

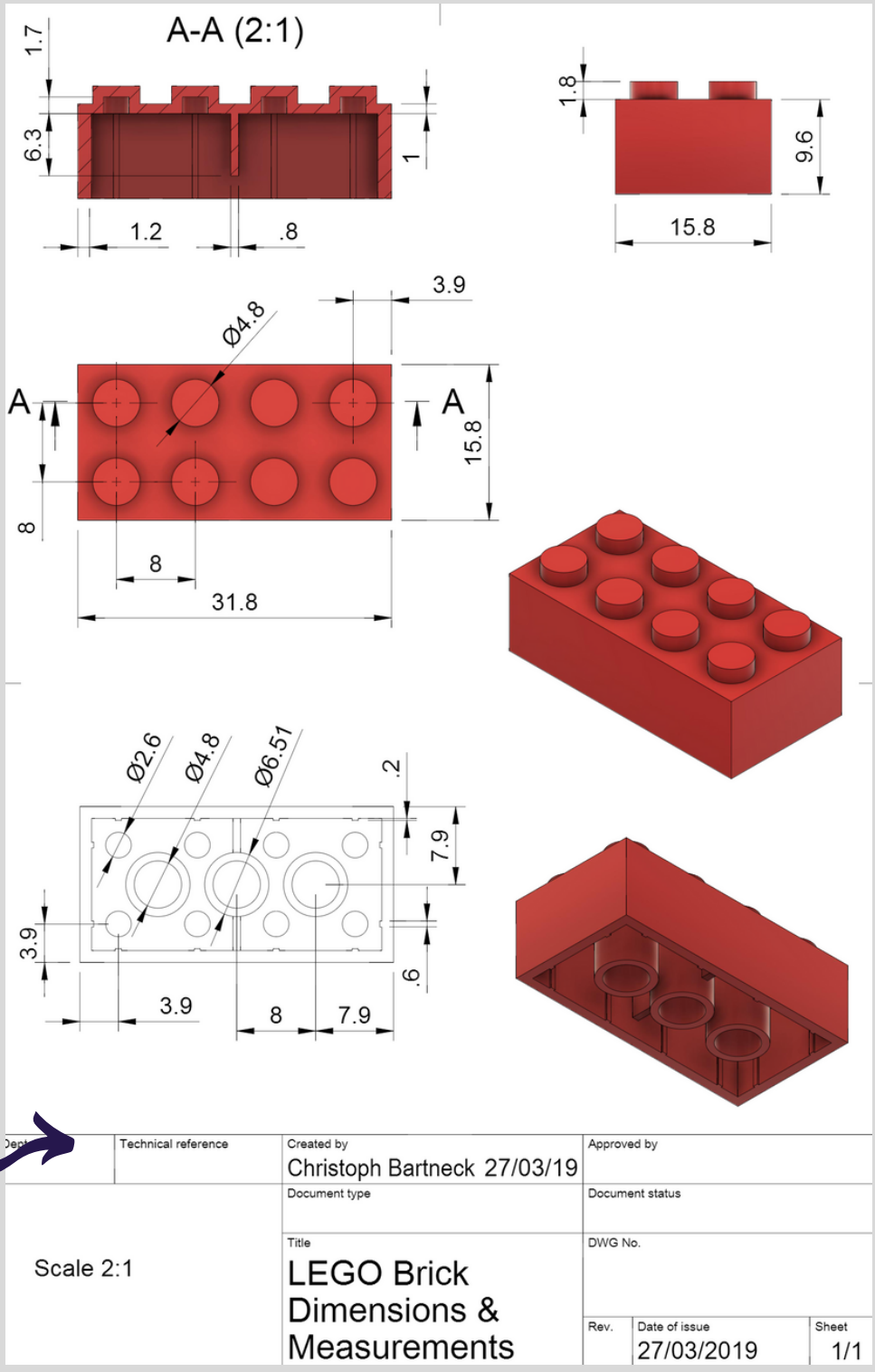
CITY OF CANADA BAY LIBRARIES
THE LEARNING SPACE

REMAKING THE BRICK

Lego's patent for it's iconic bricks began expiring in the early 2000s, but they weren't keen on 3D printers trying their hand at making their favorite bricks. A lot of that controversy has died down these days and Lego bricks make perfect learning models for experienced and budding parametric modelers alike.

There is one big issue we'll hit as we create our own Lego compatible blocks; tolerance. Normal Lego bricks have a very small tolerance so the bricks sit together smoothly with no gaps. As anyone who has 3D printed before should know, 3D printers aren't fantastic with very small tolerances. Add to that the support material needed for this print and you run into a few challenges.

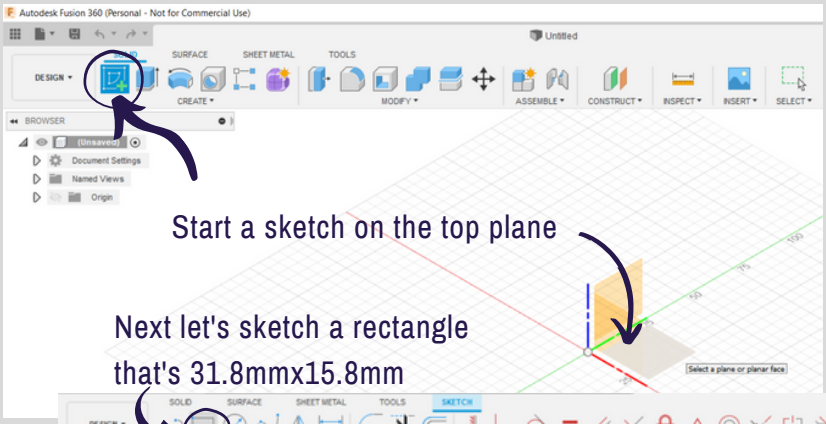
To begin we'll recreate a Lego brick using the measurements from Christopher Bartneck.





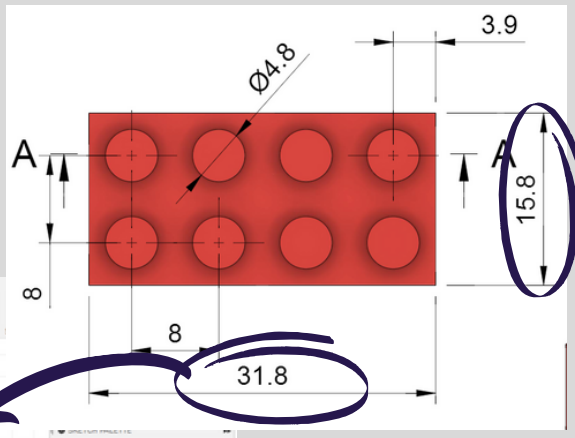
CITY OF CANADA BAY LIBRARIES
THE LEARNING SPACE

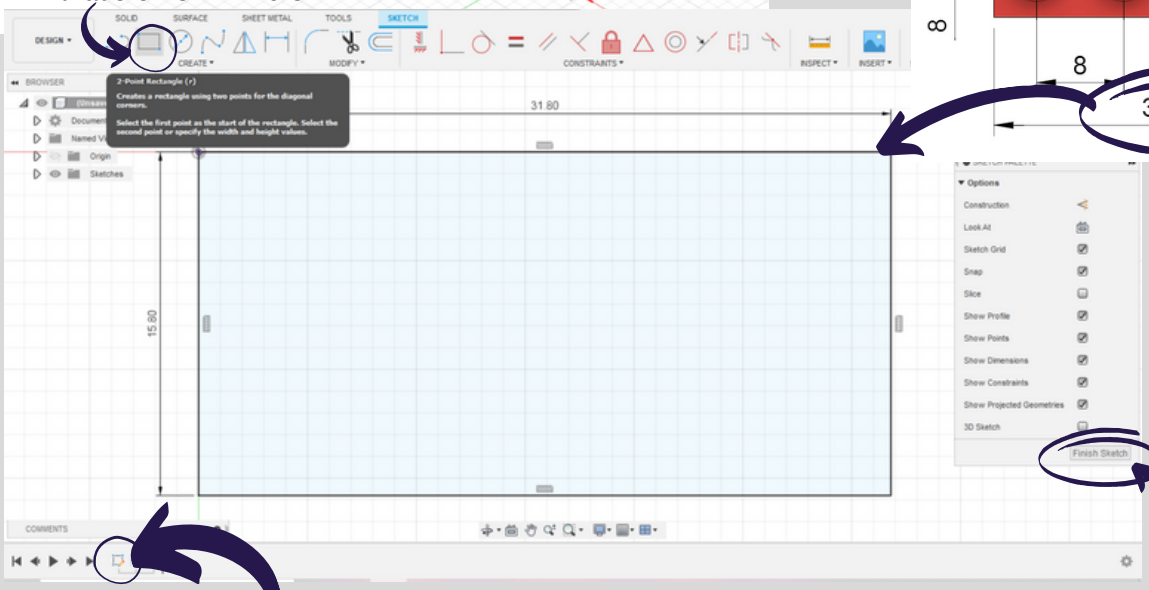
GETTING STARTED



Start a sketch on the top plane

Next let's sketch a rectangle that's 31.8mmx15.8mm

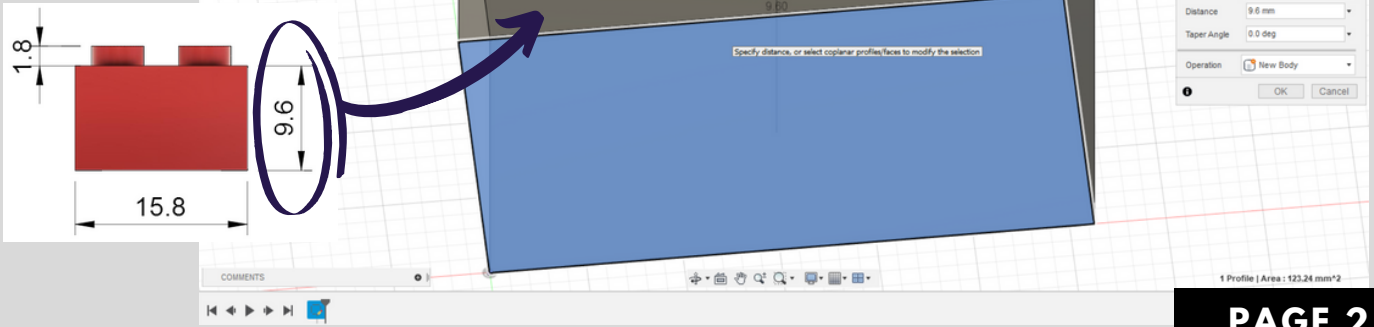




Next let's hit the Finish Sketch button and extrude up the bricks height: 9.6mm

Technical Pointers

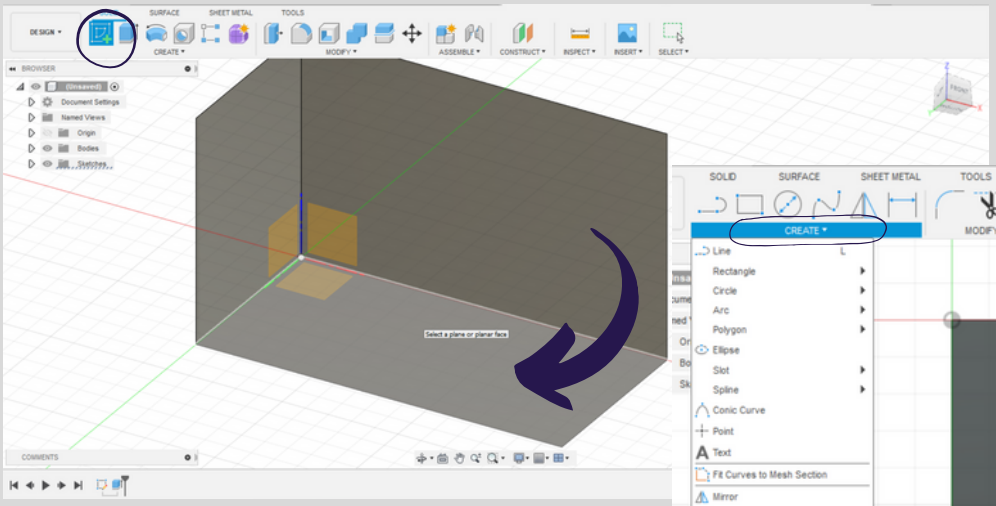
It's easy to get out of the sketch menu while editing your sketch. If this happens don't make a new sketch, instead double click on your original sketch in the timeline



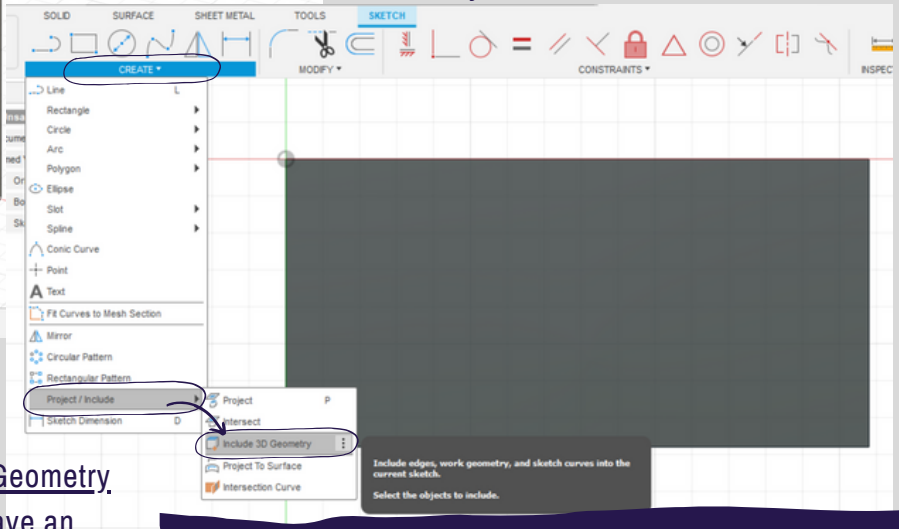


CITY OF CANADA BAY LIBRARIES
THE LEARNING SPACE

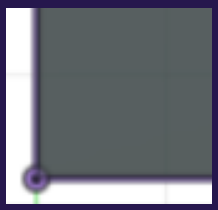
START THE BASE



To make the base of our brick we're going to hollow it out. Start by pressing the Start Sketch button and click the bottom of your brick.



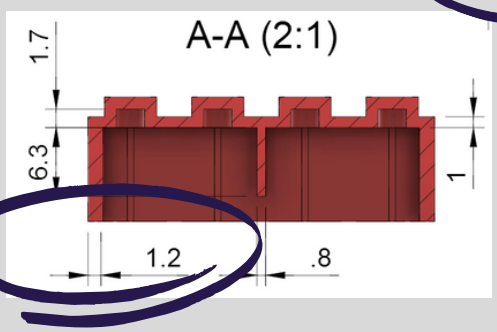
Next head to Create > Project/Include > Include 3D Geometry
Click on the bottom face of your brick so you have have an outline of it.



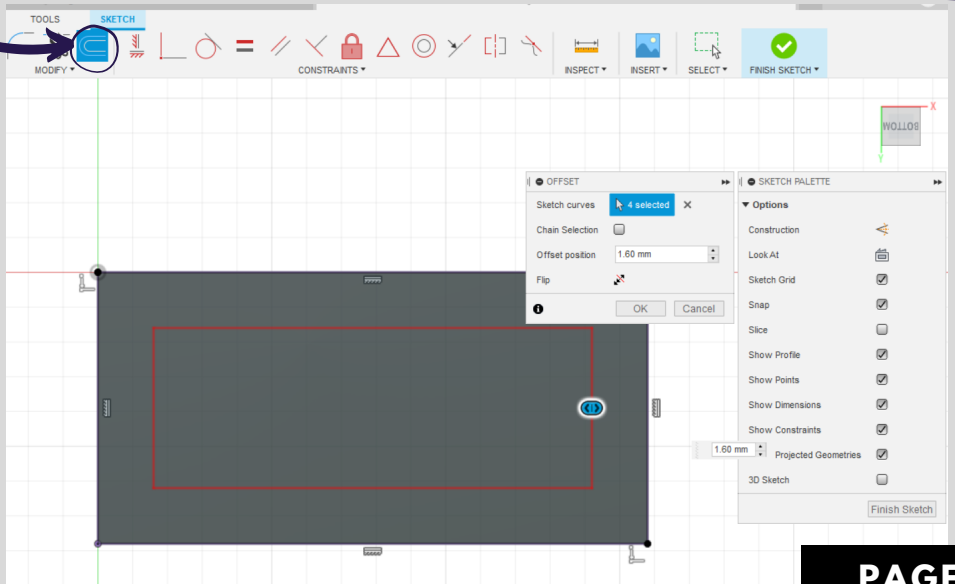
Technical Pointers

Including geometry helps to line up your sketch with previously created bodies. When a line or point has been 'included' it will turn purple. Always check you've got the line you want by rotating your model.

Once you've got the bottom of your brick as part of this sketch click it's outline and create an offset using the Offset tool in the Modify menu.



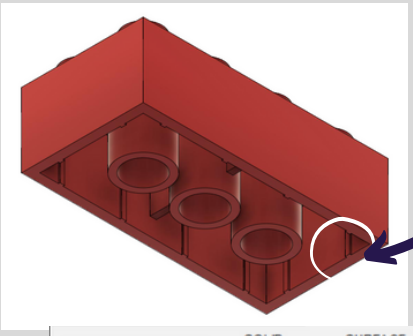
The inner wall of a Lego brick is 1.2mm thick so our offset will be 1.2mm.





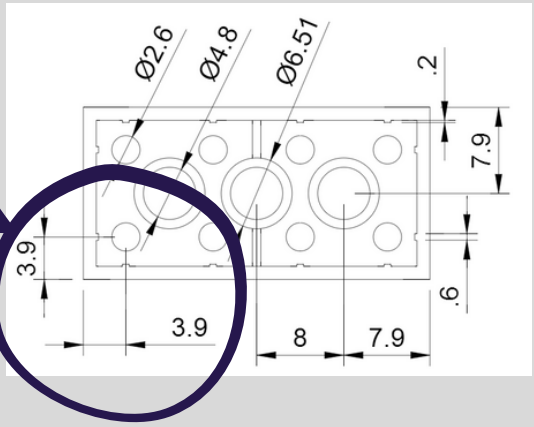
CITY OF CANADA BAY LIBRARIES
THE LEARNING SPACE

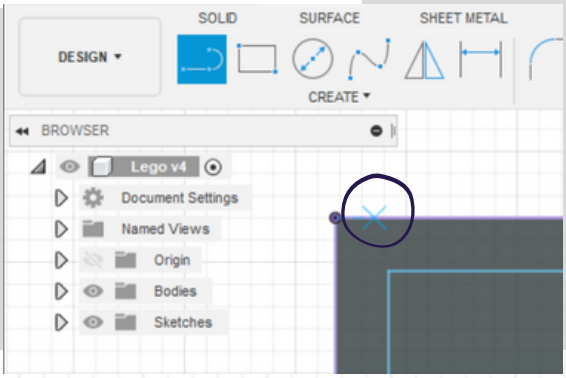
CONSTRAINTS



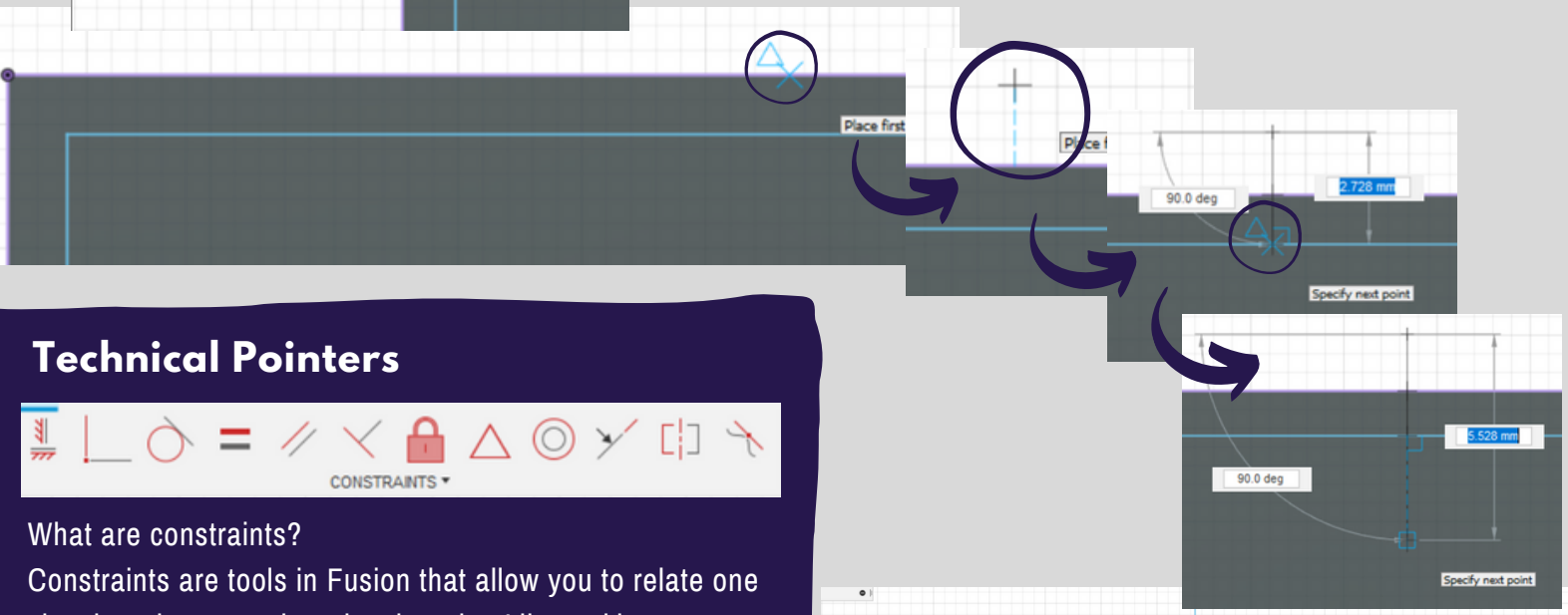
Next we'll be creating these little nubs that help the bottom of the bricks attach to the top of the bricks.

First we'll create a line to use for mirroring, draw a line through the middle of the brick.



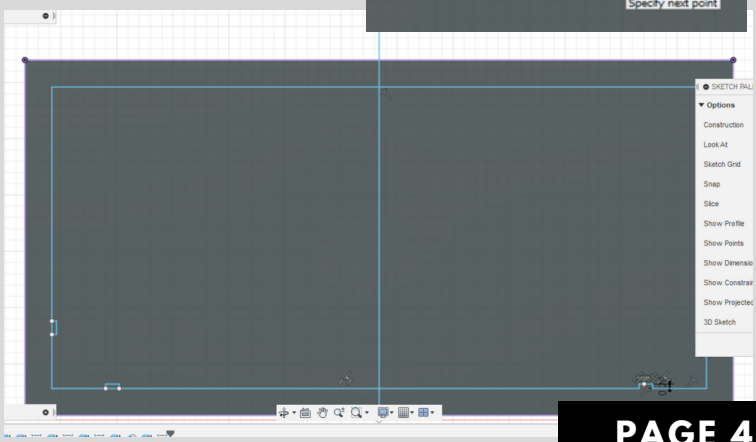


To make sure it's at the midpoint of the brick base, move your mouse over the outside line (your mouse pointer will turn into an X to indicate it's intersecting with another line) until you see a feint blue triangle, this is the midpoint constraint. Once you see the triangle draw a line from to the bottom of your rectangle (or beyond!)



Technical Pointers

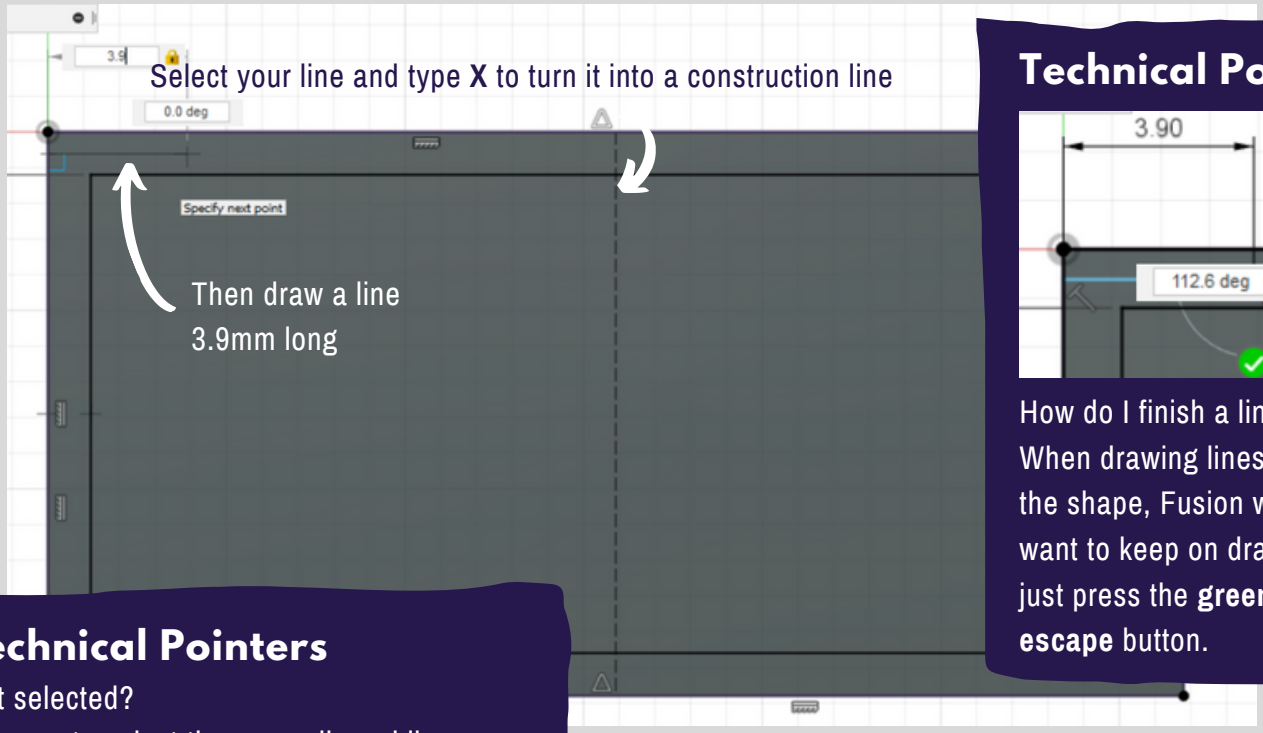
What are constraints?
Constraints are tools in Fusion that allow you to relate one sketch entity to another sketch entity. Like making sure a line intersects with another at it's midpoint or one circle is at the absolute center of another. Constraints are your friends in sketching and Fusion will often automatically apply best constraint to your sketch while your working.





CITY OF CANADA BAY LIBRARIES
THE LEARNING SPACE

CONSTRUCTION LINES



Select your line and type **X** to turn it into a construction line

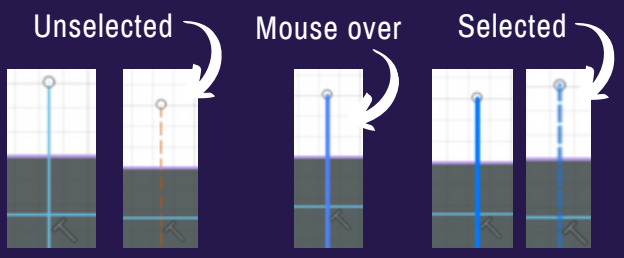
Then draw a line 3.9mm long

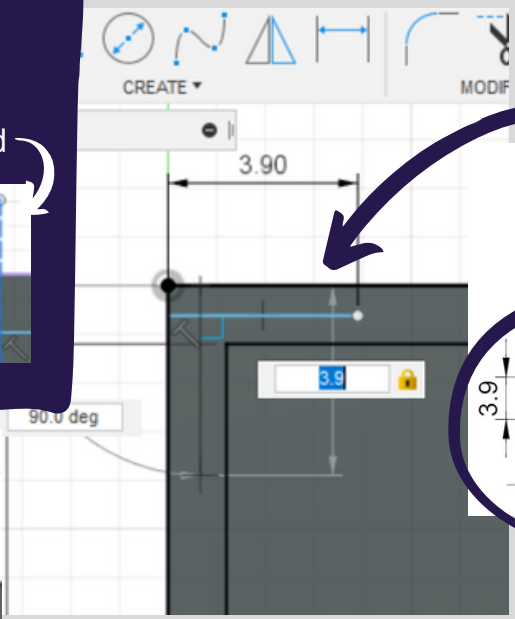
Technical Pointers

How do I finish a line?
When drawing lines unless you close the shape, Fusion will assume you want to keep on drawing. To finish just press the **green tick** or press the **escape** button.

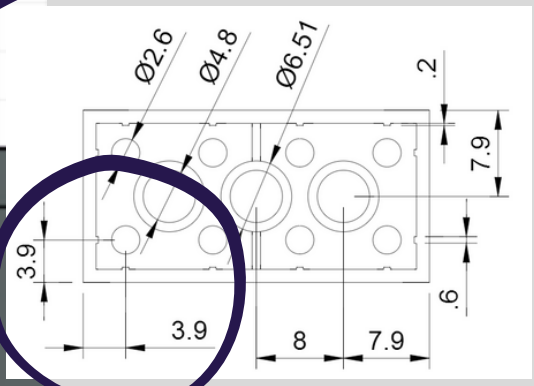
Technical Pointers

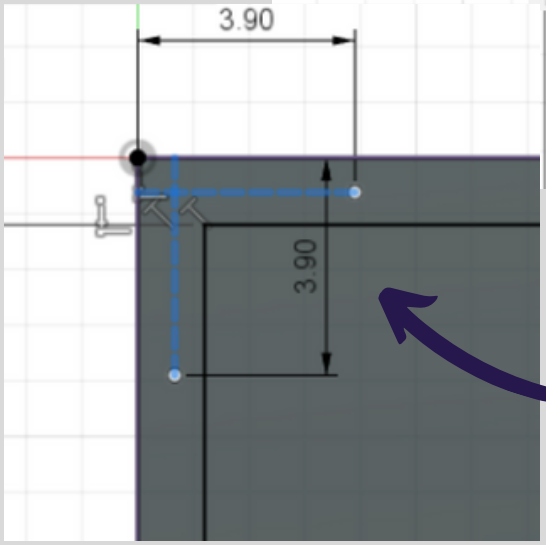
Is it selected?
It's easy to select the wrong line while working, a selected line will go dark blue, even a construction line.





And a second line 3.9mm long



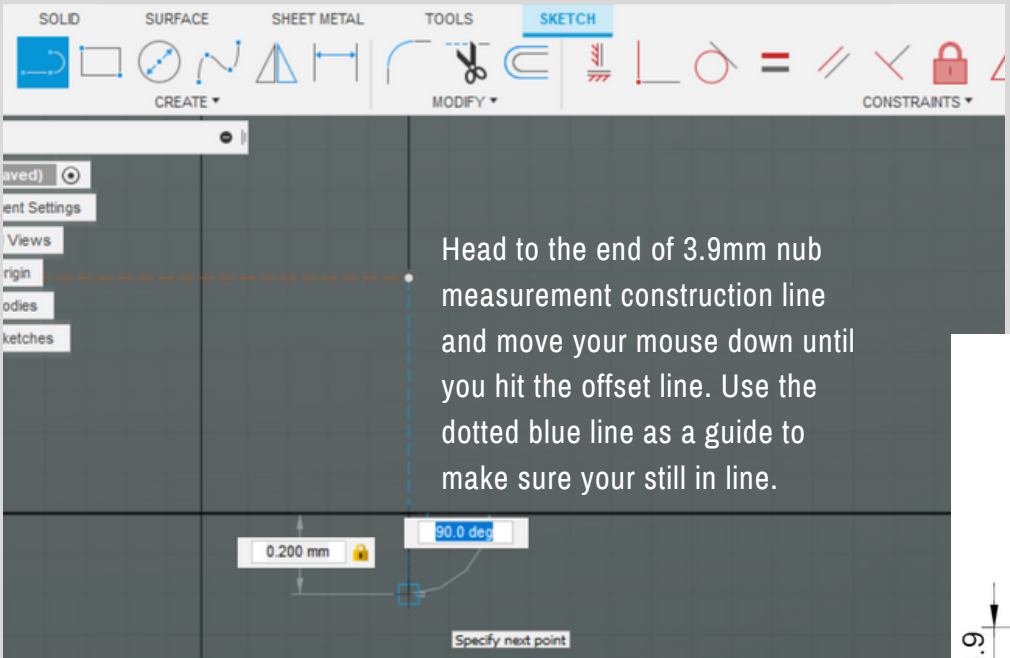


Select both lines and type **X** to turn them into construction lines. Now we've created our measurement lines for the nubs.



CITY OF CANADA BAY LIBRARIES
THE LEARNING SPACE

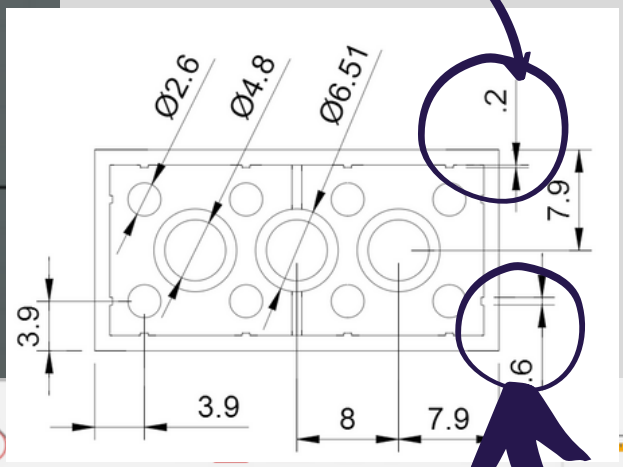
DRAW THE NUB

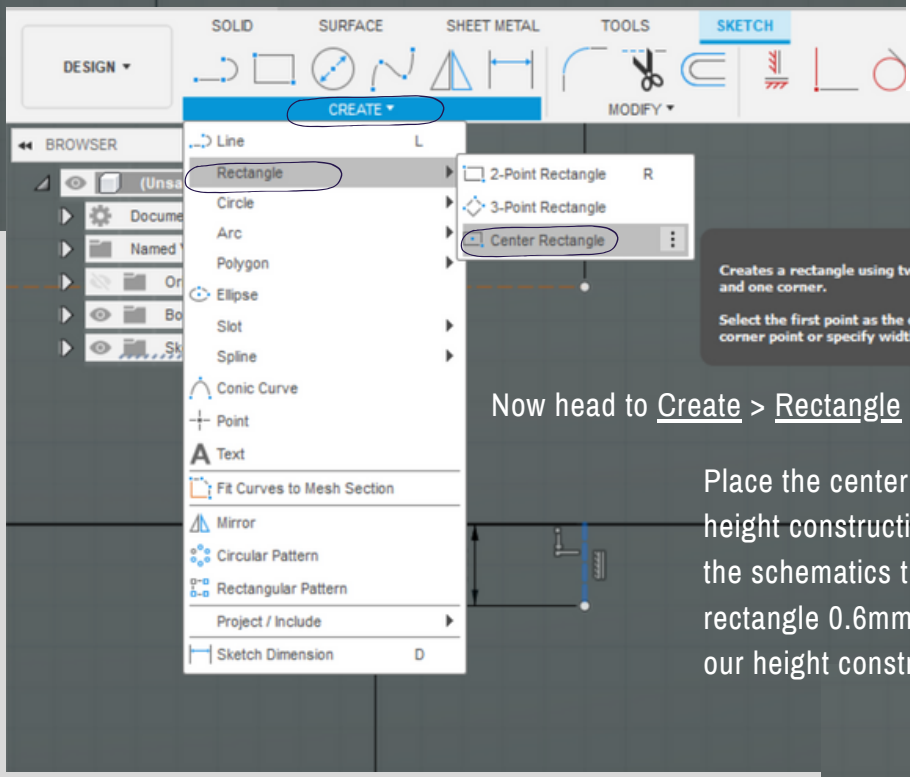


Head to the end of 3.9mm nub measurement construction line and move your mouse down until you hit the offset line. Use the dotted blue line as a guide to make sure your still in line.

Then draw a line 0.2mm down and make it a construction line by typing **X**.

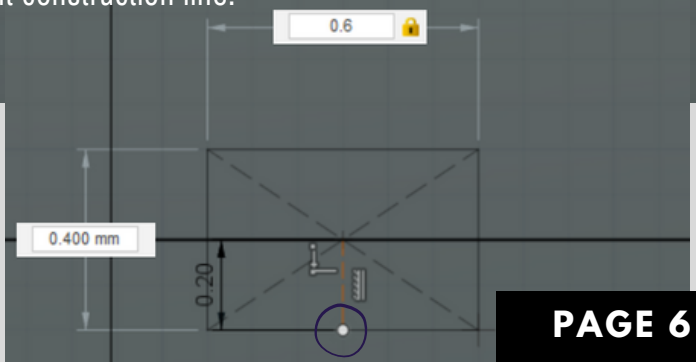
Before I draw the nub I'll create one more construction line for the height of the nub, which is 0.2mm according to our schematics.





Now head to Create > Rectangle > Center Rectangle.

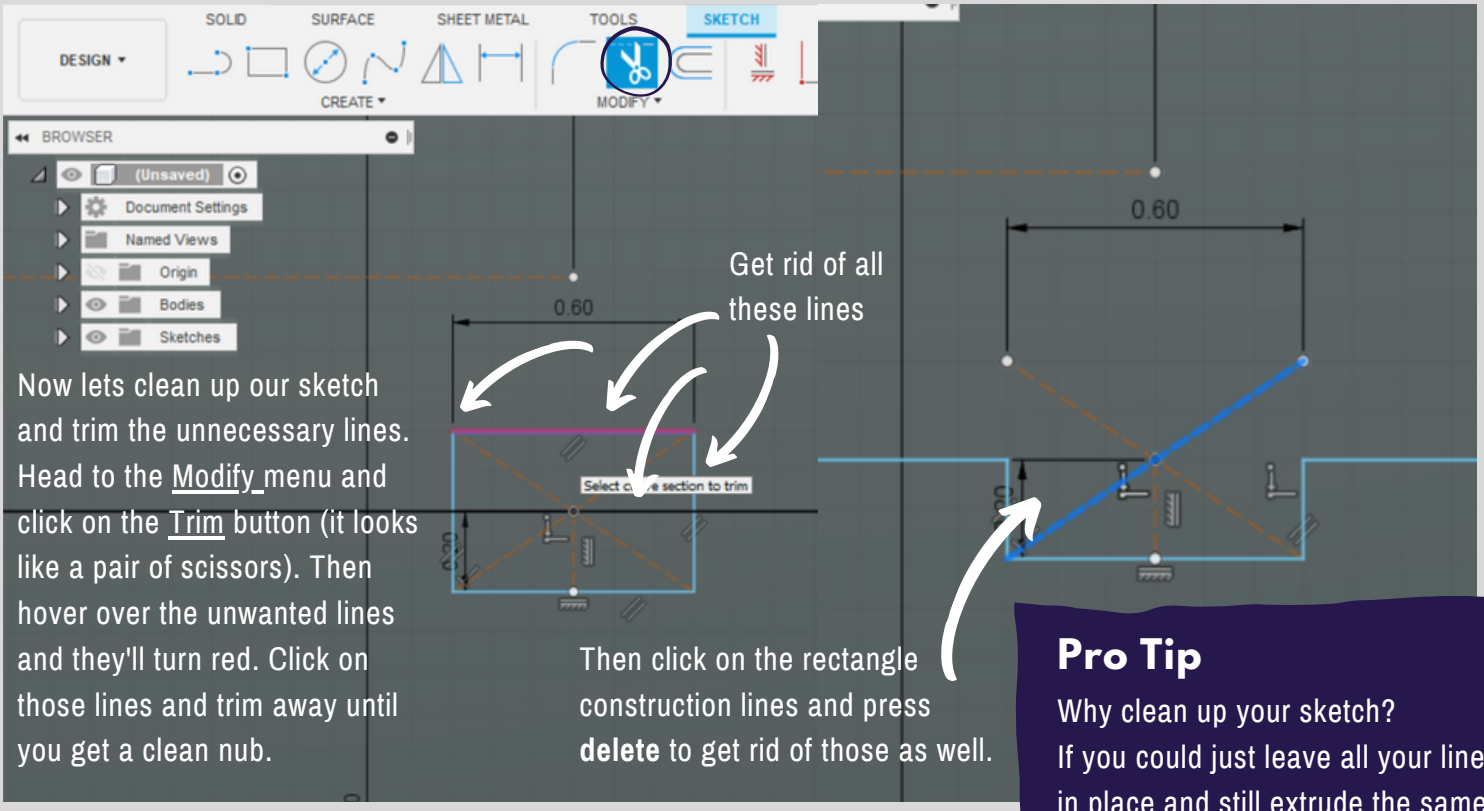
Place the center of the rectangle at the bottom of your nub height construction line and move your mouse out. According to the schematics the nub is 0.6mm wide so lets make our rectangle 0.6mm wide. The height should be 0.4mm/the end of our height construction line.





CITY OF CANADA BAY LIBRARIES
THE LEARNING SPACE

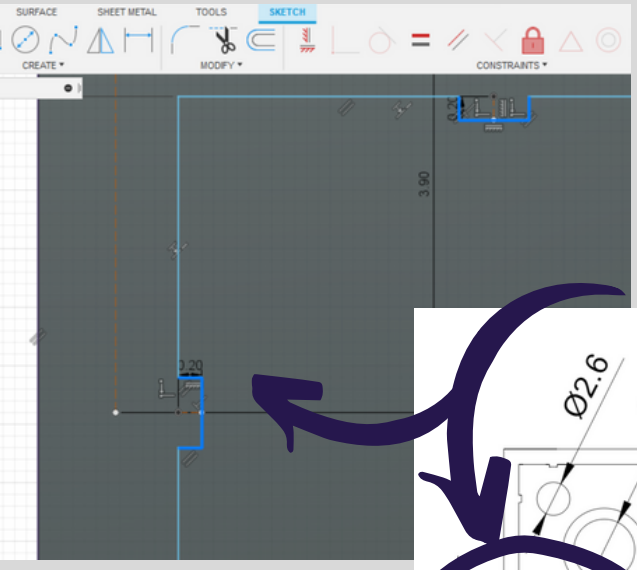
FINISH THE NUB



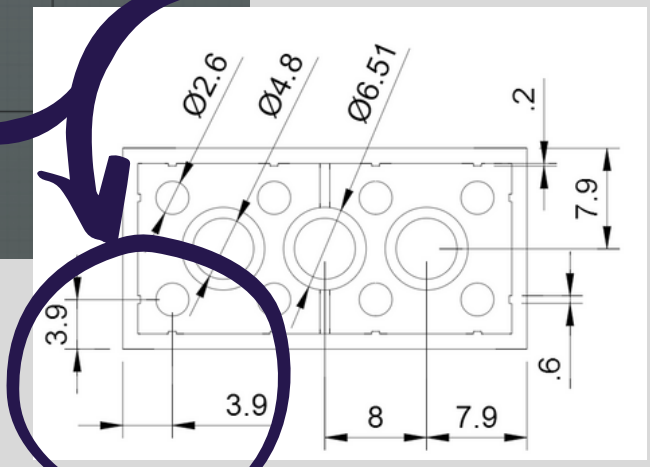
Get rid of all these lines

Now lets clean up our sketch and trim the unnecessary lines. Head to the Modify menu and click on the Trim button (it looks like a pair of scissors). Then hover over the unwanted lines and they'll turn red. Click on those lines and trim away until you get a clean nub.

Then click on the rectangle construction lines and press **delete** to get rid of those as well.



Now repeat the process on the other side to make two nubs, like our schematics.



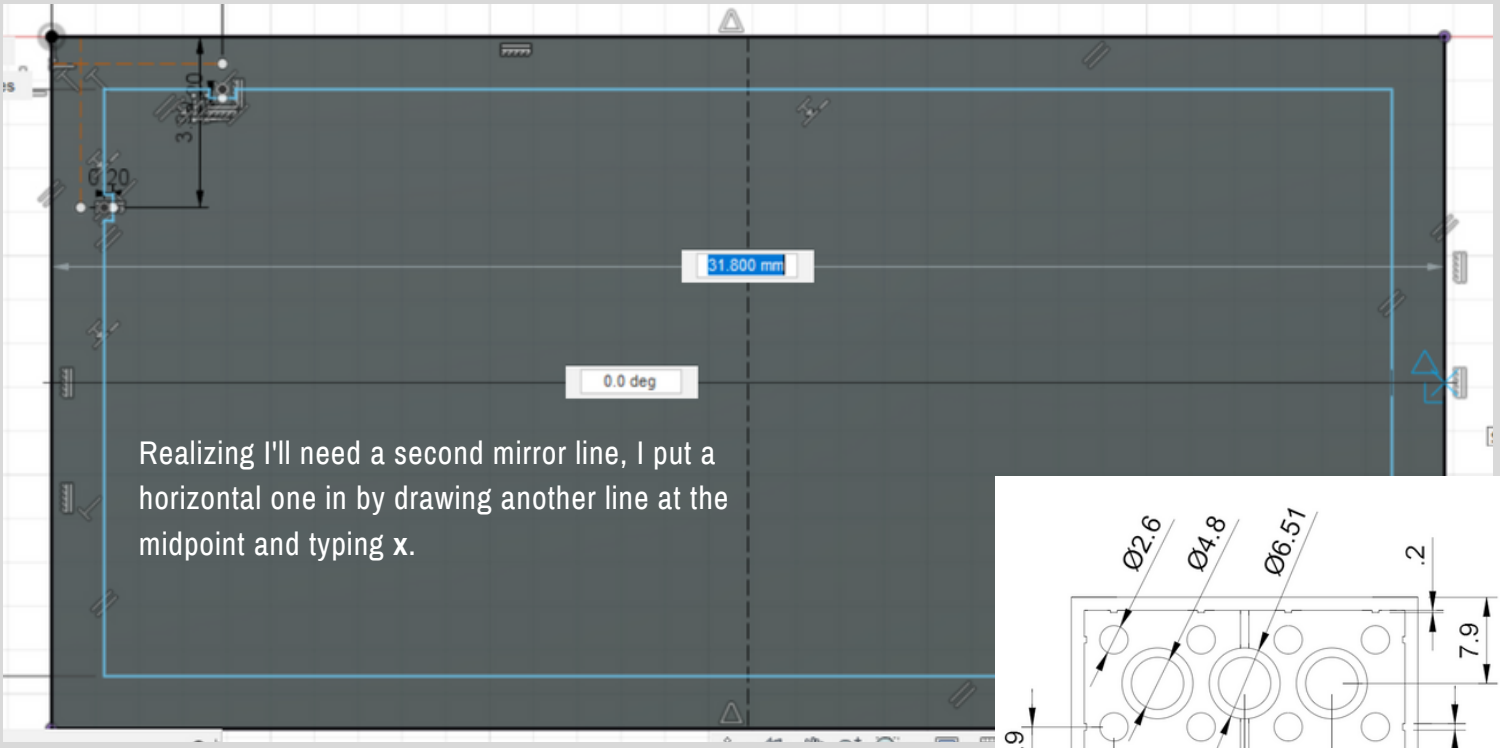
Pro Tip

Why clean up your sketch?
If you could just leave all your lines in place and still extrude the same shape, why bother cleaning up your sketch and trimming lines? The main reason is a clean sketch helps with extrusion. It can be easy to miss small parts of your sketch when extruding leading to holes in your design.

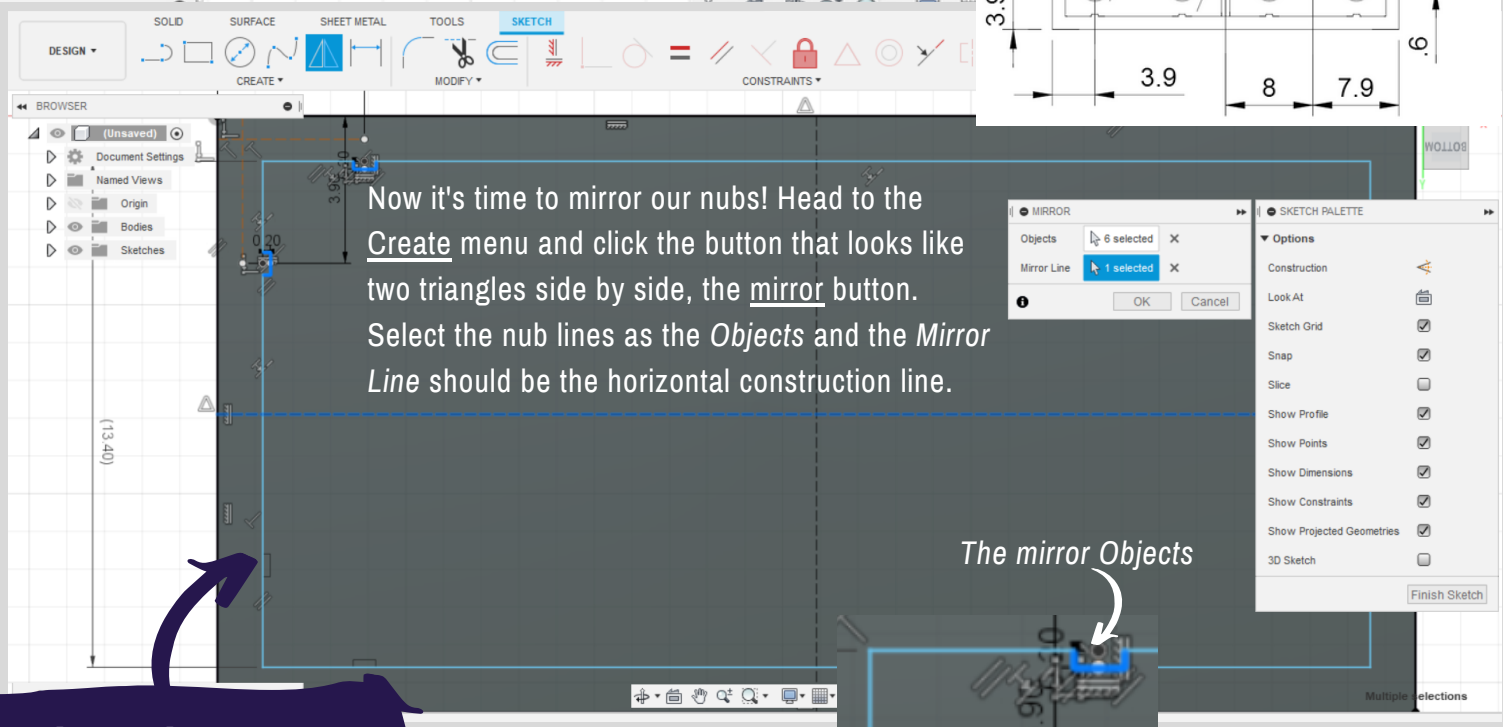


CITY OF CANADA BAY LIBRARIES
THE LEARNING SPACE

MIRROR IT

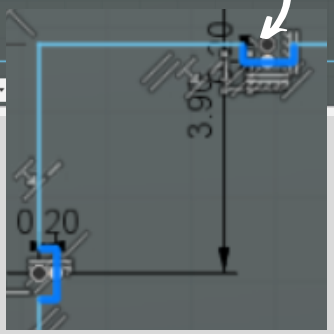


Realizing I'll need a second mirror line, I put a horizontal one in by drawing another line at the midpoint and typing **x**.



Now it's time to mirror our nubs! Head to the Create menu and click the button that looks like two triangles side by side, the mirror button. Select the nub lines as the *Objects* and the *Mirror Line* should be the horizontal construction line.

The mirror Objects

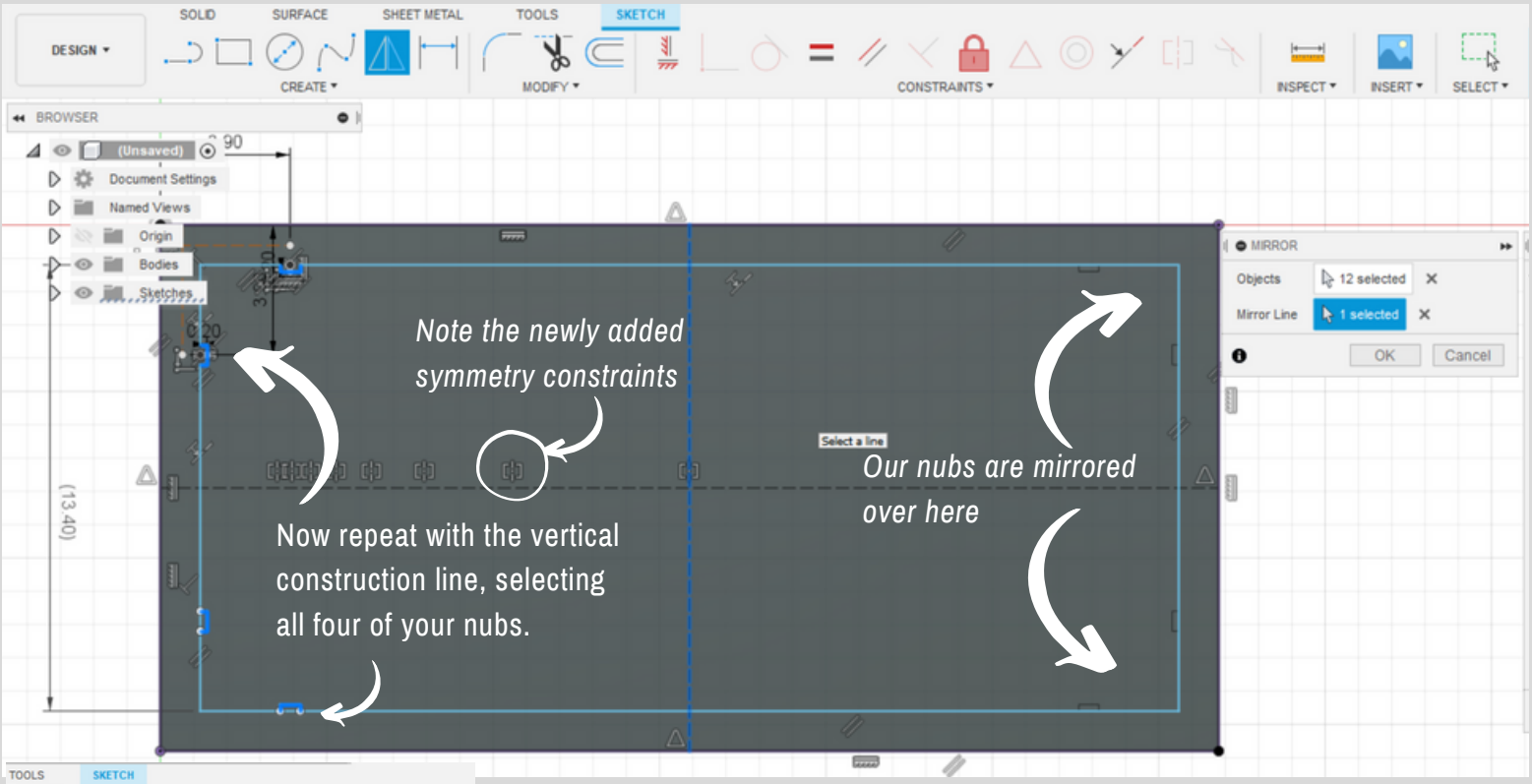


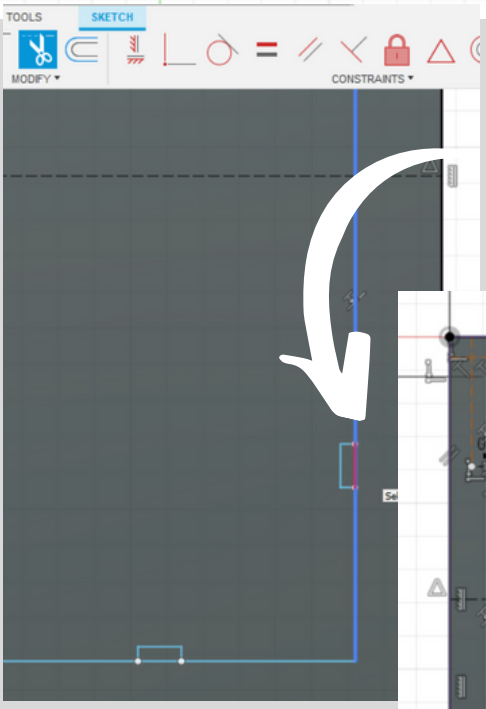
Technical Pointers

Fusion will show what the mirror will produce with black lines



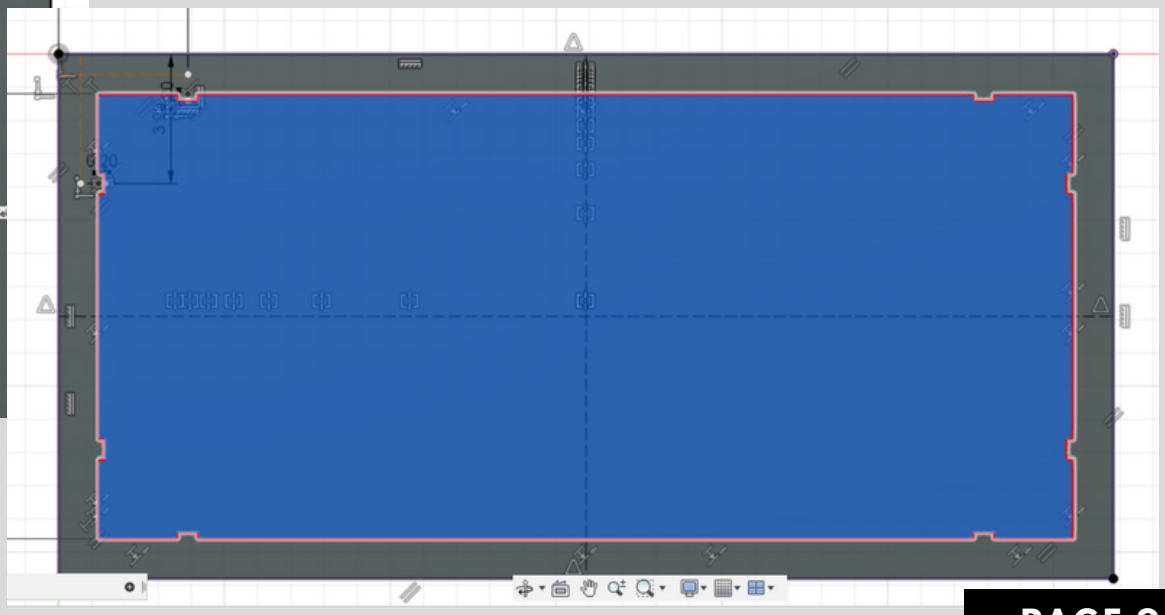
AND AGAIN!





Finally go through and trim all the unwanted lines on all our new nubs.

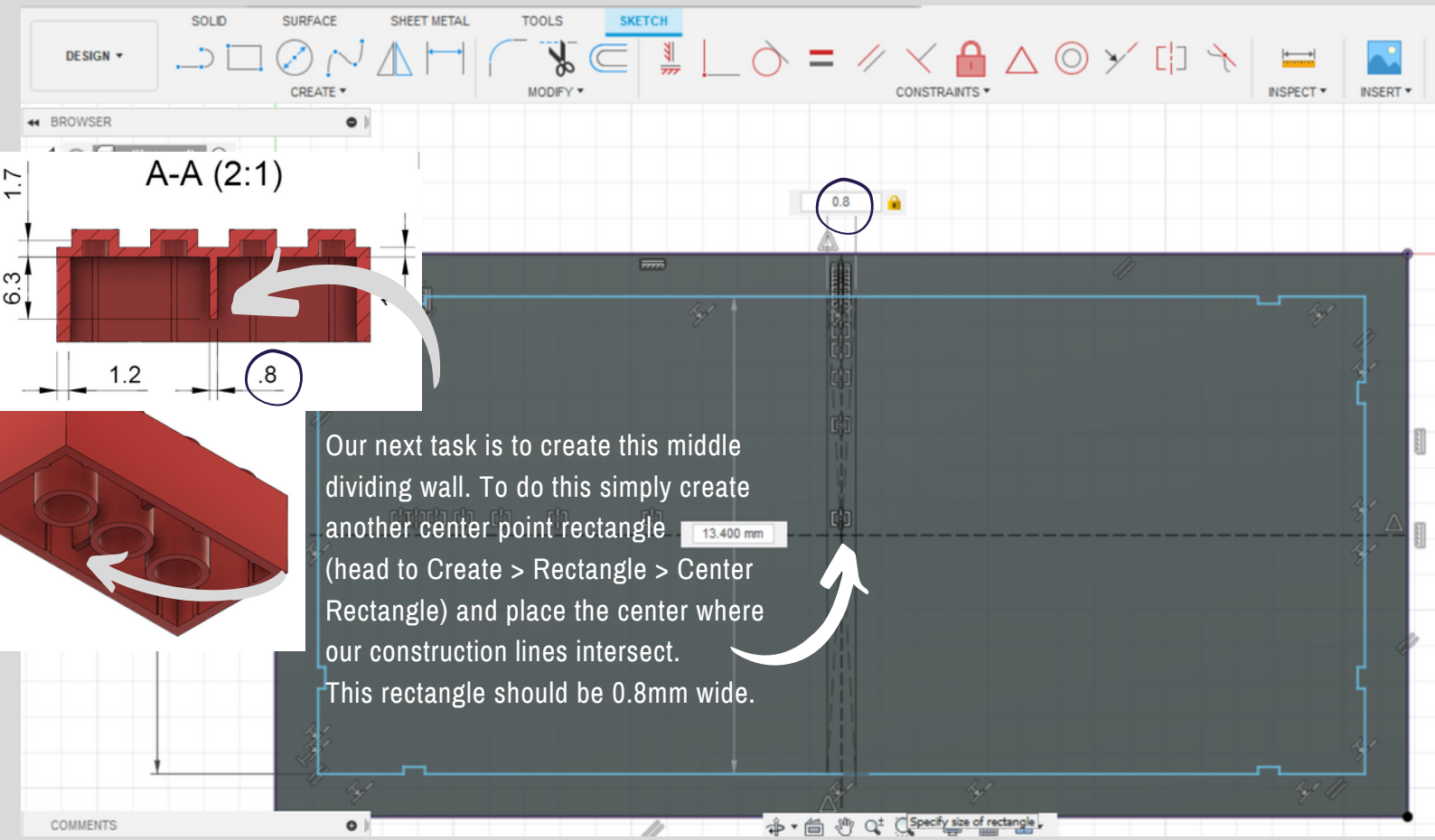
You'll be left with a shape that looks like this but there's still more to go!



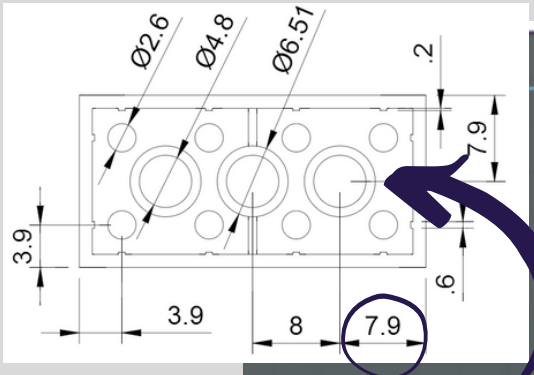


CITY OF CANADA BAY LIBRARIES
THE LEARNING SPACE

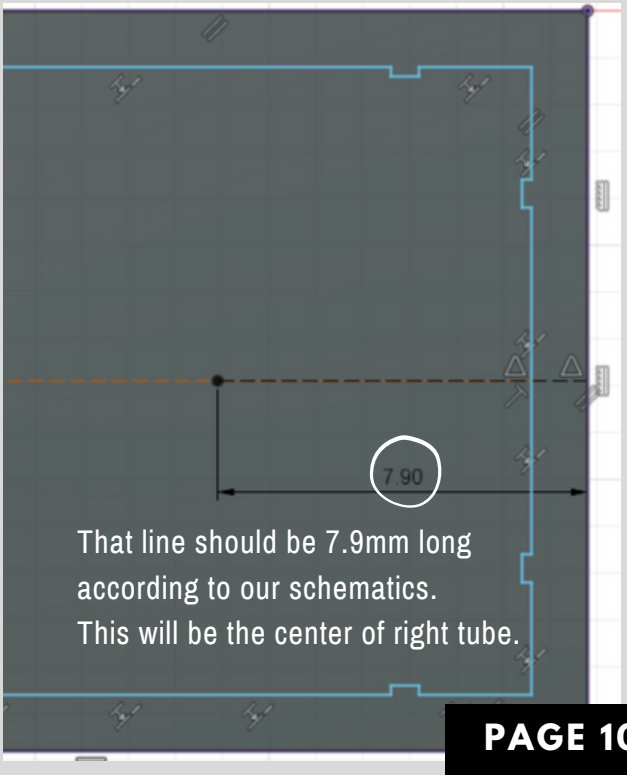
DIVIDING WALL



Our next task is to create this middle dividing wall. To do this simply create another center point rectangle (head to Create > Rectangle > Center Rectangle) and place the center where our construction lines intersect.
This rectangle should be 0.8mm wide.



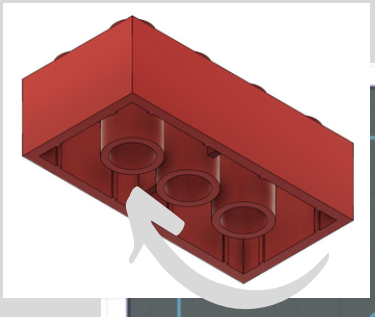
Next let's measure up for the placement of these internal tubes.
Start by drawing a line from the outer edge of the brick.
Remember to look for that X to make sure your intersecting with the line and that triangle to make sure your at the midpoint.



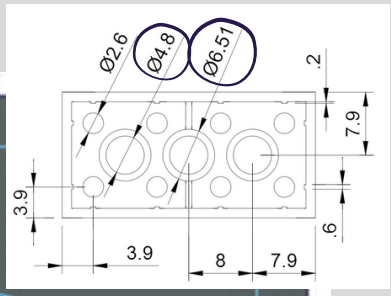
That line should be 7.9mm long according to our schematics.
This will be the center of right tube.

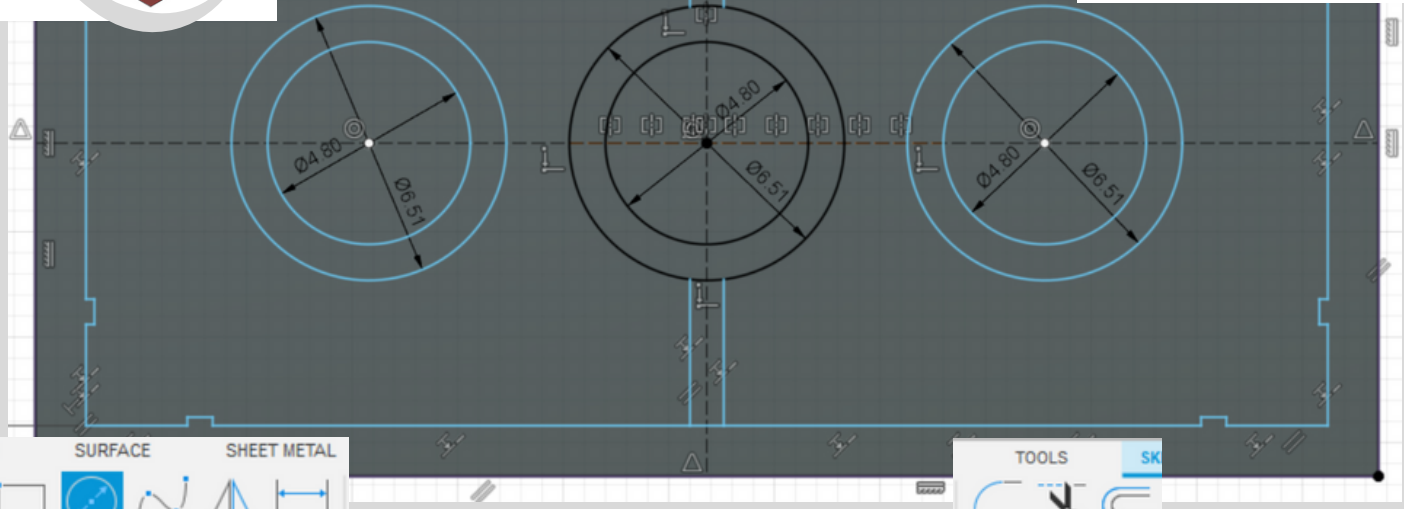


SKETCHING TUBES

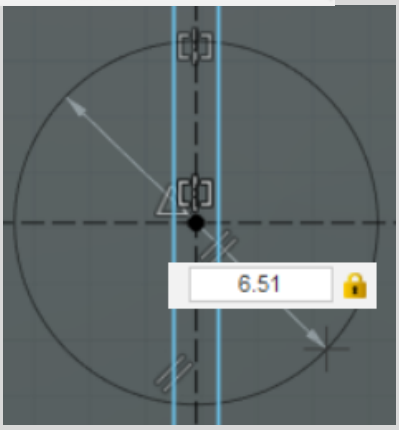


Next we'll be making these three circles that will turn into the tubes under the brick. The circles are all the same size.

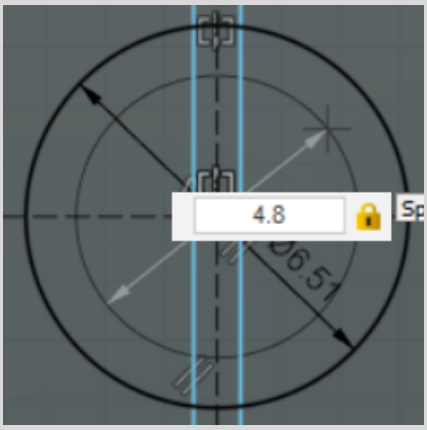




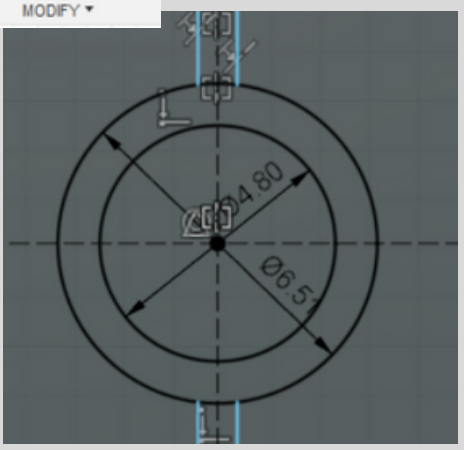




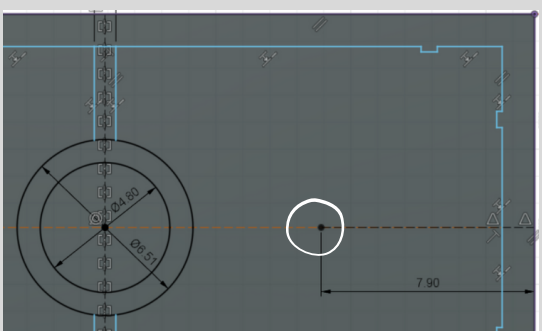
First draw a center point circle with a diameter of 6.51mm in the very center of the brick.



Then draw a second circle inside it that is 4.8mm in diameter.



Finally trim the unnecessary lines from your center wall.



Now repeat the process for the right circles, using the end of the construction lines we made as the center points of the circles.



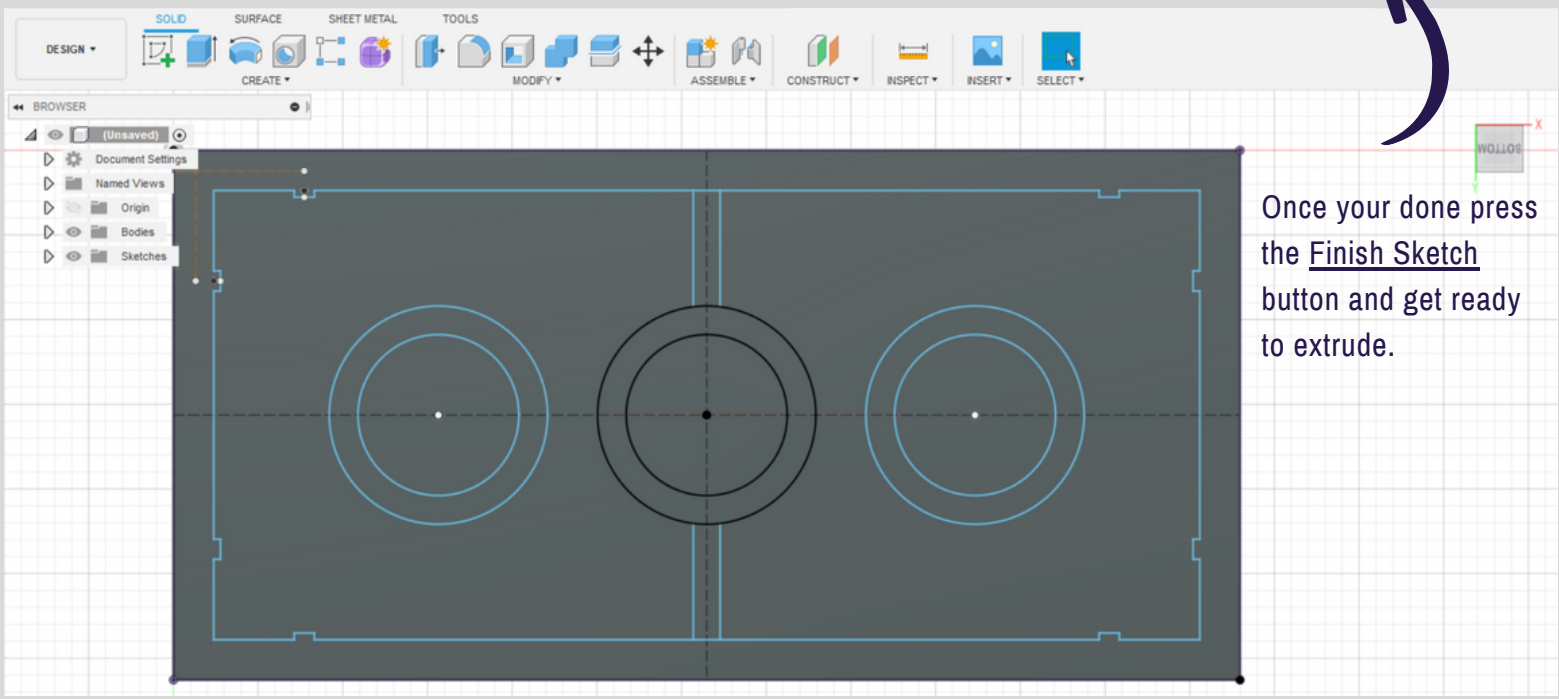
After that use the Mirror tool to mirror the right circles.



CITY OF CANADA BAY LIBRARIES
THE LEARNING SPACE

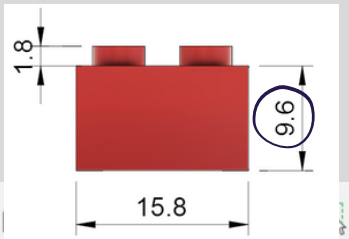
EXTRUDING THE BASE

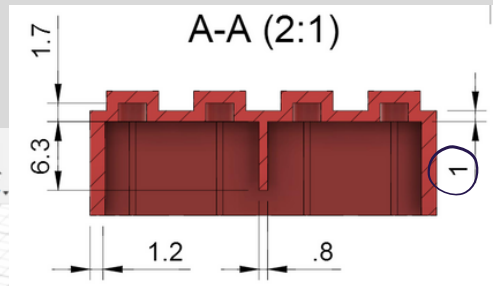




Once your done press the Finish Sketch button and get ready to extrude.

Once in the Extrude tool menu, extrude your face up (including the middle wall) -8.6mm (the thickness of the brick roof is 1mm and the brick height is 9.6mm)

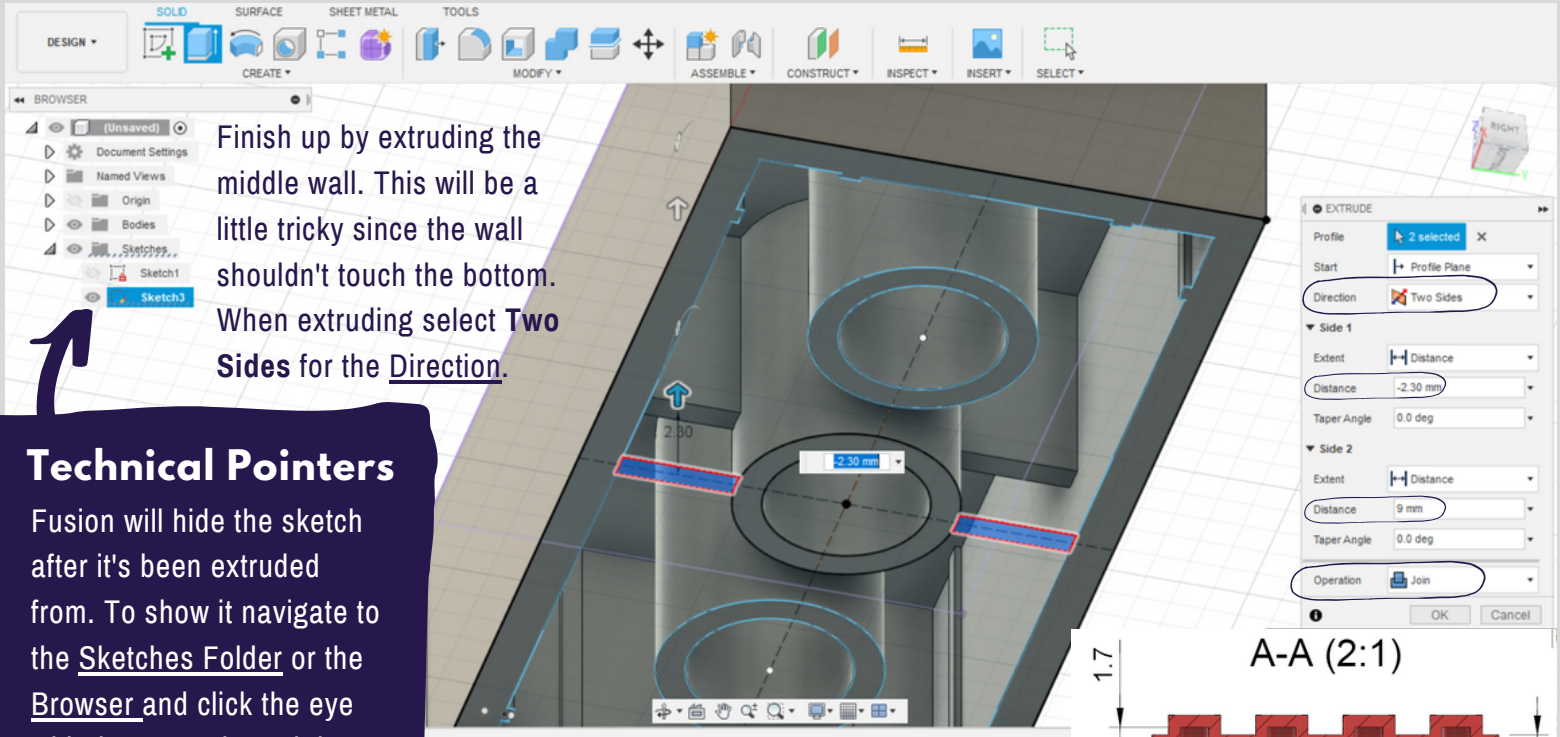






CITY OF CANADA BAY LIBRARIES
THE LEARNING SPACE

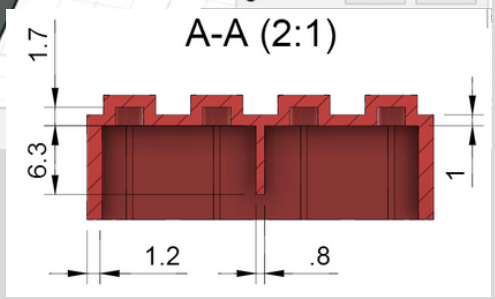
FINISHING THE BASE



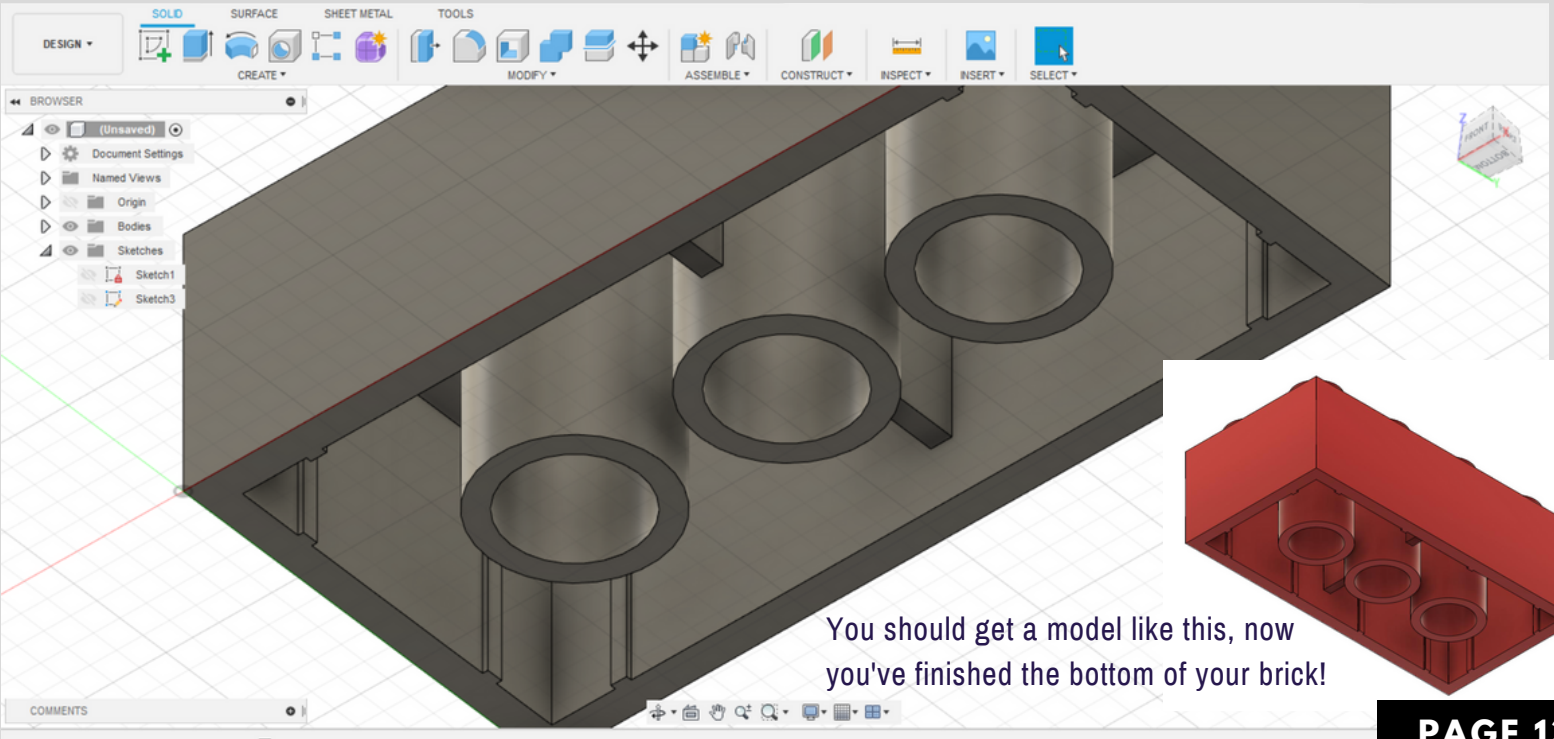
Finish up by extruding the middle wall. This will be a little tricky since the wall shouldn't touch the bottom. When extruding select **Two Sides** for the Direction.

Technical Pointers

Fusion will hide the sketch after it's been extruded from. To show it navigate to the Sketches Folder or the Browser and click the eye with the cross through it.



Next make the **distance** for side one -2.3mm (that's how high off the ground the wall is) and the **distance** for side two 9mm. Finally make sure the Operation is **Join** and click the OK button.

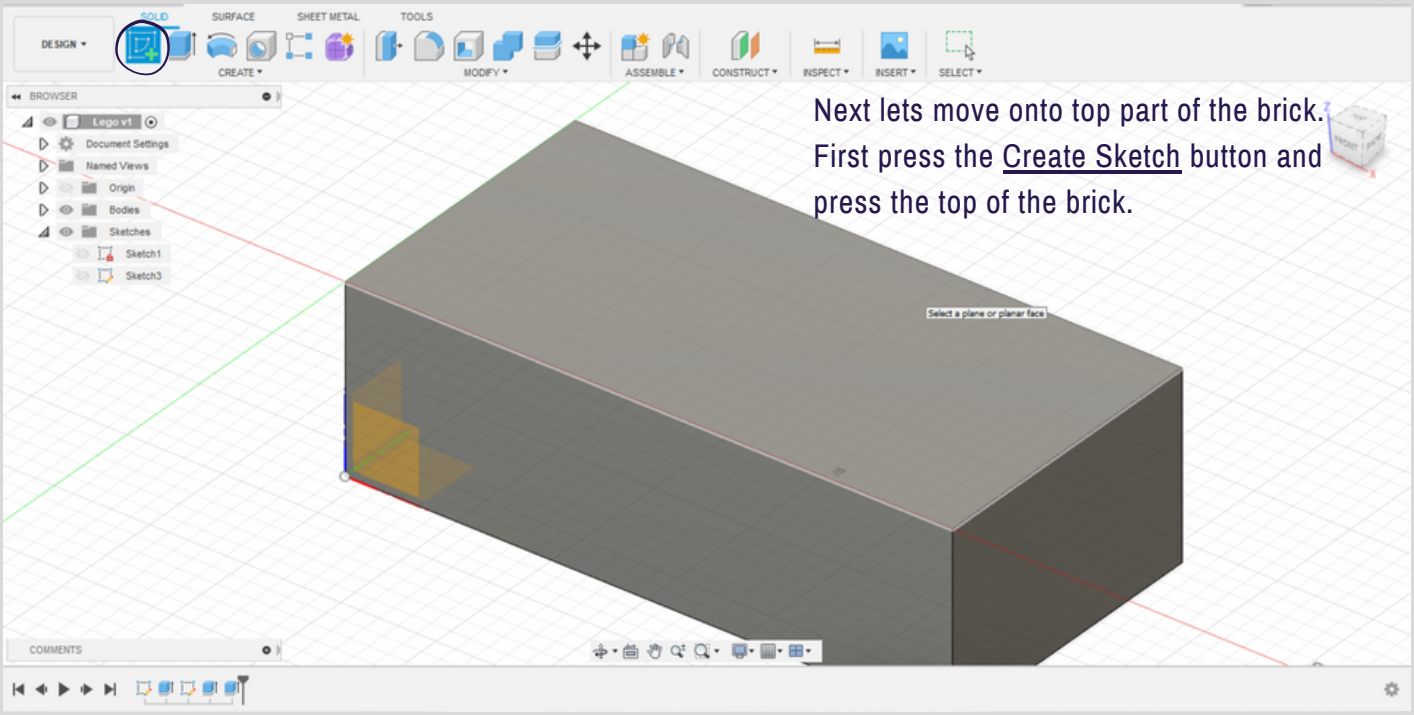


You should get a model like this, now you've finished the bottom of your brick!

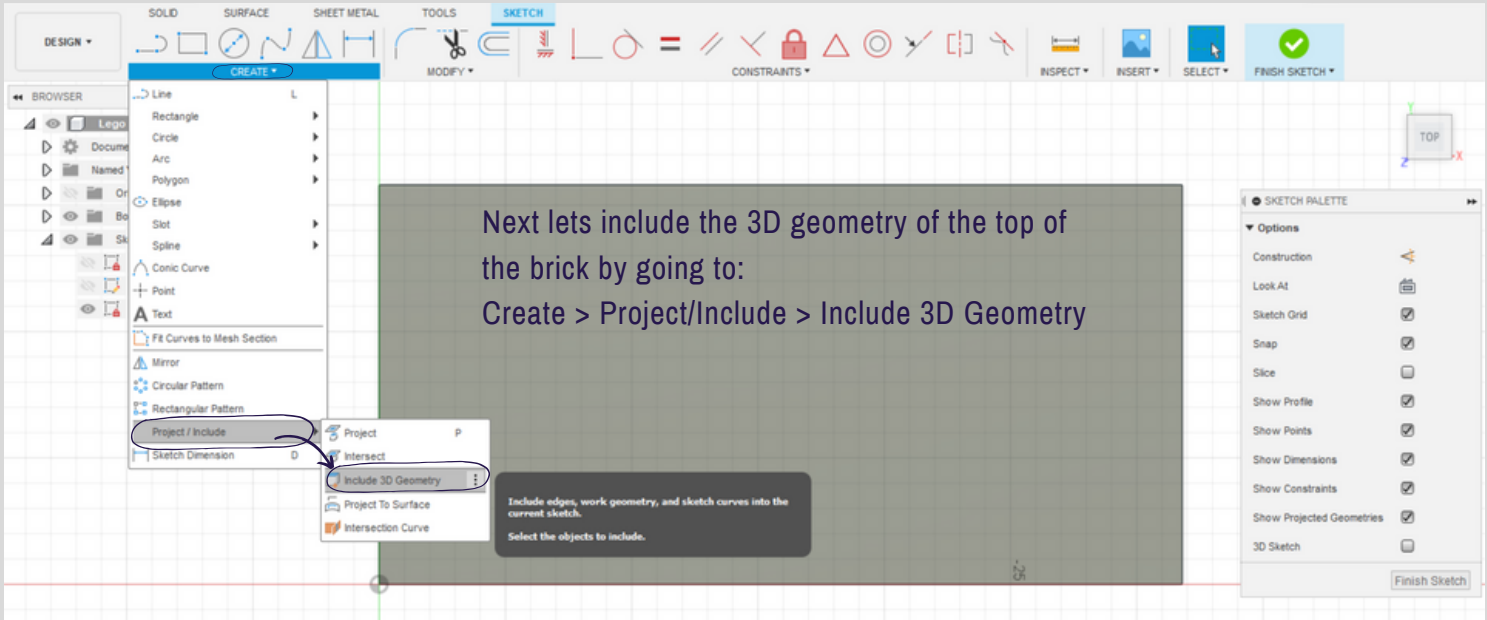


CITY OF CANADA BAY LIBRARIES
THE LEARNING SPACE

NOW TO THE TOP



Next lets move onto top part of the brick. First press the Create Sketch button and press the top of the brick.

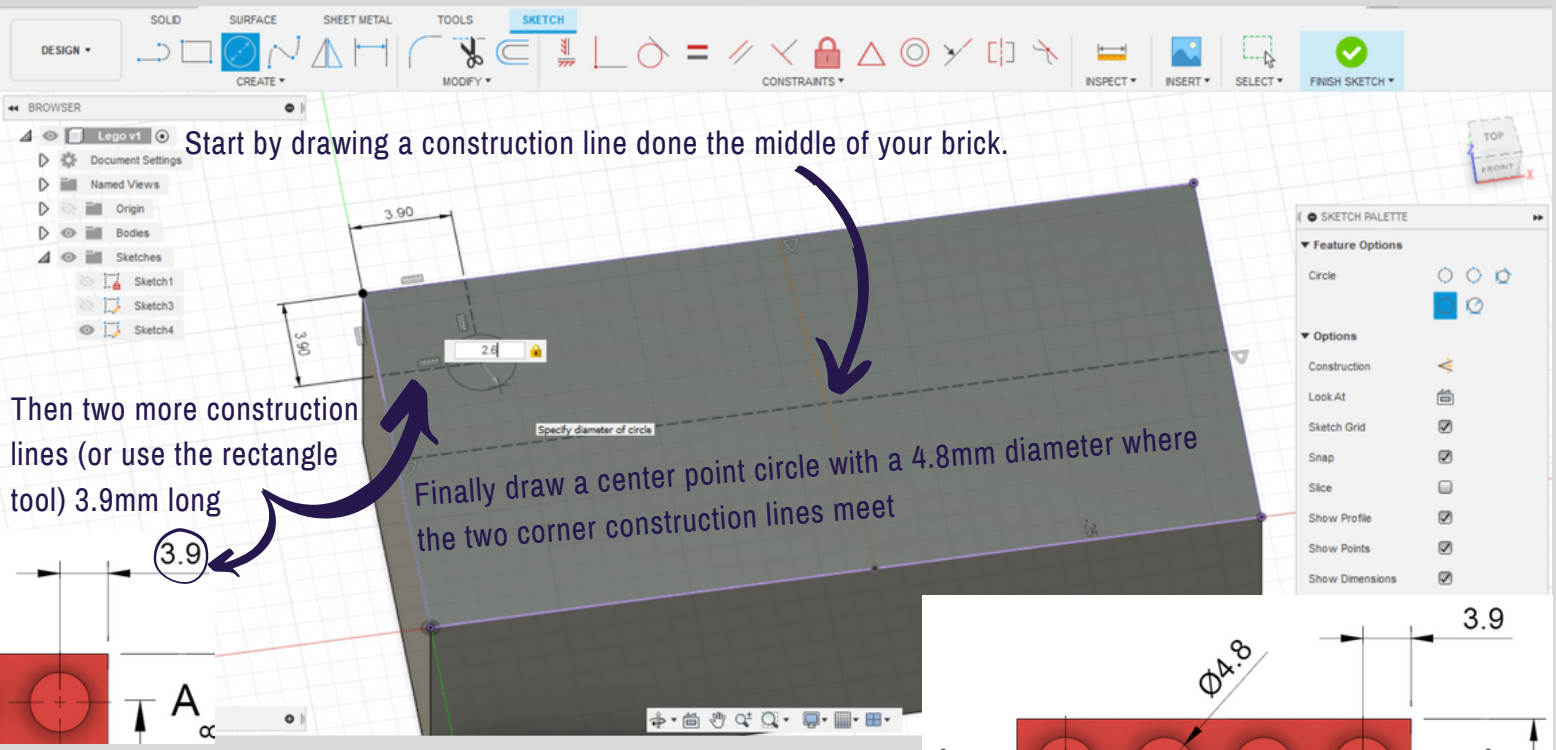


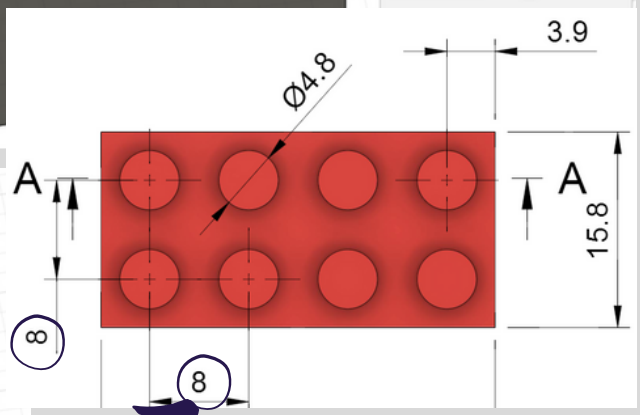
Next lets include the 3D geometry of the top of the brick by going to:
Create > Project/Include > Include 3D Geometry

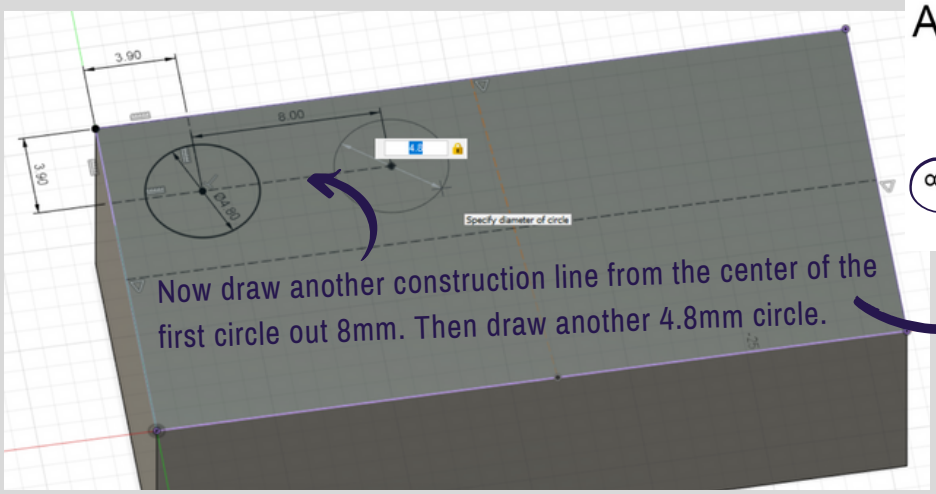


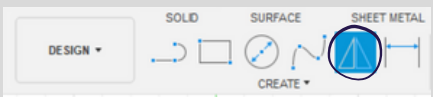
CITY OF CANADA BAY LIBRARIES
THE LEARNING SPACE

SKETCH THE STUDS

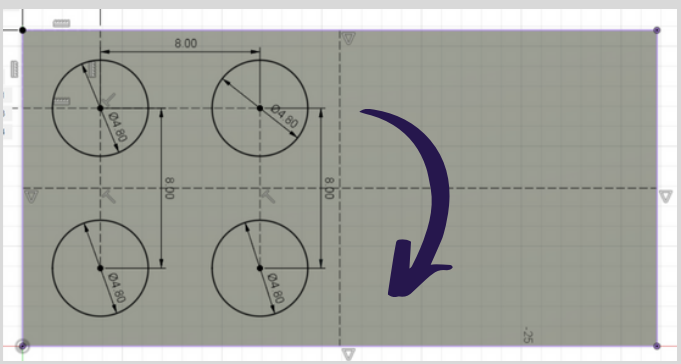


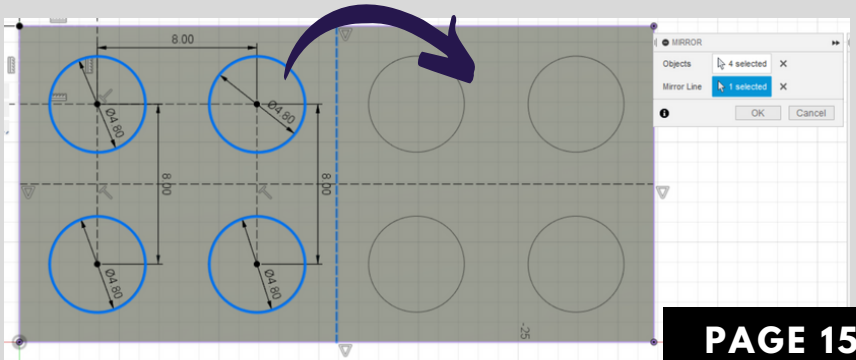






Next use the Mirror tool to mirror your first two circles.
Then draw a horizontal center line and mirror your four circles.



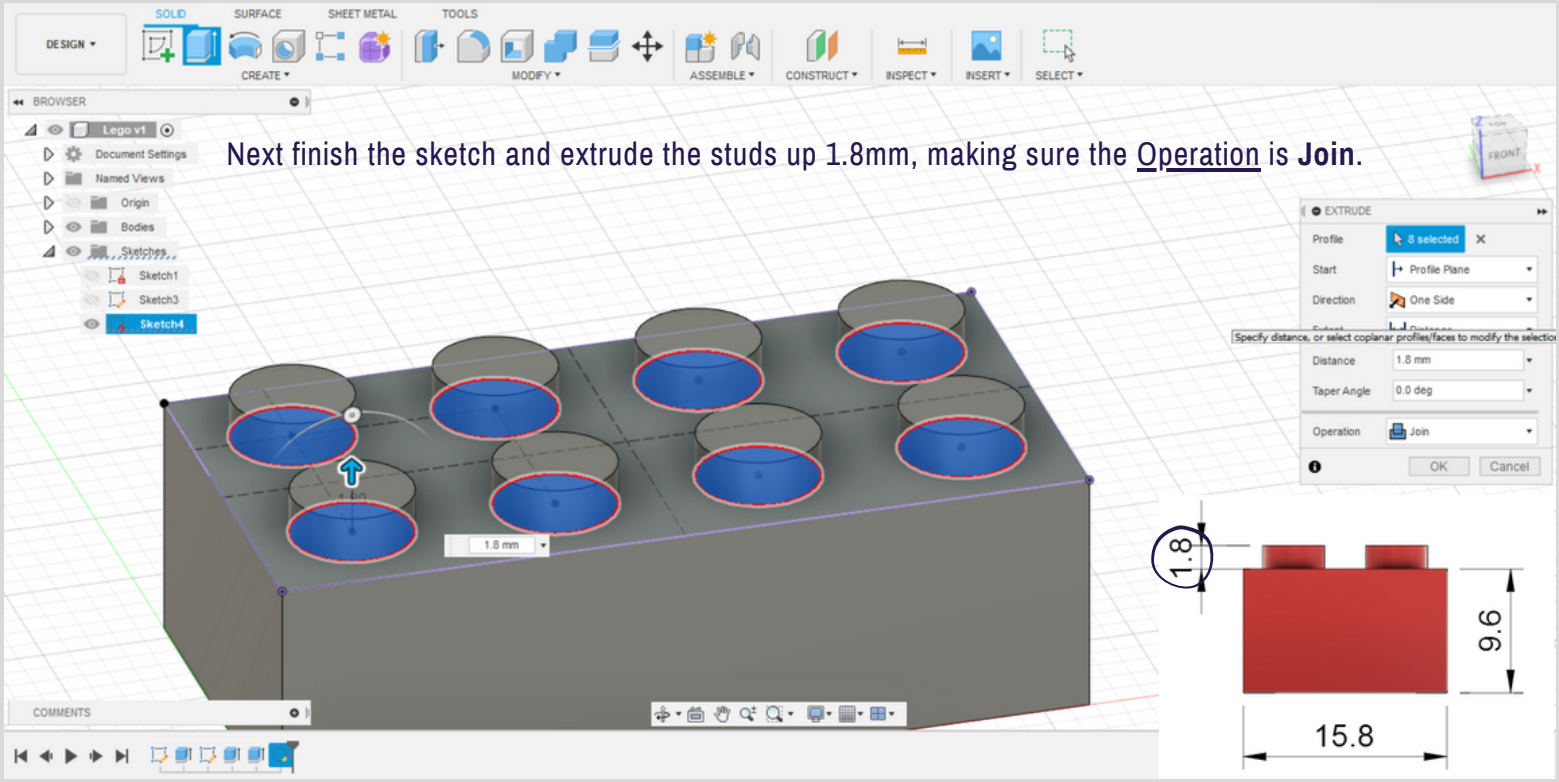


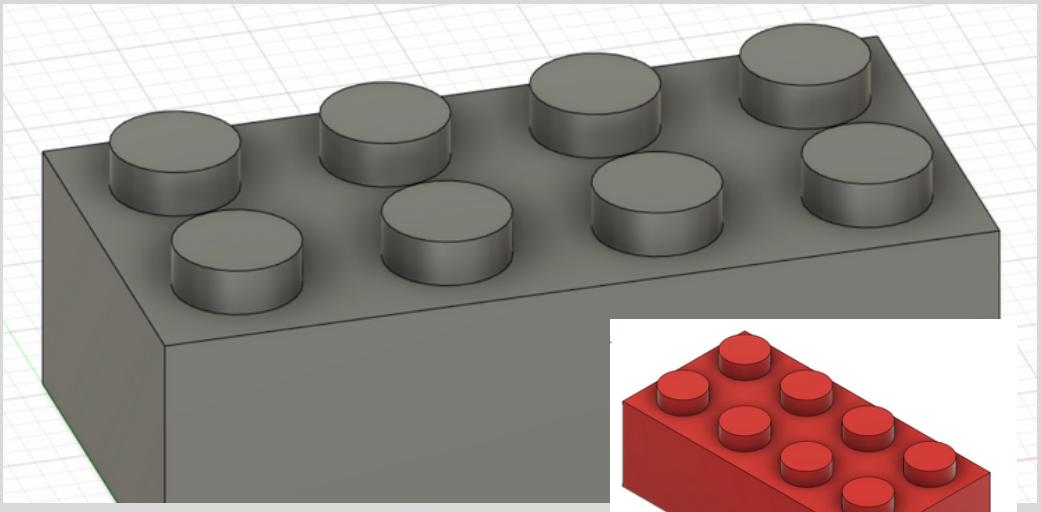


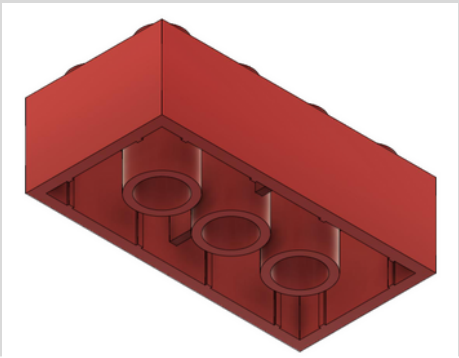
CITY OF CANADA BAY LIBRARIES
THE LEARNING SPACE

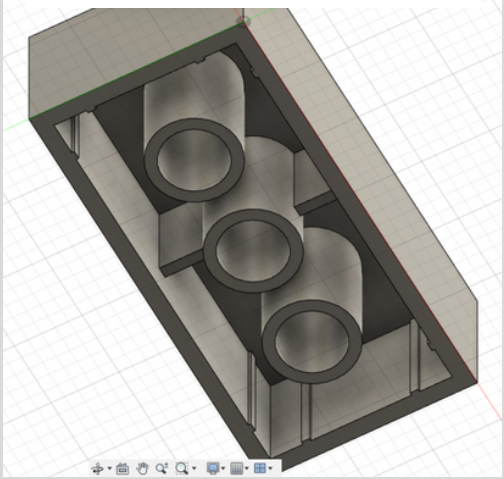
EXTRUDE UP

Next finish the sketch and extrude the studs up 1.8mm, making sure the Operation is **Join**.







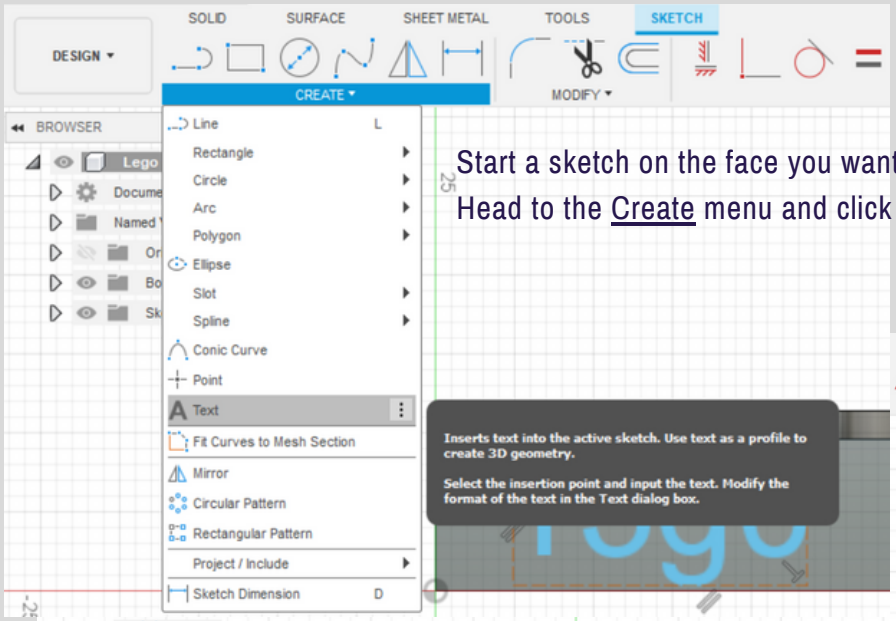


Now we've got a finished building brick, however lets add a little text for fun.

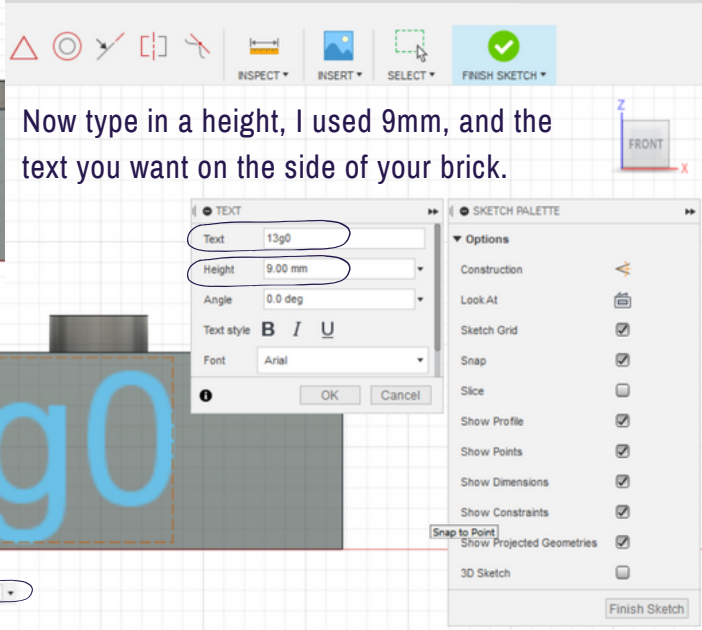


CITY OF CANADA BAY LIBRARIES
THE LEARNING SPACE

ADD SOME TEXT!



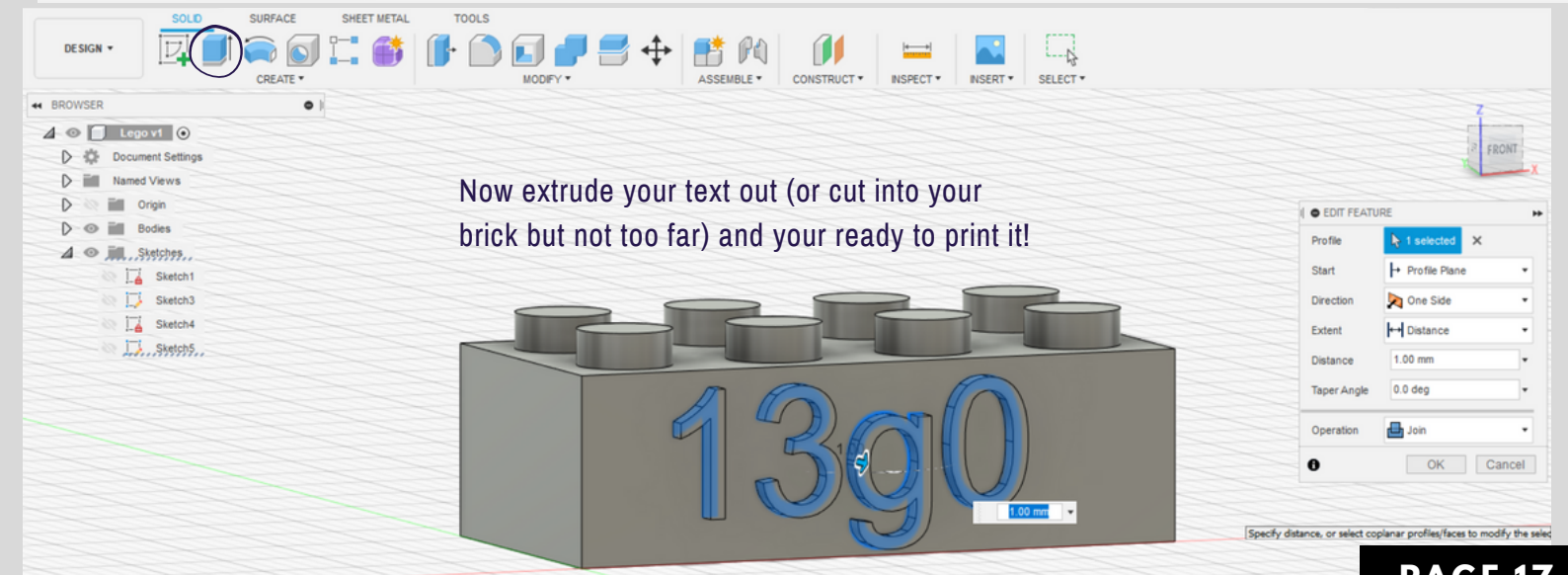
Start a sketch on the face you want the text to be on.
Head to the Create menu and click Text.



Now type in a height, I used 9mm, and the text you want on the side of your brick.

You may also need to rotate your text, you can use this handle

You can use the blue handle to move your text



Now extrude your text out (or cut into your brick but not too far) and your ready to print it!



CITY OF CANADA BAY LIBRARIES
THE LEARNING SPACE

3D PRINT IT

Lego bricks are a tad notorious to print. After some experiementation I found printing the bricks upside down the best option. Support material is much easier to remove when not inside the model. However watch out for thin walls.

