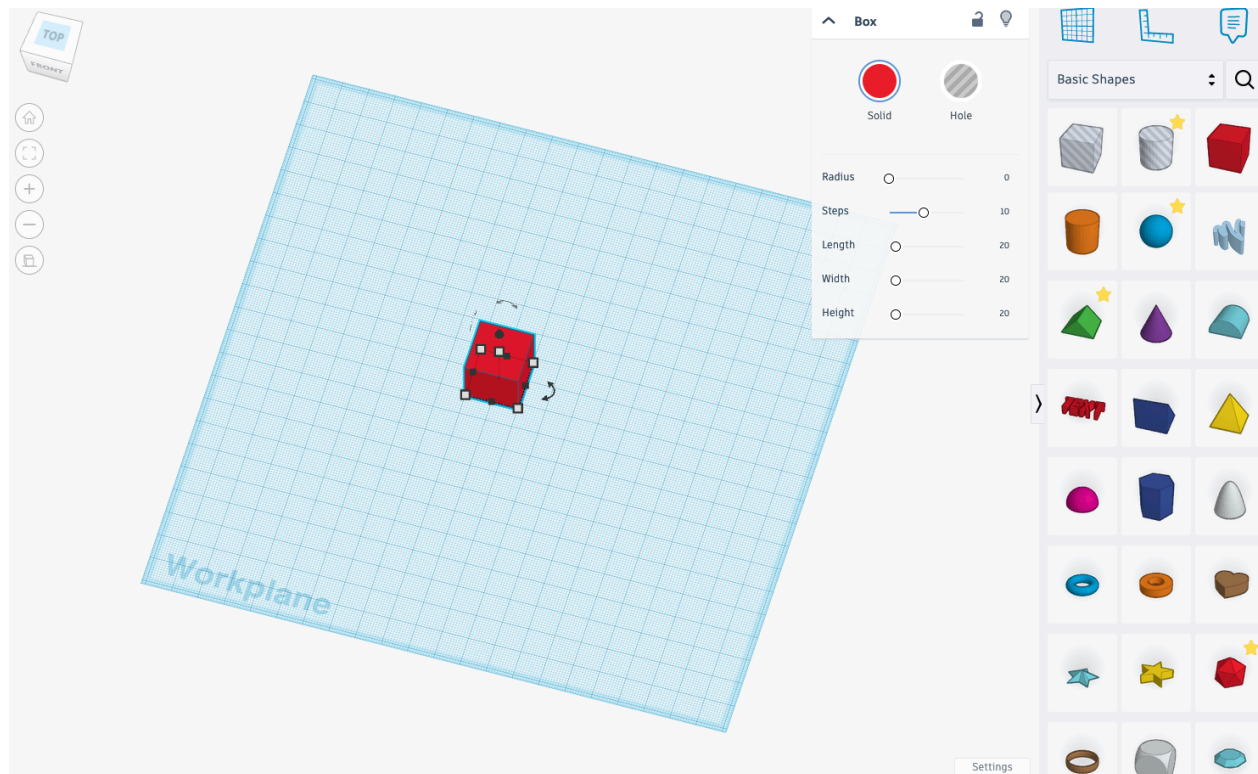
Switch the viewing mode to “flat view (orthographic)”



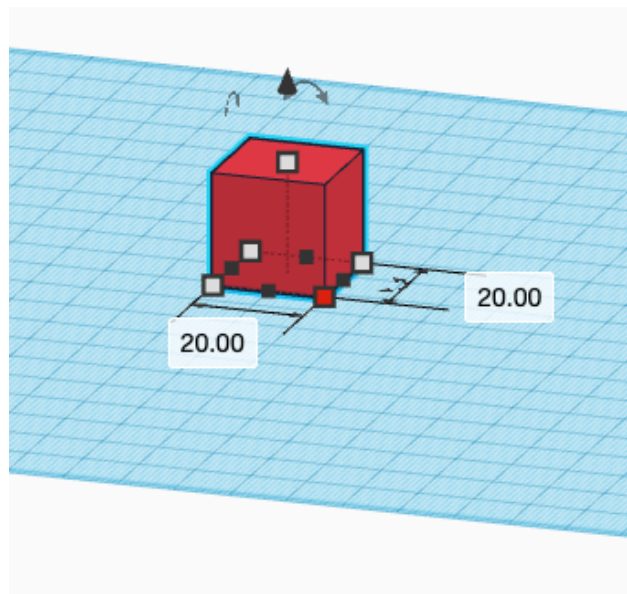
Now make sure the Workspace settings identify the printer as an Ultimaker 2+:



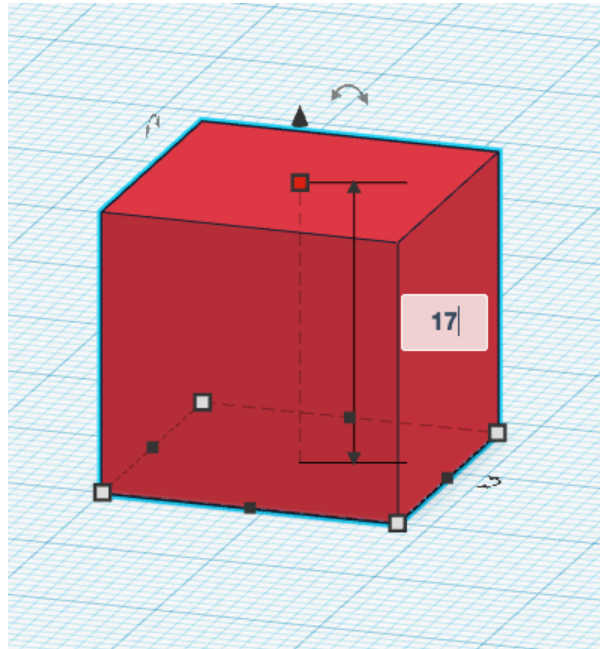
Now drag a red cube from the “Basic Shapes” collection onto the work space.



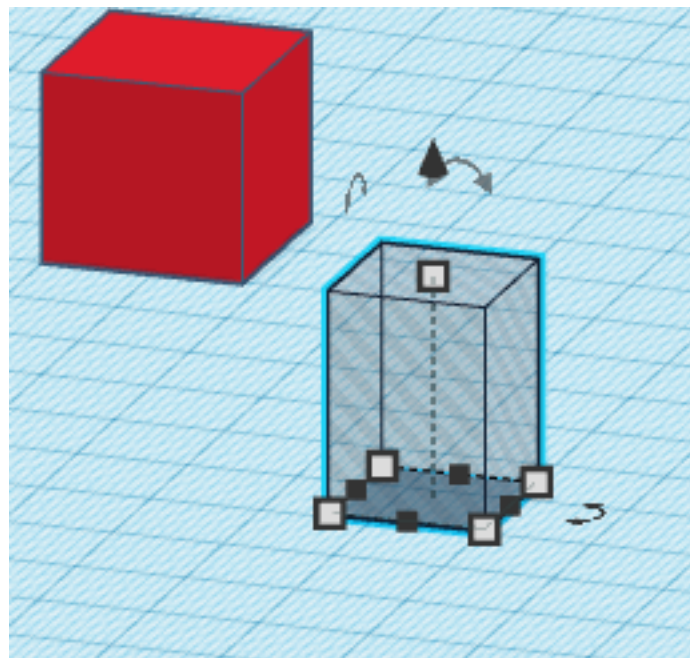
Now set the lengths of the cube's sides to 18 mm from the default of 20 mm.



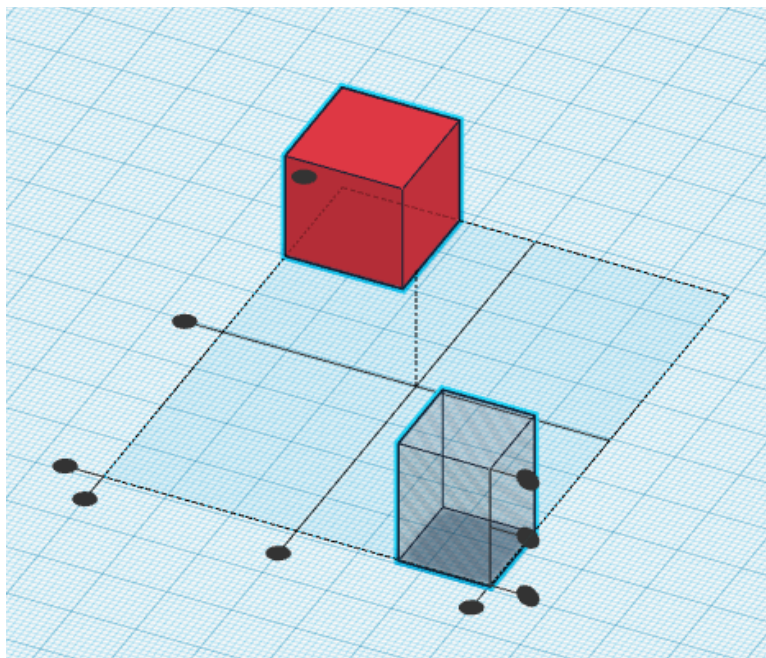
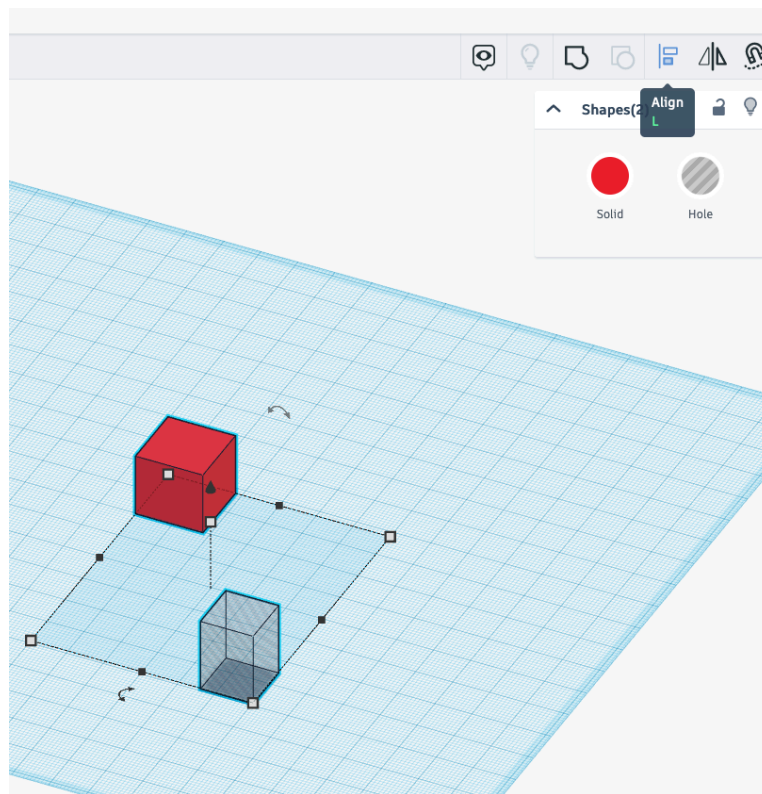
Also set the height to 17 (not 18) mm.



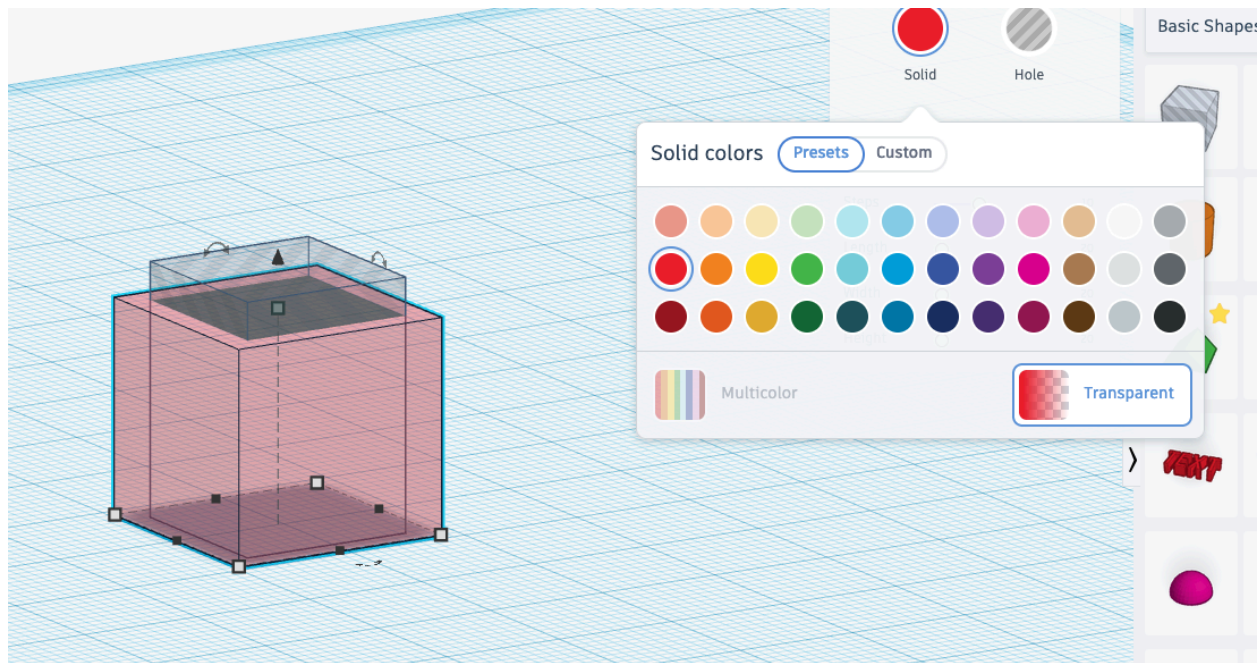
Now drag a cube-shaped “hole” onto the workplane. Set its width and depth to 14 mm but leave its height as 20 mm.



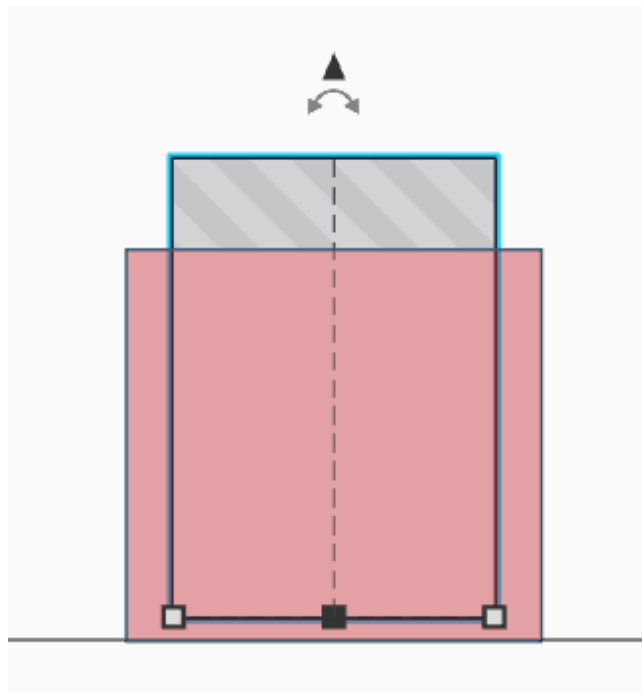
Select both objects and click on the “Align” tool. Align the horizontal centers, but leave the vertical unchanged.



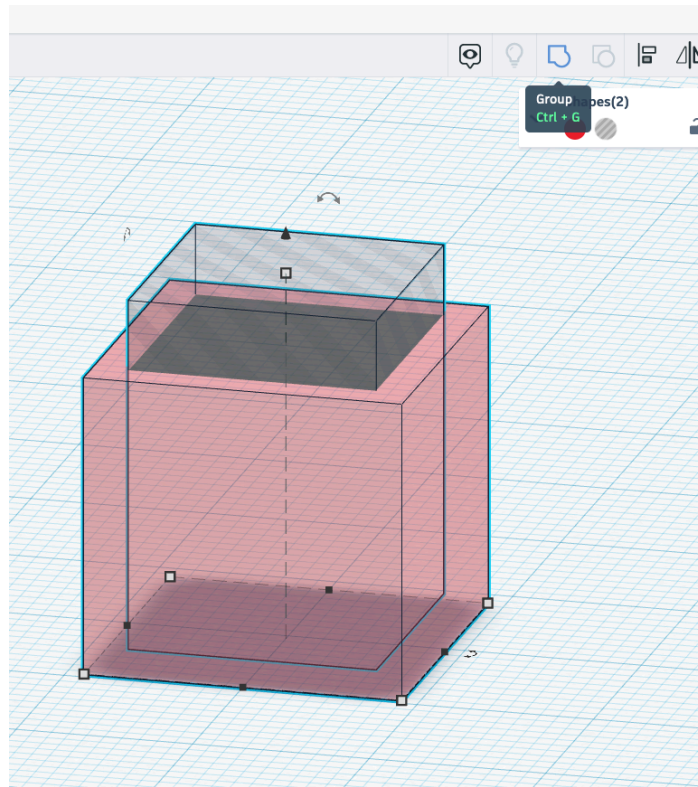
Note that I've set the red shape's color mode to "Transparent" in the following post-alignment image. The bottom faces of both the red box and the hole are at $z = 0$.



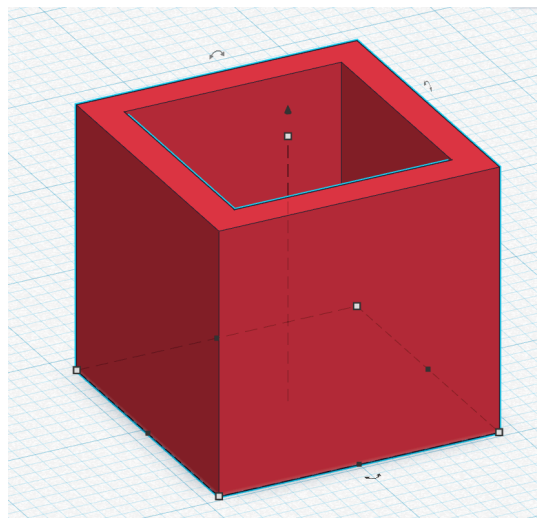
Now select only the hole and move it up 2 mm. On a Mac you can do this by holding down the command key and using the up arrow cursor. Perhaps with Windows you'd use ctrl instead of command?



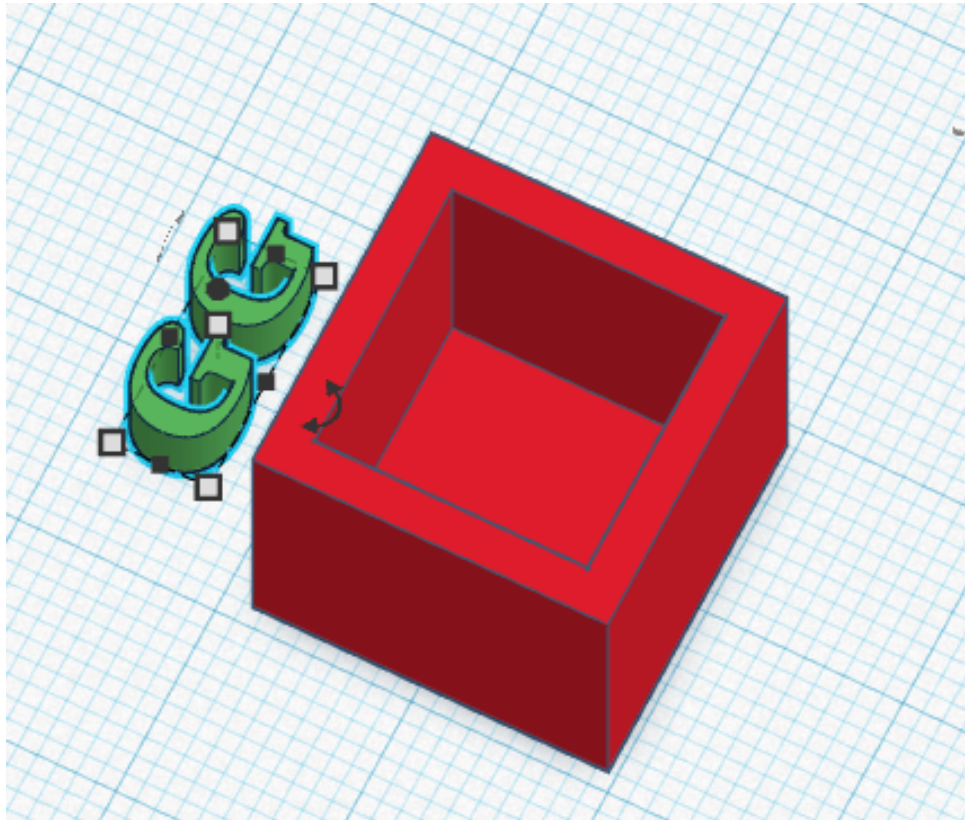
Select both objects and click the “group” tile.



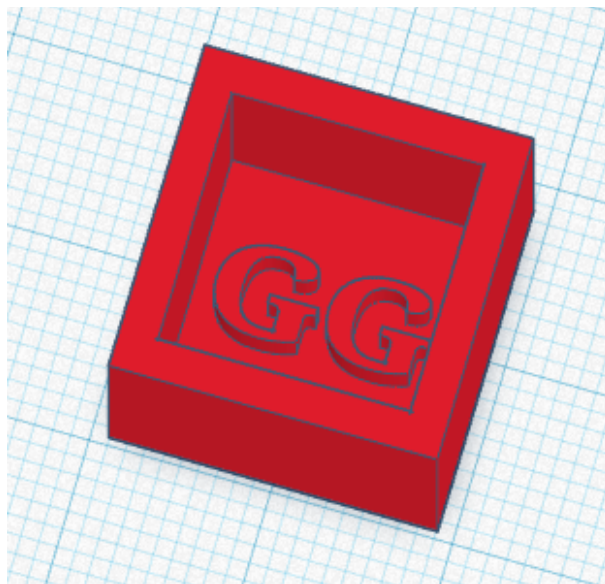
Voilà! (I’ve turned off transparency.)



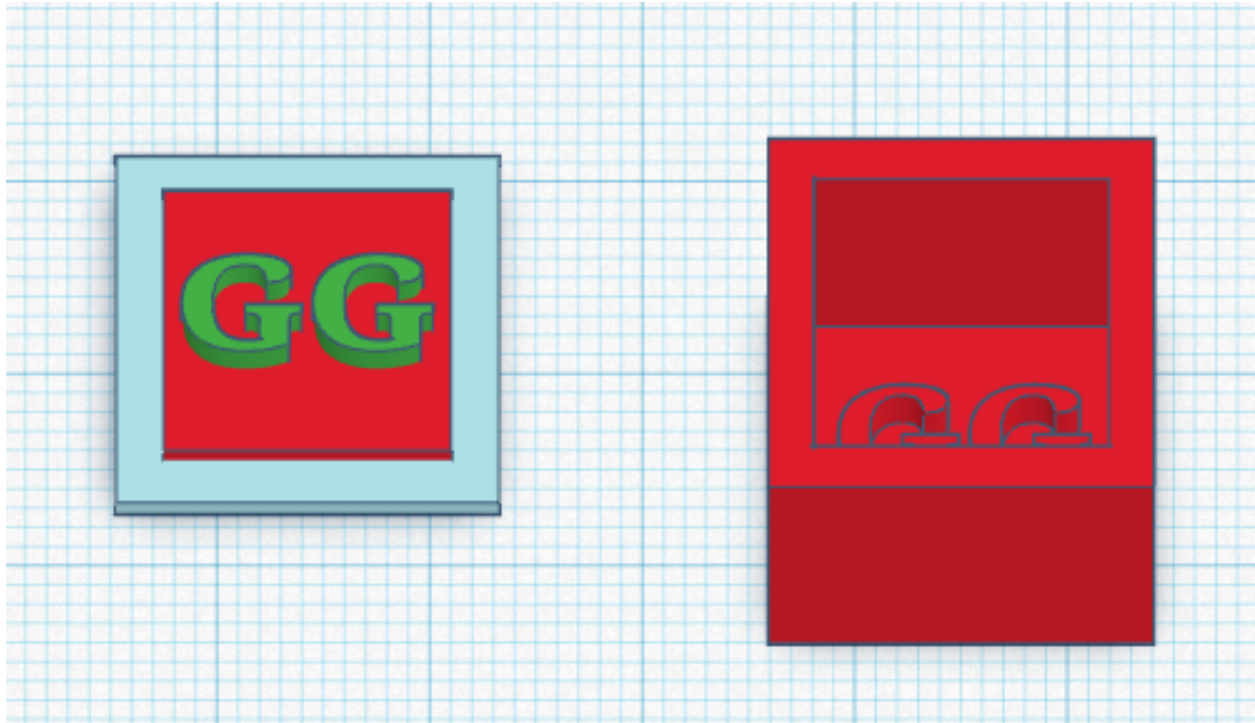
Now use the text basic shape to put your initials into the bottom of the box. Make the letters about 4 mm high so they extend above the floor of the box by 2 mm.



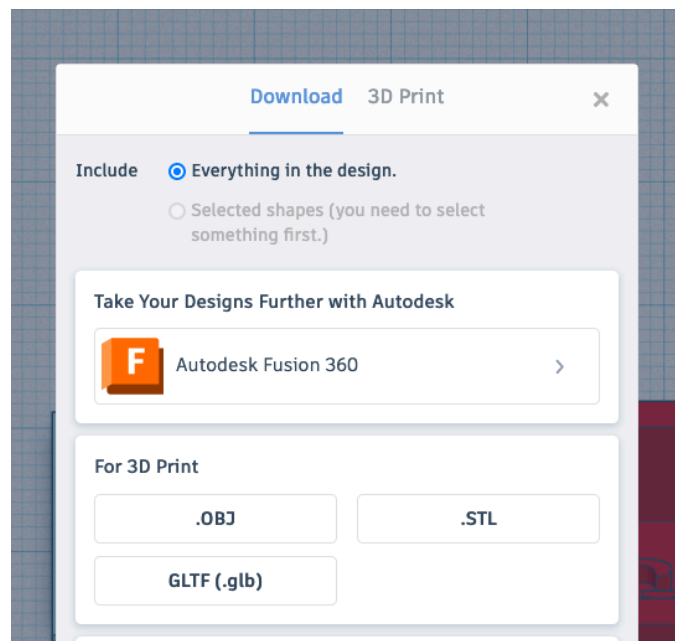
Put your initials inside the box, select everything, then group all objects.



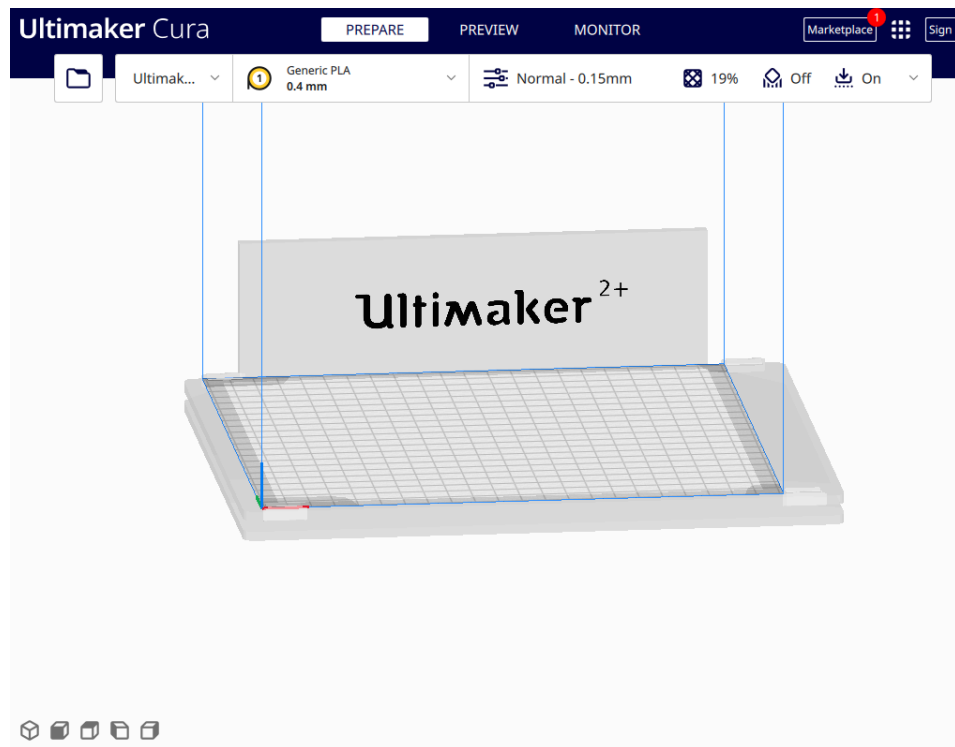
Now make the lid from a 1 mm thick square that's 18 mm on a side, and a 2mm thick square that's 13.5 mm on a side. (This'll give us a little bit of clearance.) have the bottoms of both squares set to $z = 0$. Put your initials on the lid, then group the lid components.



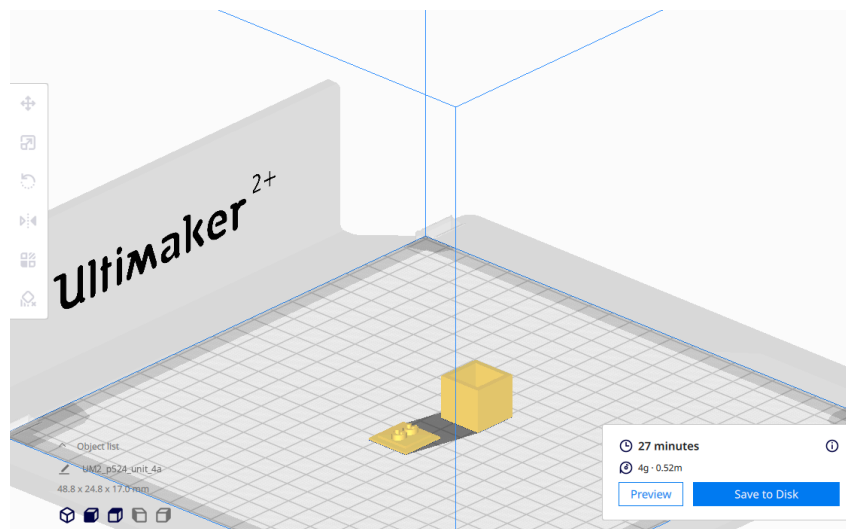
Now click the Export tab and save everything as an .STL file:



Download and install Cura from <https://ultimaker.com/software/ultimaker-cura/>. Open Cura and set the printer model to Ultimaker 2+, the filament to “generic PLA,” the nozzle size to 0.4mm, and the printer profile to “normal.”



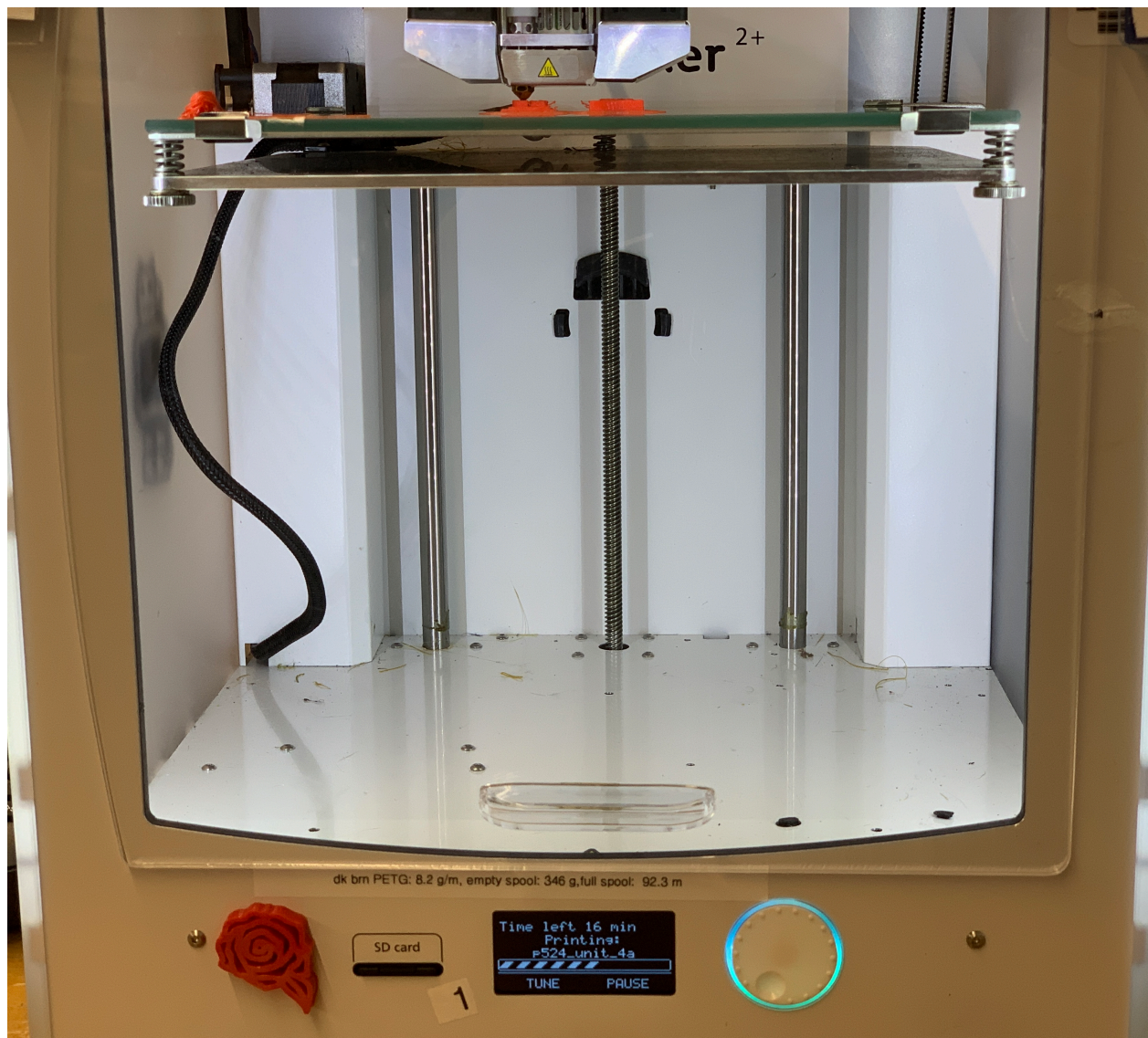
Drop the STL file from Tinkercad onto the Cura window. Click “slice” then save the gcode file to disk, then a microSD card.



Prepare the printer: lightly swab the build plate with 70/30% isopropanol/water. Load the SD card, pick the correct file, and start the print job! Turn on the exhaust fan at the back of the printer cover.

I find it works best if I tune some of the printer settings: speed to 80%, nozzle temperature to 225 degrees, build plate temperature to 50 degrees, and material flow to 150%.

Here's a picture:



Homework (due 10/2/2025)

Design a box lid that slides into place instead of just sitting on top of the box. When you're finished with your design, email me both the STL file and the gcode file. Then print and show me the box.

