

Make a Robot-Head Pencil Top

3D Design for the Beginner (Adapted from *Make: 3D Printing_The Essential Guide to 3D Printers*, Maker Media, Inc. 2014)

We're going to make a personalized Robot Head Pencil Top in TinkercAD. Start by:

1. Open a Chrome browser, navigate to TinkercAD and log into your account.
2. Start a new design.
3. Before starting, rename. Do this by clicking "Design" and "Properties" from the dropdown. Rename the File: **First & Last Name_PencilTop_r1_vA**
4. In the same window, change visibility to public and click "Save Changes". You're ready to begin!

Step 1. Make a Hole

To make the hole that your pencil will fit into, measure the width and height of a pencil eraser. It's about 7.5 mm at the widest point, so click and drag a cylinder onto the Tinkercad "workplane" (the blue grid) and scale it to a 8 mm diameter. This will provide 0.25 mm of wiggle room all around the pencil. To scale something in Tinkercad, first select it by clicking on it, then click on one of the small white rectangles situated around the object—these are called handles—and drag it.

To scale the shape uniformly in all directions, hold the Shift key while dragging.

The height of the eraser is about 20 mm, so stretch the cylinder to 20 mm using the top handle. Don't use the Shift key here because you want to stretch only the height, not the diameter.

Now, with the cylinder selected, click the Hole icon (next to Color in the upper-right corner of the workplane window). This will turn the cylinder into negative space, indicated by gray stripes (see Figure 4-1).

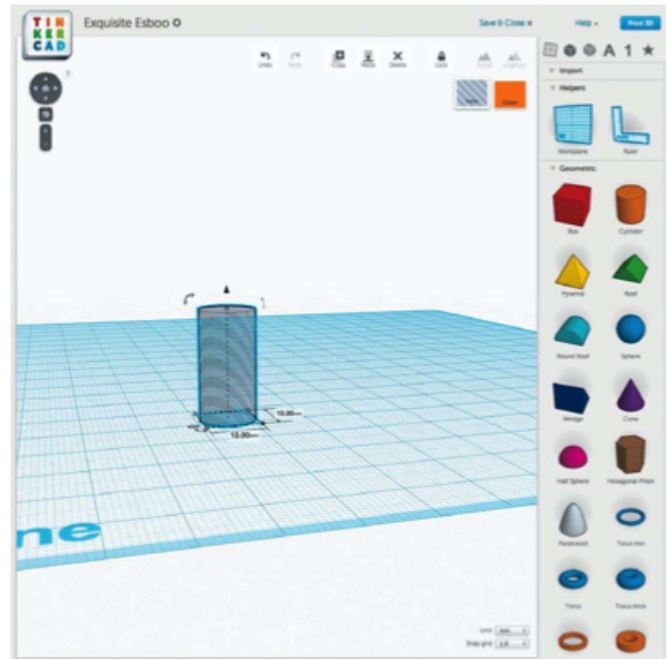


Figure 4-1. A negative space object

Step 2. Make the Robot Head

Make a box for the robot head. You can make it any size, as long as the width and depth will encompass the negative cylinder with at least 1–2 mm on each side. I made a head that was 34 mm wide × 24 mm deep × 24 mm high, and placed it alongside the hole. (Figure 4-2).

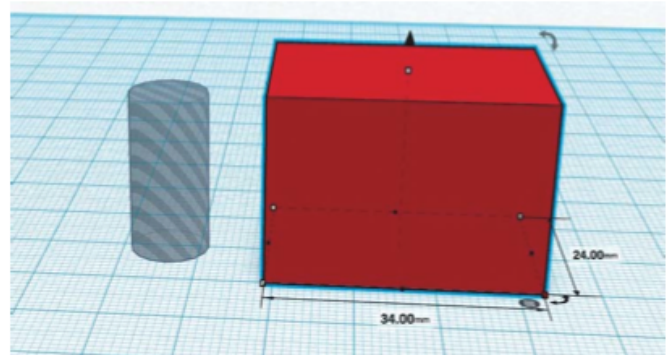


Figure 4-2. Make the robot head

Step 3. Align the Head and the Hole

To make sure the hole is in the center of the box, use the handy Align tool. Select both the box and the hole cylinder by Shift-clicking each object, or click-dragging your cursor to create a Select box around them, or using Ctrl-A (Cmd-A on a Mac) on your keyboard to select everything. Look for the small gray circle with three white lines next to your selection. Click it and select Align.

Tinkercad will highlight both objects with alignment dots. Click the two middle dots on the horizontal plane to position the hole in the center of the box (Figure 4-3). Don't center the hole on the vertical axis because that would seal the hole entirely inside the box, which would make it impossible to fit a pencil in the bottom.

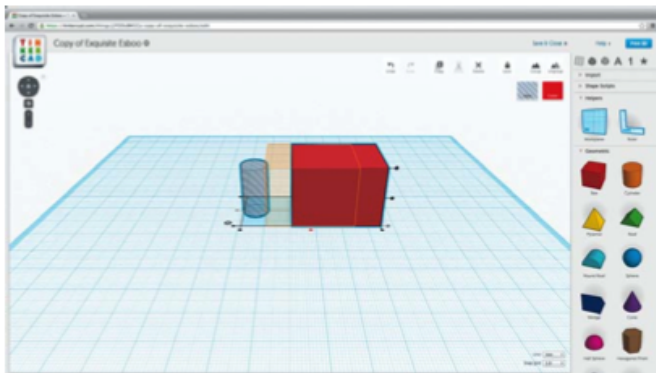


Figure 4-3. Align the head and the hole

Step 4. Combine the Head and Hole into a Single Object

Select both pieces and combine them into a single object by clicking the Group icon (Figure 4-4).

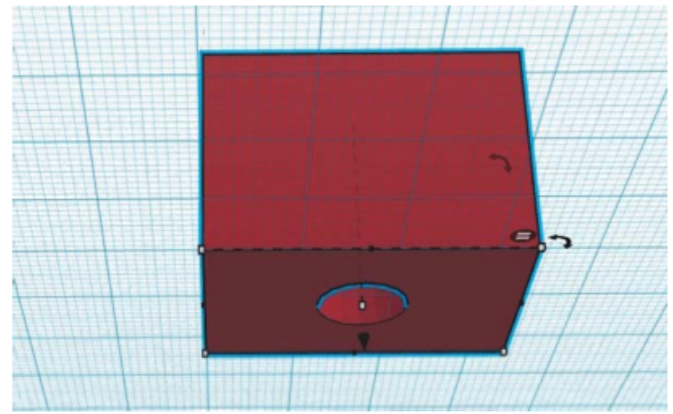


Figure 4-4. Combine into a single object

Step 5. Make the Head Hollow

Make a hole box to put inside the robot's head. Size it 4 mm smaller than the head in both width and depth. This will leave the head with 2 mm-thick walls.

We don't want the inside to be completely hollow, as we need material at the bottom to hold the pencil in place. So, leave about 10 mm of material at the base by making your hole box 10 mm shorter than the head. In my case, the interior hole is 30 mm wide × 20 mm deep × 14 mm high (Figure 4-5).

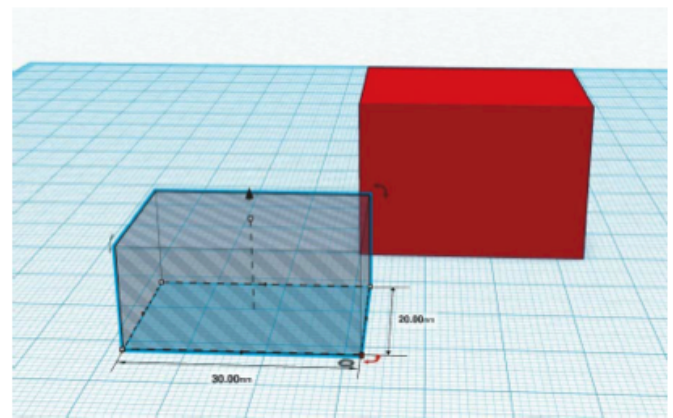


Figure 4-5. Create an interior hole

Use the Align tool to align the hole box to the top of the robot head, by selecting the top-most vertical dot (Figure 4-6). Now select just the hole box and use the arrow handle to move it down 2 mm (Figure 4-7).

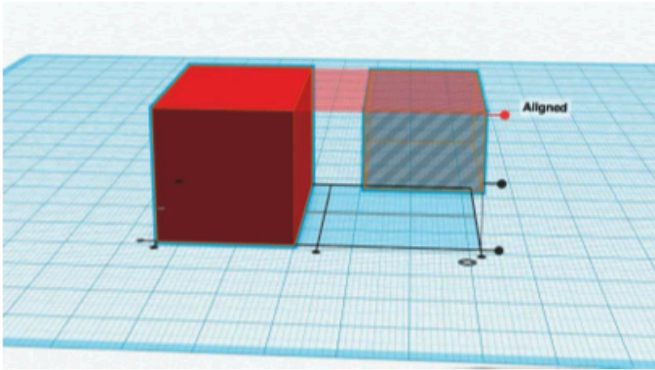


Figure 4-6. Select the topmost vertical dot

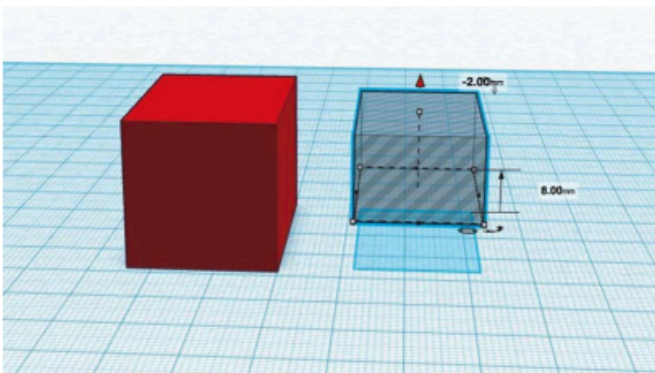


Figure 4-7. Select the hole box and use the arrow handle to move it down 2 mm

Select the hole box and the head box again, and align them on the horizontal plane (but again, don't click the vertical align buttons or else the hole box will move to the top or bottom of the head box).

Select all the pieces and combine them into a single object by clicking the Group icon. You now have a nice 2 mm border on the top and sides of your hollow robot head.

By default, the workspace has a grid snap size of 1 mm, so when adjusting the space between two objects, you can use the arrow keys to move the selected shape in 1 mm increments.

Notice that a selected shape casts a shadow

on the blue gridded plan of your workspace. Use this shadow to help you place your pieces into their proper locations.

Step 6. Make Your Robot's Mouth

Start by making a mouthpiece with a box that's smaller than the robot's head.

To create the speaker-grill ridges, make a series of even smaller hole boxes. You can make one and create copies by clicking the Copy button; using copy-paste keyboard commands; or clicking on the original, holding the Option key, and dragging off a clone. Space them evenly apart and slide them into the mouth box (Figure 4-8).

Then, with only the hole boxes and the mouth box selected, click Group. This will apply the hole objects to the box, cutting out the negative shapes, and turning them into holes (Figure 4-9).

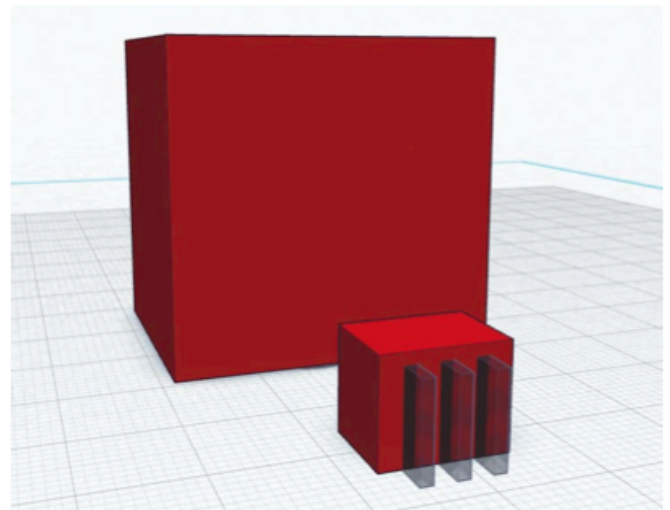


Figure 4-8. Construct the mouth ridges

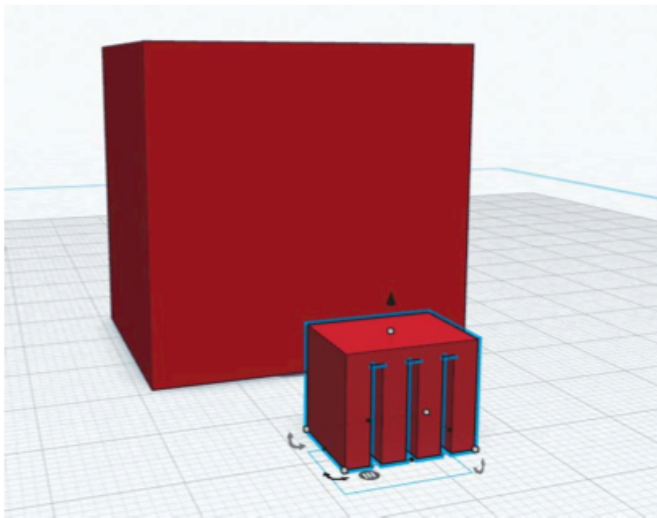


Figure 4-9. Create the mouth ridge holes

Place the mouthpiece so it sticks out from the front and bottom of the head box. (Don't push it in so deep that it intersects the pencil hole.) Group the head and the mouthpiece (Figure 4-10).

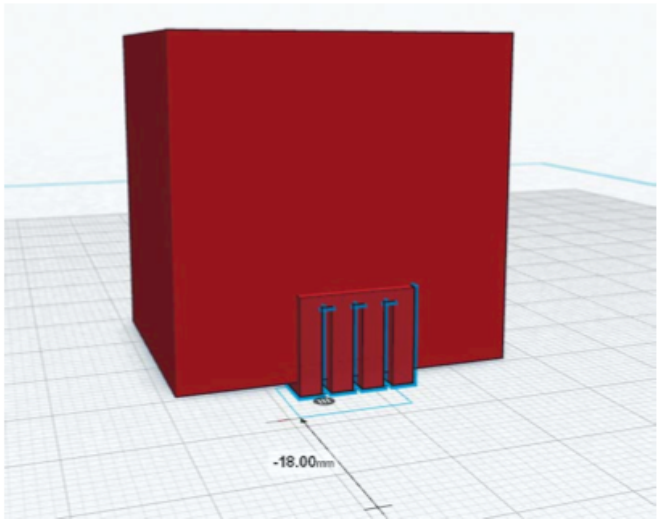


Figure 4-10. Group the head and the mouthpiece

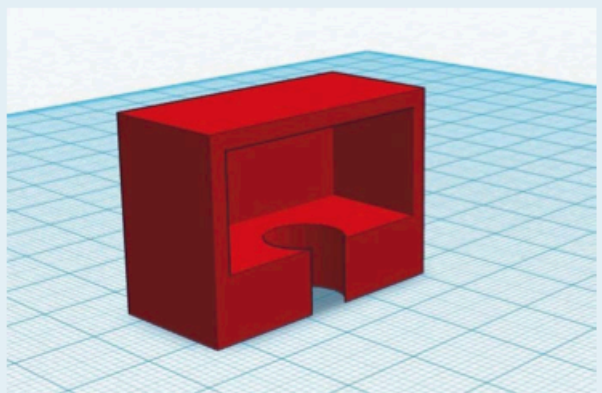
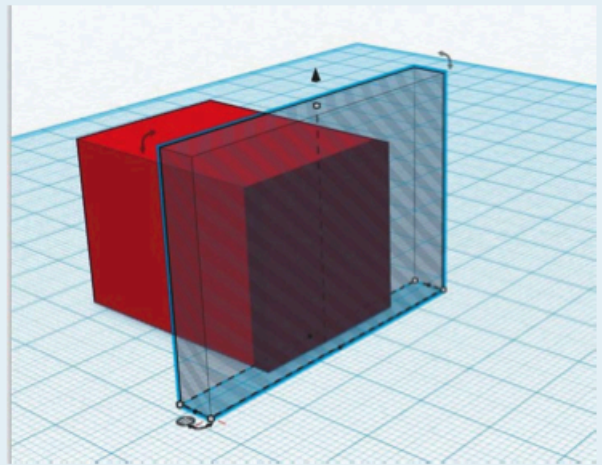
Step 7. Make Your Robot's Eyes

To make the eyes, drag two cylinders into the workspace and make them holes. See those curved arrows next to the cylinder? Click and drag them to rotate the cylinder into the proper orientation (Figures 4-11 and 4-12).

X-Ray Vision

How can you verify that the hole box is positioned correctly inside the head? Here's a little hack that provides a clearer view inside your work.

Drag a box onto the workplane, turn it into a hole, and change its dimensions until it's larger than one side of your design. Move the hole box so that it intersects your design, select all the objects, then click Group. *Voilà!* An interior view. Now, just Undo your way back to where you left off.



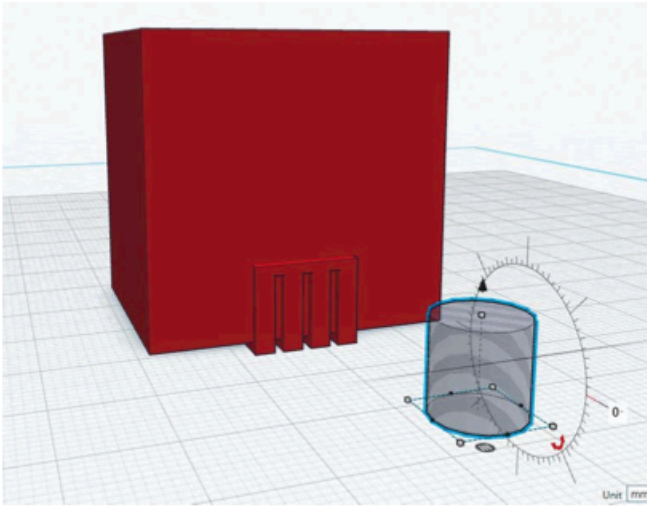


Figure 4-11. Get a cylinder

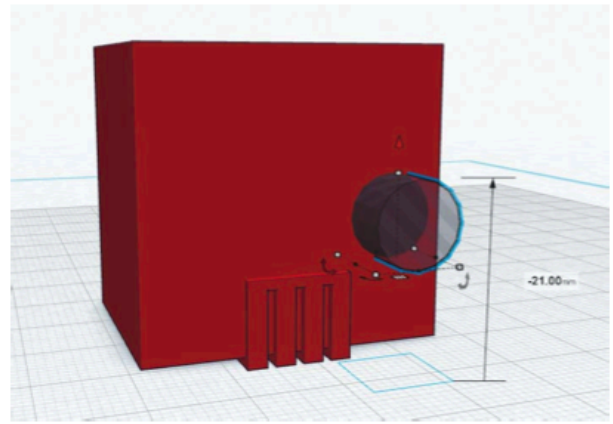


Figure 4-13. Intersect the cylinder with the head by 1 mm

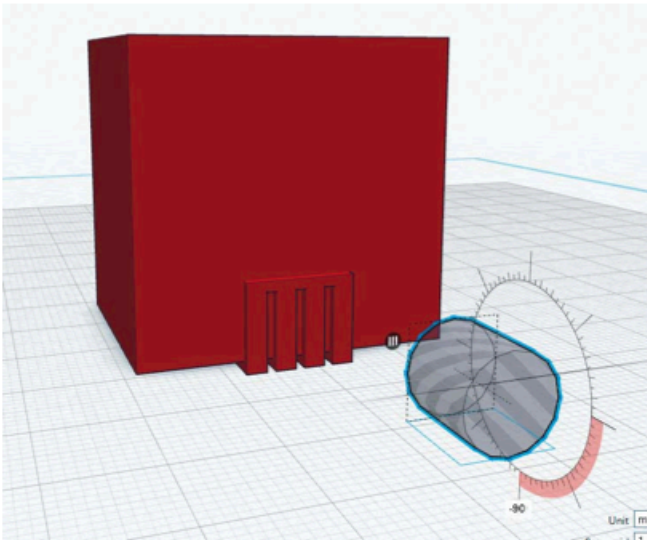


Figure 4-12. Position it into the proper orientation for eyes

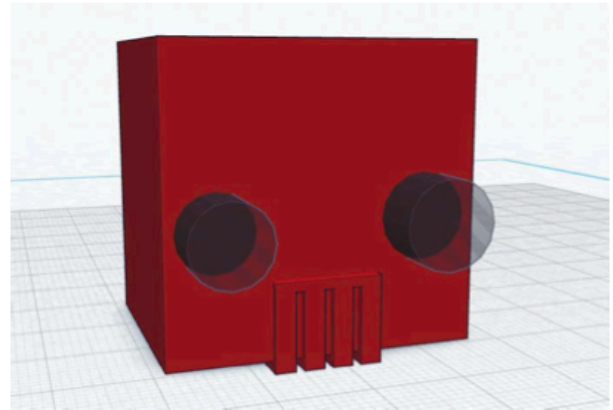


Figure 4-14. Select and group cylinders

You need to raise the cylinders above the workplane grid so you can place them above the robot's mouth. Use the black arrow handle above the cylinder to do this. Make the cylinders different sizes to add a little personality. Be sure the cylinders intersect with the head by 1 mm. Select the cylinders and the head and Group them (Figures 4-13, 4-14, and 4-15).

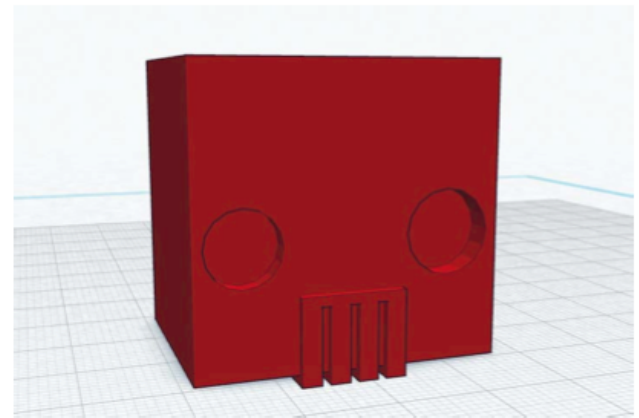


Figure 4-15. Completed print-ready robot head pencil topper

Tada! You now have a print-ready robot- head pencil topper! Bling it out by imprinting your initials! Or add any number of symbols you like to the top, back or sides!