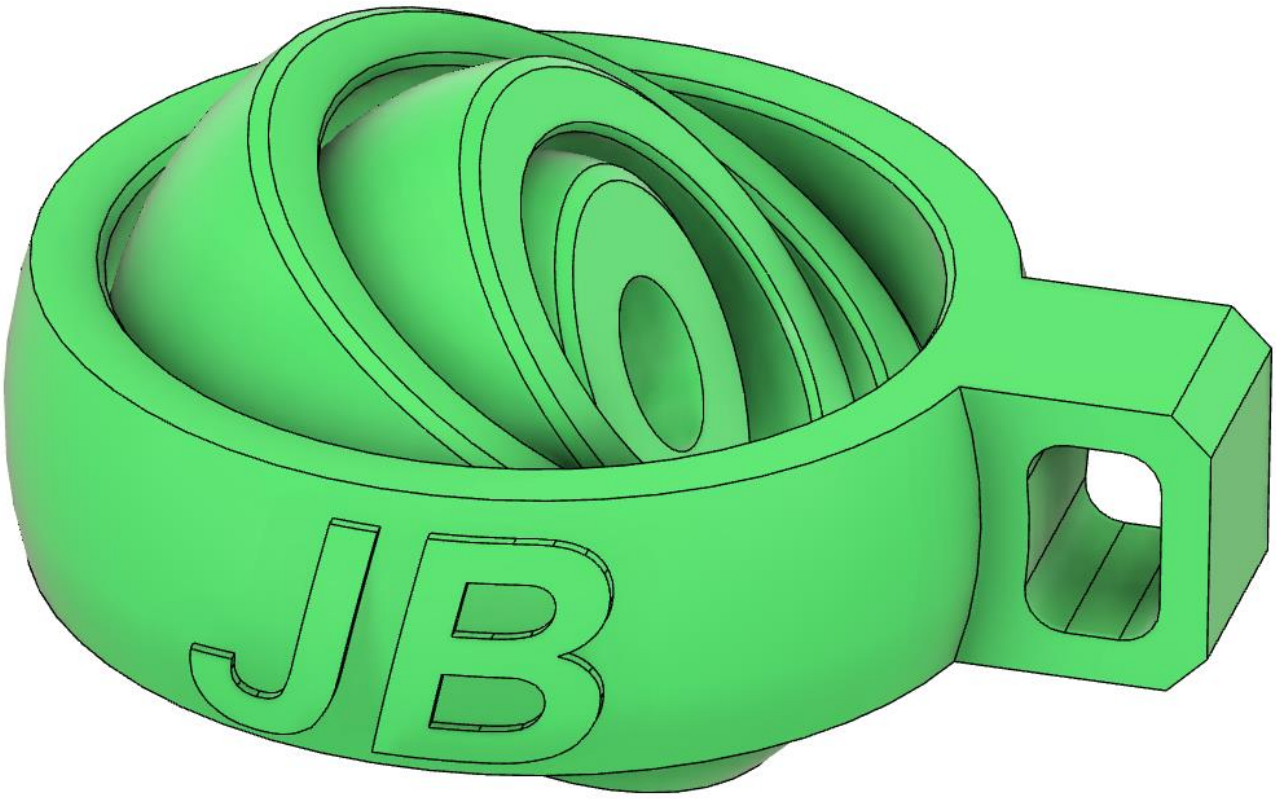
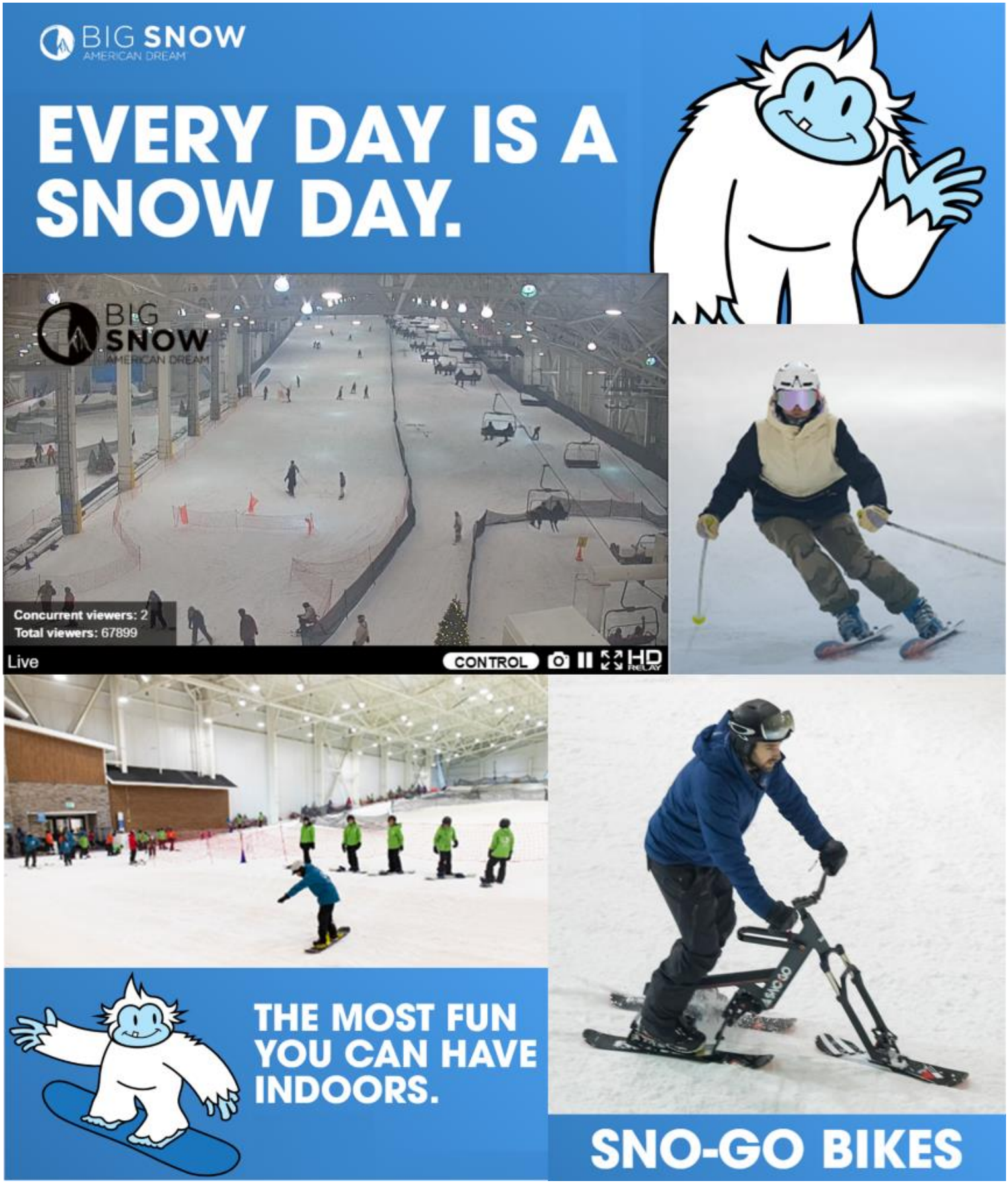
Mr. Barbetta's *"I don't care about 3D Printing. I just want the art credit."* class

Enjoy many hours of fun with a

3D Printed Ringy-Thingy



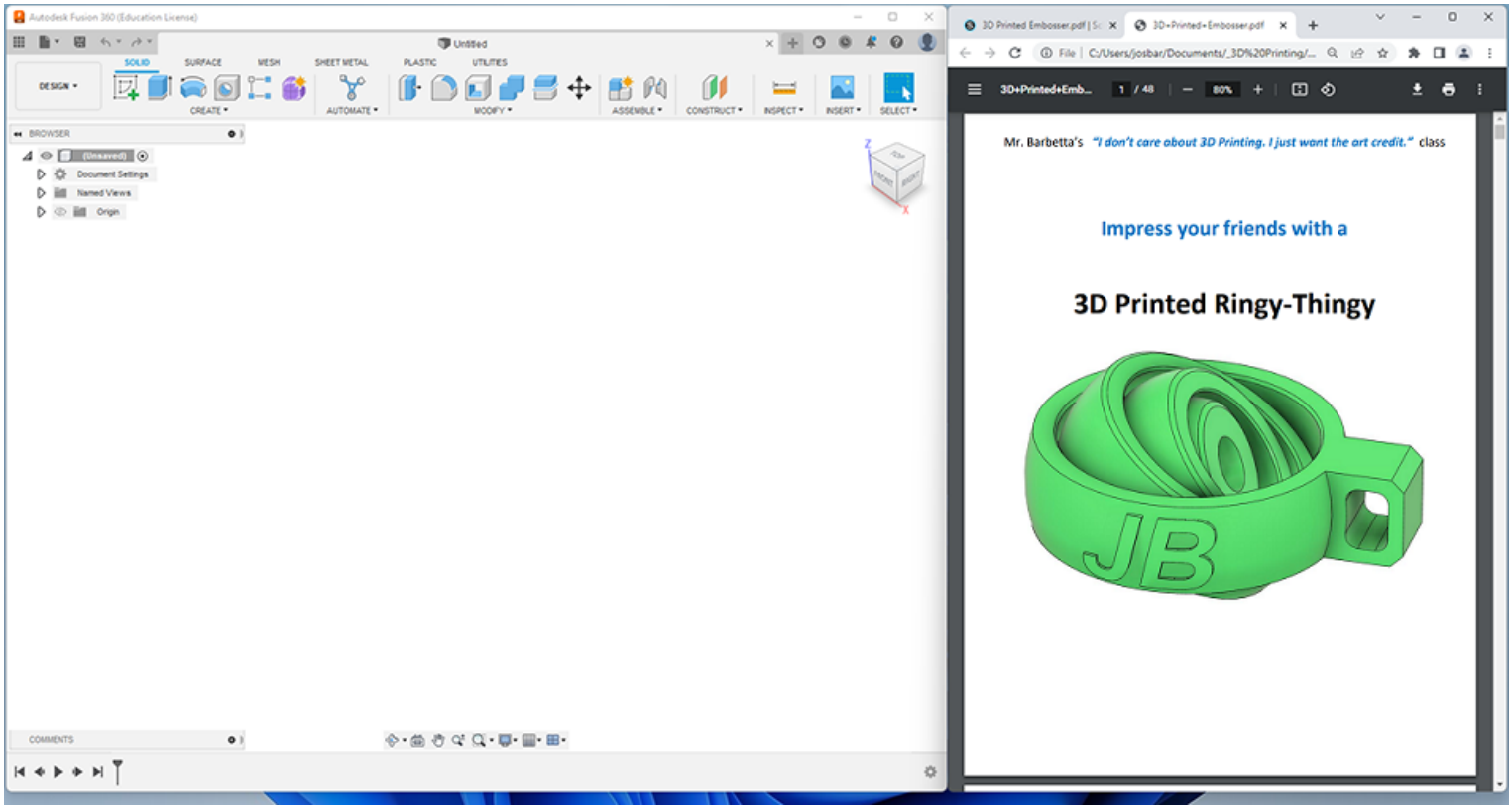
Today's Lesson is Sponsored by Big Snow at American Dream



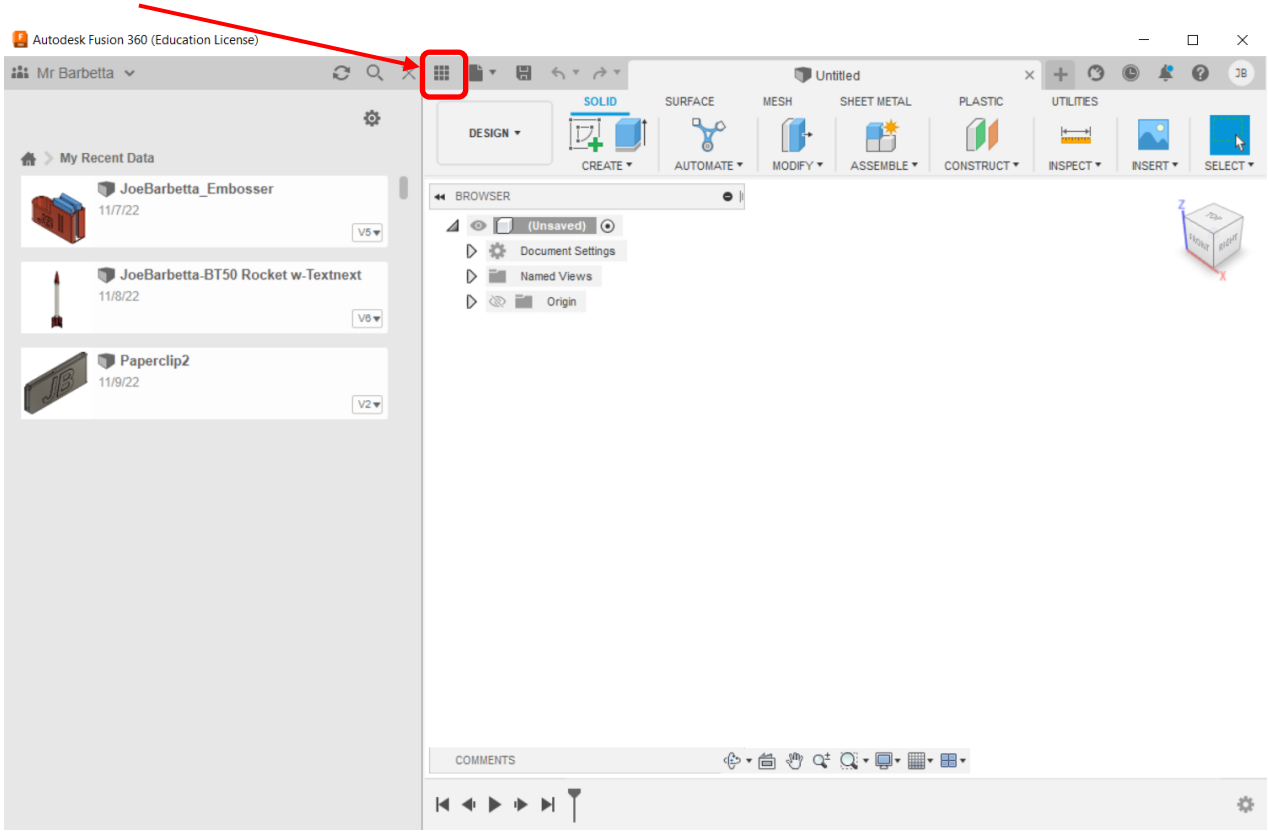
Contents

Using This Document

The best way to follow this document is to **reduce the width of the Fusion 360 window** and have this pdf document open in Chrome browser as shown below. This document can be **downloaded from Schoology and then dragged into Chrome** and scaled down to 80%.



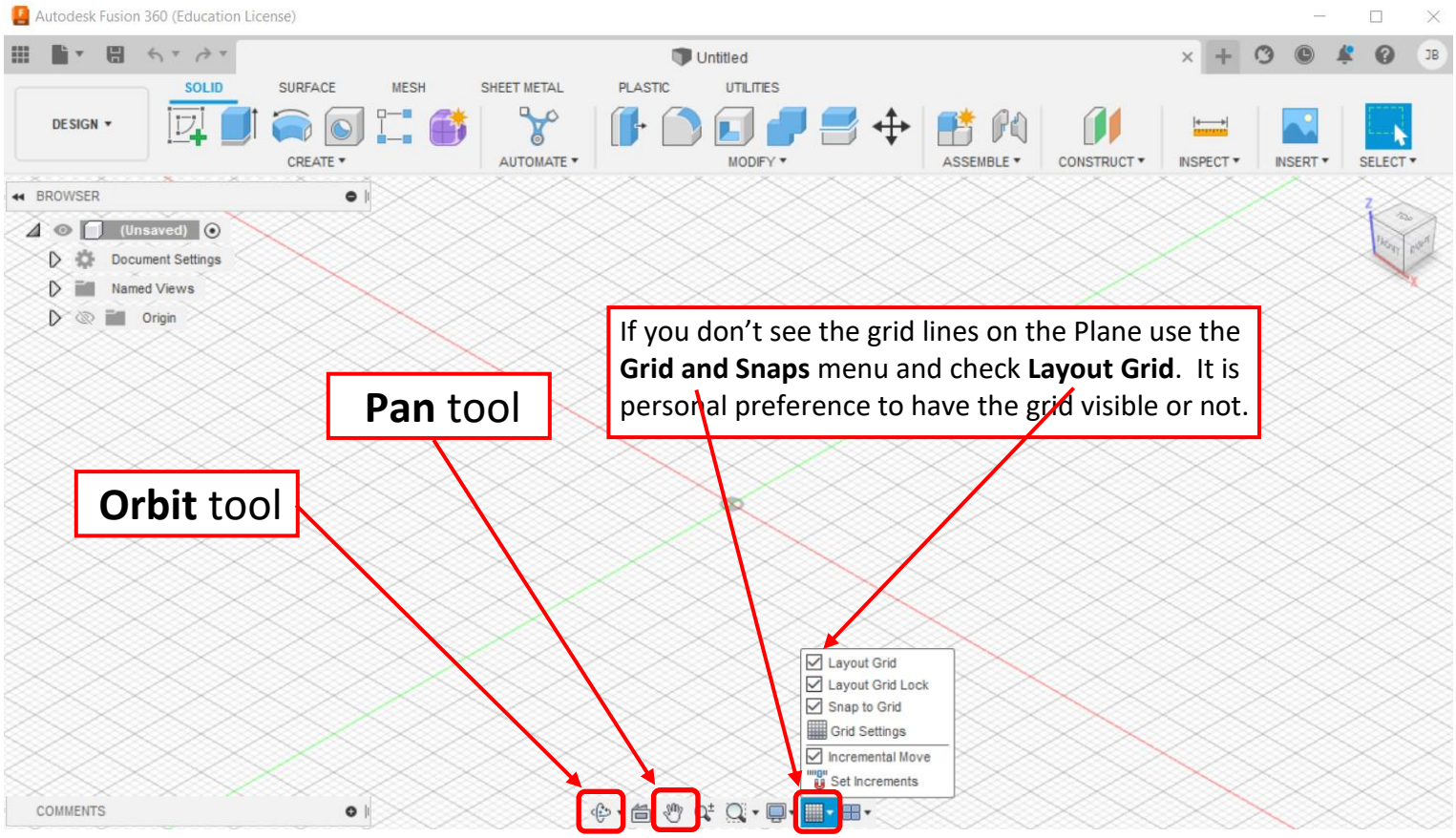
The Fusion 360 window will not allow its width to be reduced much so for smaller computer screens a trick is to click on the **Data Panel icon** and then move the window to the left with the Data Panel off the screen.



Changing the View of a Design (information only)

- if you don't see a grid in the Fusion 360 window, as shown below, click on **Grid and Snaps** and check **Layout Grid**. Displaying the *Layout Grid* is a matter of preference. When designing for 3D printing, it can be used to represent the *build plate*.

- click on the **Orbit** tool and click somewhere on the **Grid** to practice rotating and changing the angle of the view.
- click on the **Pan** tool and then on the **Grid** to practice moving the view laterally.
- after using the *Orbit* or *Pan* tool one must press the **Esc key** to exit that mode.
- use the **Mouse Wheel** to practice Zooming in and out.



Here is a close-up of the View Cube at the top right of the window.

- click on the **View Cube** and move the cube while holding the mouse button down. This is another way to rotate the view.
- click on the Top of the View Cube and note how the view just jumped to a Top View.

The View Cube now resembles that on the right.

- click on the **Curved Arrows** at the upper right of the View Cube and practice Rotating the View.
- click on the **Arrows** at the sides of the View Cube to practice jumping to various Views.
- click on the **Home** icon to the upper left of the View Cube. This can always be used to reset the view to the Home View

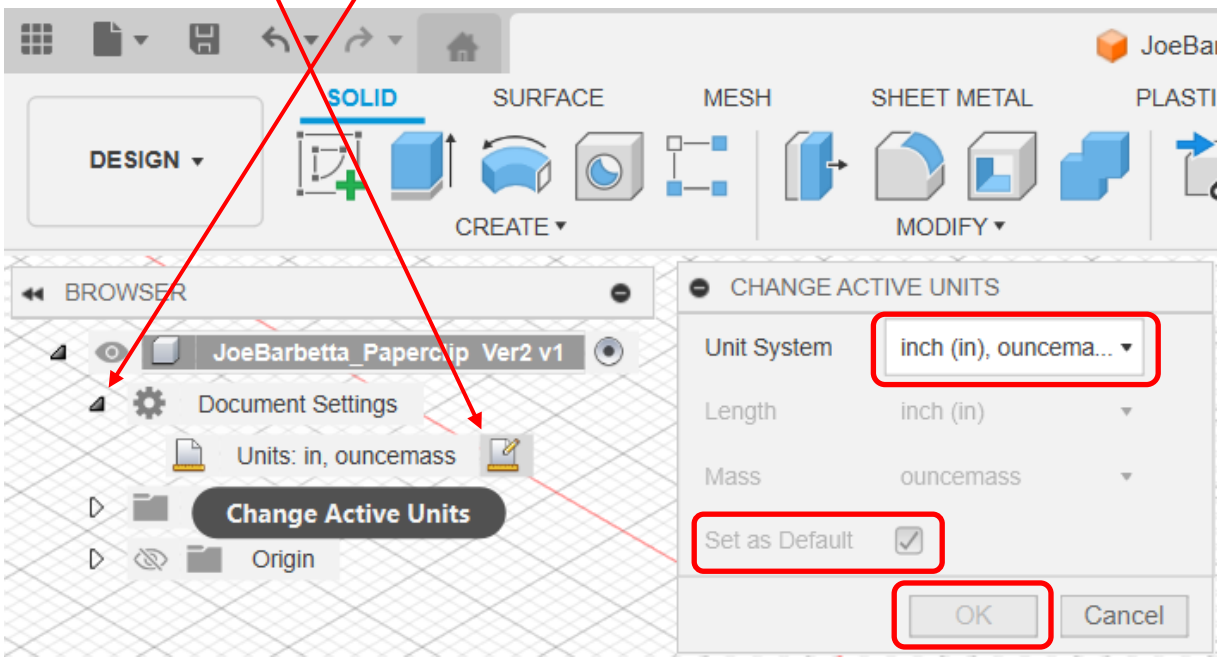
Starting a Design in Fusion (START HERE)

- open **Fusion**. If there is no icon on the Desktop, use the Windows search (magnifying glass icon) and type fusion
- from top **File** icon select **Save** and name the file.
  Use your name followed by **_RingyThingy** e.g. **JoeBarbetta_ RingyThingy** (note the use of the underscore)

Note that by default Fusion saves your project to “the cloud”, which are the servers managed by AutoDesk. When you log into Fusion on a different computer, your projects will be available.

As you work you may want to occasionally save your work in case Fusion crashes or we lose power.

- in the left **"BROWSER"** click the **arrow next to Document Settings**
- click on the **edit icon** that appears to the right when you hover over **Units**
- ensure **Active Units** are set to **Units: in, ouncemass** and click **OK**. You can also enable **Set as Default** if it is not grayed out.



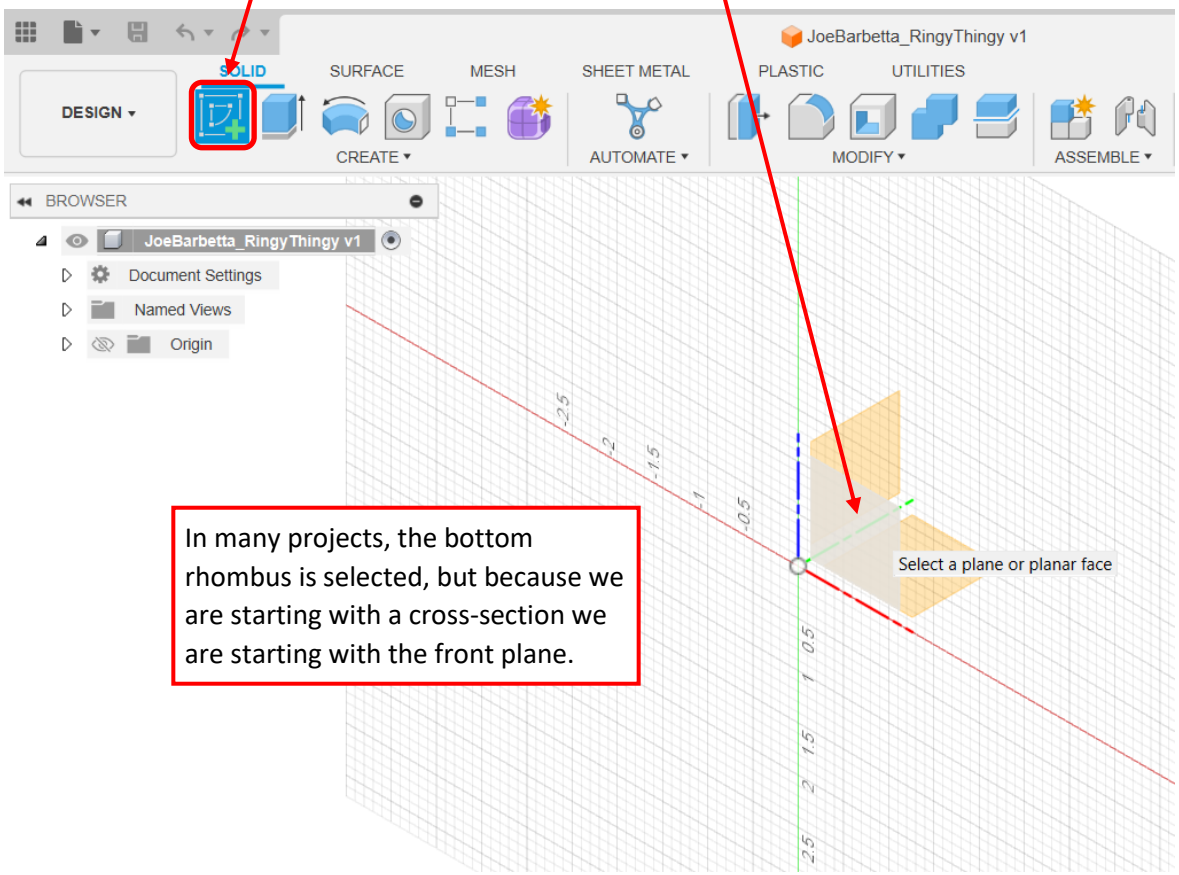
Note that the default units are in mm, which we just changed to inches.

Did you know that the default units have changed over the years? The earliest version used cubits as the default unit.

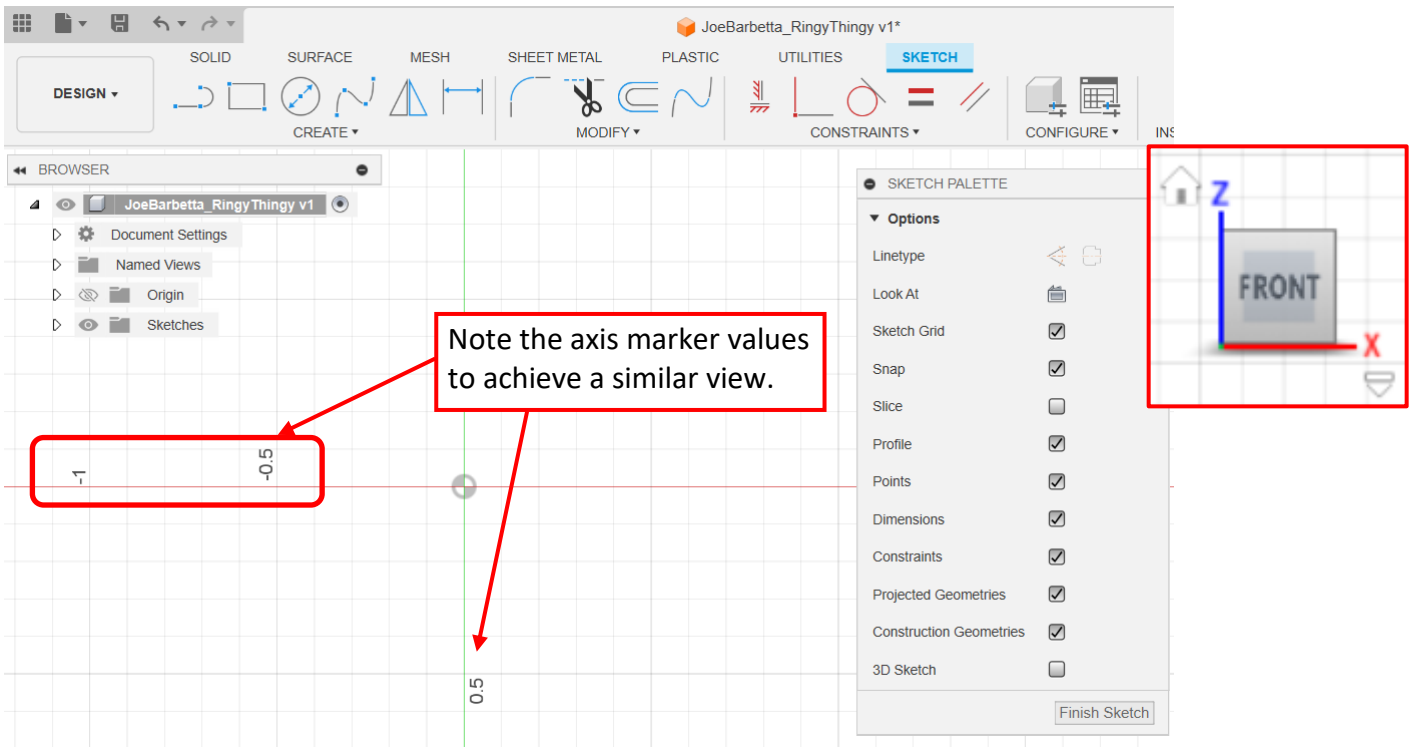
Creating the First Sketch

Note that a Fusion 360 expert may tell you to create a Component first. Just say **"Dude. I'm just making a Ringy Thingy."**

- select the top **Create Sketch** tool and click on the **front rhombus** to select the X-Z Plane.
If a tool can't be found, one can always look in the **CREATE** and **MODIFY** menus for it.

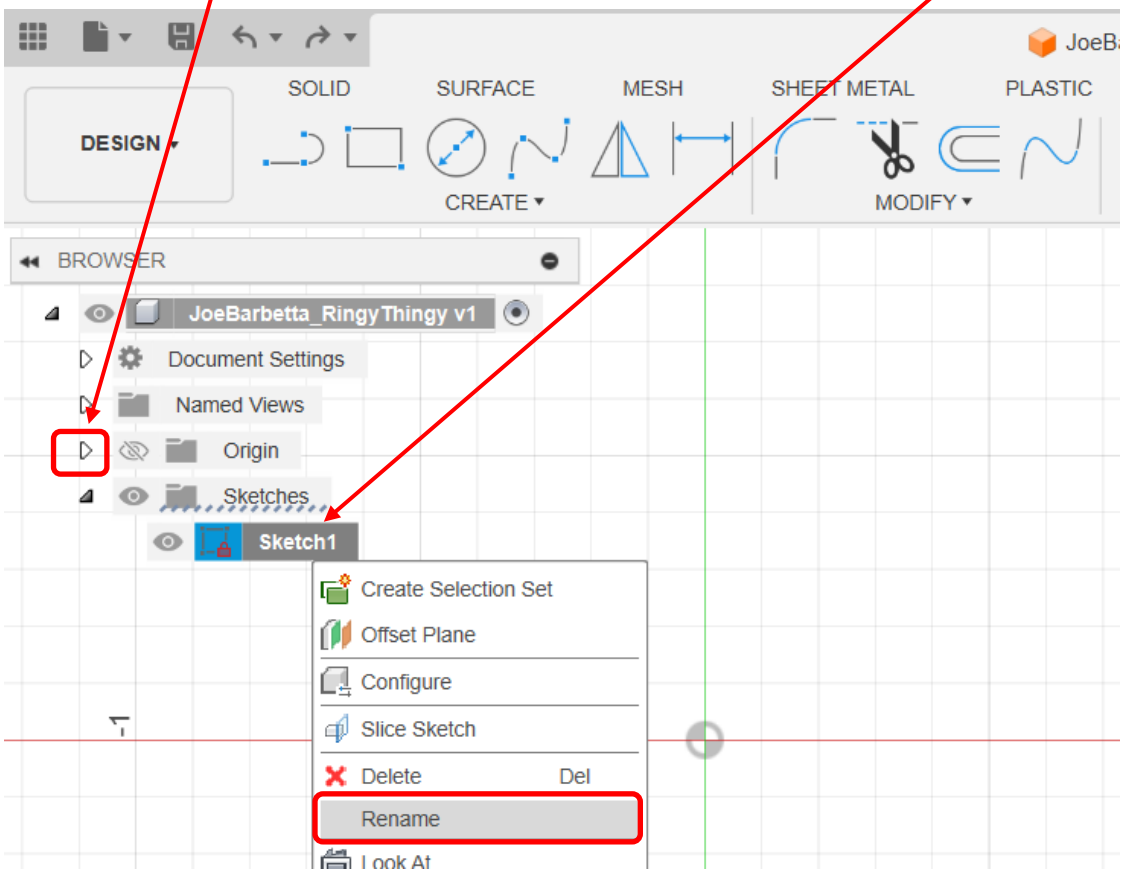


- zoom in as shown below. The scale labels can give an idea of how far one is zoomed in. The **View Cube** should indicate you are sketching on the **Front X-Z Plane**.

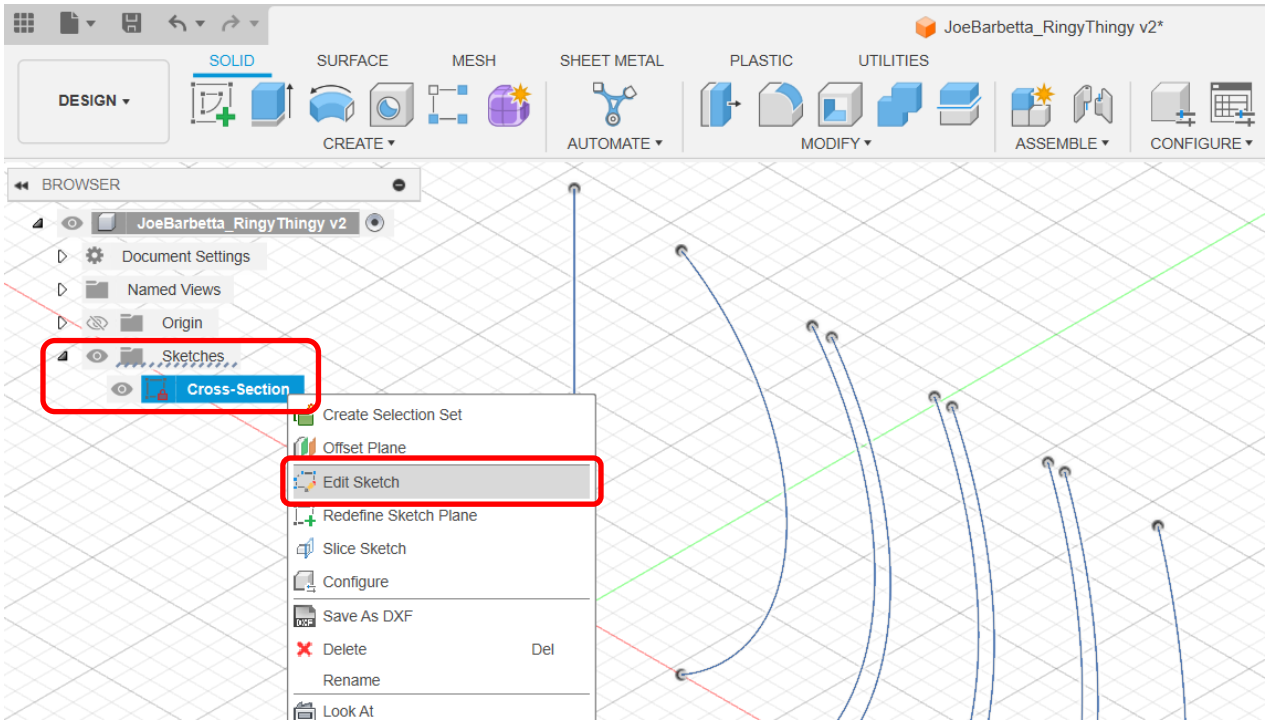


Whenever a new Sketch is created, it should be named.

- click on the **arrow** to open the Sketches folder, **right-click** on the default name **Sketch1** and select **Rename**. Change the name to **Cross-Section**.



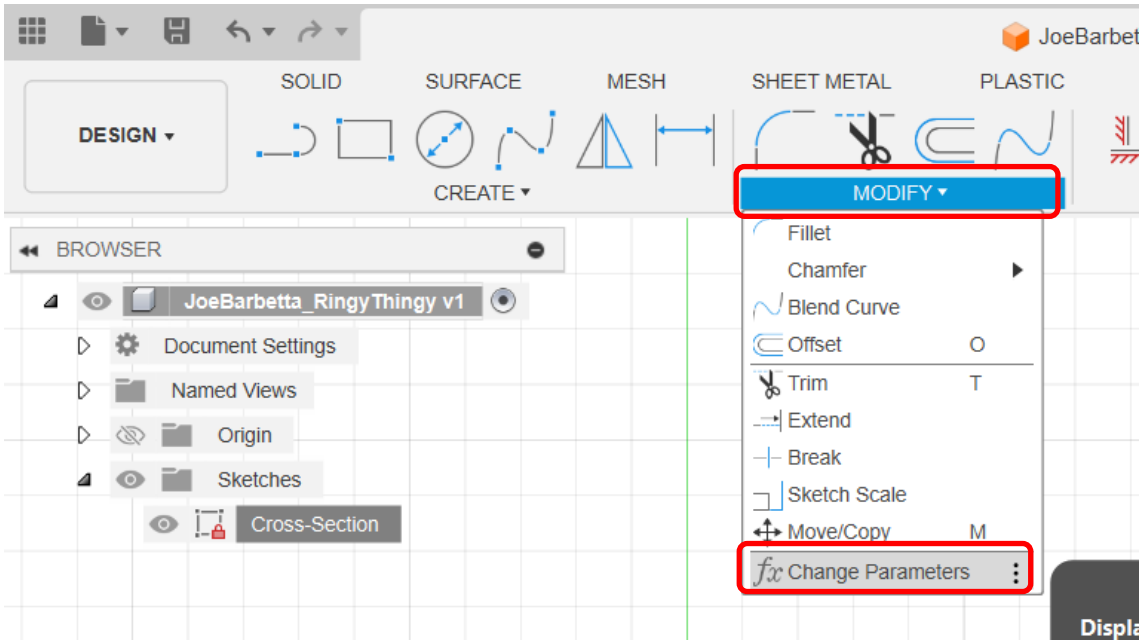
Most of the effort for this project will be creating the arcs for this sketch. If you click "Finish Sketch" by accident before you are done with a Sketch, you can **right-click on the Sketch name and select Edit Sketch** to contibue working on the Sketch.



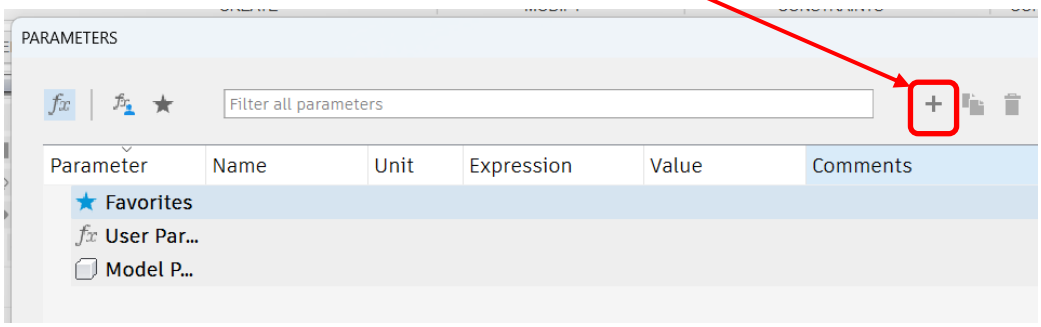
Parametric Modelling

"Parametric Modelling" is a powerful feature, wherein variables can be created, which can then be used for dimensions. One can later change values using this window to make adjustments to a design.

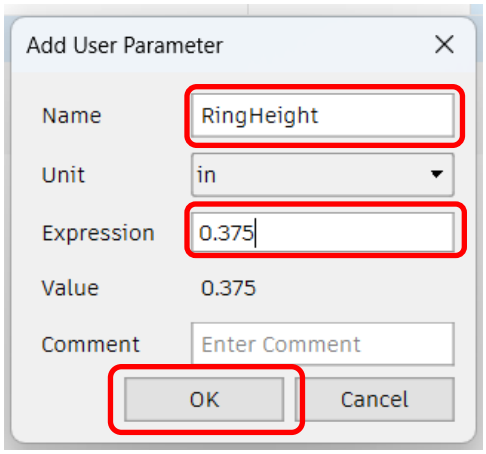
- from the **MODIFY** menu select **Change Parameters**



- in the **PARAMETERS** window that just opened, click **+**



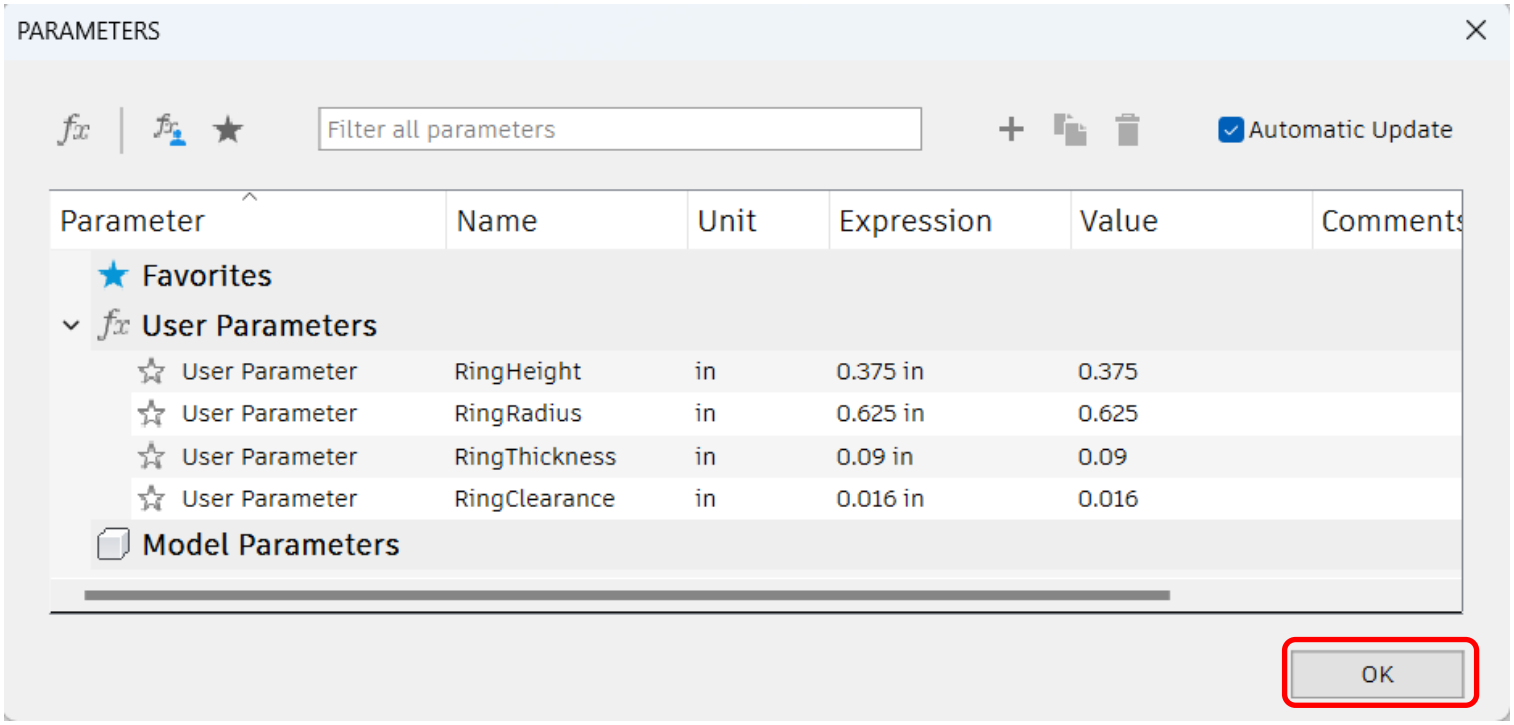
- In the pop-up window set the Name to **RingHeight** and Expression to **0.375**. Make sure that the Unit is **in** for inches and click **OK**.



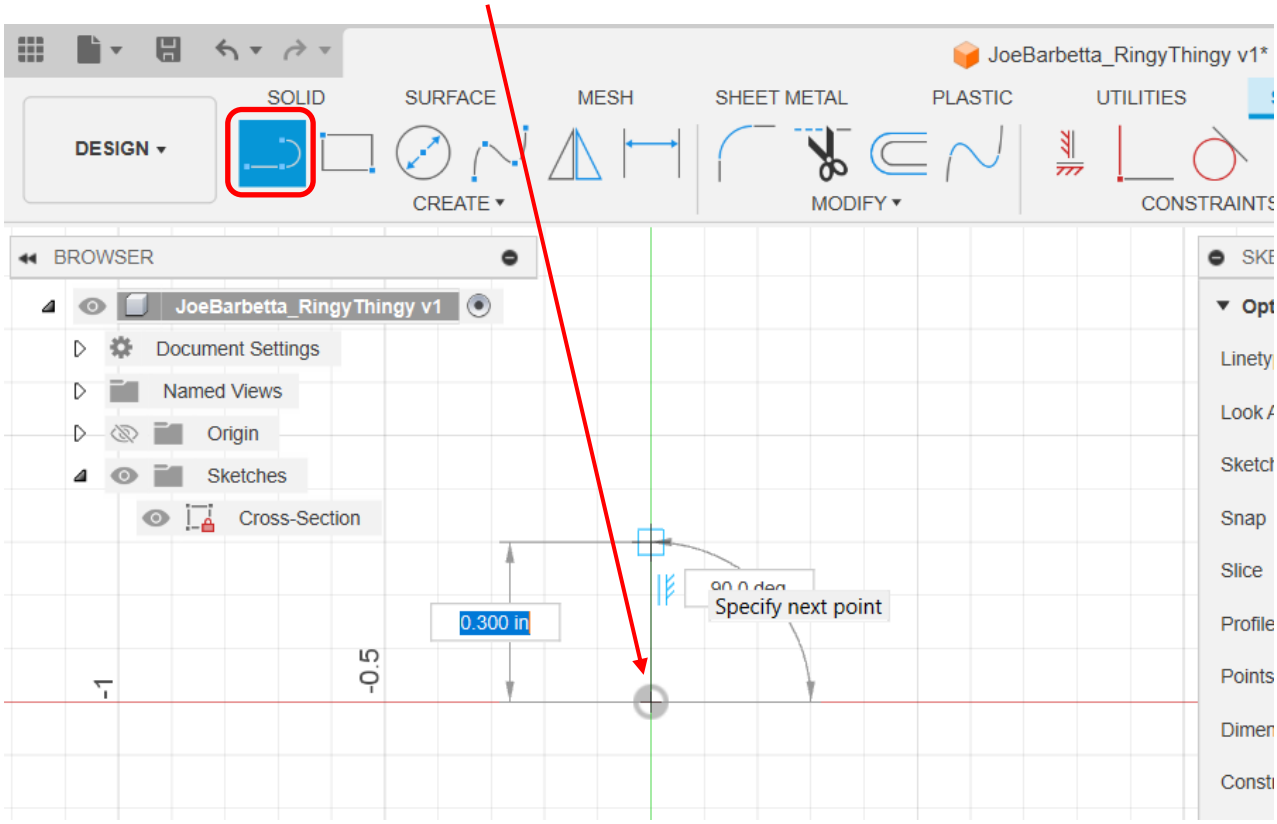
- Use the **+** three more times to enter the additional parameters **RingRadius**, **RingThickness**, and **RingClearance** with the corresponding values as shown below. Click **OK** when done.

RingRadius **0.625**
RingThickness **0.09**
RingClearance **0.016**

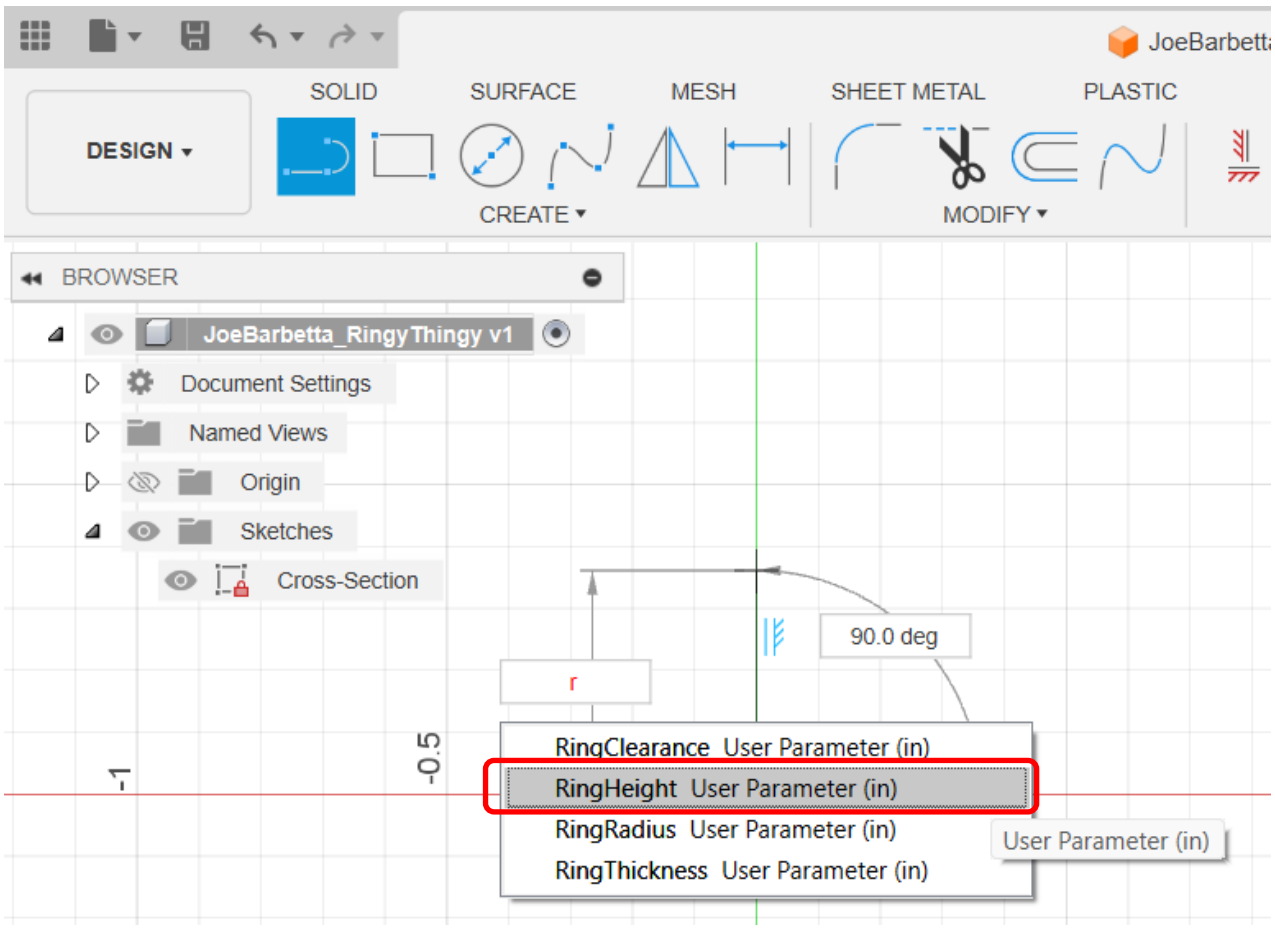
Note that this window can be opened at any time in the future to adjust values.



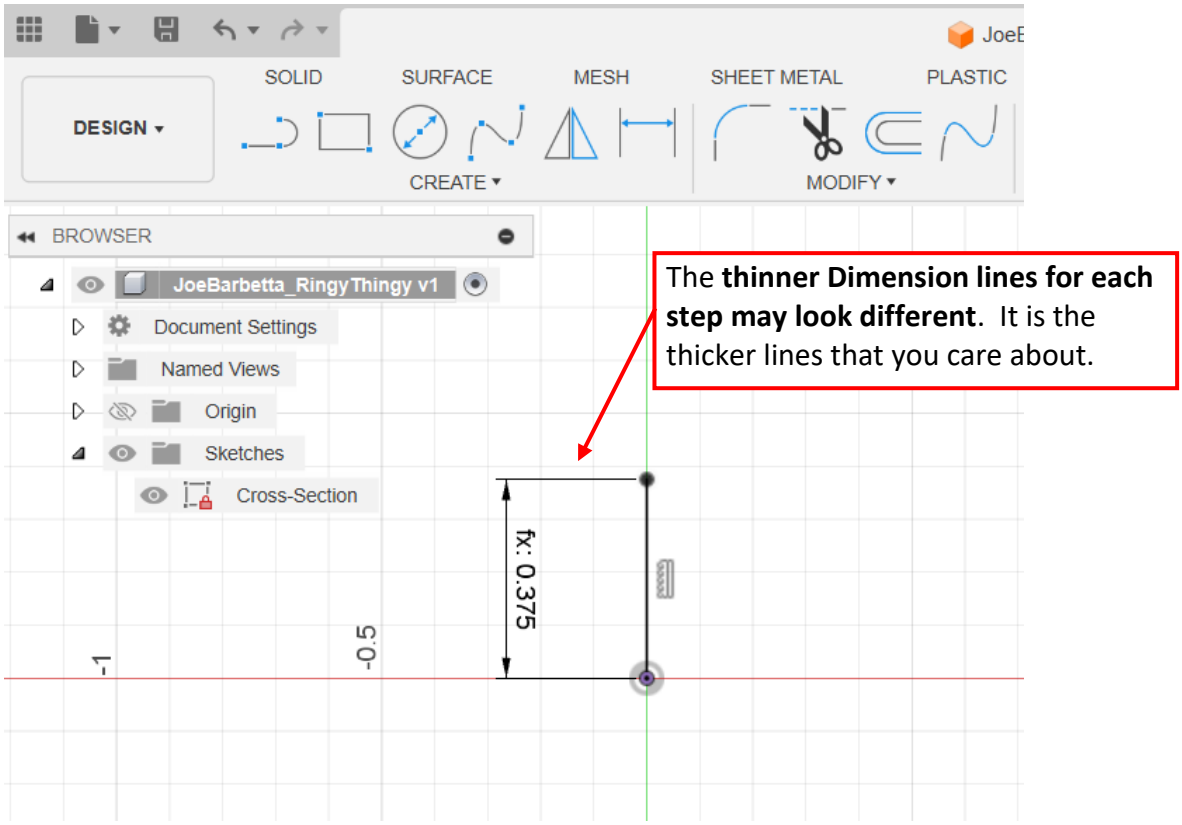
- select the **Line** tool and click on the **origin** and drag the line **upward** without clicking again



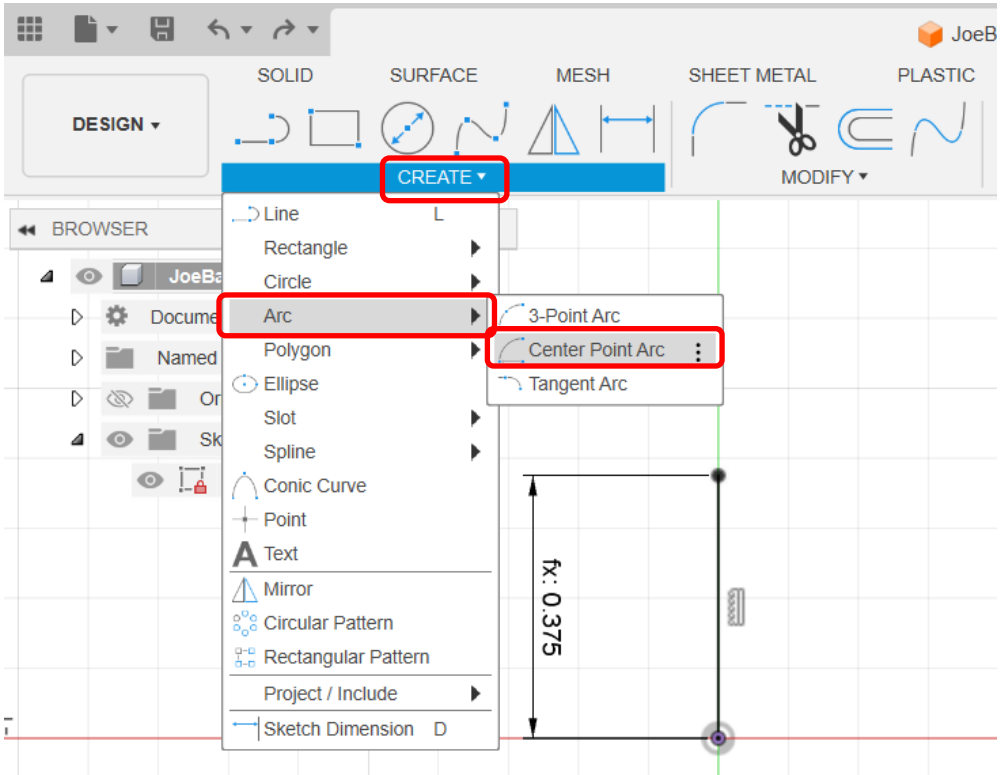
- enter **r** and select **RingHeight** from the parameter pop-up window and press the **Enter key**.



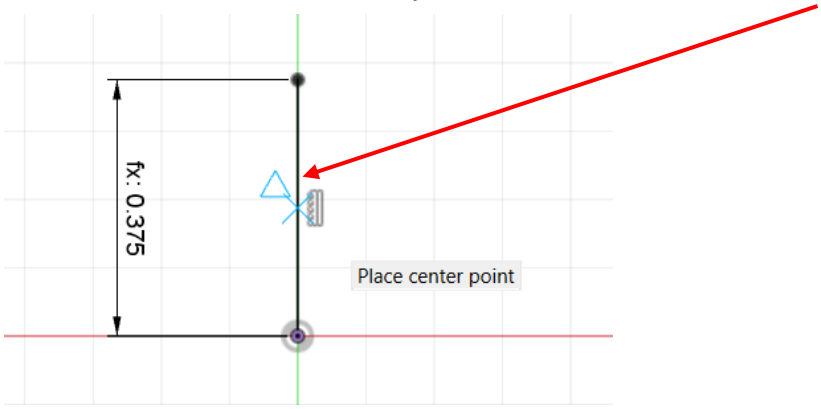
- the line should look like below. The **thick line** is what we care about. The other thin lines may look different. The "fx:" shown indicates that a **User Parameter** was used.



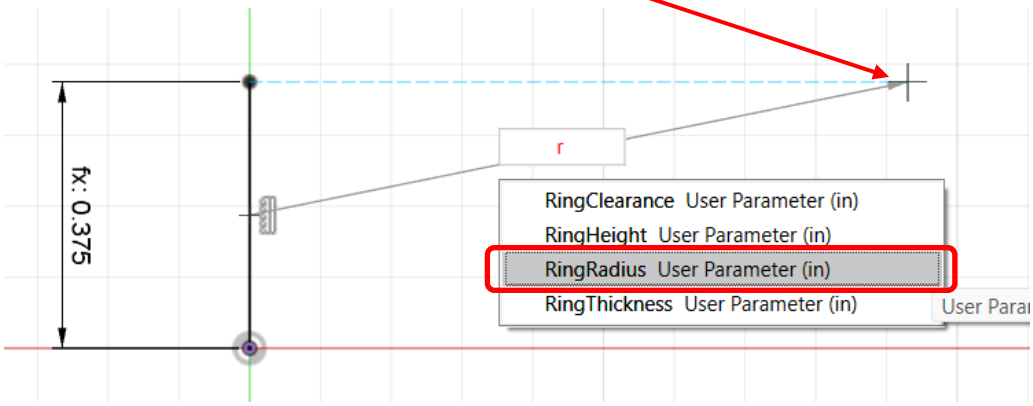
- from the CREATE menu select Arc and then Center Point Arc



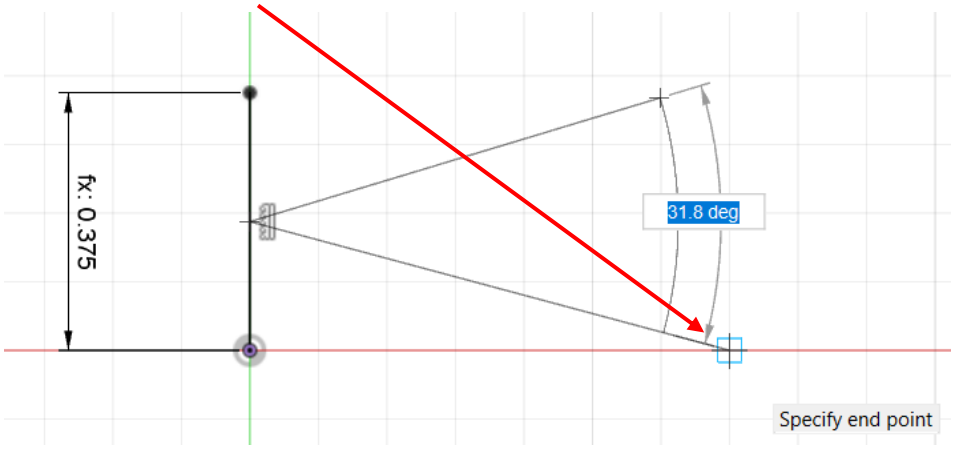
- hover over the center of the line just drawn and **click when the Triangle shows** (indicating that you are at the true center)



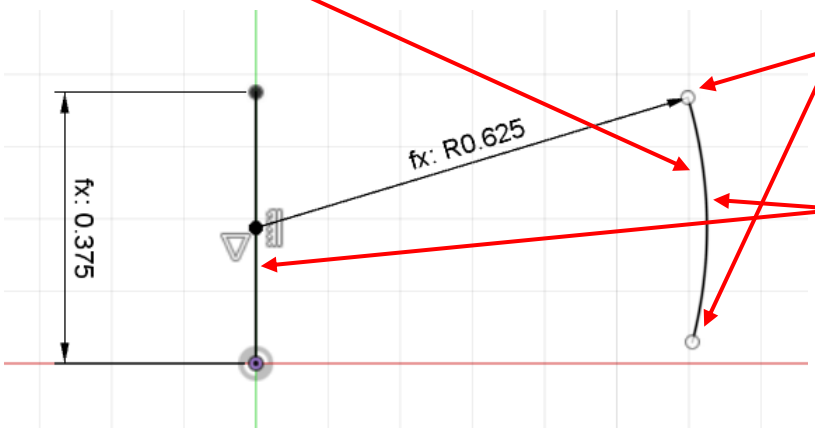
- move the mouse away to to **right and in-line with the top of the original line segment**. A dashed blue line may show, but it is OK if it doesn't. Type **r** and select **RingRadius** and click.



- click on on the **origin line just under the start position** of the arc. It's OK if the angle shown is different.



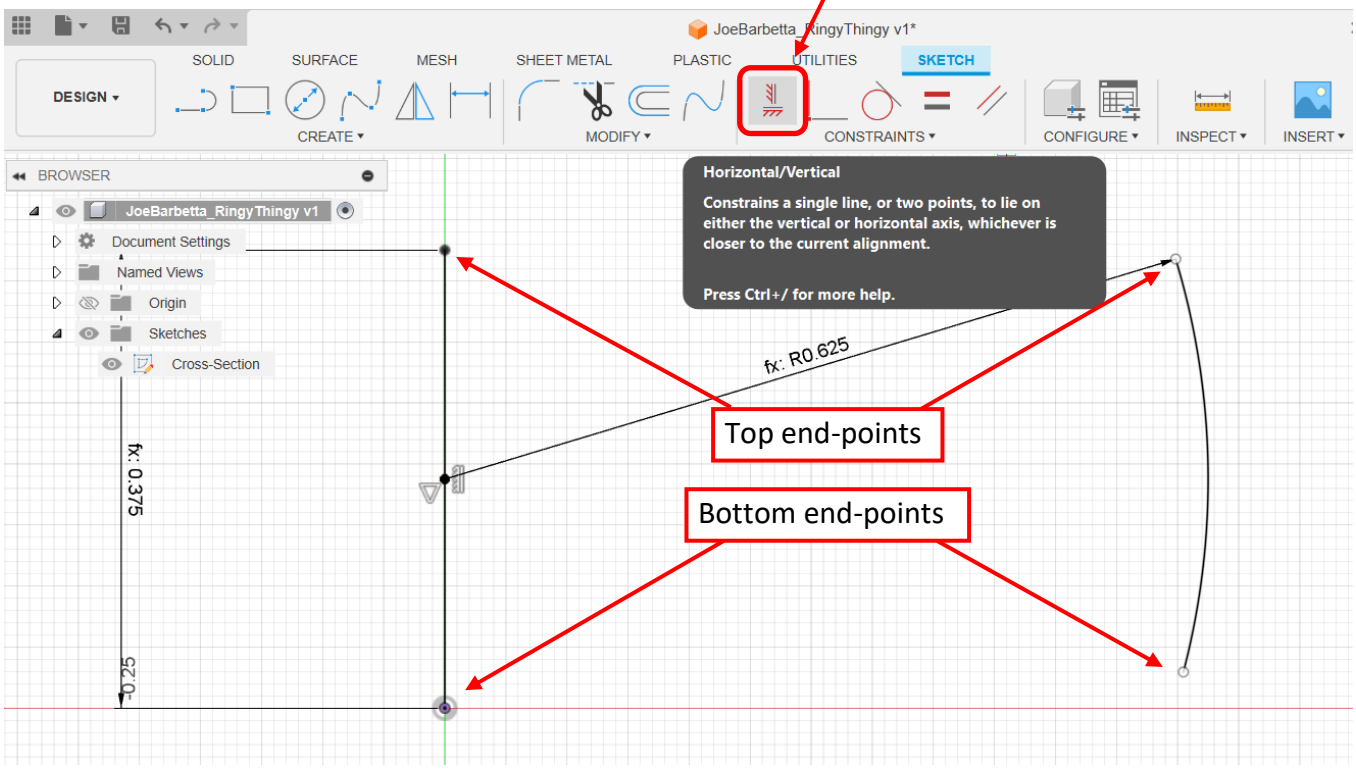
The resultant arc should look that that below. It's OK if the dimension lines look different. It is the Object lines that are important.



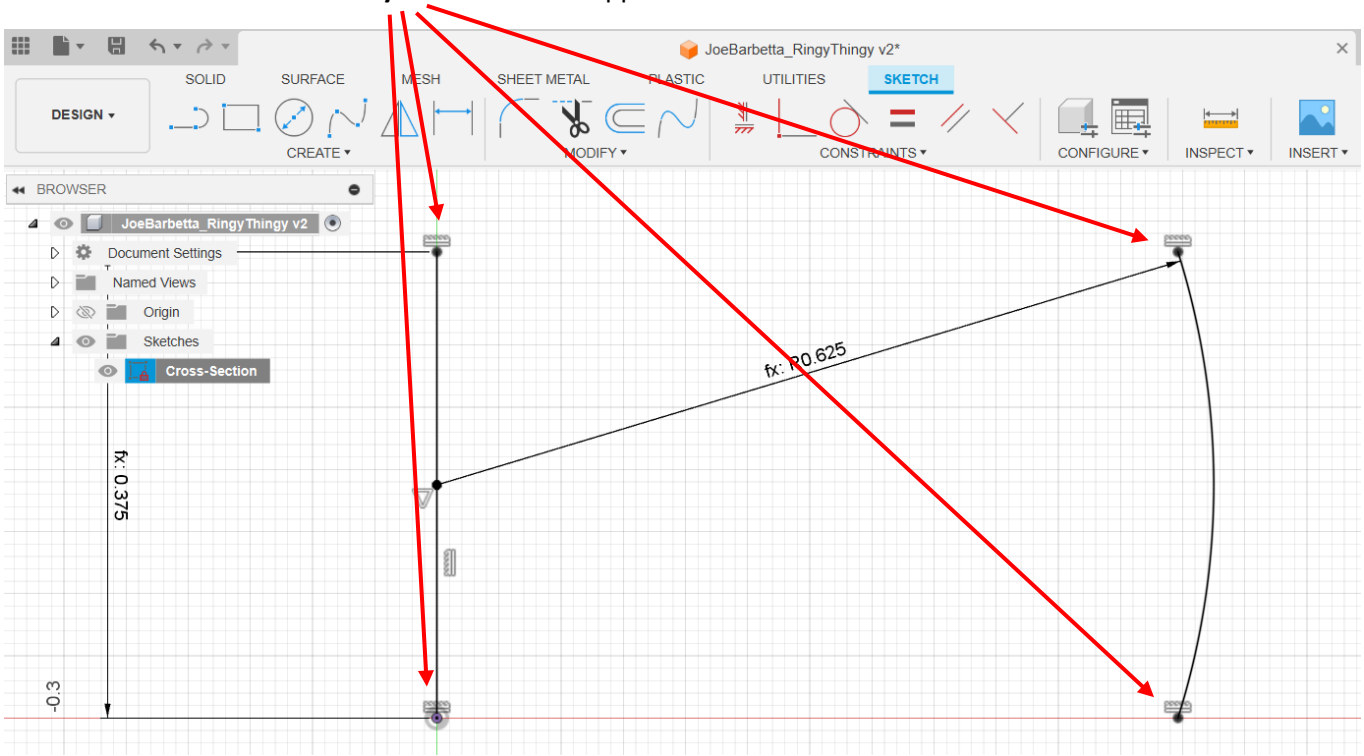
The ends of the arc do not need to be aligned with the endpoints of the vetical line. This will be corrected later.

The Object line and arc are important.

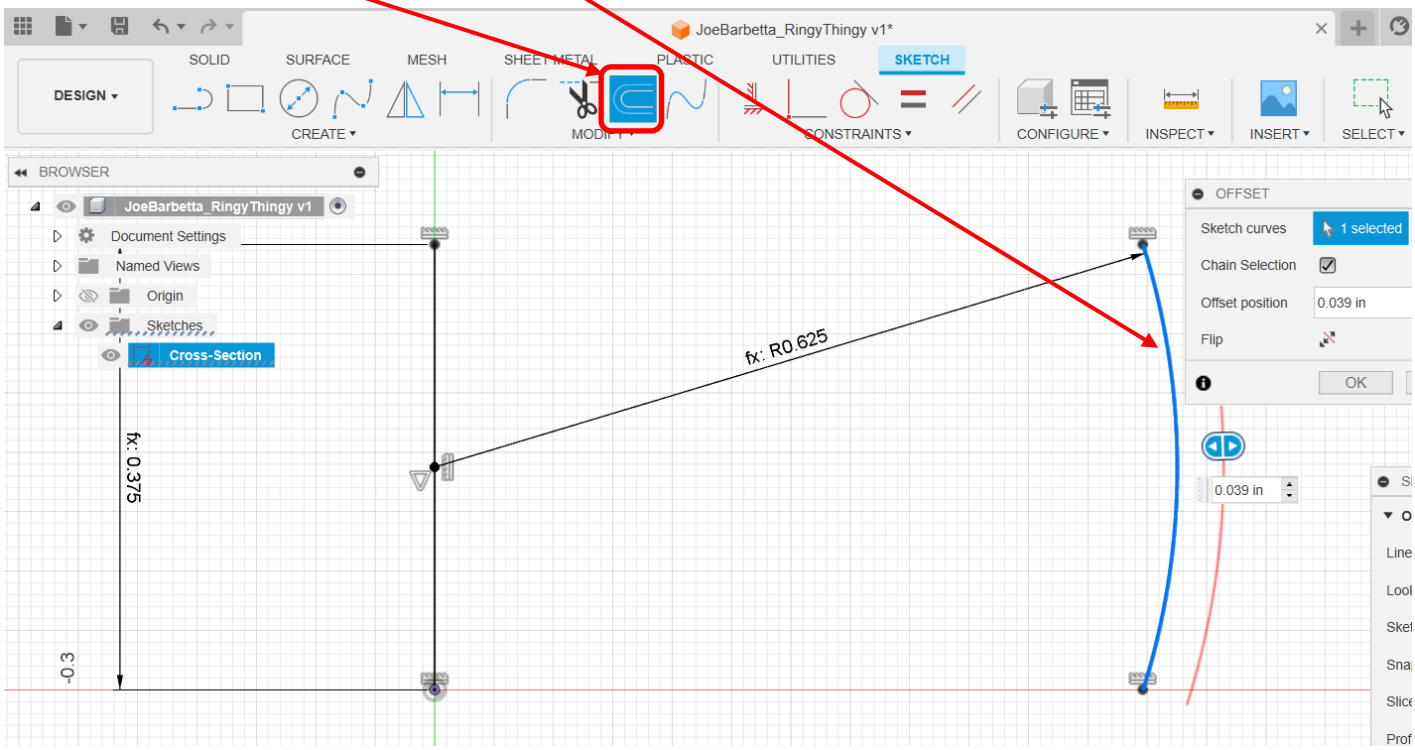
- zoom in to achieve a view similar to that below and select the **Horizontal/Vertical Constraints** tool
- click on the top **end-point of the line segment and arc**, which will cause Horizontal Constraint symbols to show
- do so for the **bottom end-points** as well and the result is shown lower down



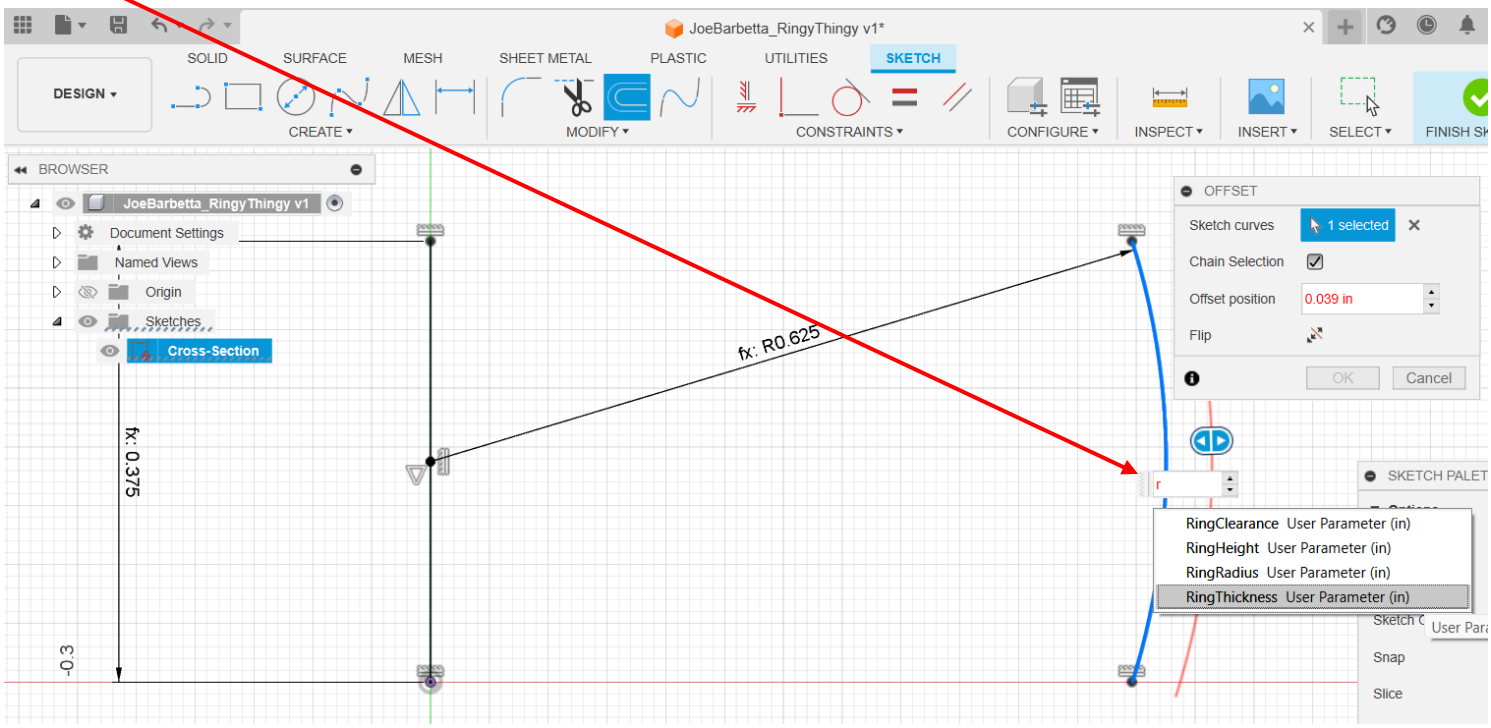
This is the result of the Constraints. Note the end-points of the arc are now horizontally aligned with those of the line segment and the **Horizontal Constraint symbols** that now appear.



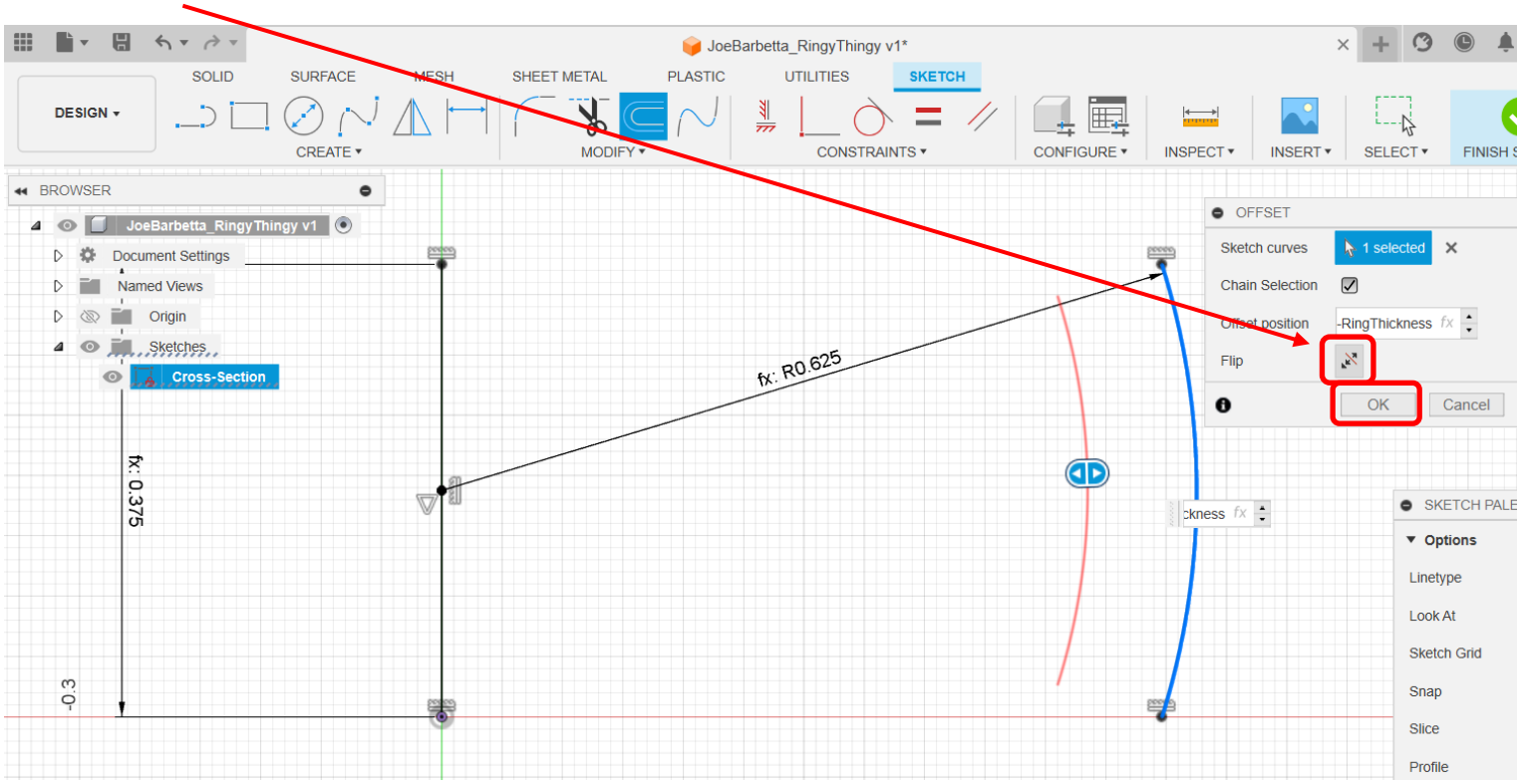
- select the **Offset** tool and **click on the arc**. **If a tool's icon does not appear at the top, one can click on the proper menu (MODIFY in this case) and select the tool.**



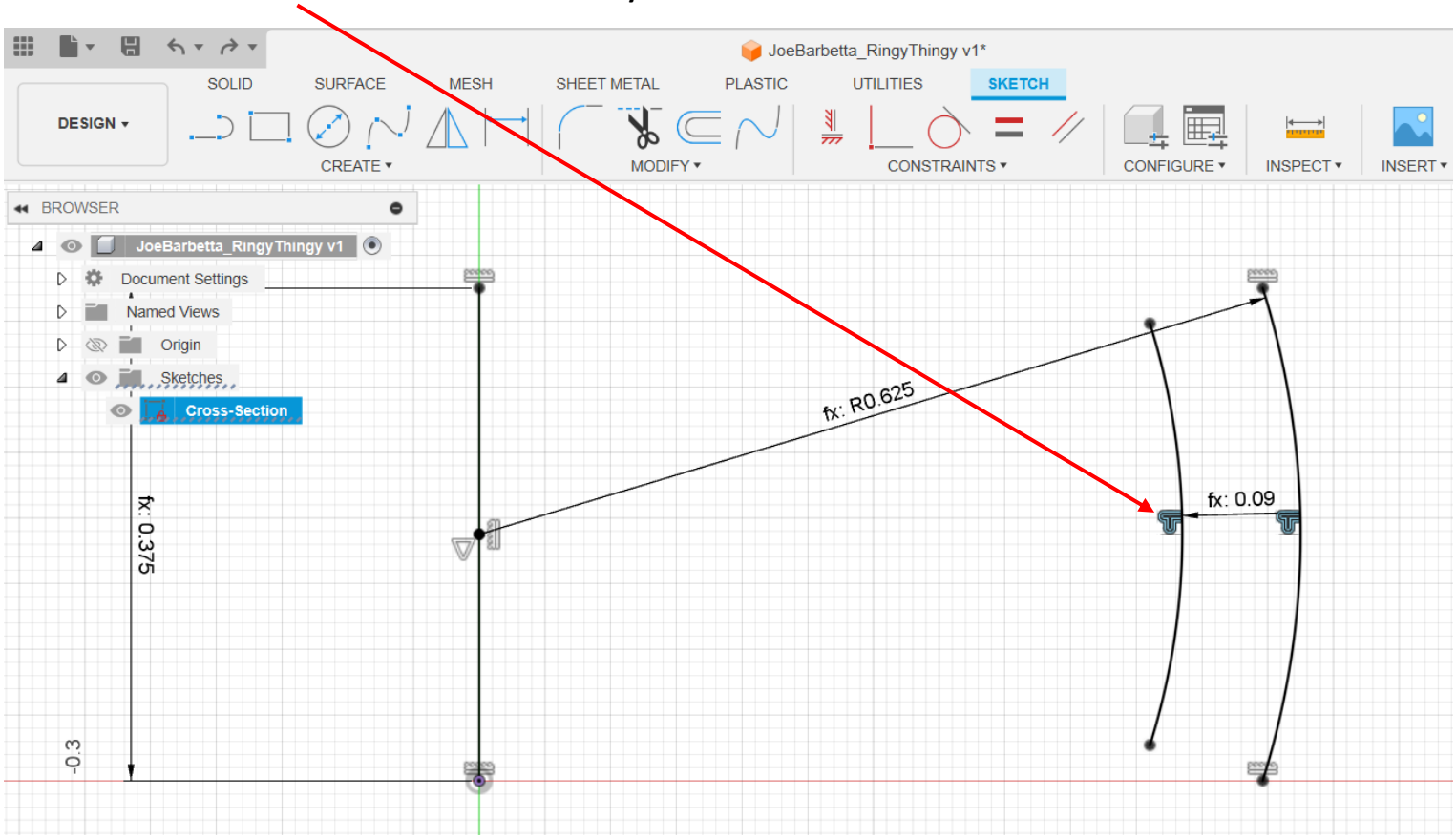
- type **r** into the dimension box and select **RingThickness**



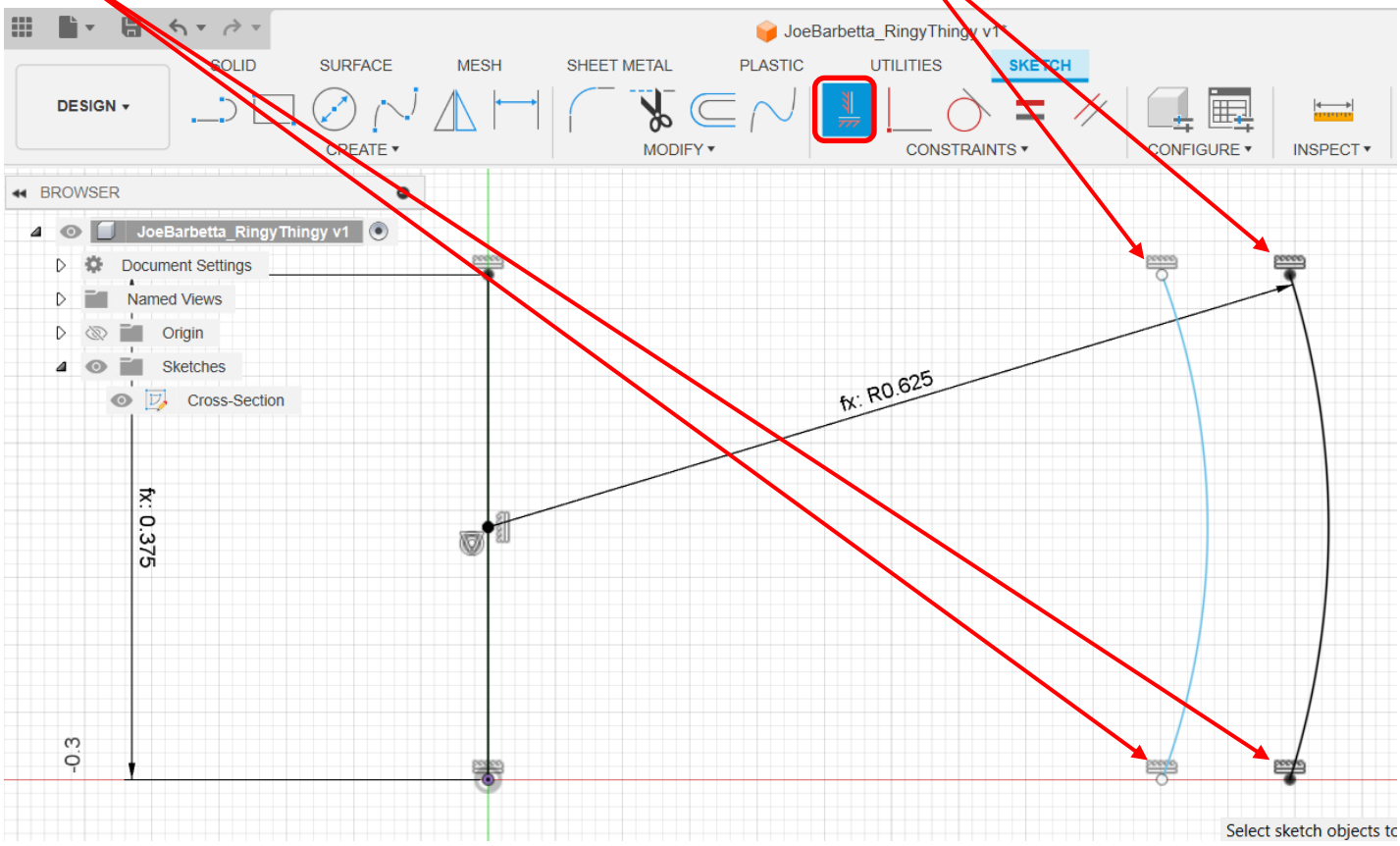
- click the **Flip icon** to move the red arc to the left, as shown below and click OK.



- click on one of the **Offset icons** and use the **delete key**.



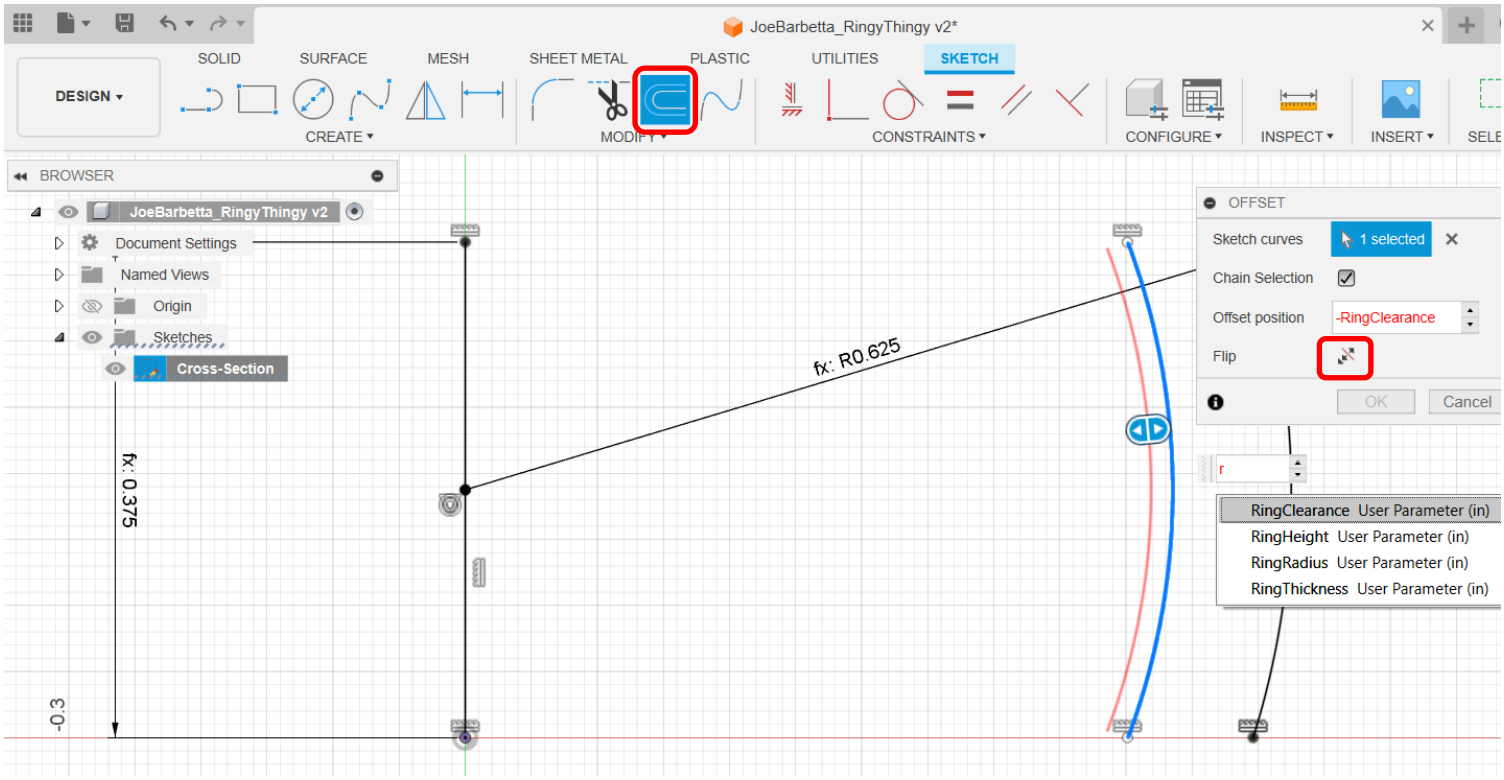
- select the **Horizontal/Vertical Constraints** tool again and click on the **top end-points of the two arcs** and then **the bottom end-points of the two arcs** with the result shown below.



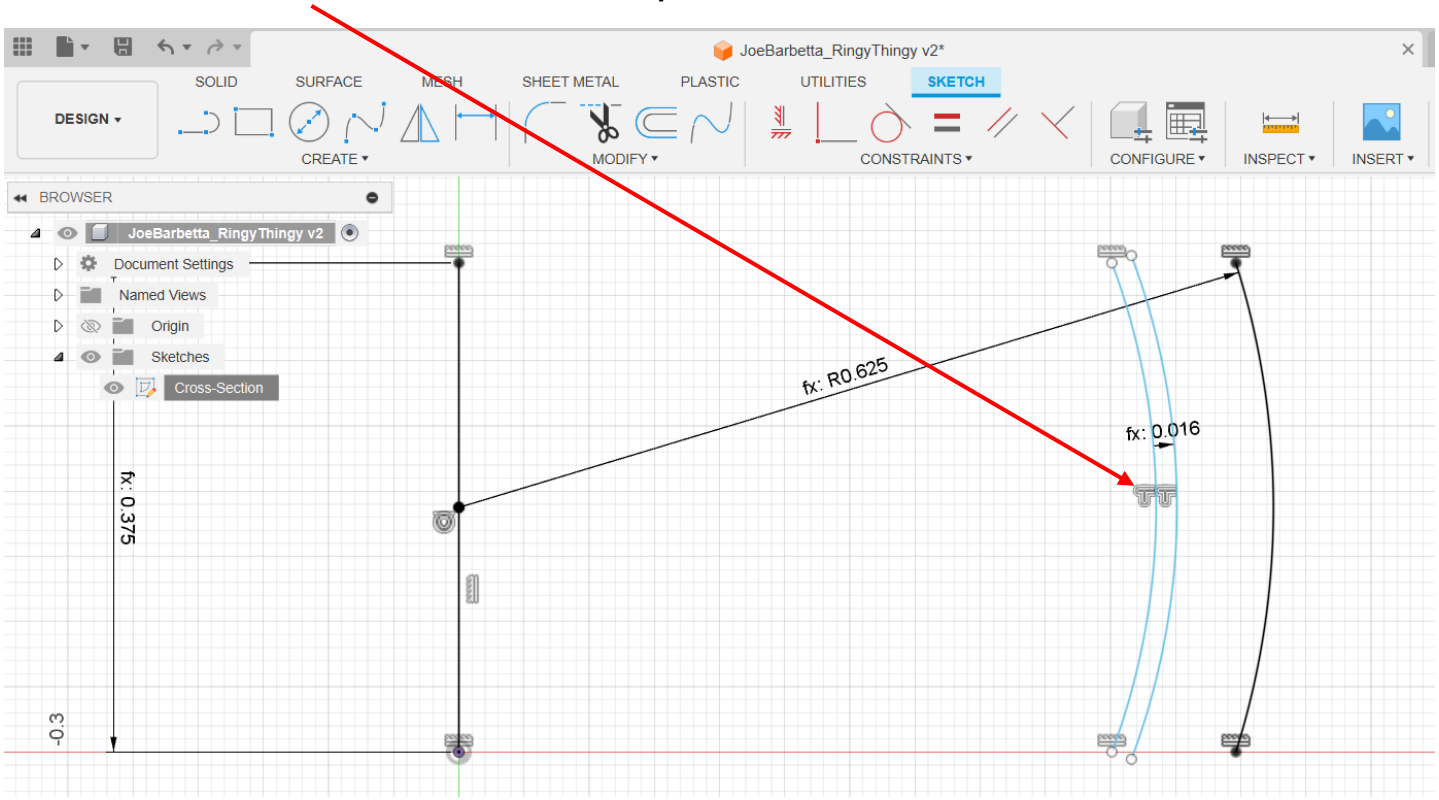
- select the **Offset** tool and click on the **last arc created**

- type **r** and select **RingClearance** and click the **Flip icon** and then click **OK**

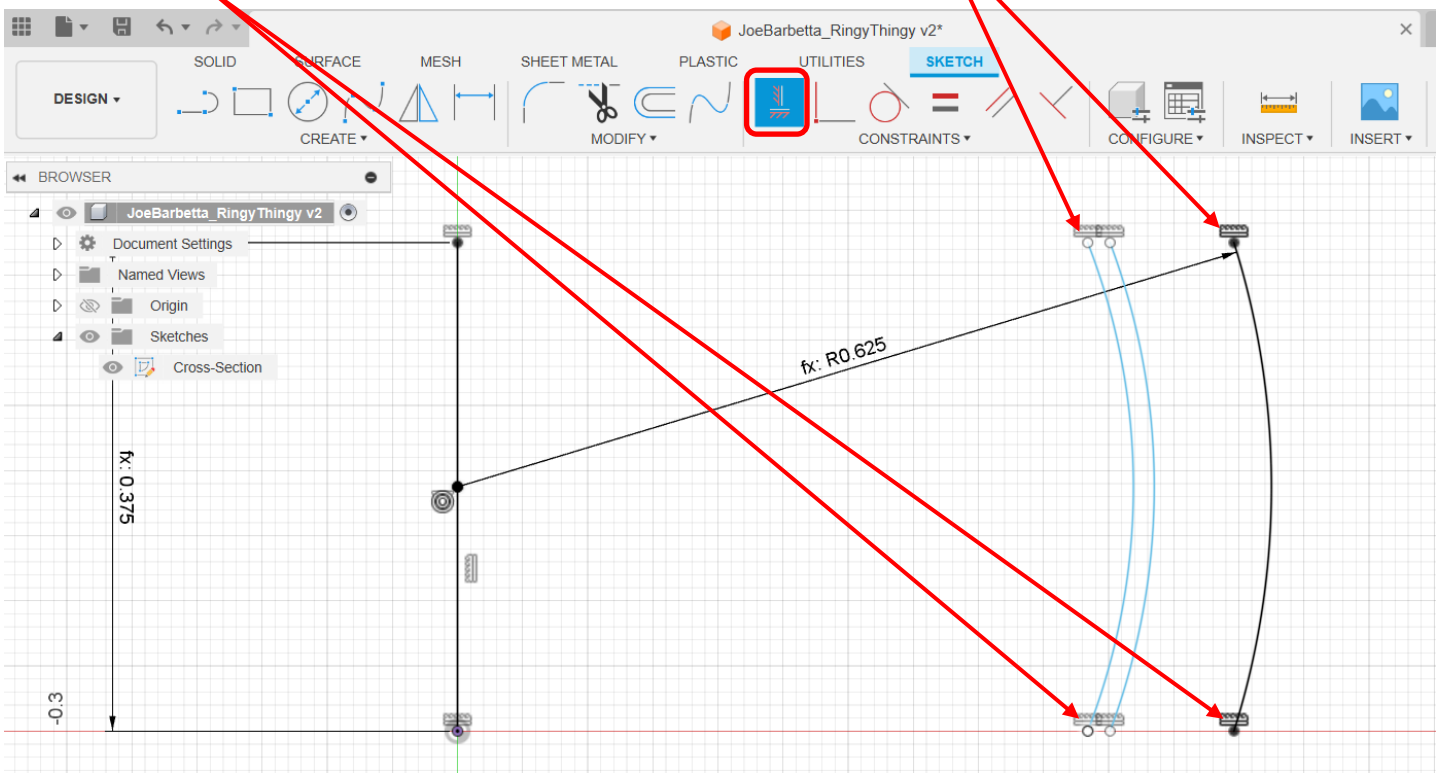
Note that this is the same as done previously, but RingClearance was used instead and the distance to this arc will be smaller.



- click on one of the **Offset icons** and use the **delete key**.



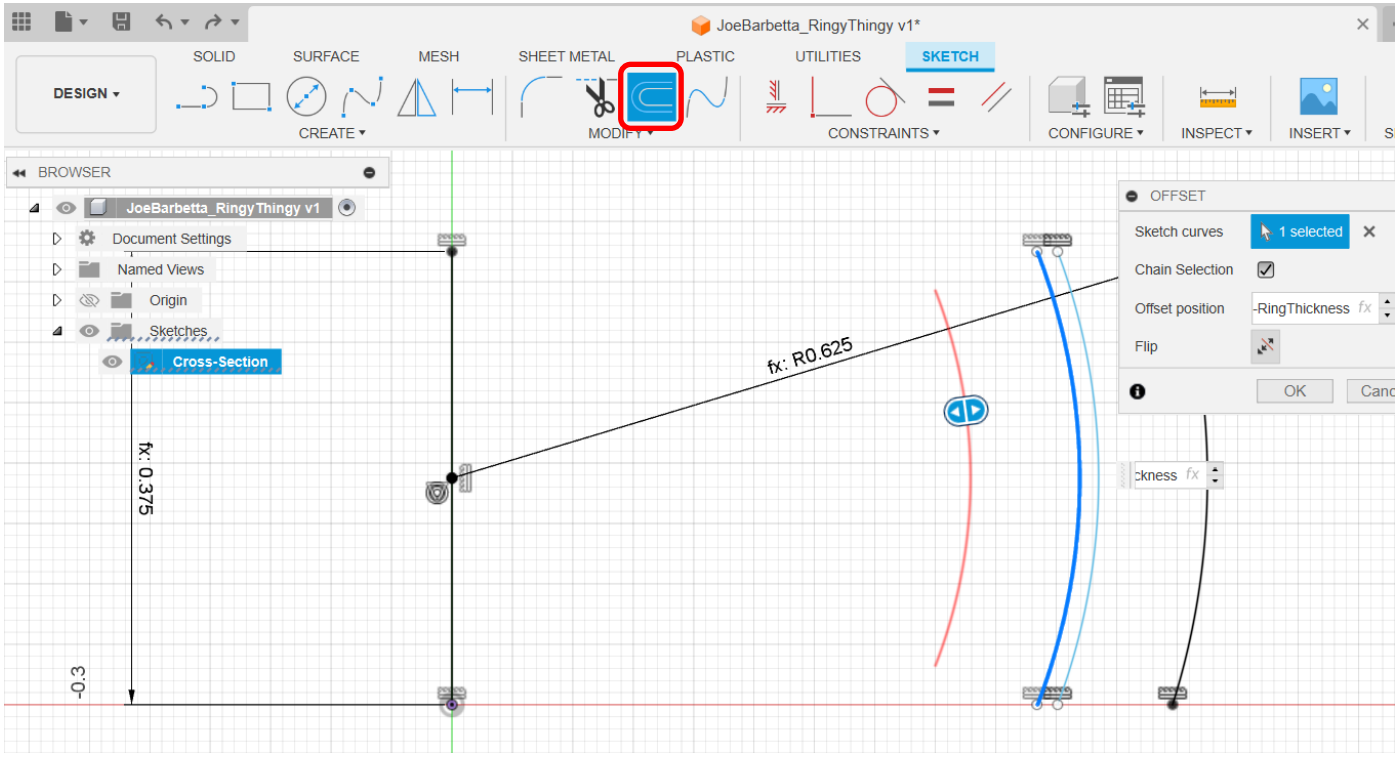
- select the **Horizontal/Vertical Constraints** tool again and click on the **top end-points of the original and new arcs** and then **the bottom end-points of the original and new arcs** with the result shown below.



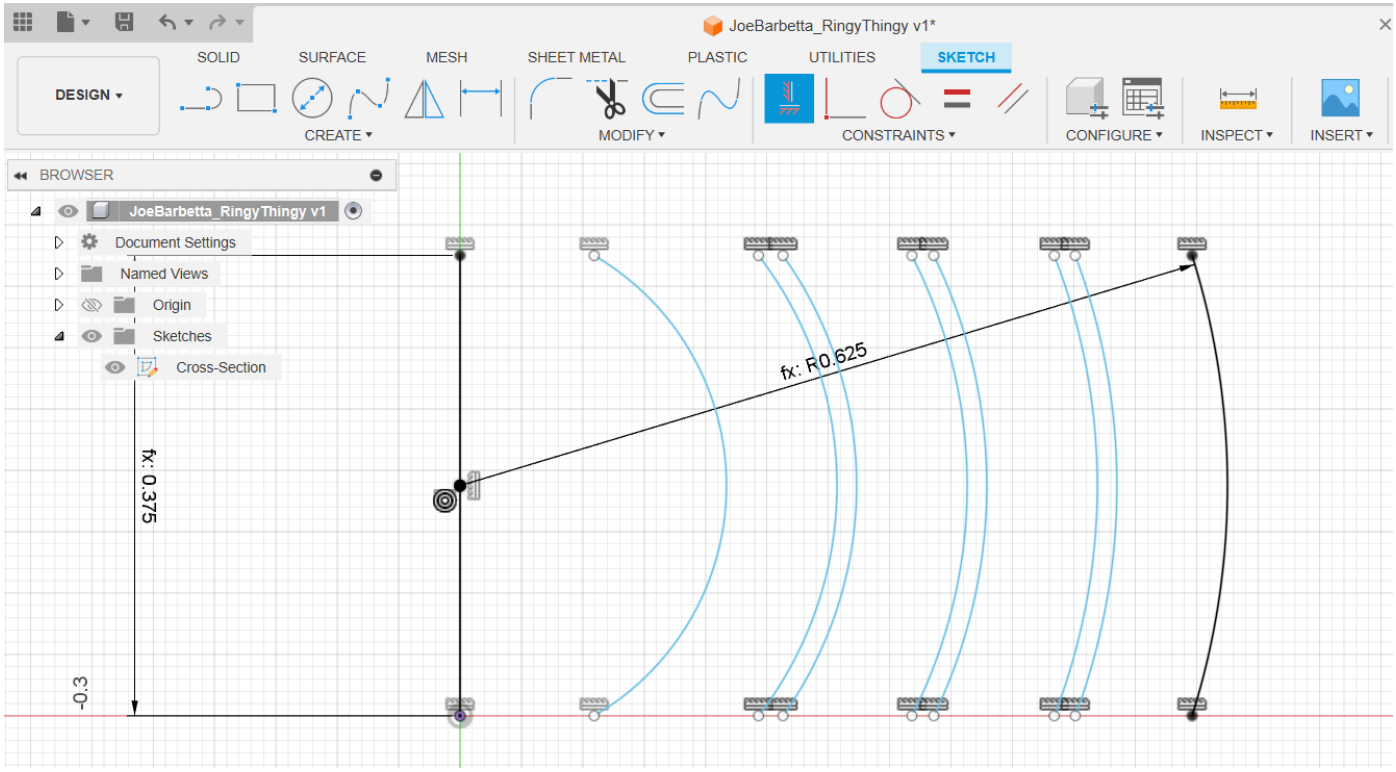
Having fun? Does this seem like a major pain in the butt?

You have to repeat this sequence of these steps a few more times! You are going to have to work to get this art credit.

The next two screen shots show starting the next arc and then the final set of arcs. Just go through the **same sequence of using the offset, deleting the Offset icons, and using the Constraints**. **Remember to alternate between using RingThickness and RingClearance.**



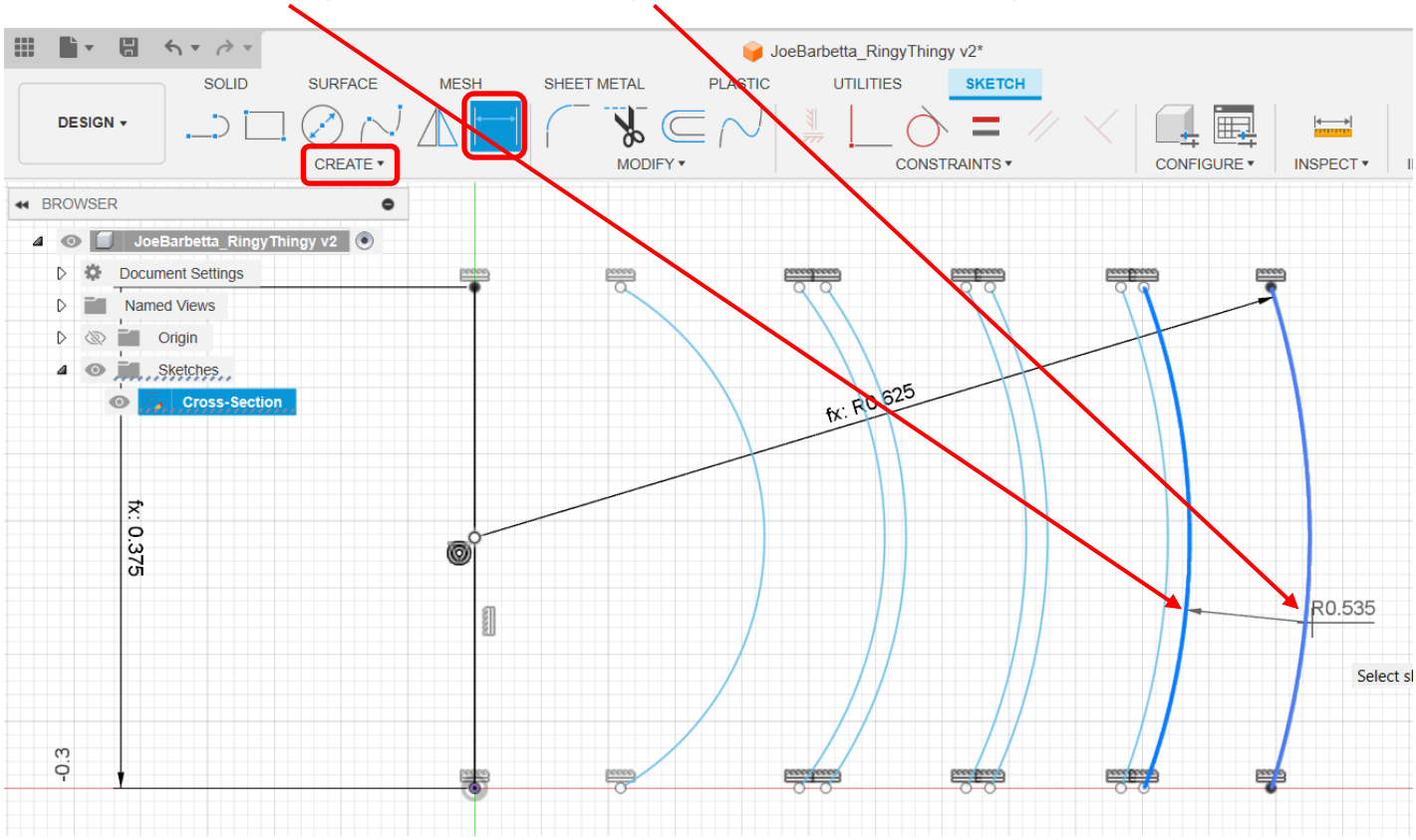
The result of having all arcs finished. Note that the overall Sketch is not yet complete. Don't click Finish Sketch!



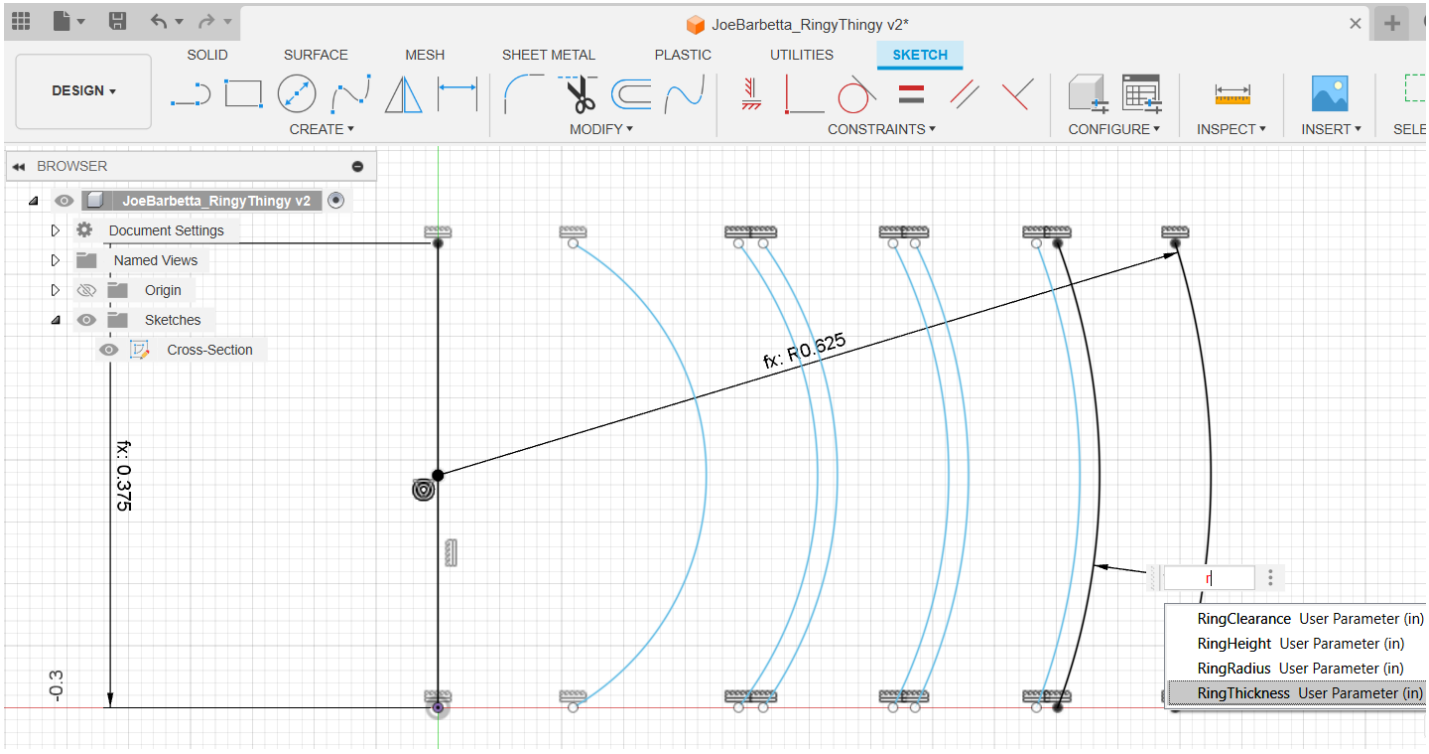
Using the Sketch Dimension tool

Note that dimensions were set when creating the arcs using the Offset tool. However, the dimension parameters were cleared when the Offset icons were deleted to allow Constraining the endpoints. They will be added back now.

- select the **Sketch Dimension** tool. If not seen find it in the **CREATE** menu.
- click on the **2nd to last arc**, then click on the **last arc**, and then click **near the last arc**, but Not on it

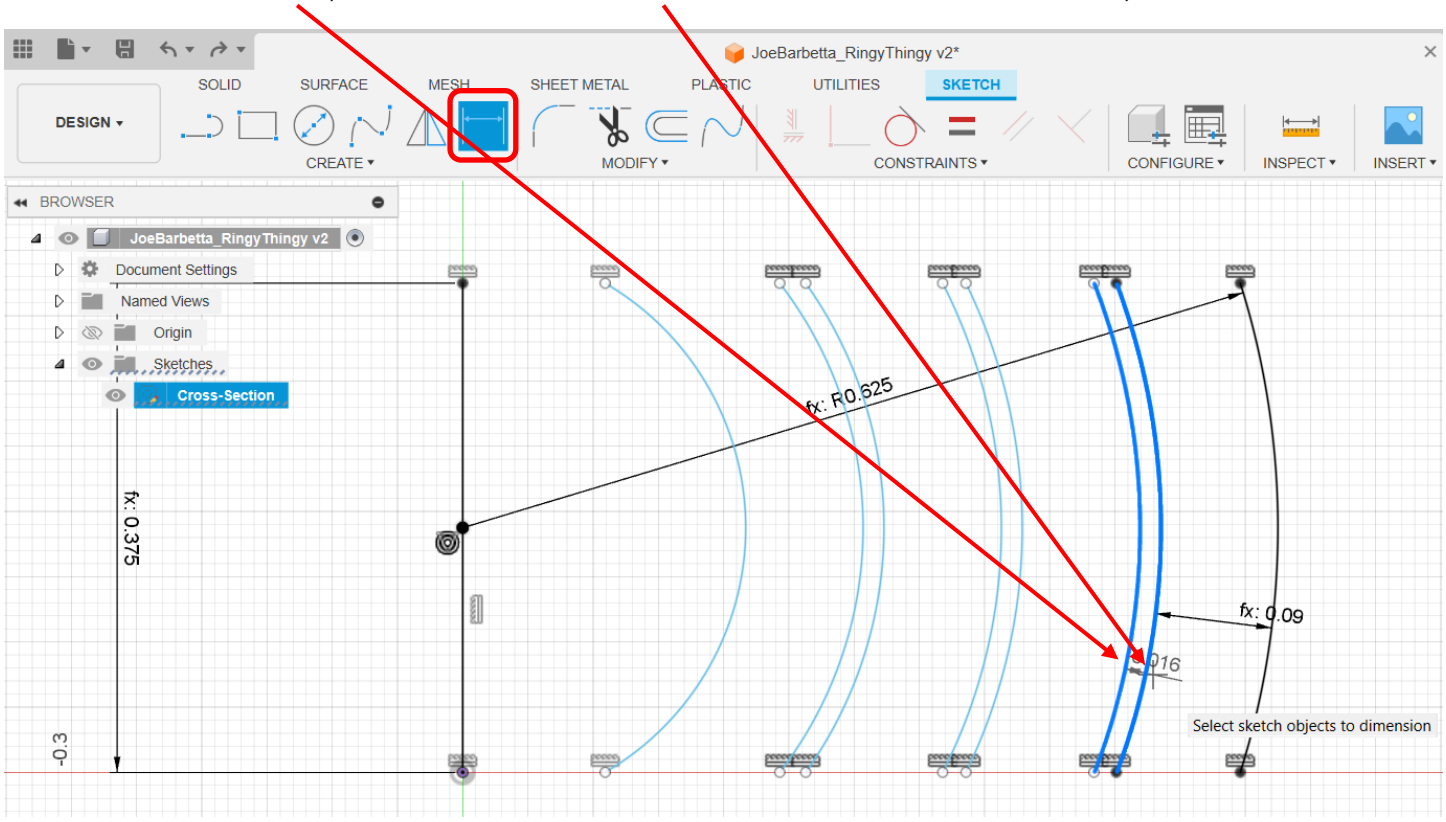


- type **r** and select **RingThickness** and then press the **Enter key**. Note that the inner arc will turn black.

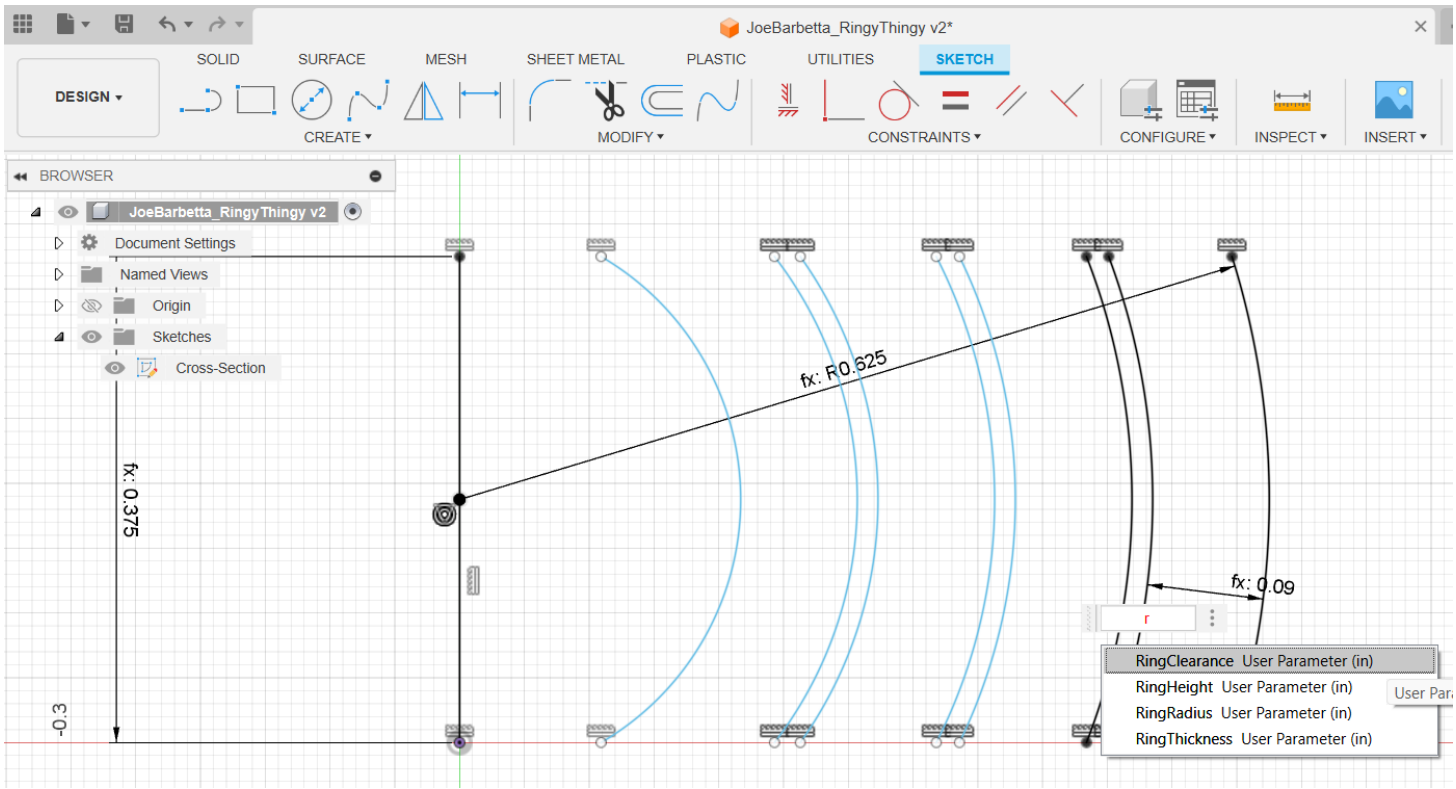


- select the **Sketch Dimension** tool again

- click on the **3rd to last arc**, then click on the **2nd to last arc twice** then click **near the that arc**, but Not on it



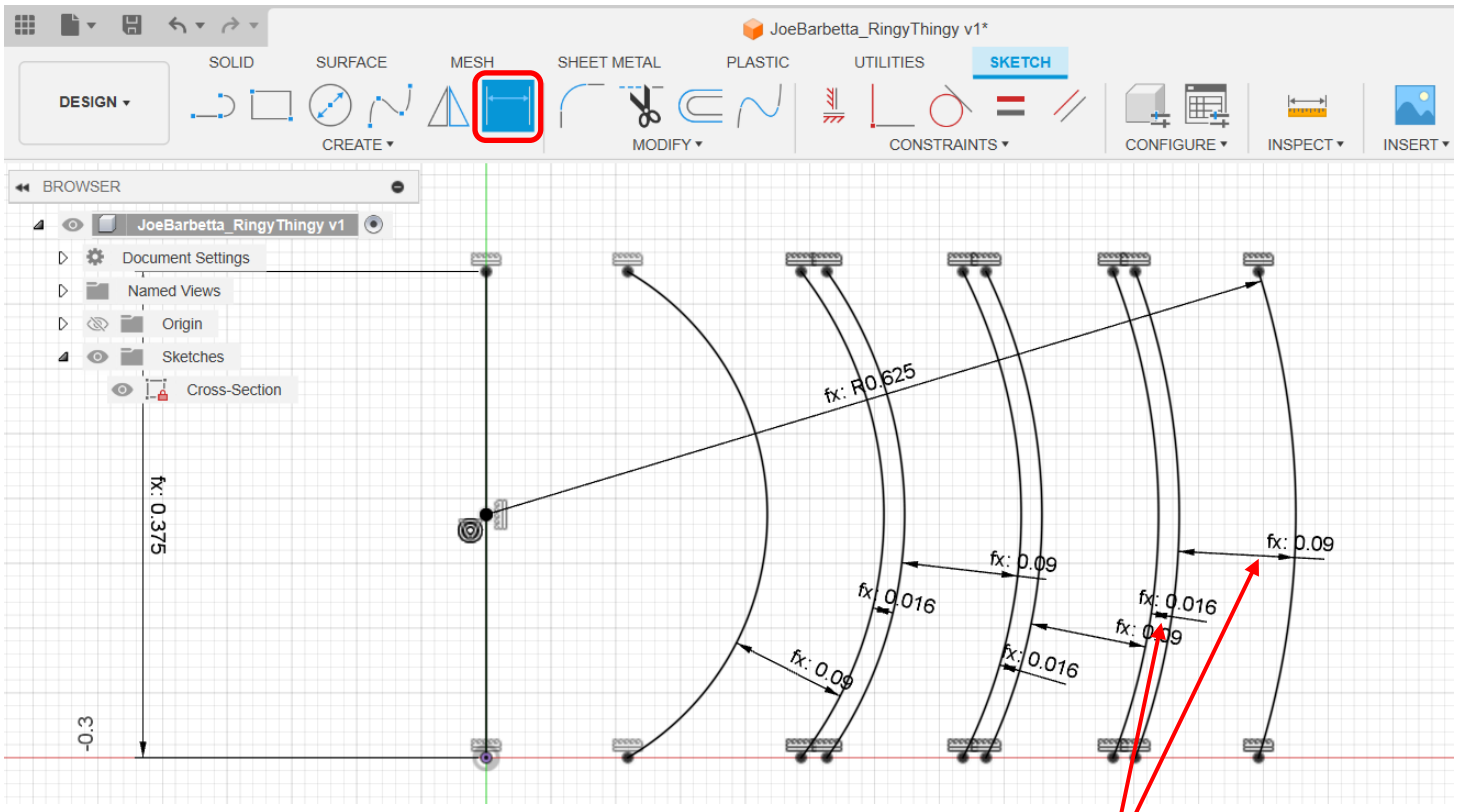
- type **r** and select **RingClearance** and then press the **Enter key**. Note that the inner arc will turn black.



- continue using the Sketch Dimension tool, clicking on the arcs, and selecting parameters until all the arcs are black.

Ensure that **RingThickness** is selected when arcs are far apart and **RingClearance** when they are close together.

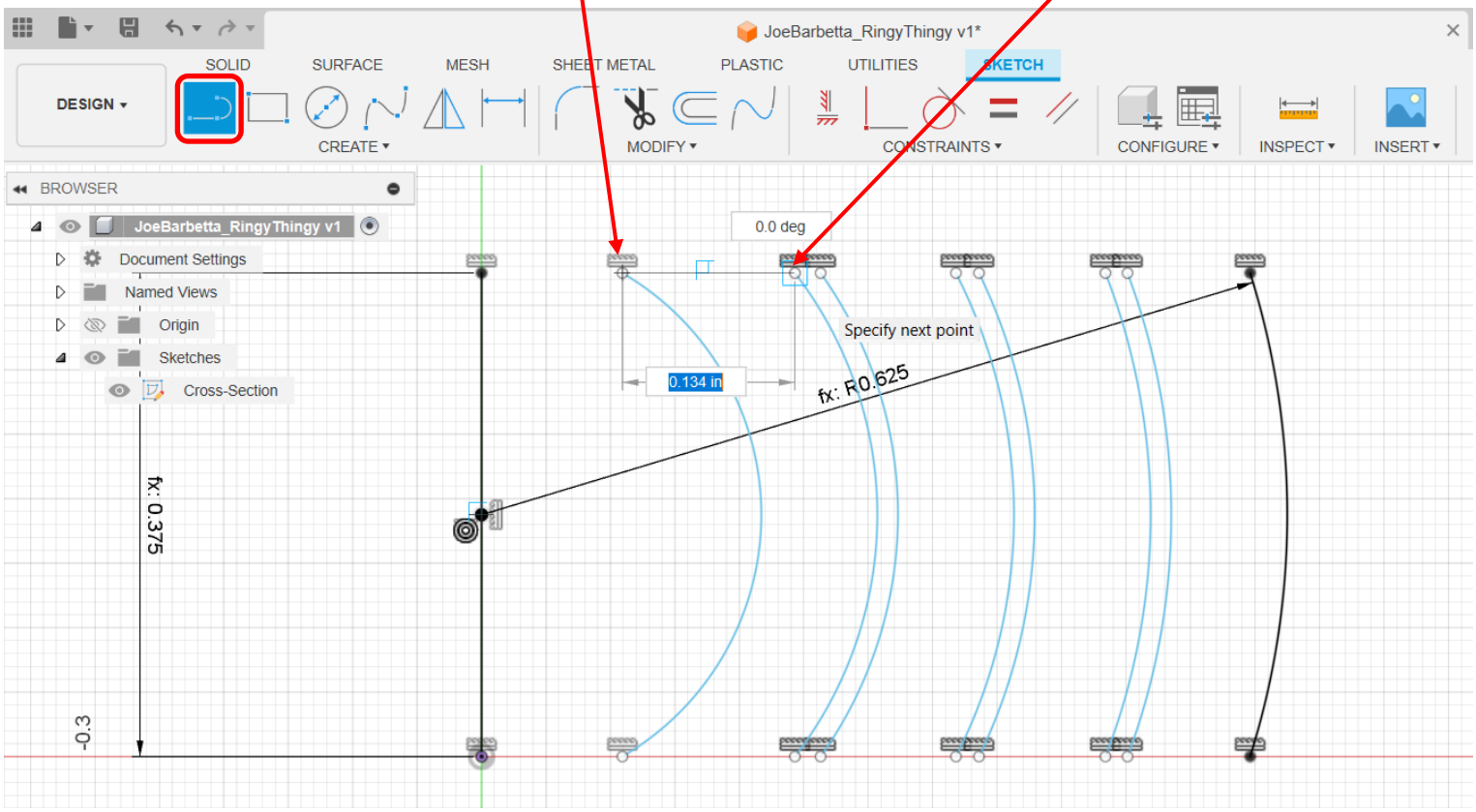
When done the sketch should look similar to that below. Note that the dimension lines can look different.



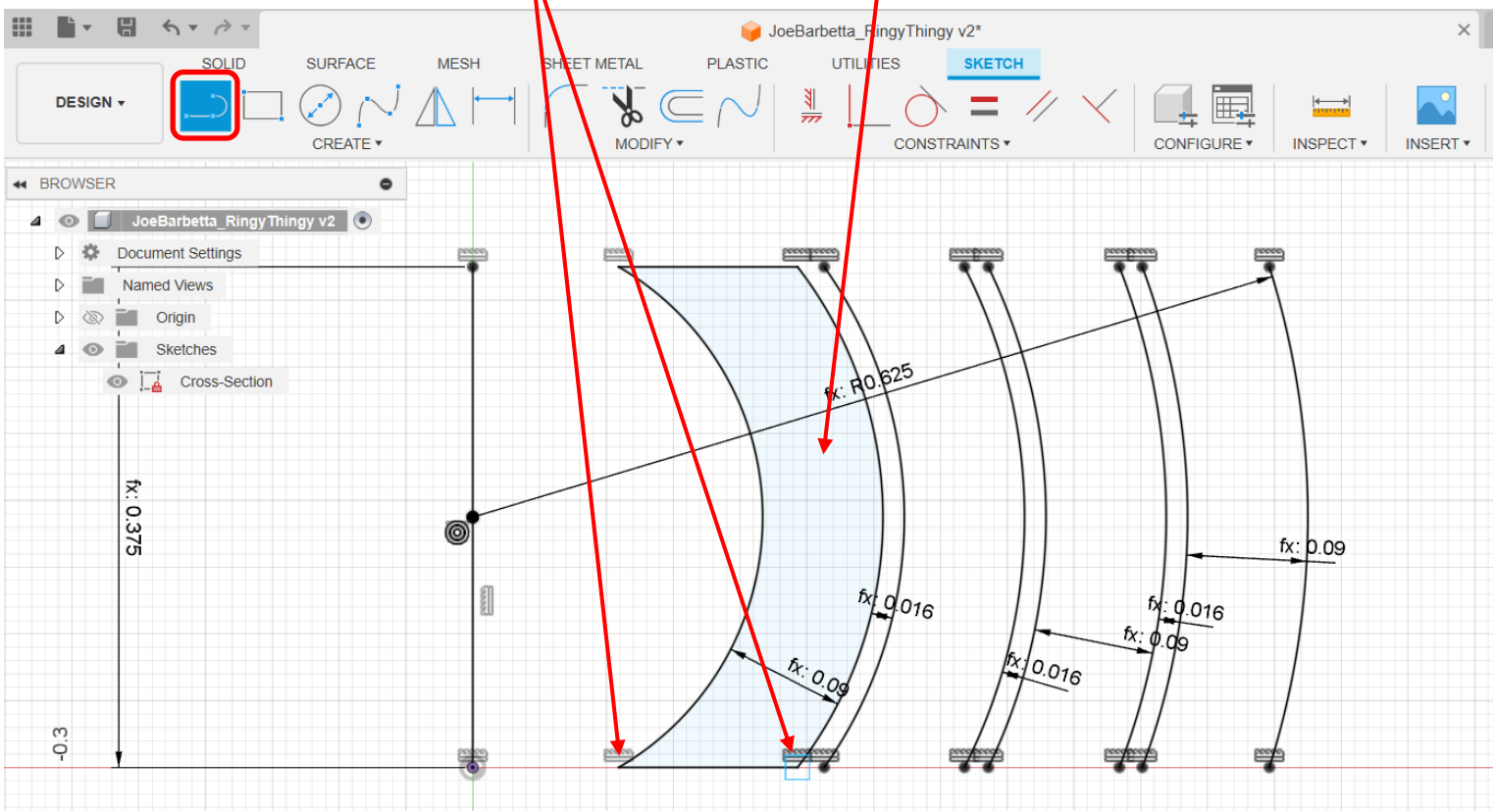
As mentioned, the dimension lines may be in different positions. It is important to note that the values alternate between **0.09** and **0.016**, which correspond to **RingThickness** and **RingClearance**.

Closing the Profile Shapes

- select the **Line** tool and click on the **top of the 1st arc** (left most) and then the **top of the 2nd arc**.

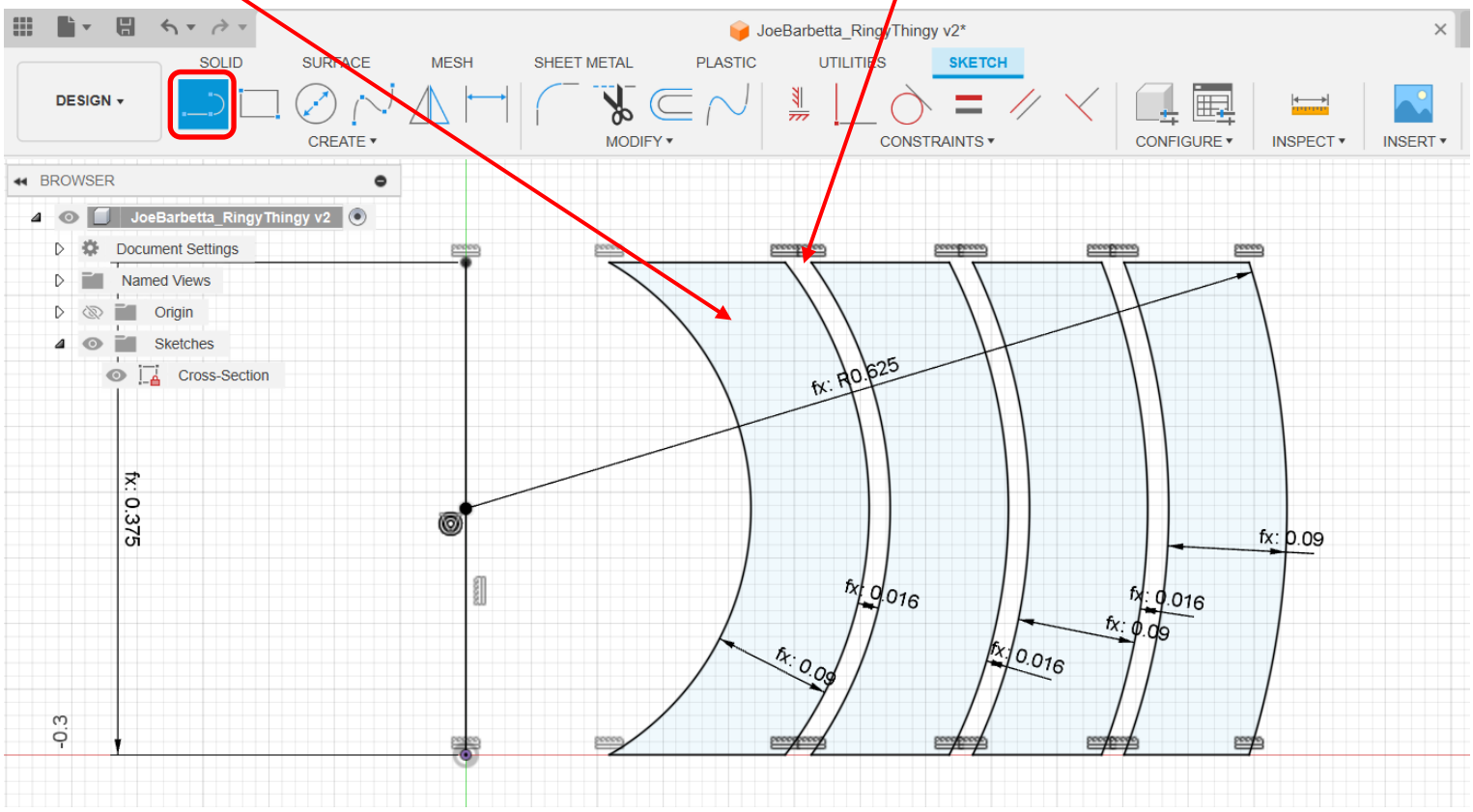


- use the **Line** tool again and click on the **bottoms of the two arcs**. The region between the two arcs should turn blue.

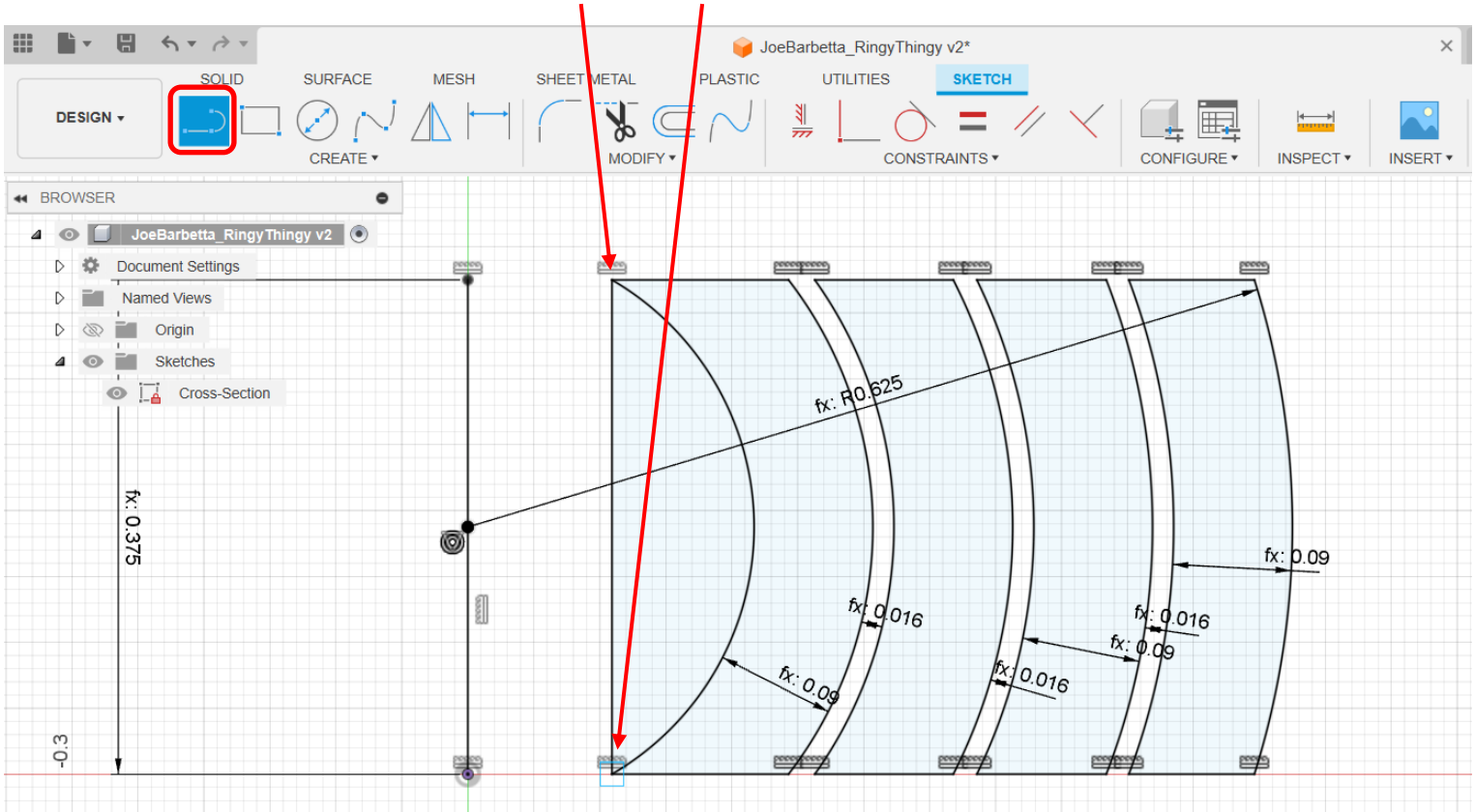


- continue using the **Line** tool to connect the **tops and bottoms of pairs of arcs** until there are **four closed regions**.

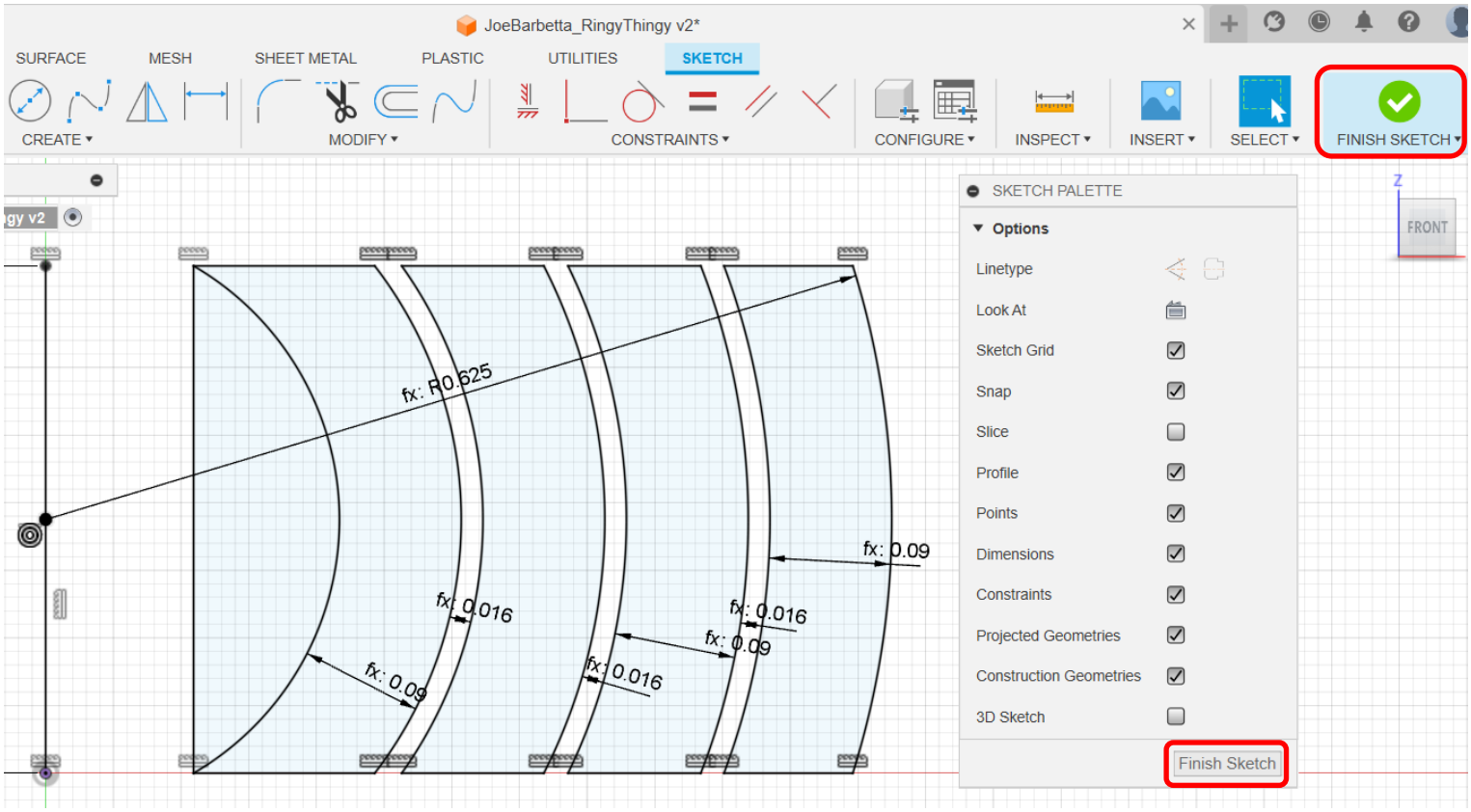
Note that tops are arcs that are further apart are connected and Not those that are close. This will ensure that only the larger regions are **closed (blue)** and that spaces between these regions remain **open (white)**.



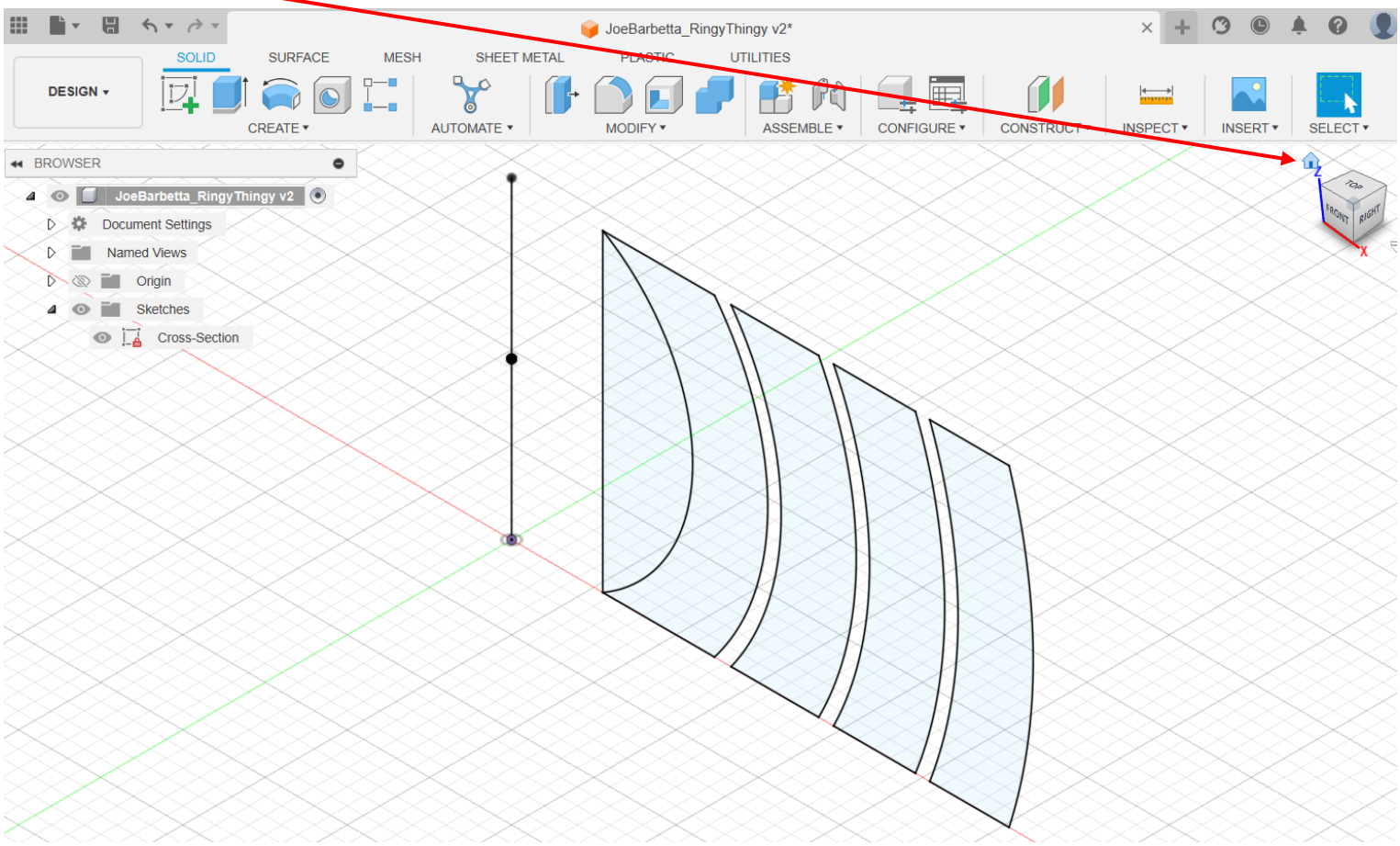
- use the **Line** tool one last time and click on the **top** and **bottom** of the innermost arc to create a vertical line.



- jump up and yell **"I am finally finished with my sketch!"** Click either **Finish Sketch** button.



- click on the **Home** icon to see this view.

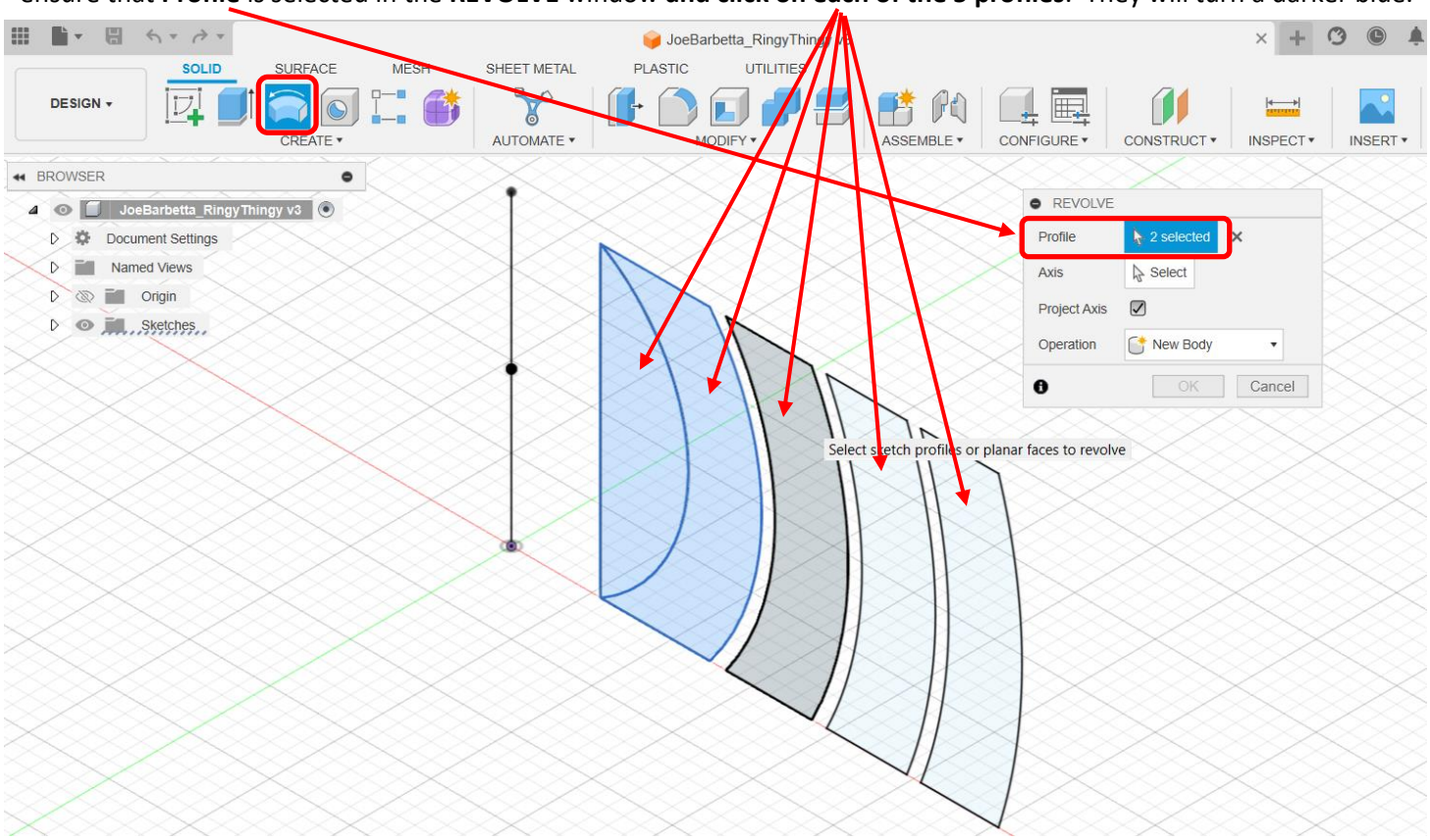


Performing a Revolve

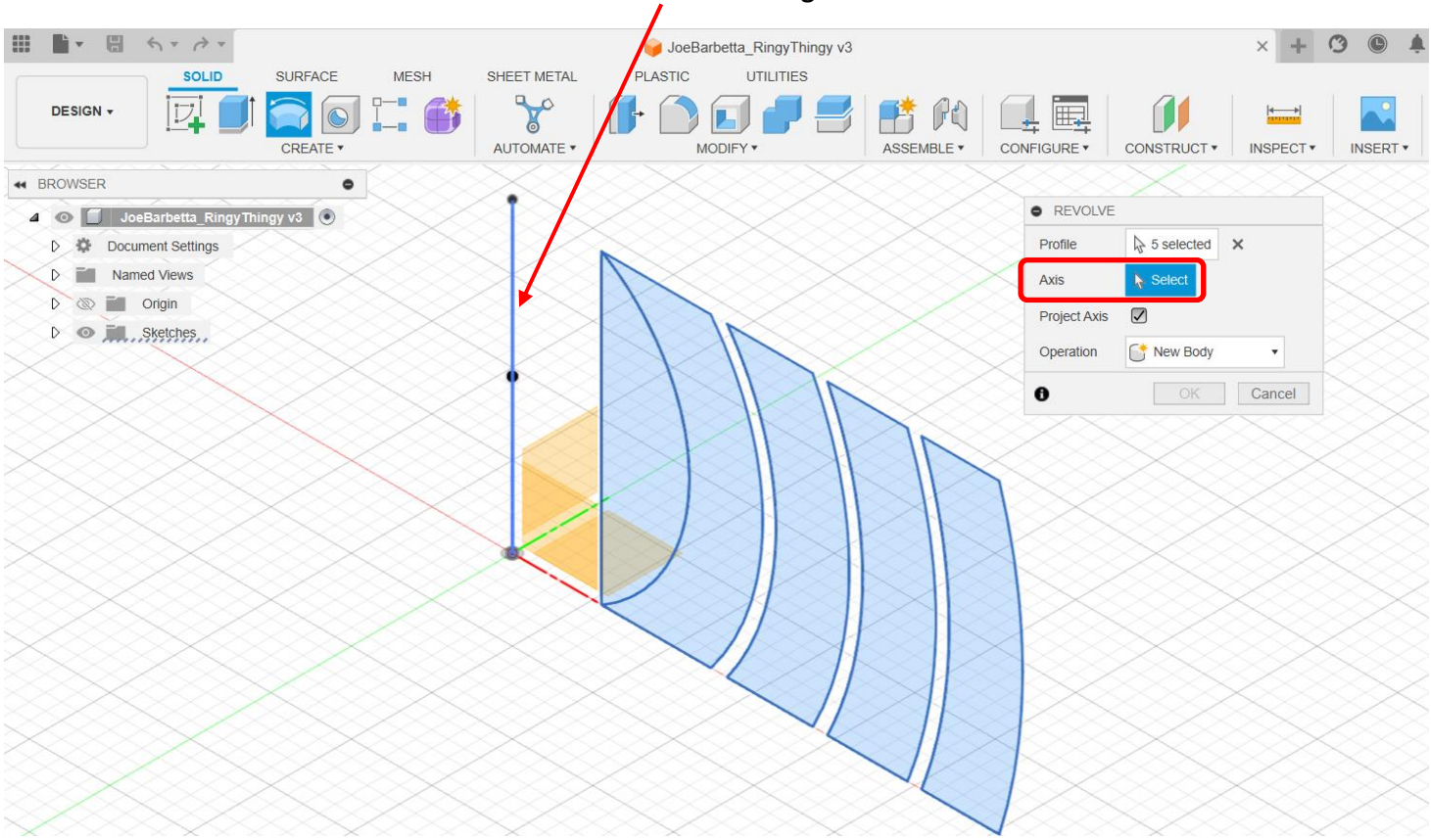
This next step is really neat!

- select the **Revolve** tool. Remember if you don't see the icon, find it using the CREATE menu.

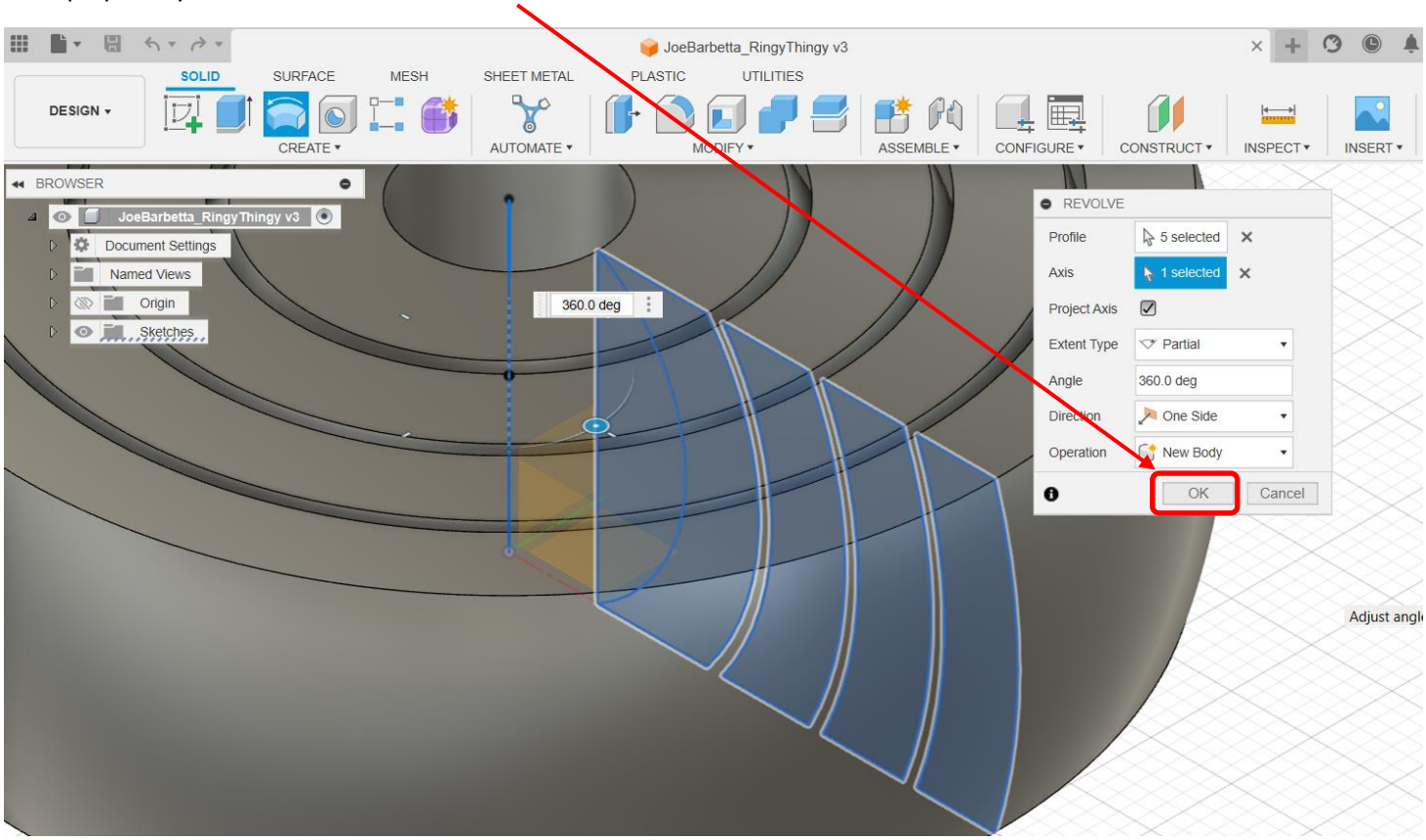
- ensure that **Profile** is selected in the **REVOLVE** window **and click on each of the 5 profiles**. They will turn a darker blue.



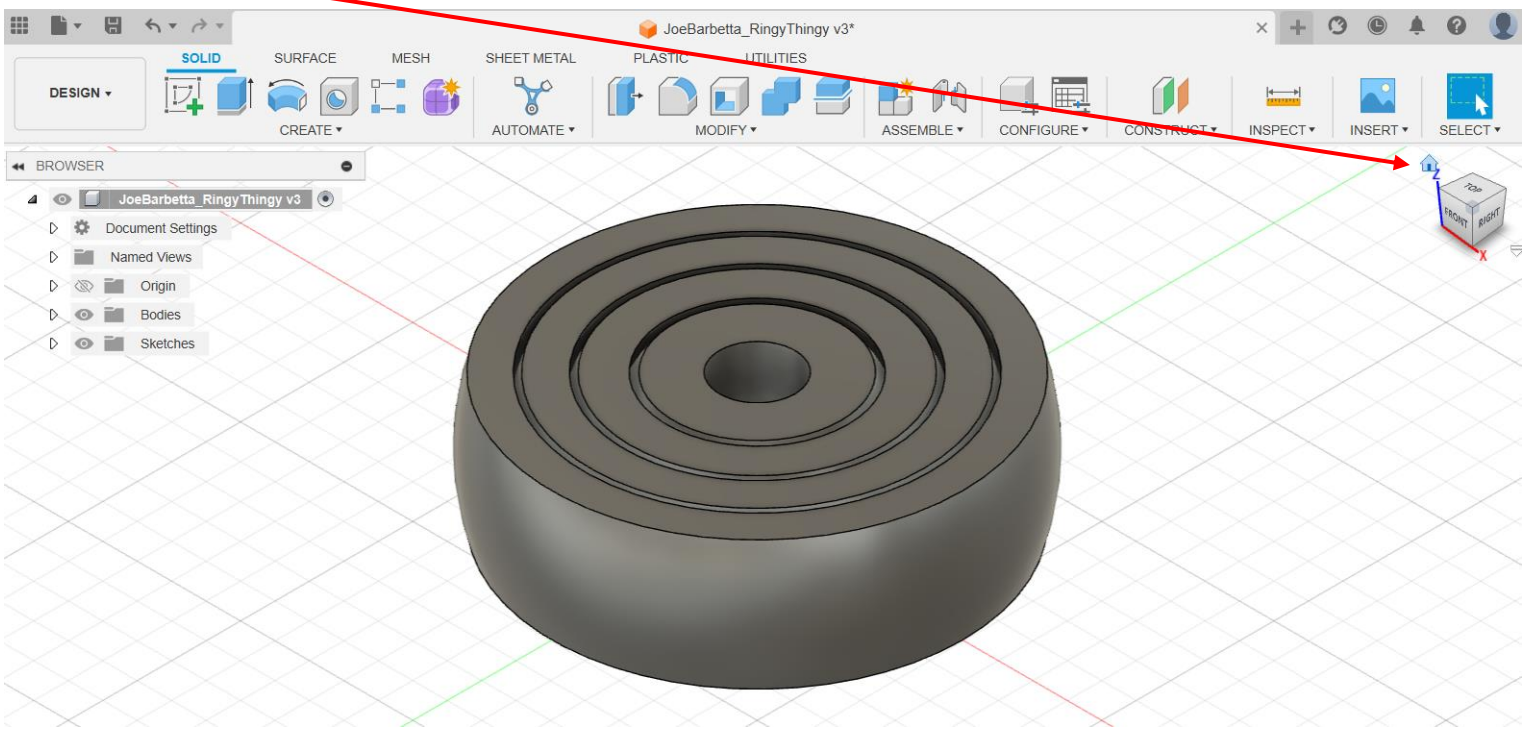
- select Axis in the **REVOLVE** window and **click on the vertical line segment.**



- Jump up and yell **"That was neat!"** Click **OK**.

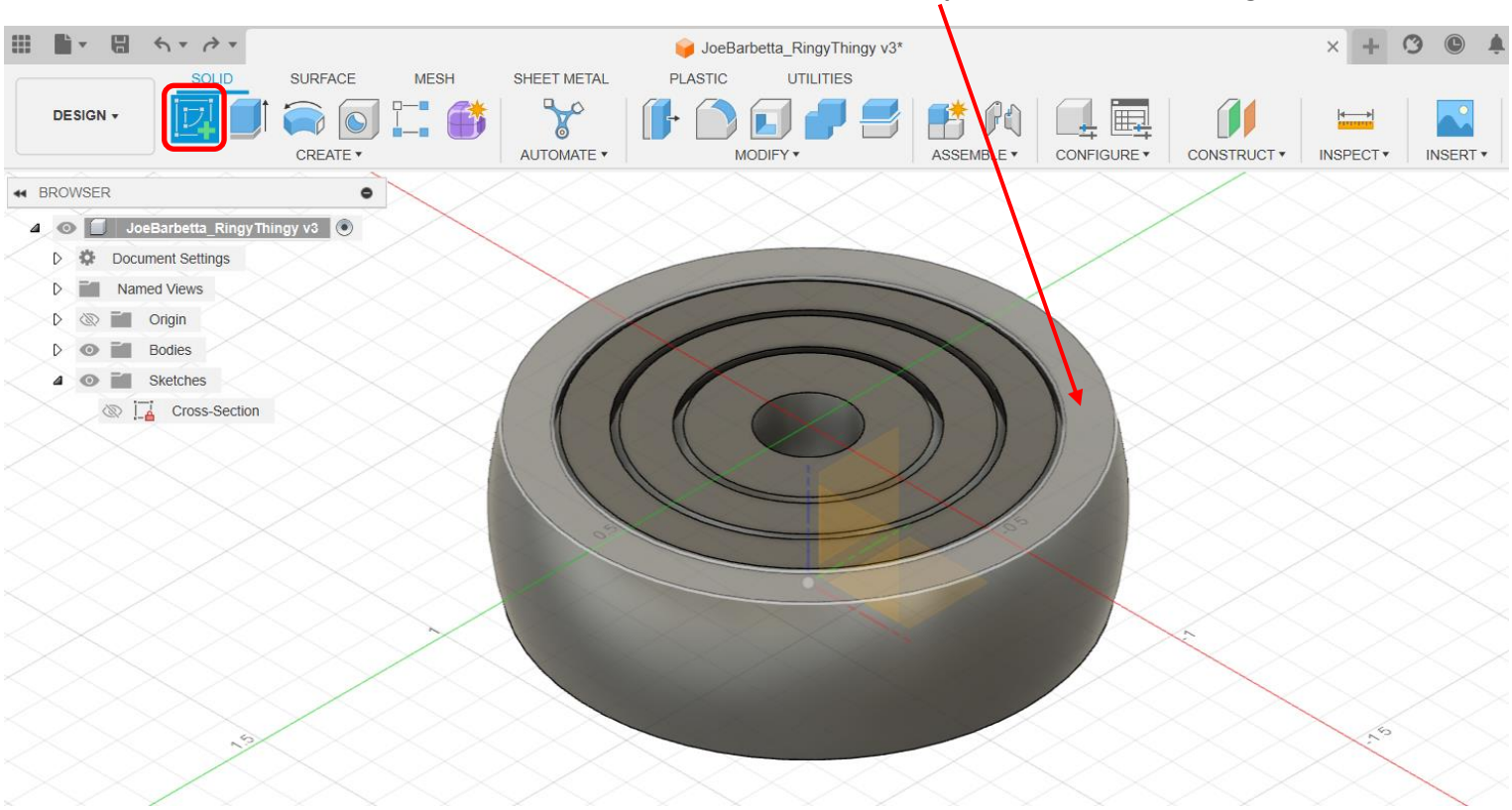


- click on the **Home icon** to view the entire masterpiece.



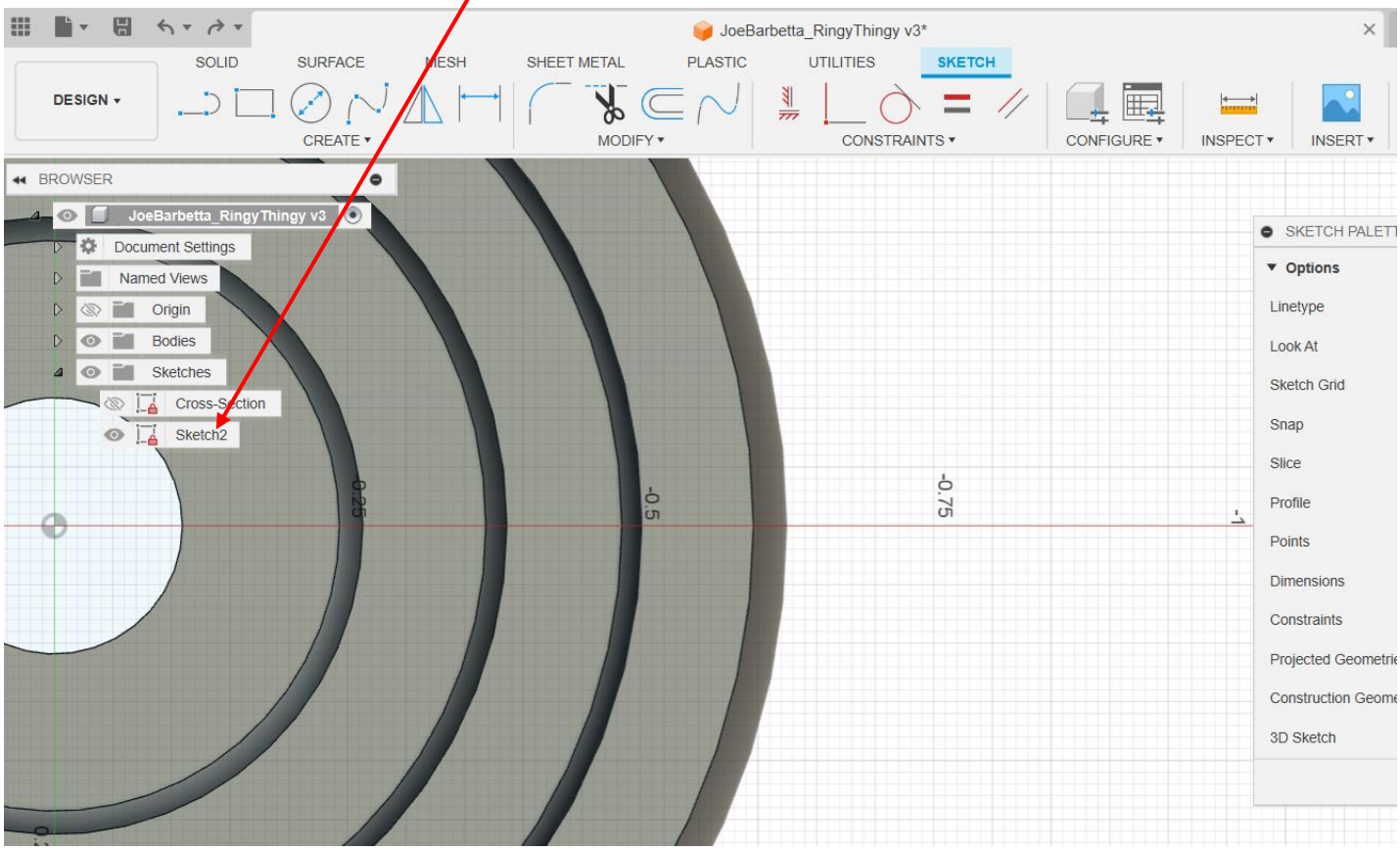
Adding the loop

- select the **Create Sketch** tool or find it in the CREATE menu and **click on the top surface of the outer ring**.

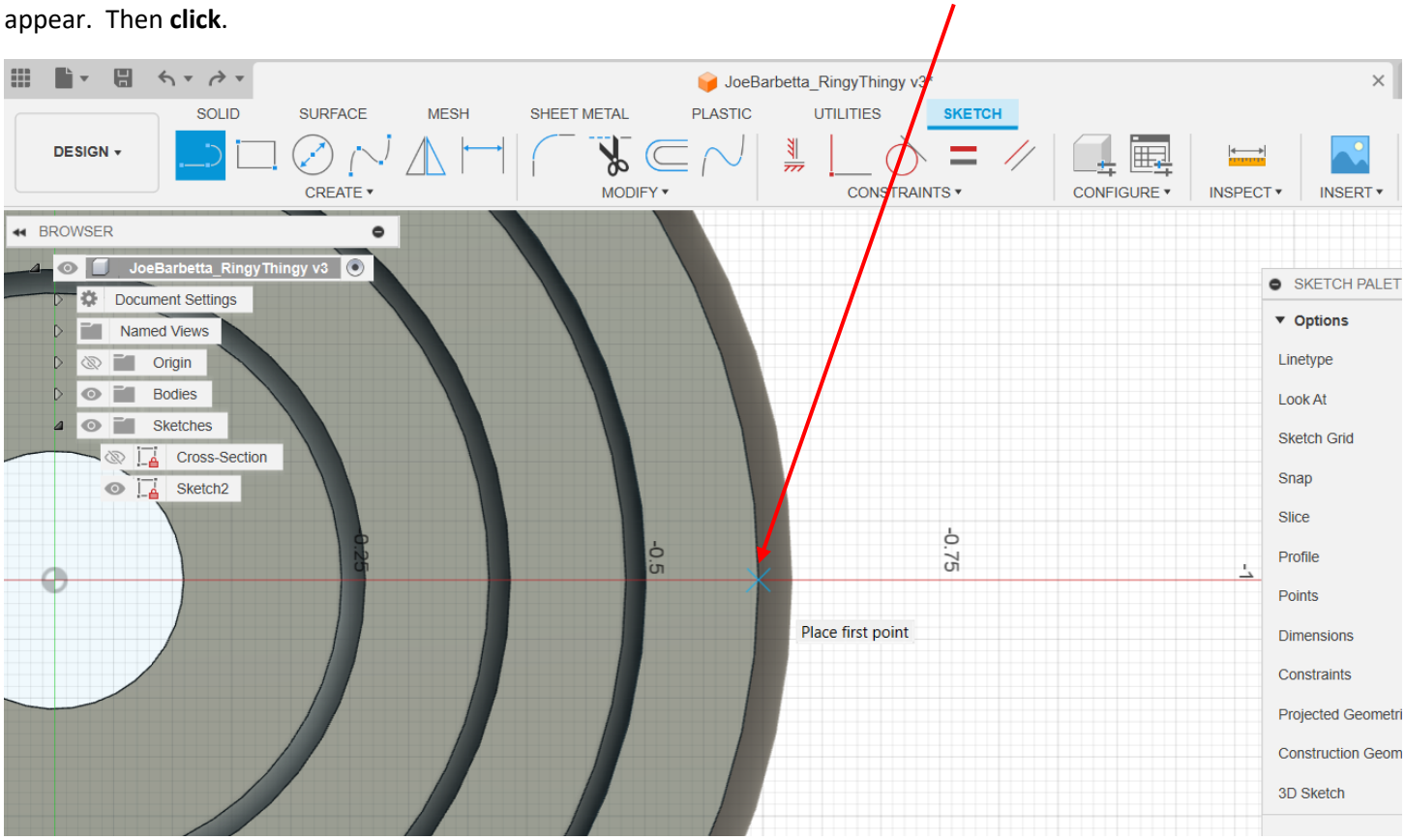


- right click on the new **Sketch name "Sketch2"** and select **Rename** and change the name to **"Loop Top"**

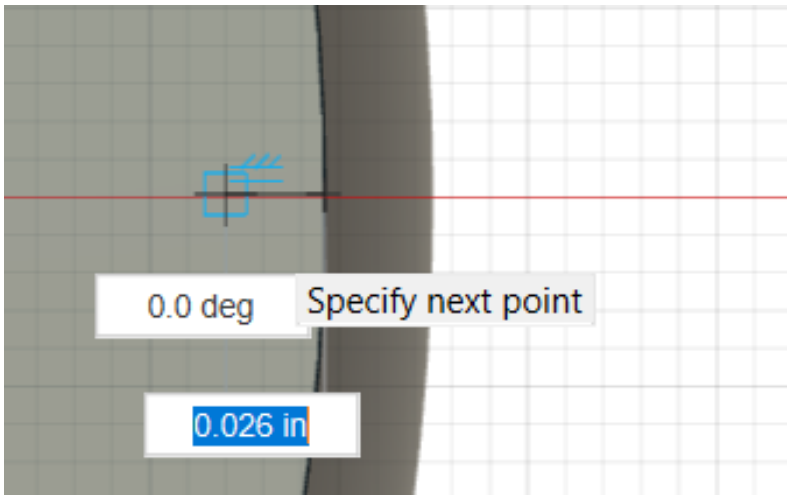
- **Zoom** in to the **right edge** as shown below



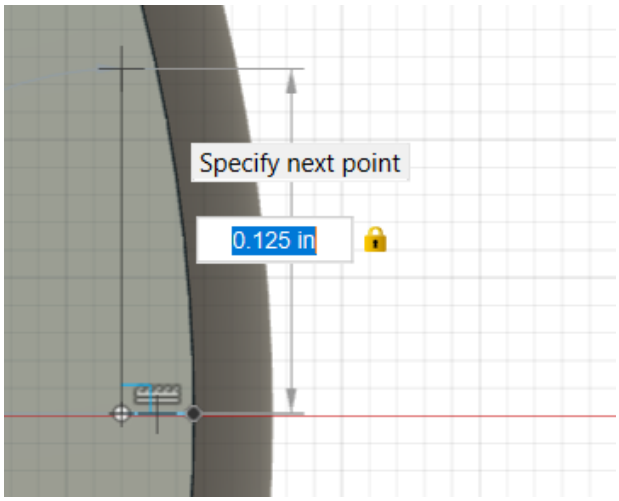
- select the **Line** tool and carefully place the mouse cursor on the **red line at the edge of the outer ring** to cause a **X icon** to appear. Then **click**.



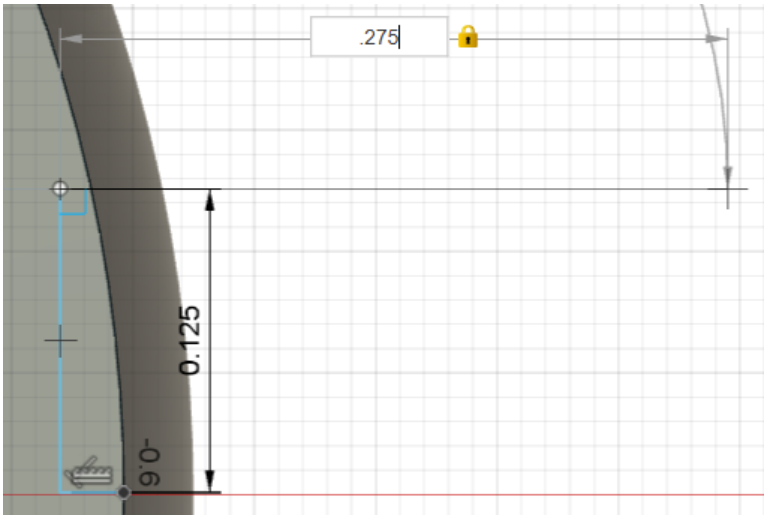
- extend the line to the left, type **0.026**, and **click**.



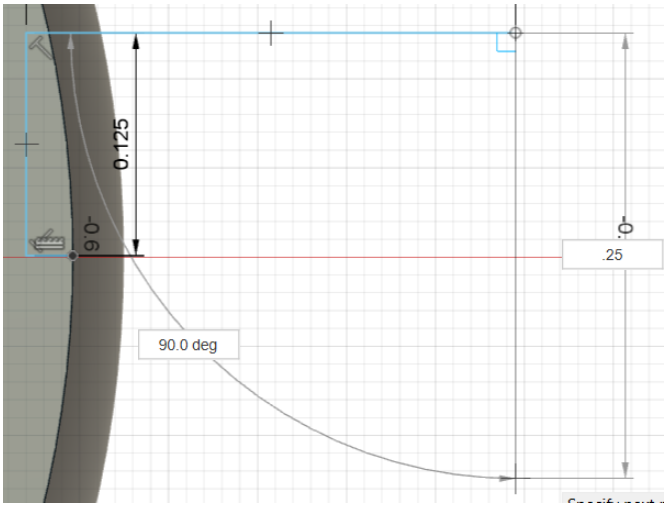
- extend the line upward, type **0.125**, and **click**.



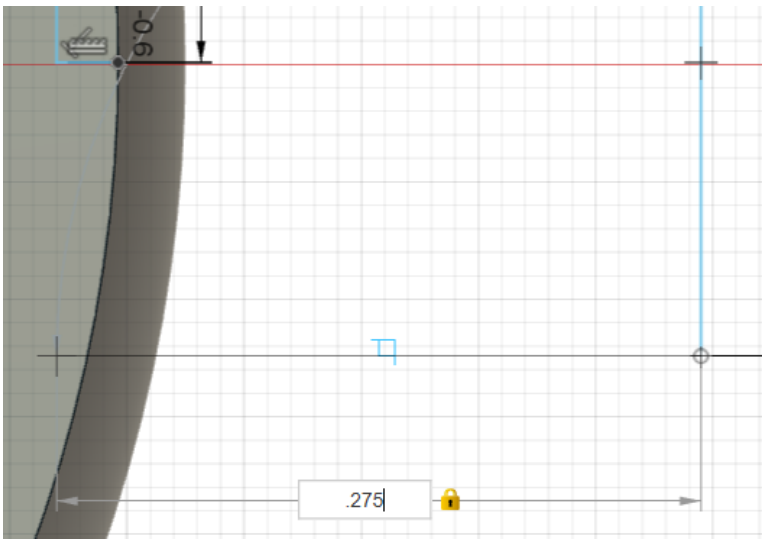
- extend the line to the right, type **0.275**, and **click**.



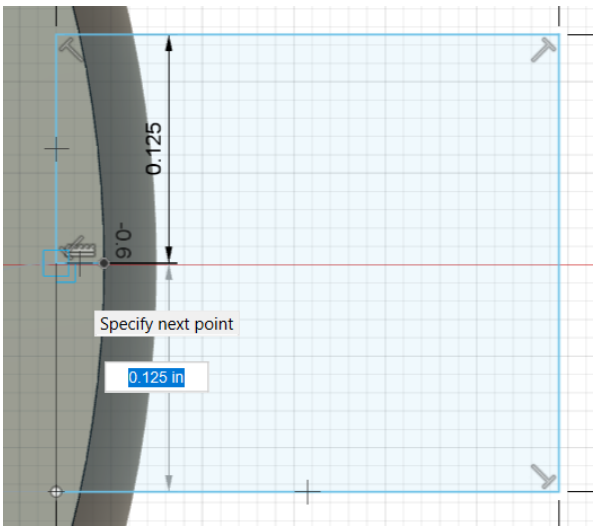
- extend the line downward, type **0.25**, and **click**.

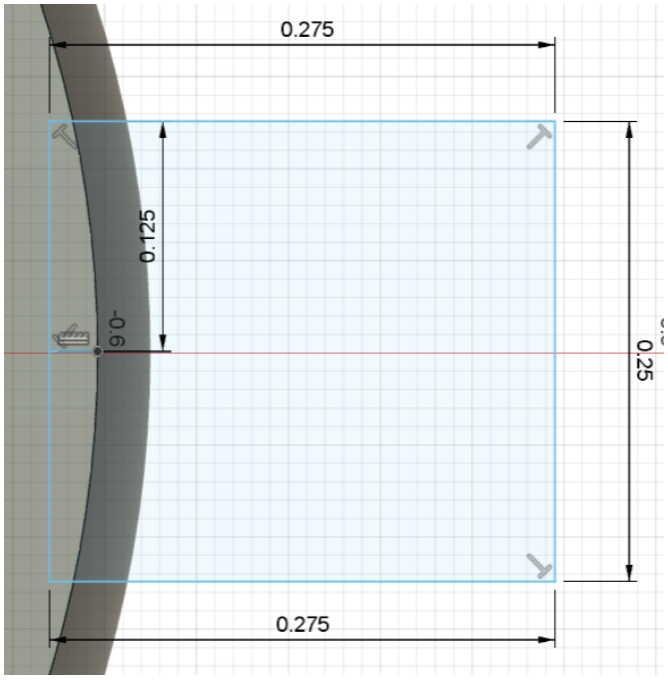


- extend the line to the left, type **0.275**, and **click**.



- extend the line upward to meet the top line, and **click**.





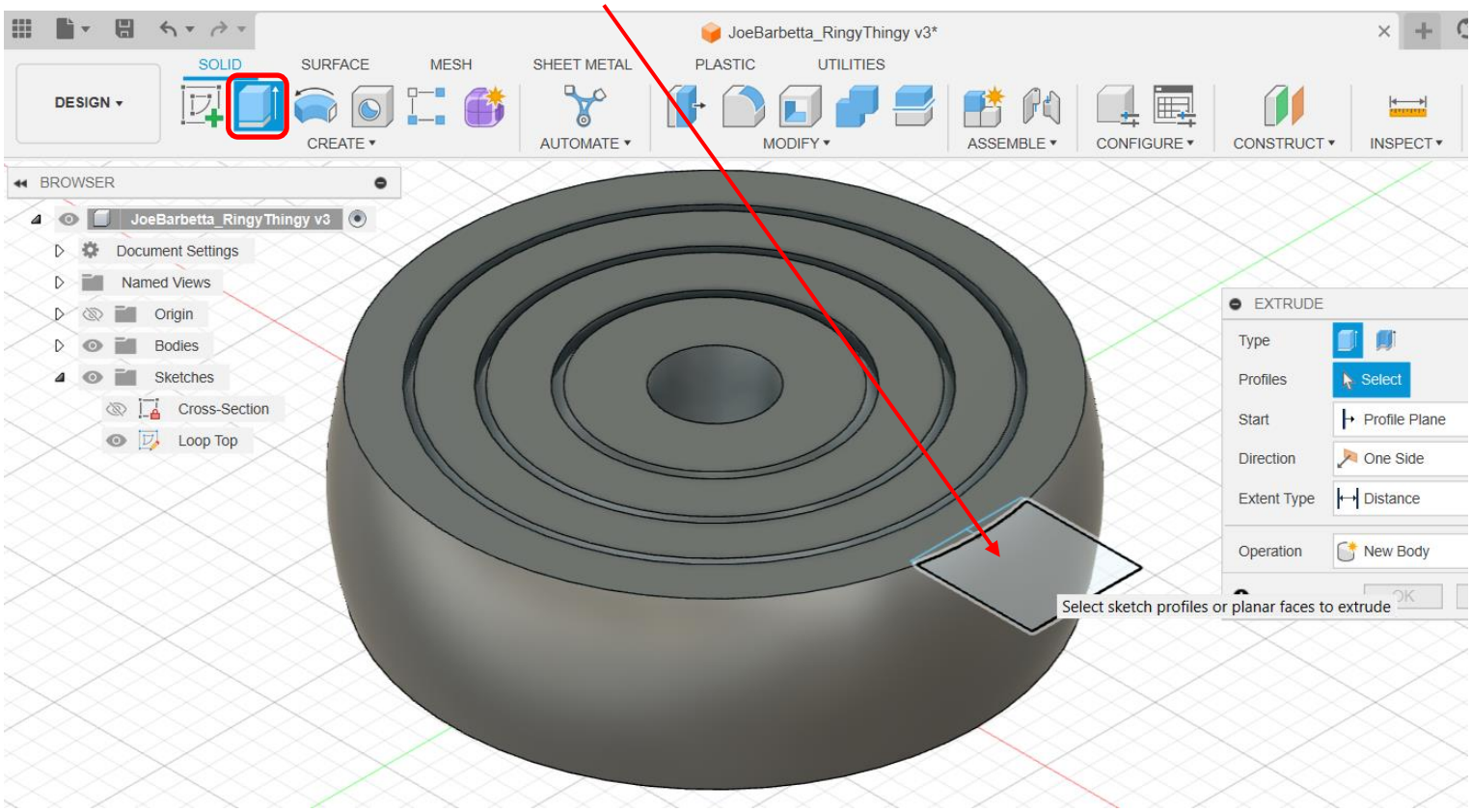
The finished Sketch should look like that on the left. Note that the dimension lines may look different.

Click **Finish Sketch**.

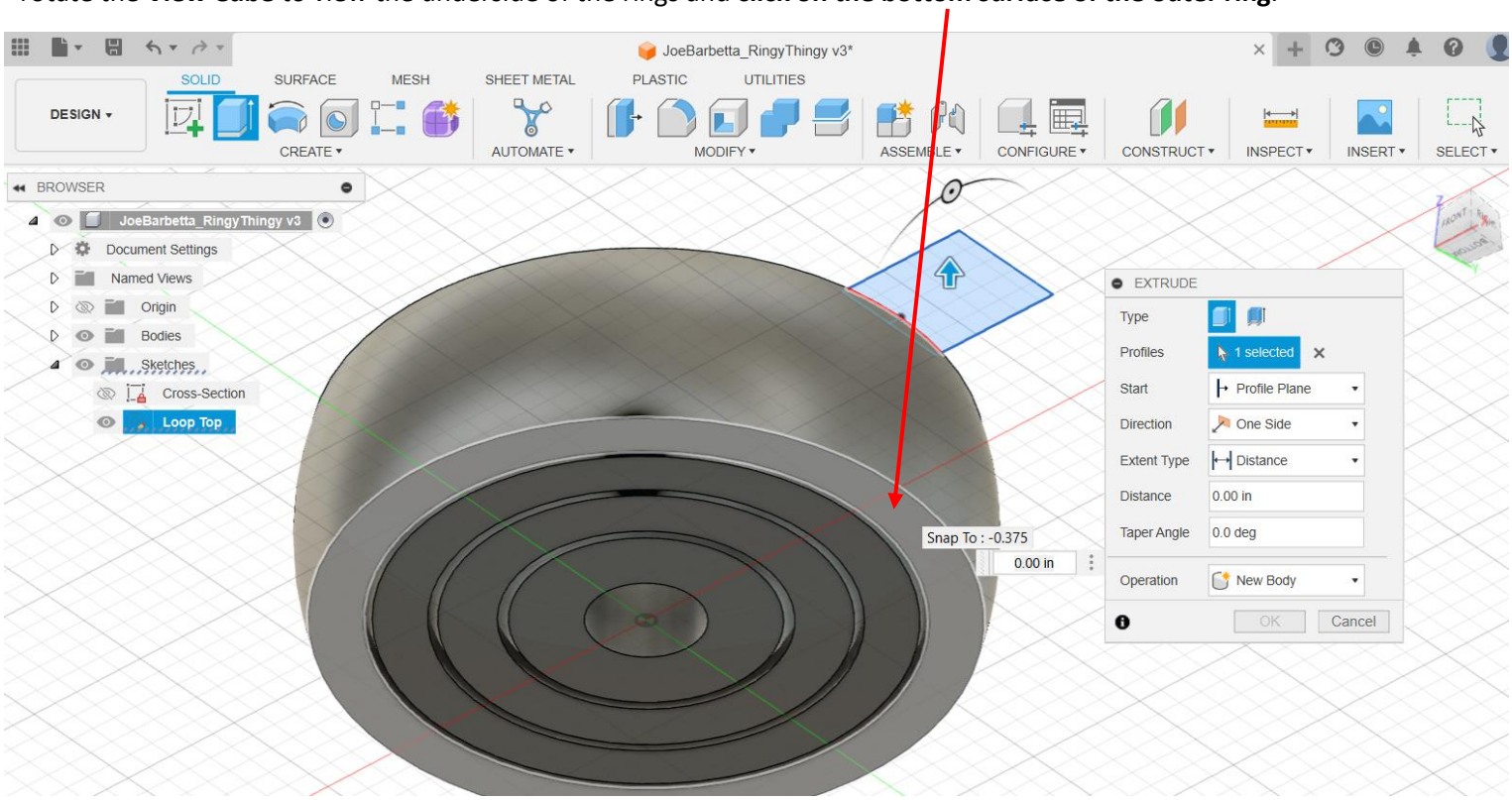
Extruding the Loop

- go to the **Home** view

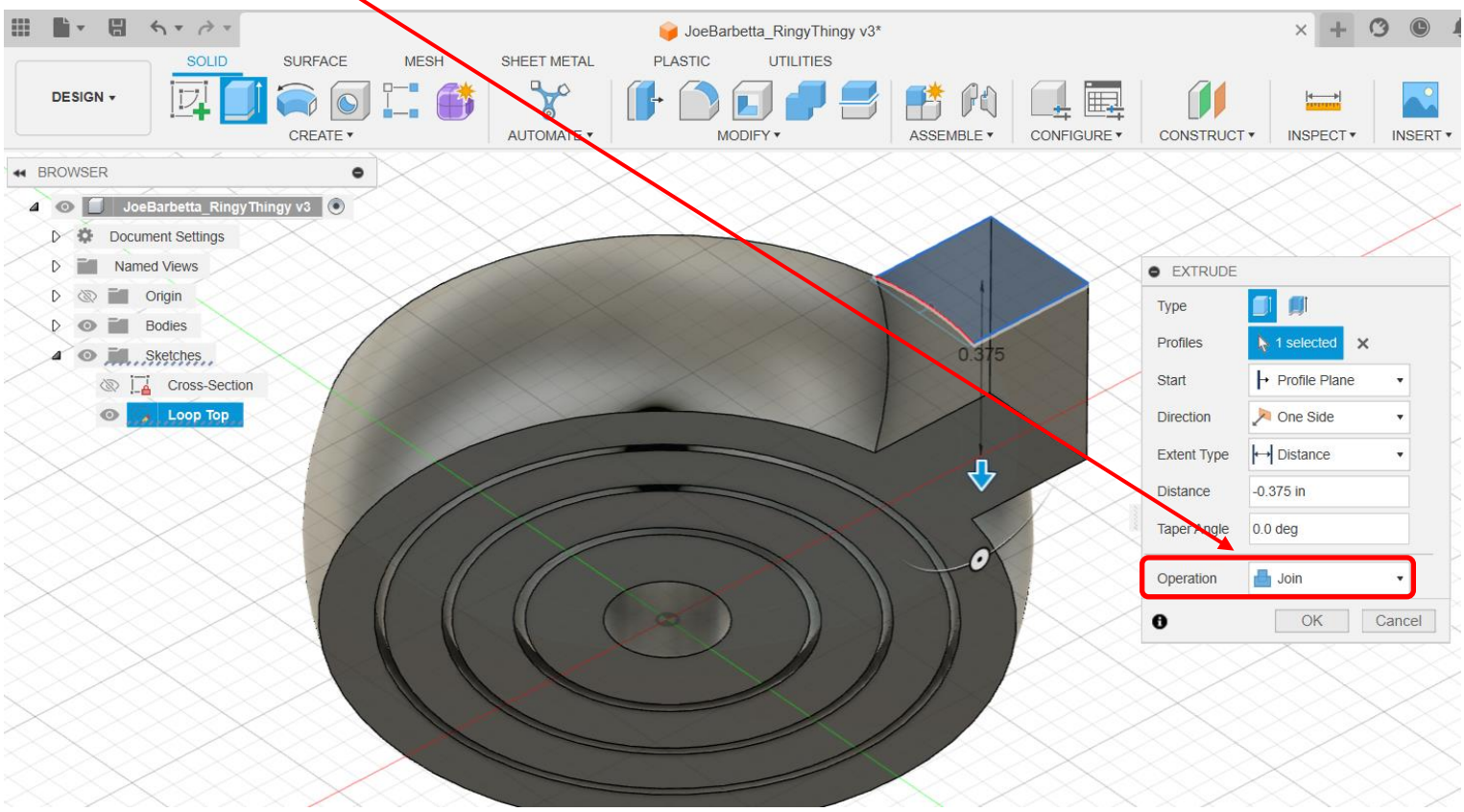
- select the **Extrude** tool and click on the **loop top sketch**.



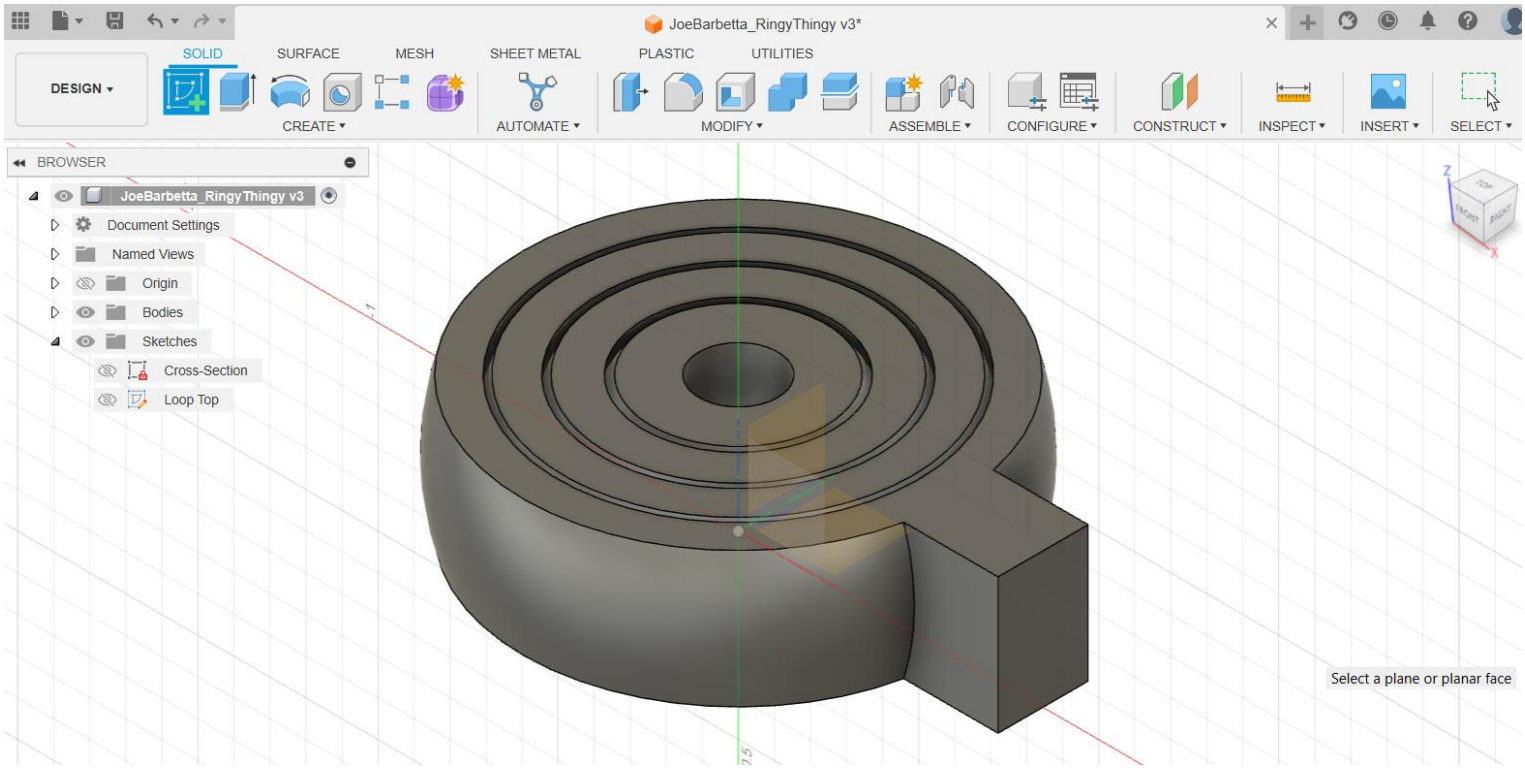
- rotate the **View Cube** to view the underside of the rings and **click on the bottom surface of the outer ring**.



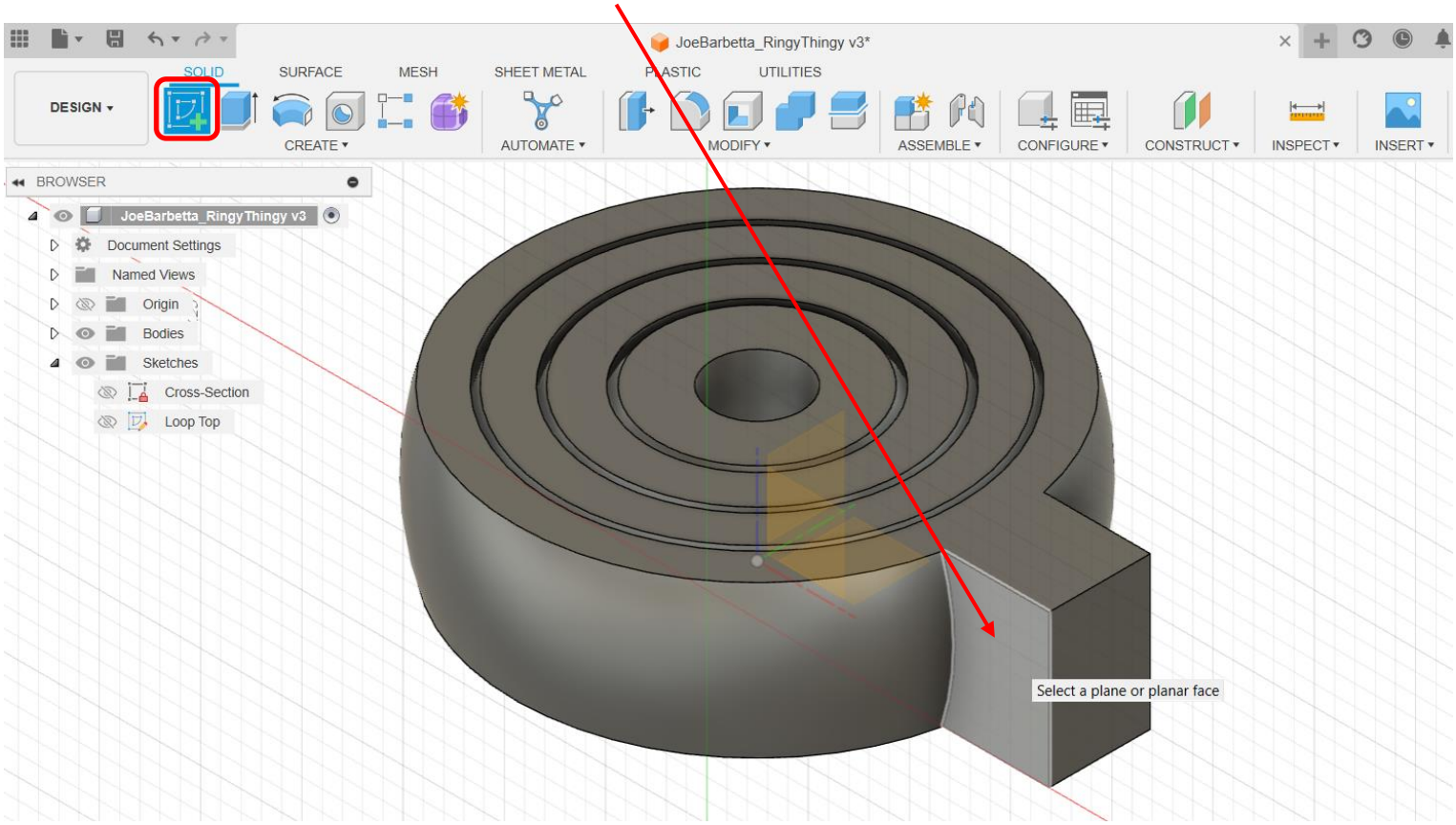
- change the **Operation** to **Join** and click **OK**.



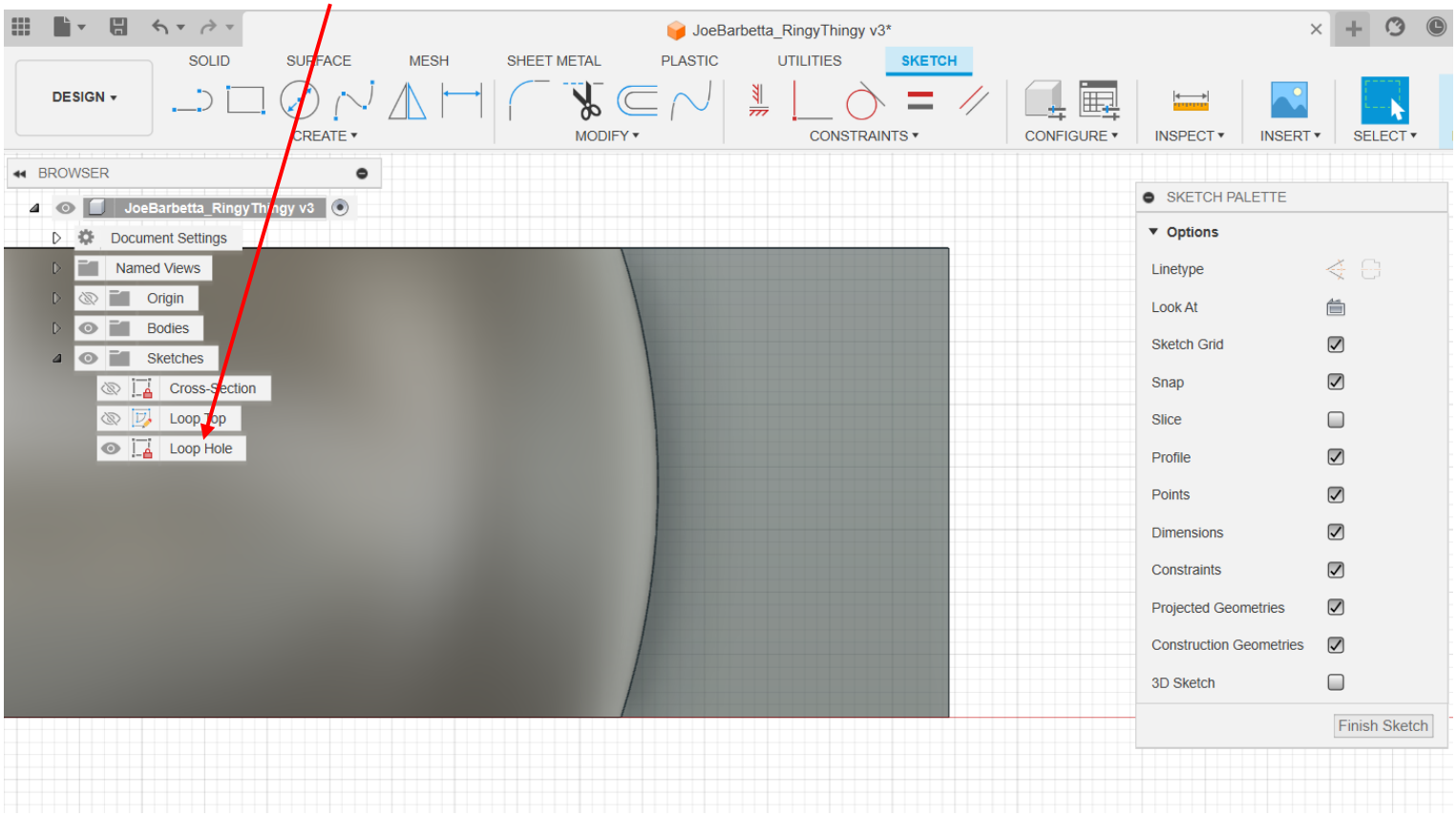
- return to the **Home** view



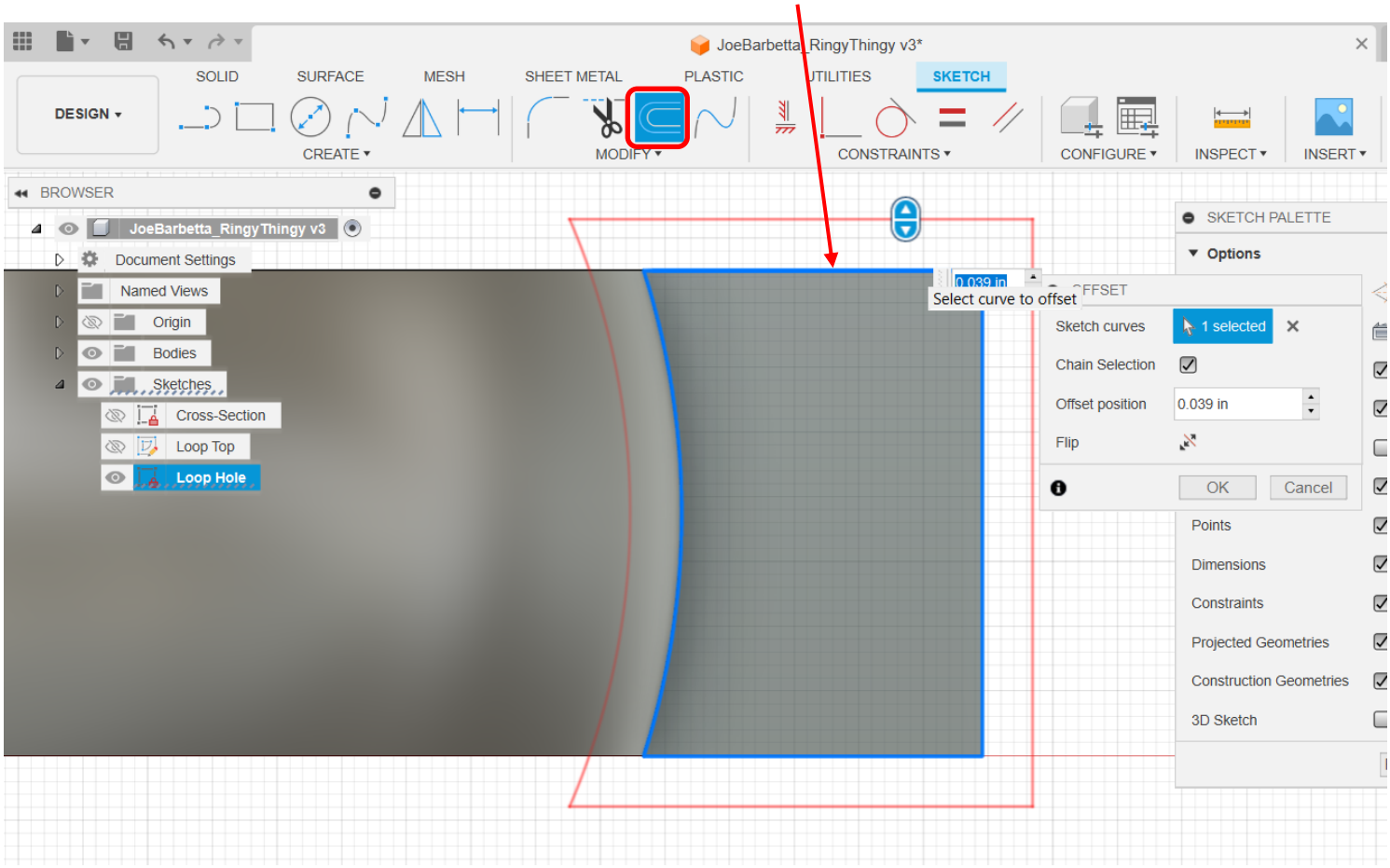
- select the **Create Sketch** tool and click on the **side of the loop**.



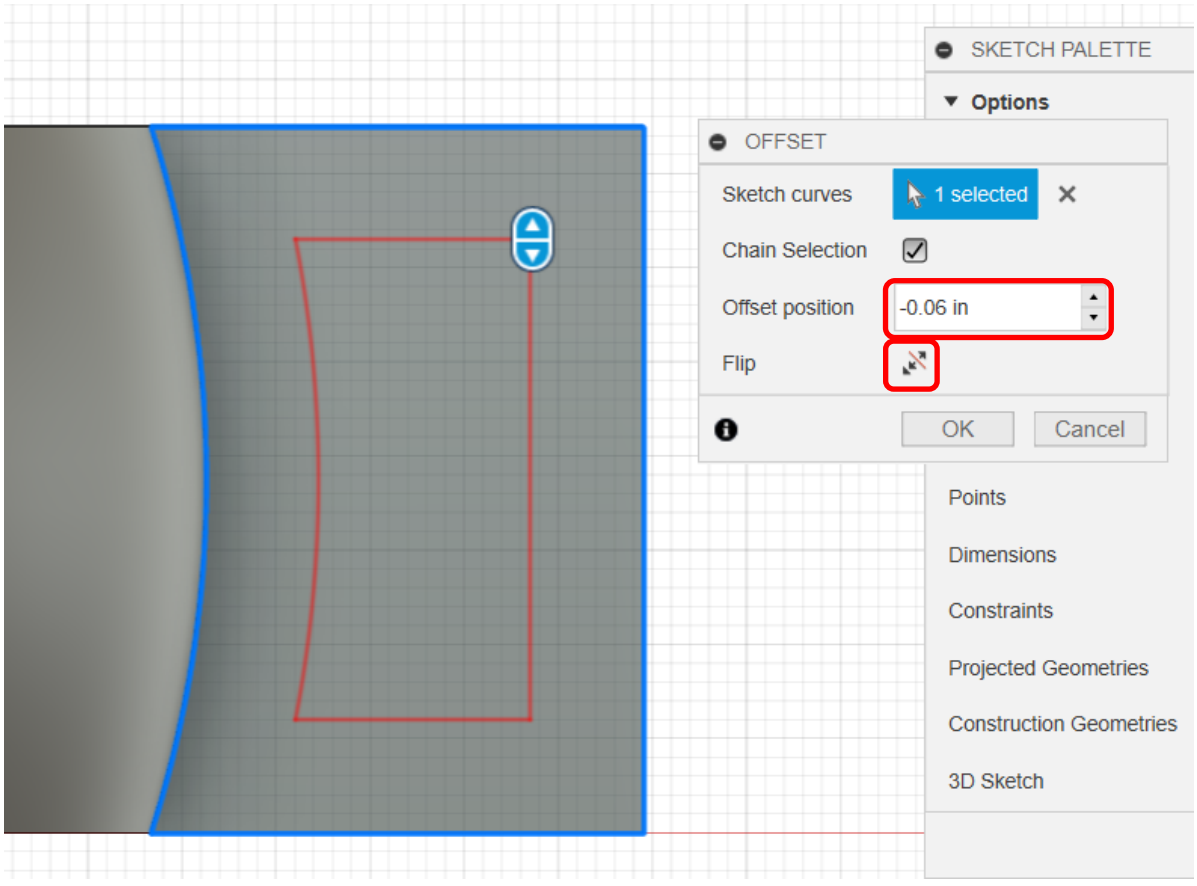
- **zoom in** and postion (by pressing the mouse wheel down) the Sketch view as shown below.
- **rename** the Sketch to "**Loop Hole**".



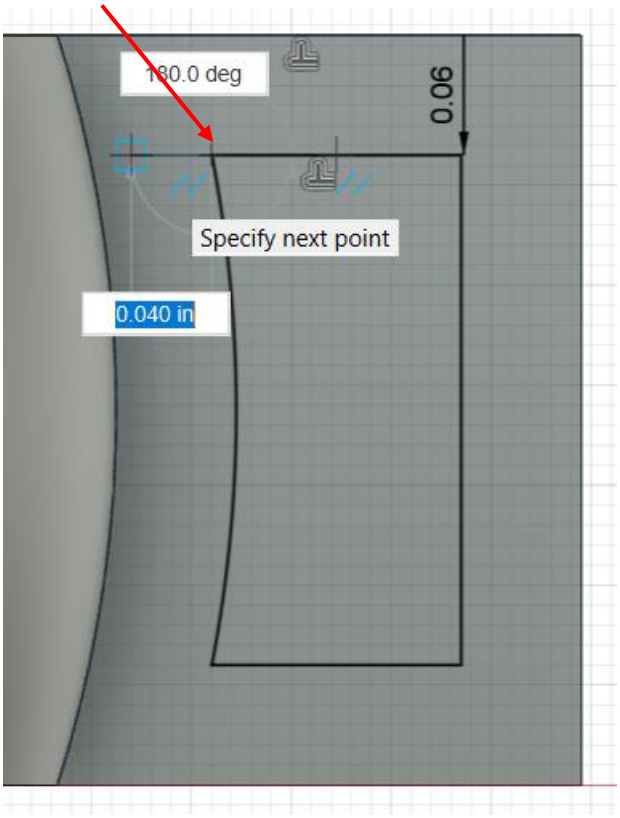
- select the **Offset tool** or find it in the MODIFY menu and click on an **edge of the loop**. A red outline will appear.



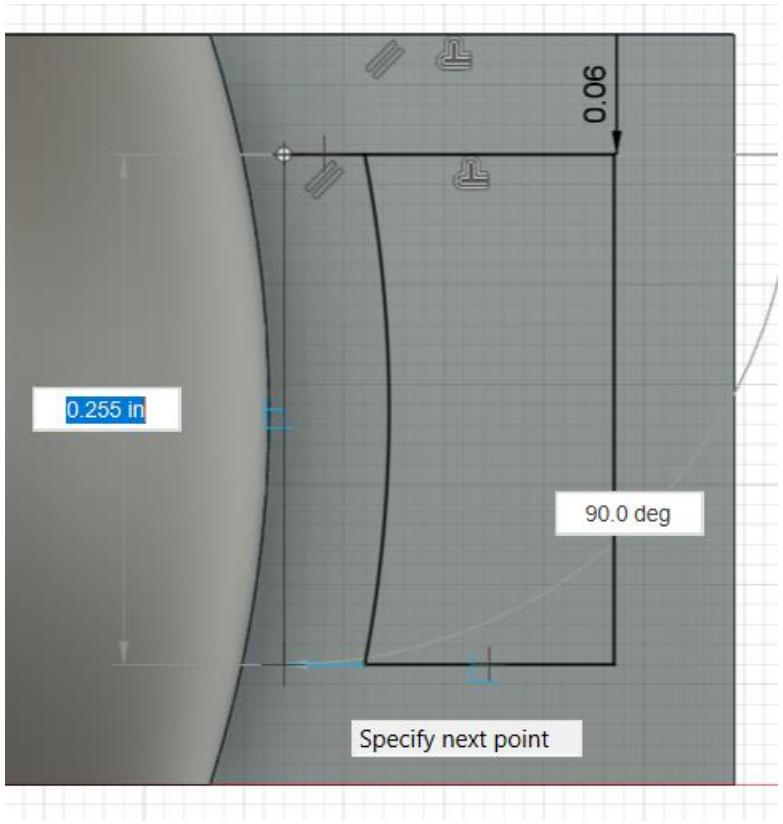
- enter **0.06** for Offset position, click the **Flip icon**, and then **OK**.



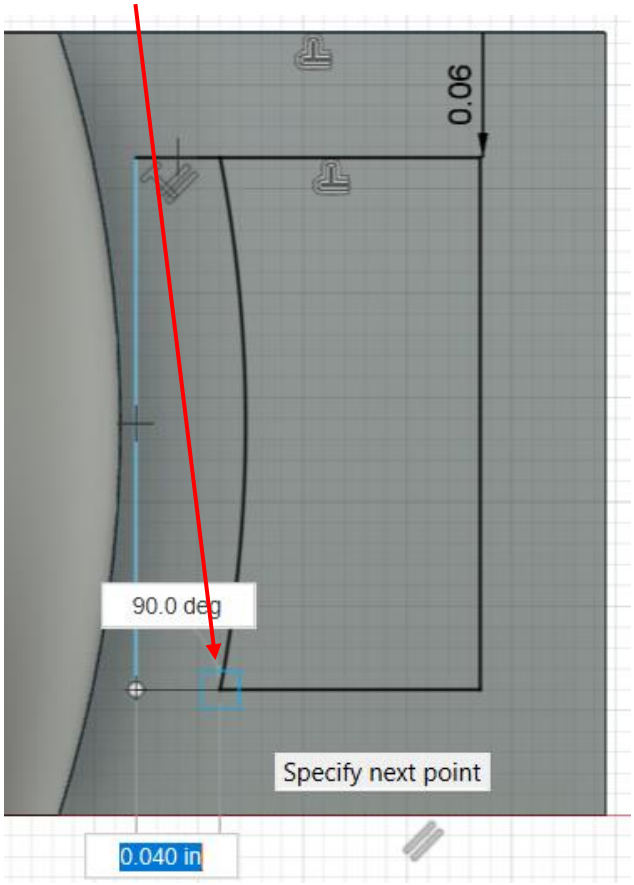
- select the **Line** tool and create a line starting from the **upper-left edge** of the hole shape and to the left by **0.040**



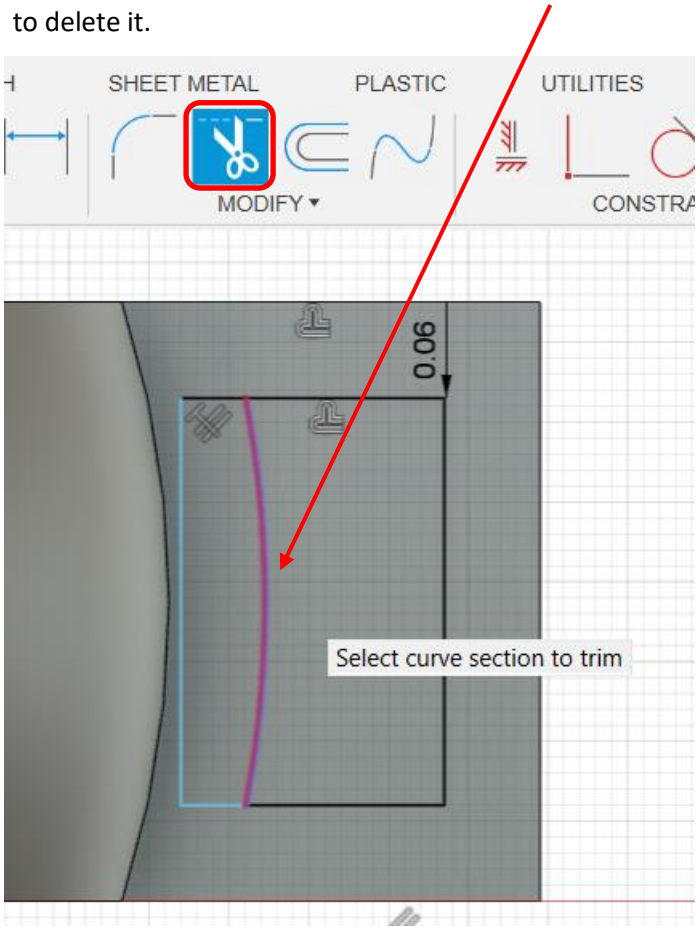
- create a line downward by **0.255**



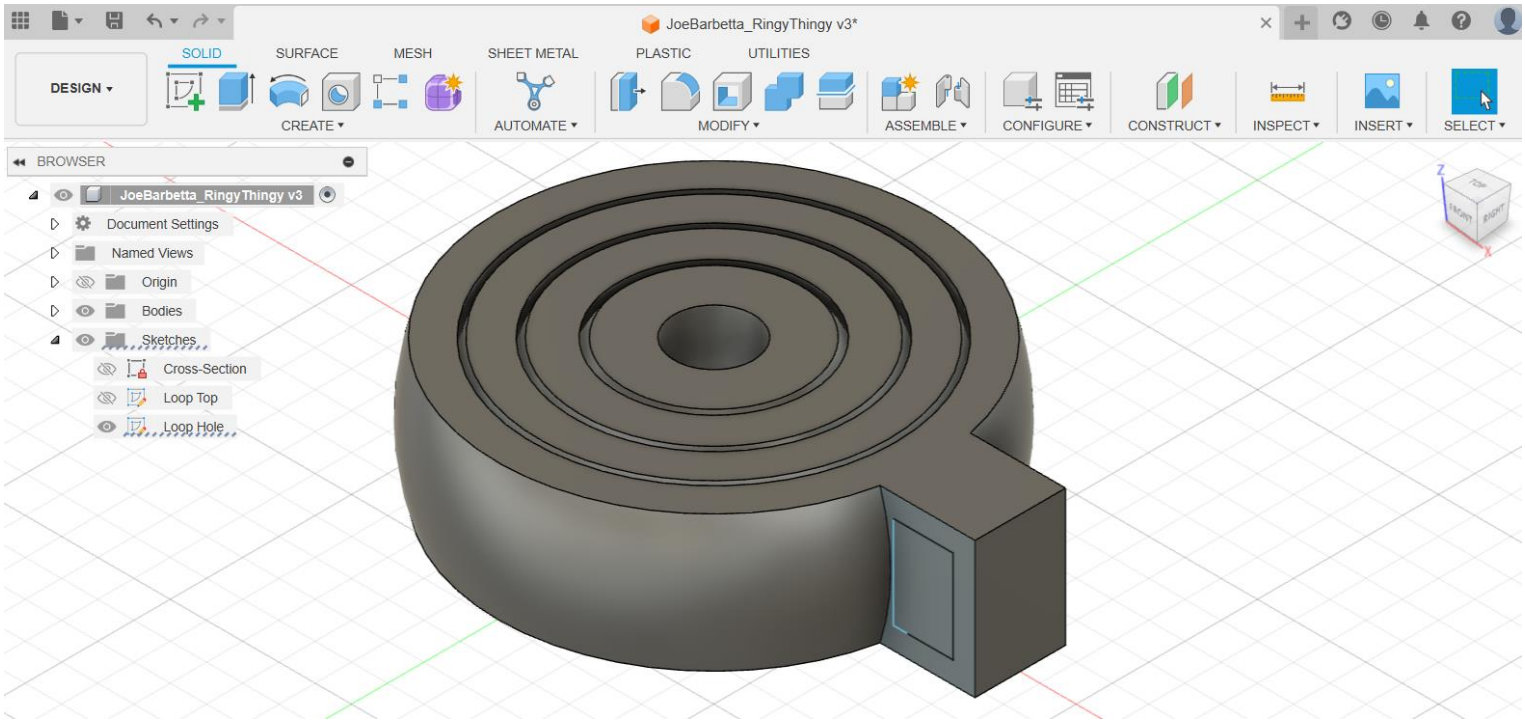
- create a line to the right by **0.040** to meet the bottom-left corner of the hole shape.



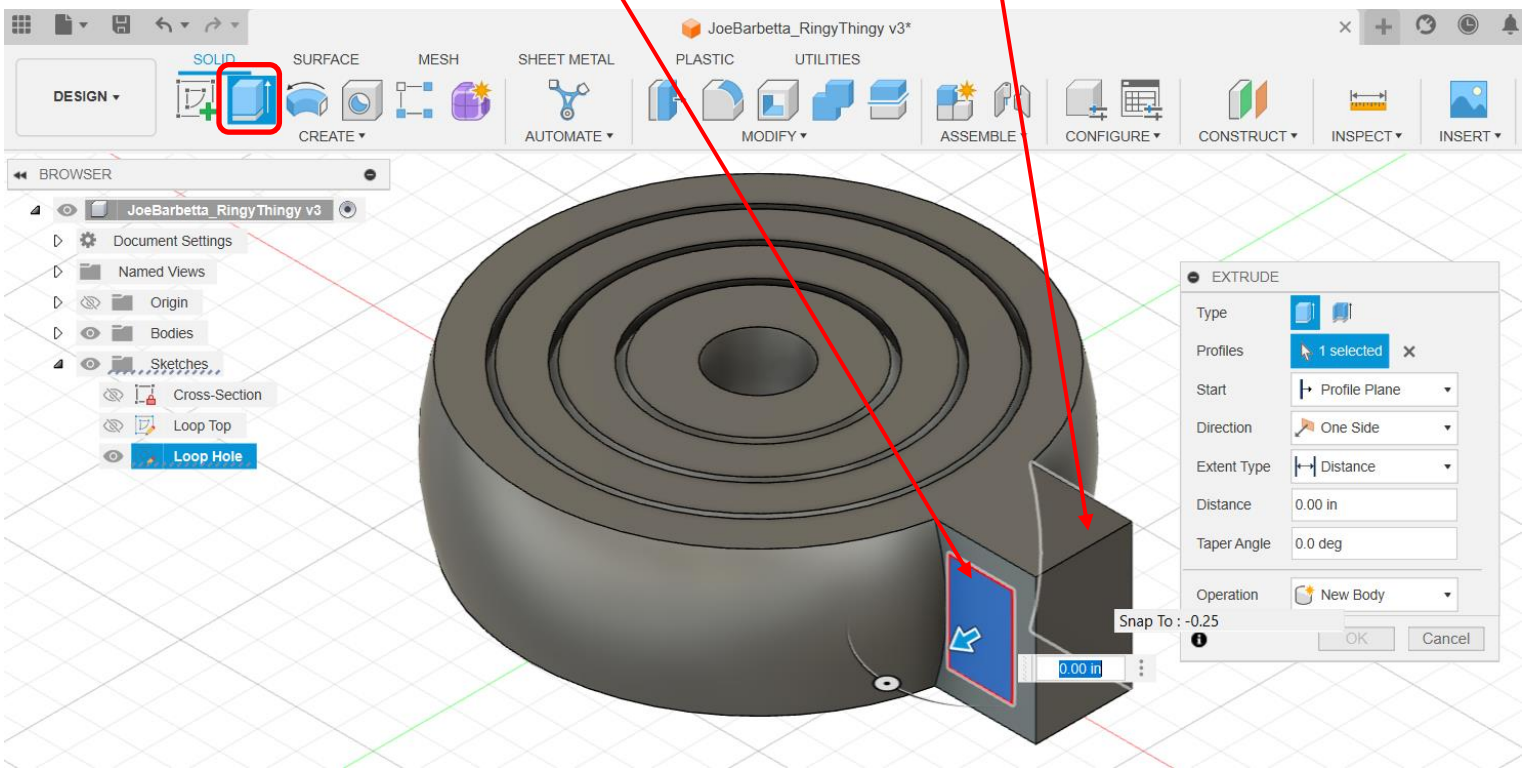
- select the **Trim** tool and then **click on the center arc** to delete it.



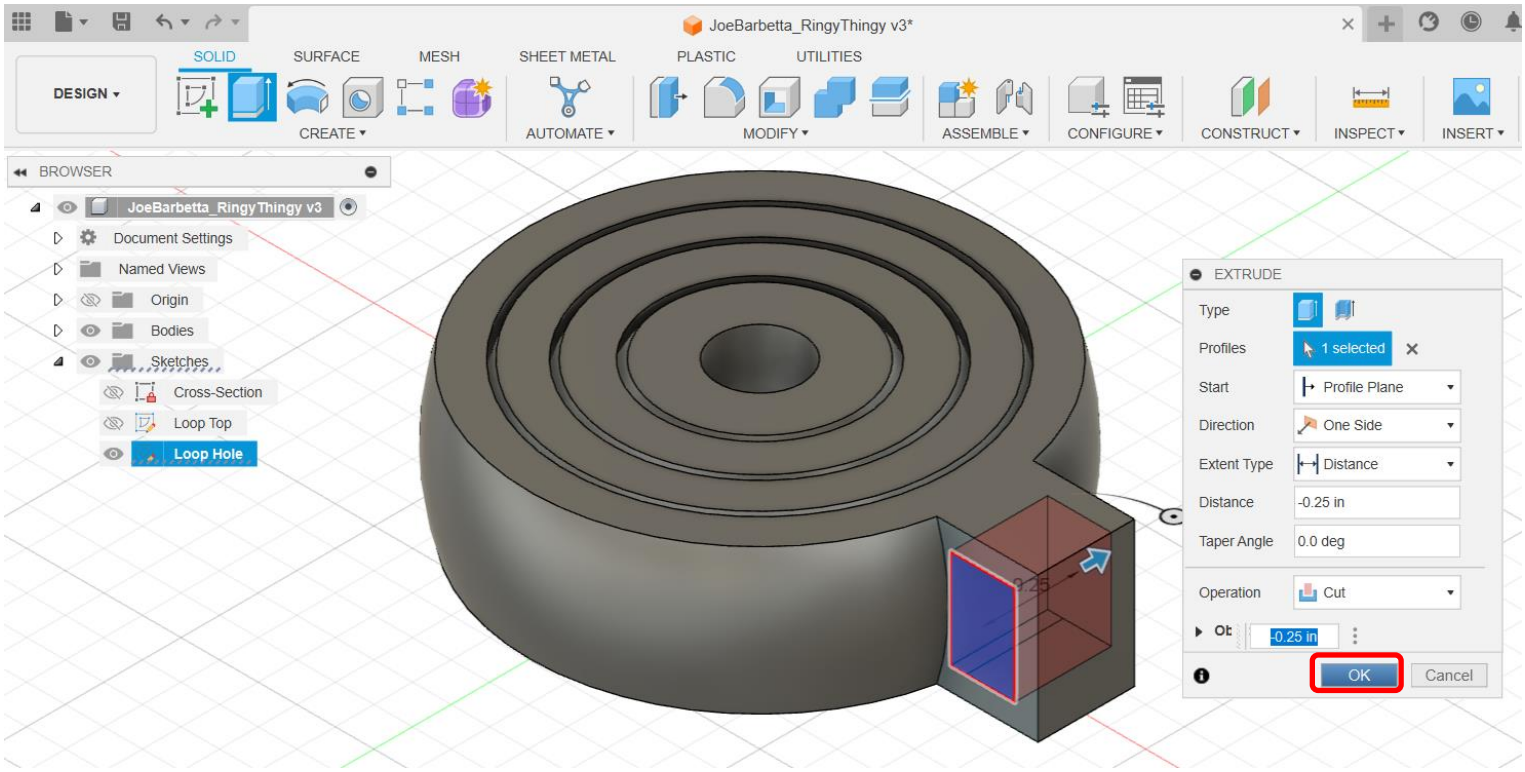
- click **Finish Sketch** and return to the **Home view**



- select the **Extrude** tool and **click on the hole shape** and then the **location of the other side** of the loop. Note that face of the other side of the loop is being selected "through" the body.

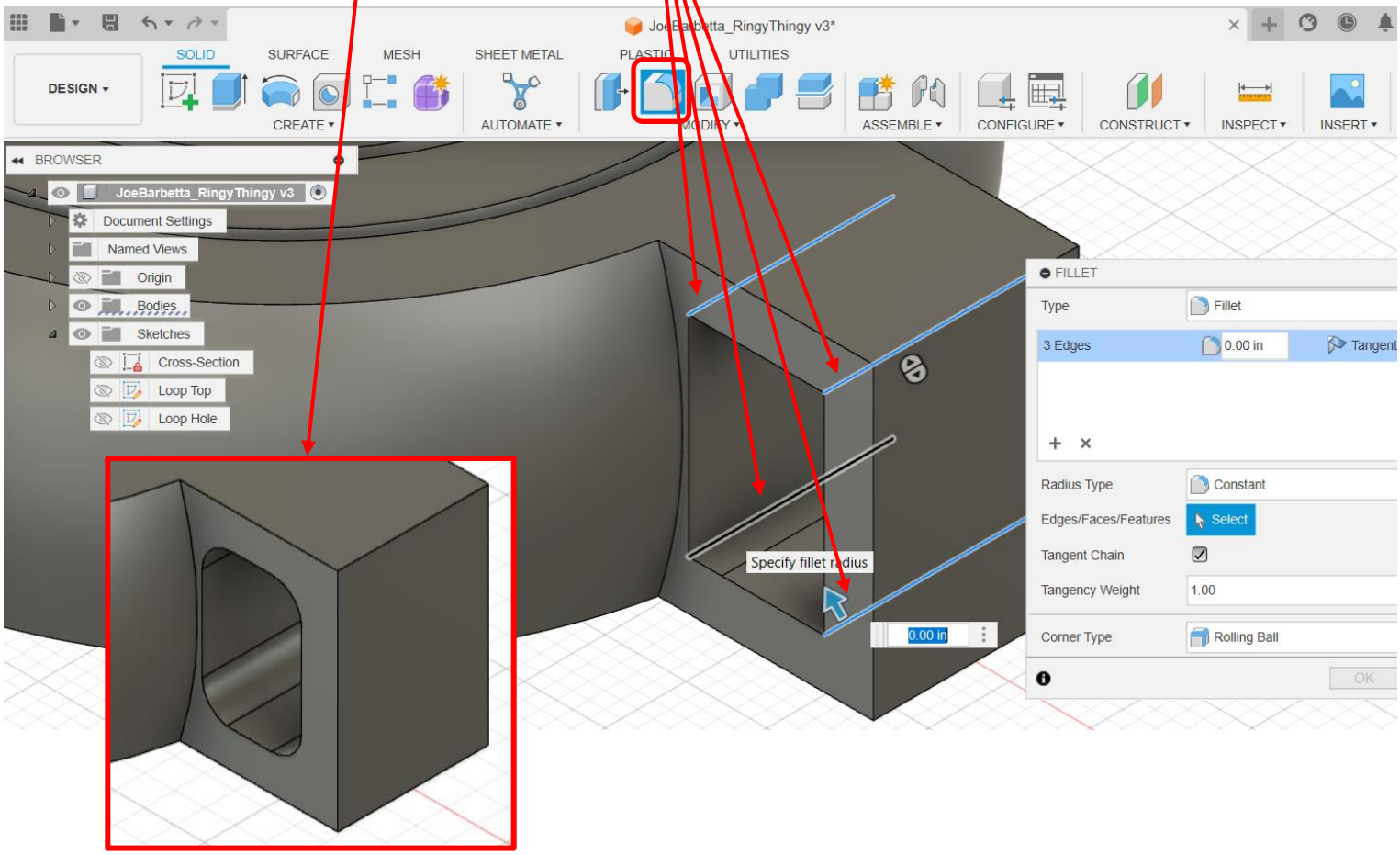


- Note the indication of a hole being created through the loop. Click **OK**.



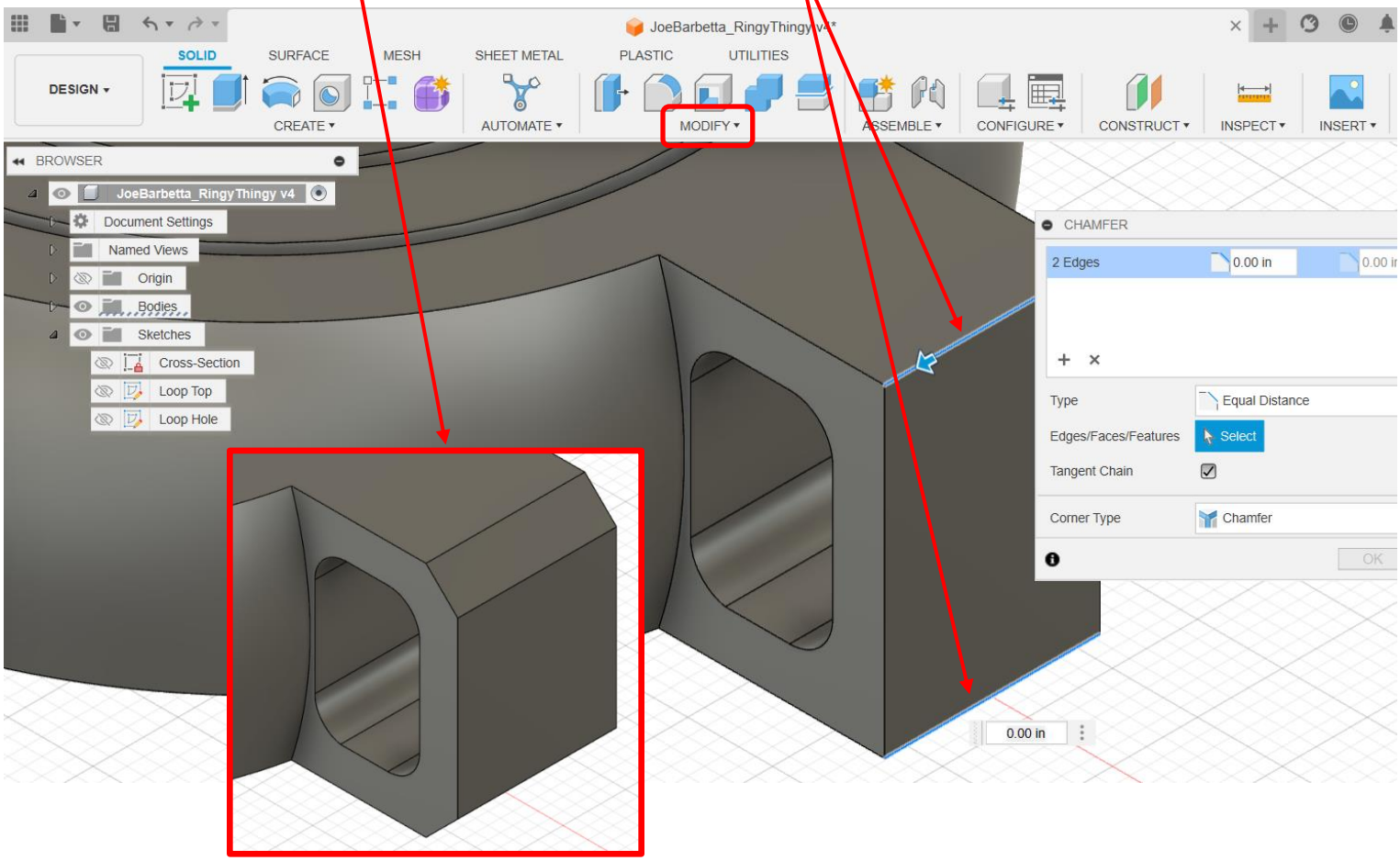
- select the **Fillet** tool or find it in the MODIFY menu and **click on the 4 edges** of the loop hole. You can click on edges "through" the body.

- type **0.05** and click **OK**. The result of the hole edges is shown in the inset picture.

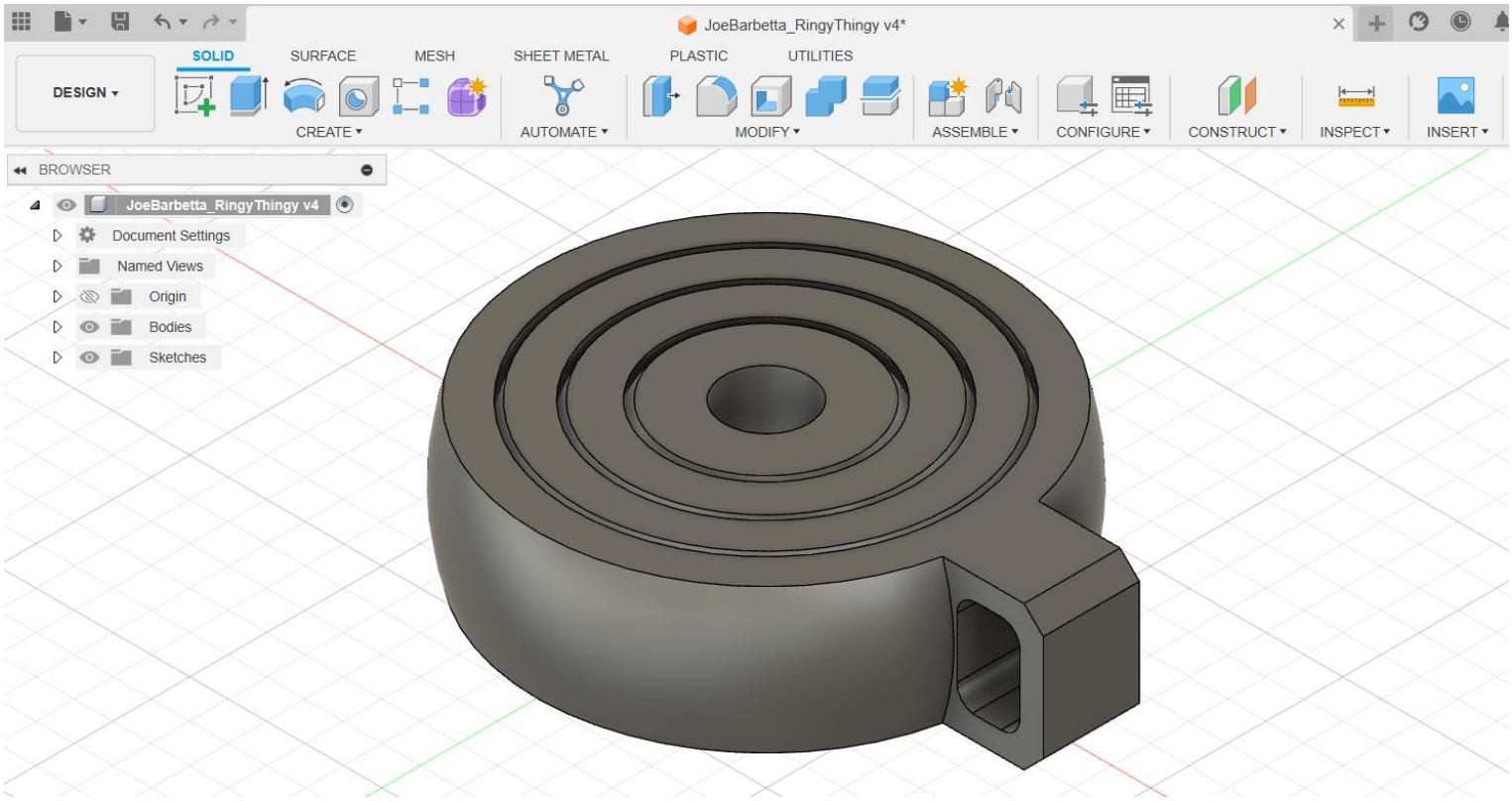


- select the **Chamfer** tool in the **MODIFY** menu and click on the **two loop edges** as shown

- type **0.05** and click **OK**. The result of the hole edges is shown in the inset picture.

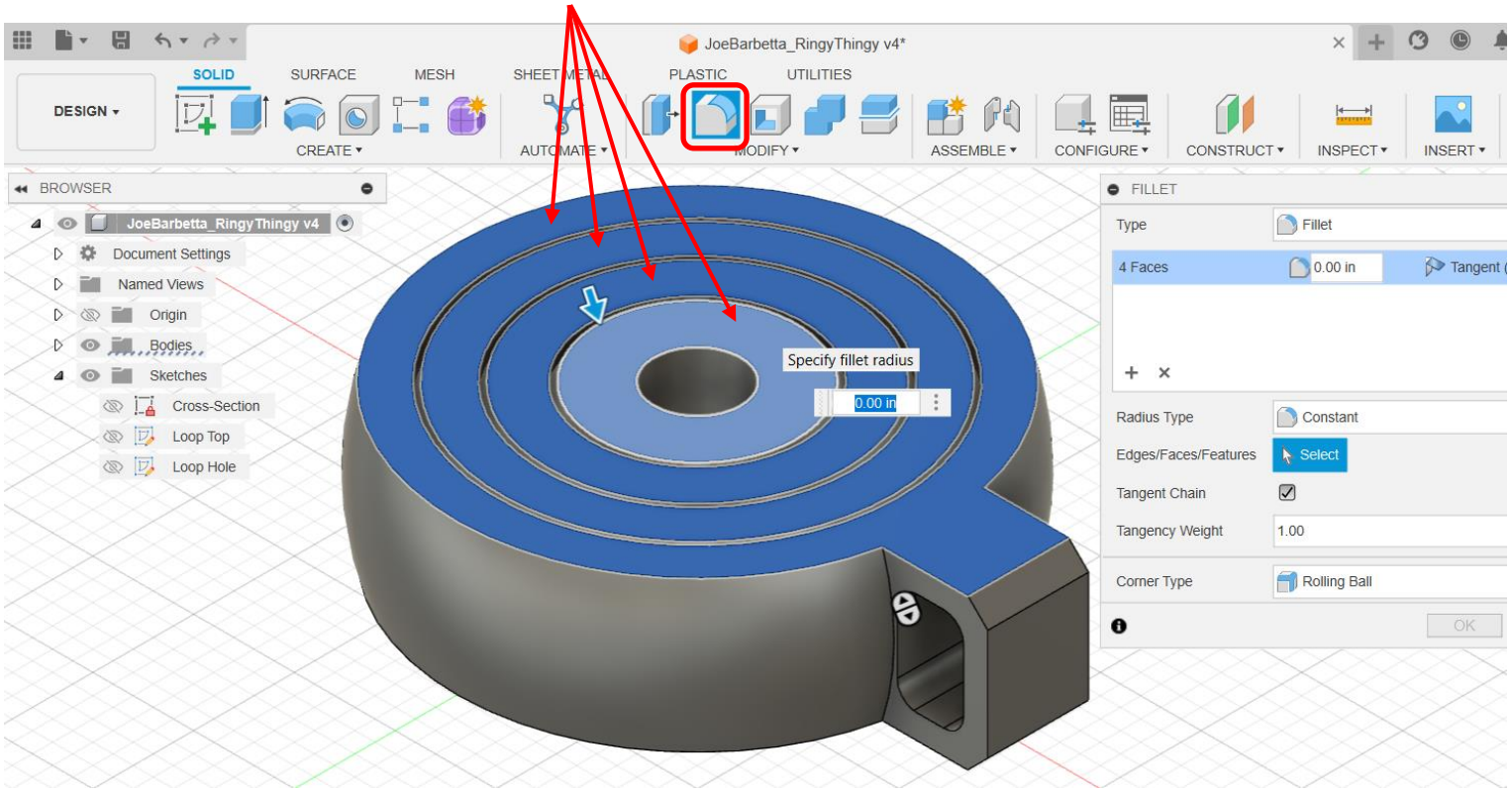


- select the **Home view** and the Ringy-Thingy should look like that below

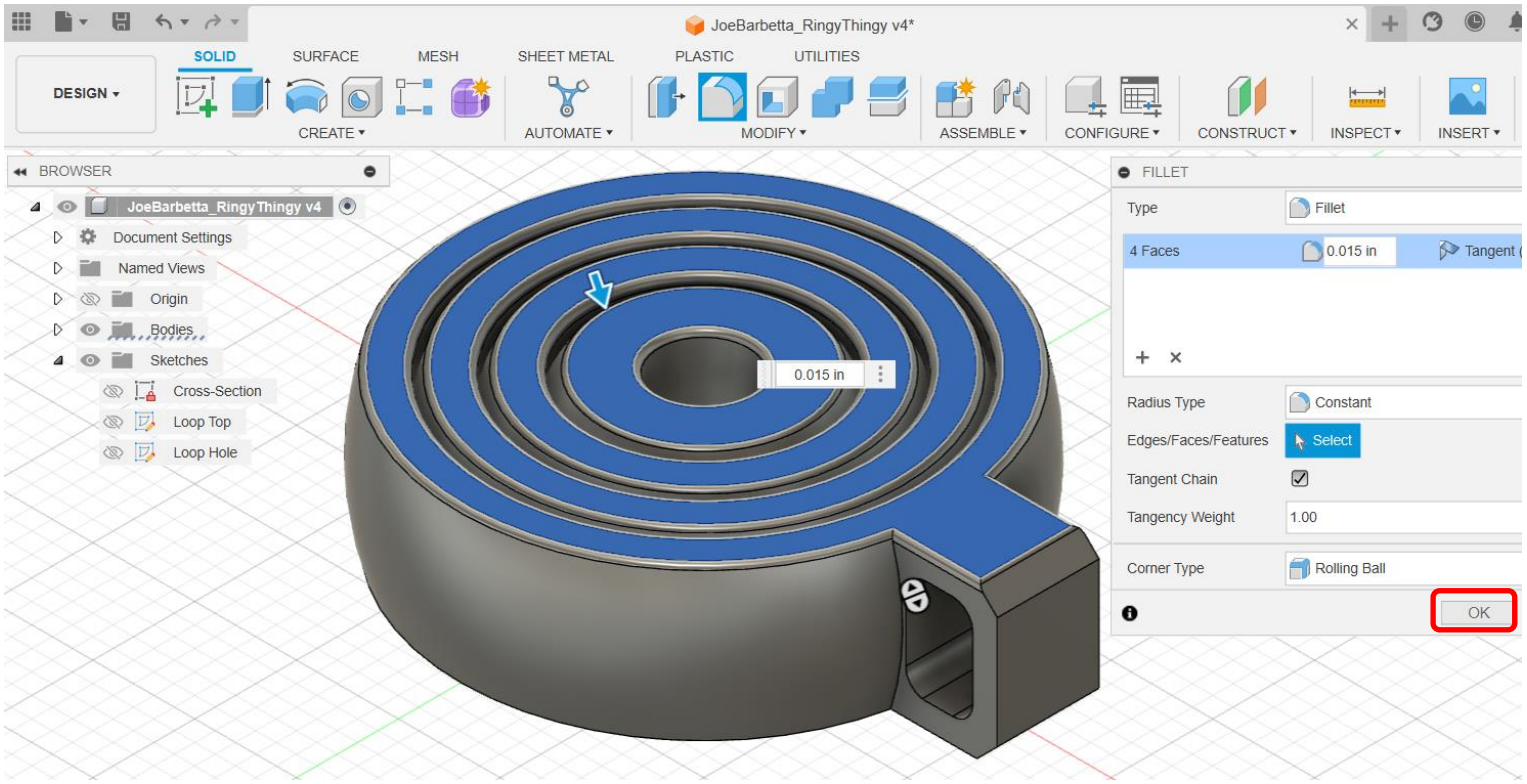


Filleting the Ring Edges

- select the **Fillet tool** and click on the **face of each of the 4 rings**, which will turn the tops blue

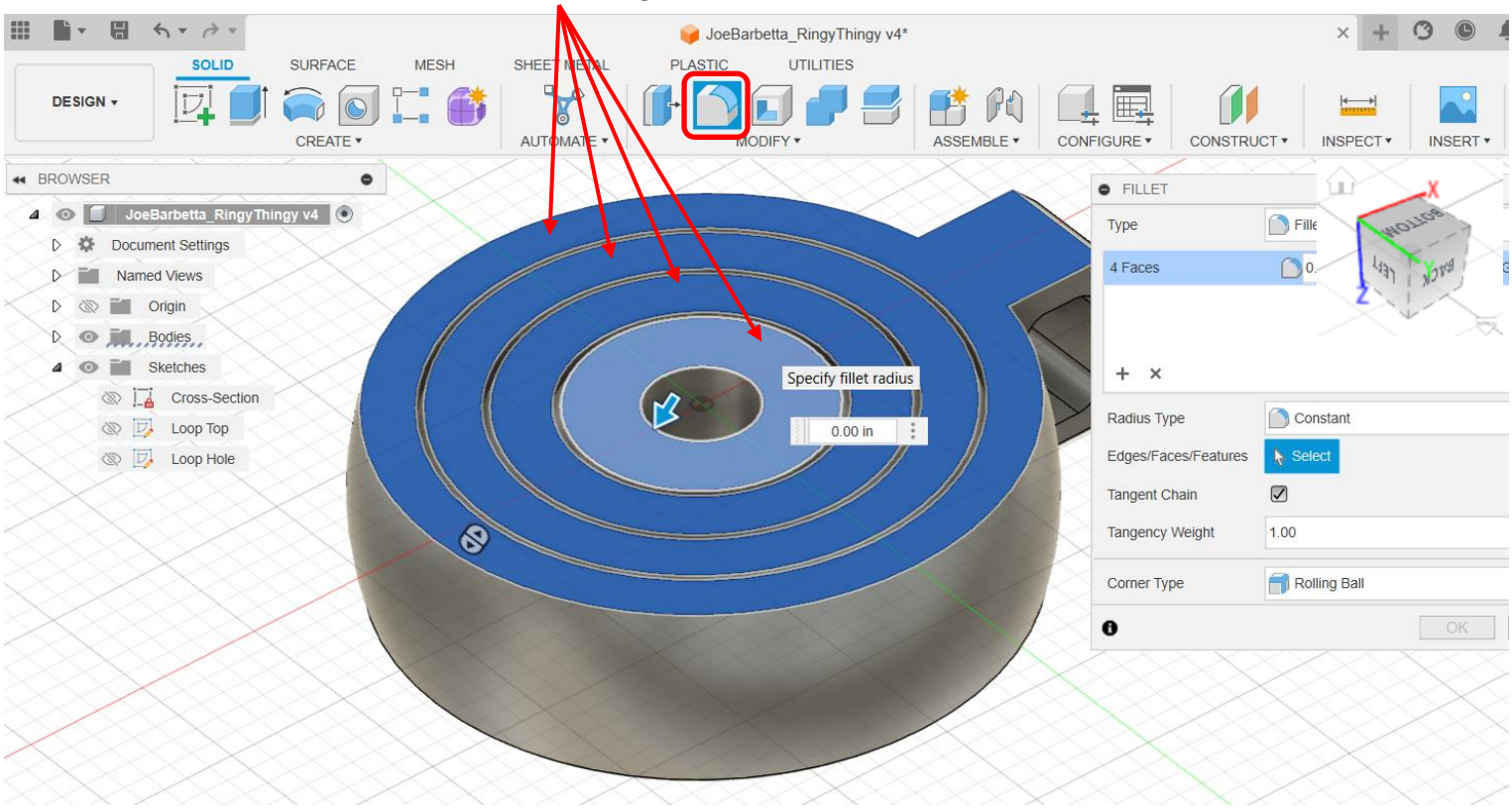


- type **0.015** and click **OK**

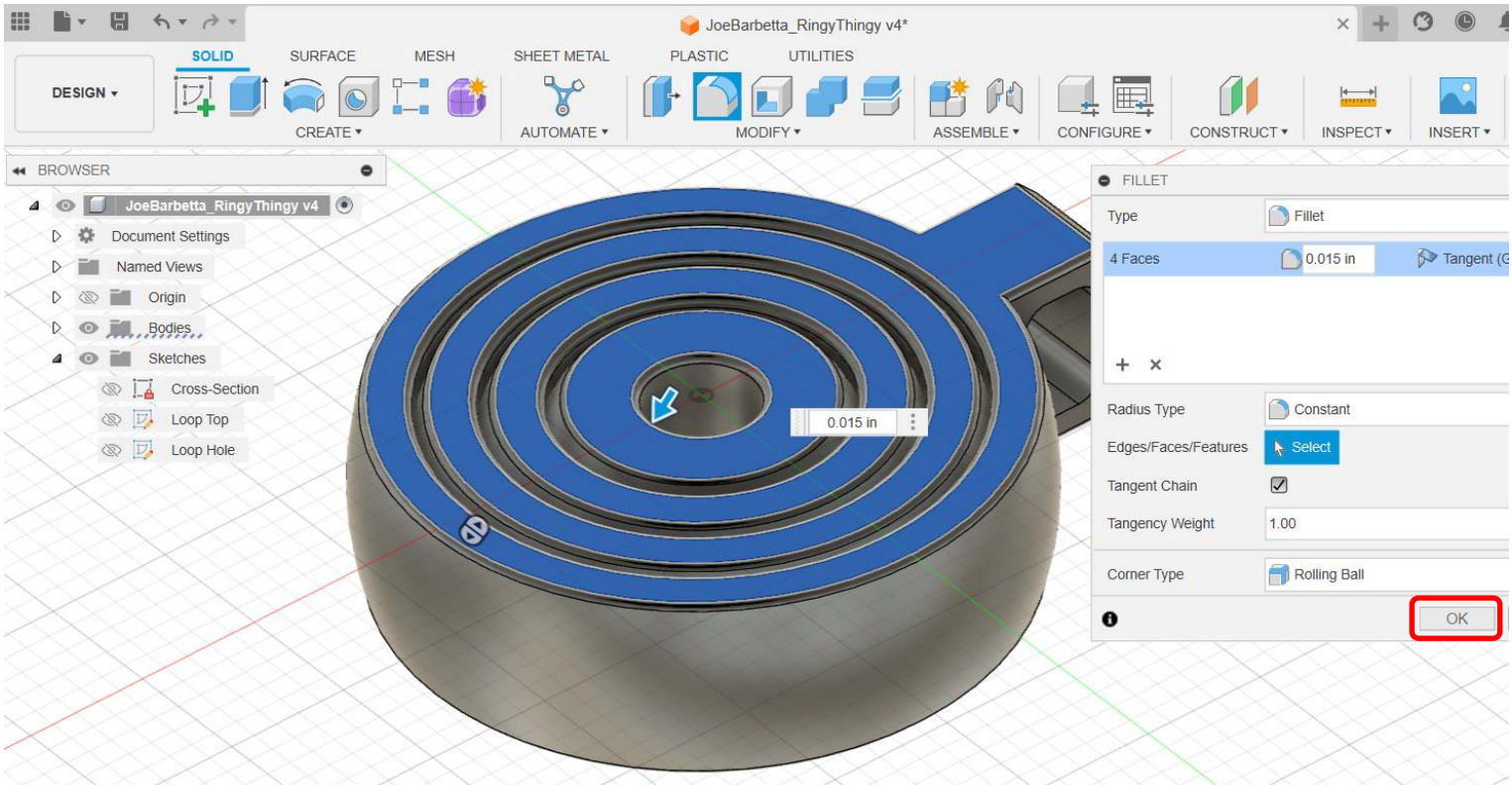


- rotate the View cube to **access the bottom** of the Ringy Thingy

- select the **Fillet** tool and click on the **face of each ring** as done before



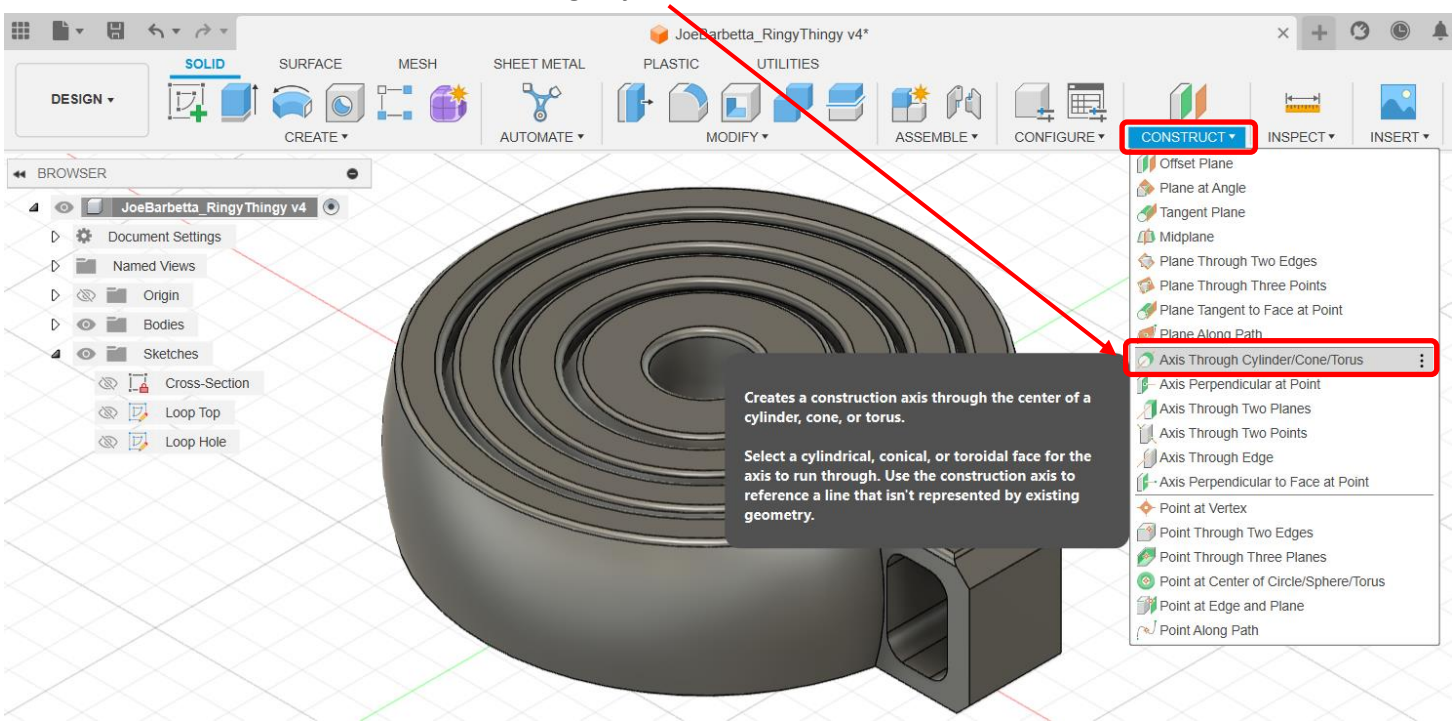
- type **0.015** and click **OK**



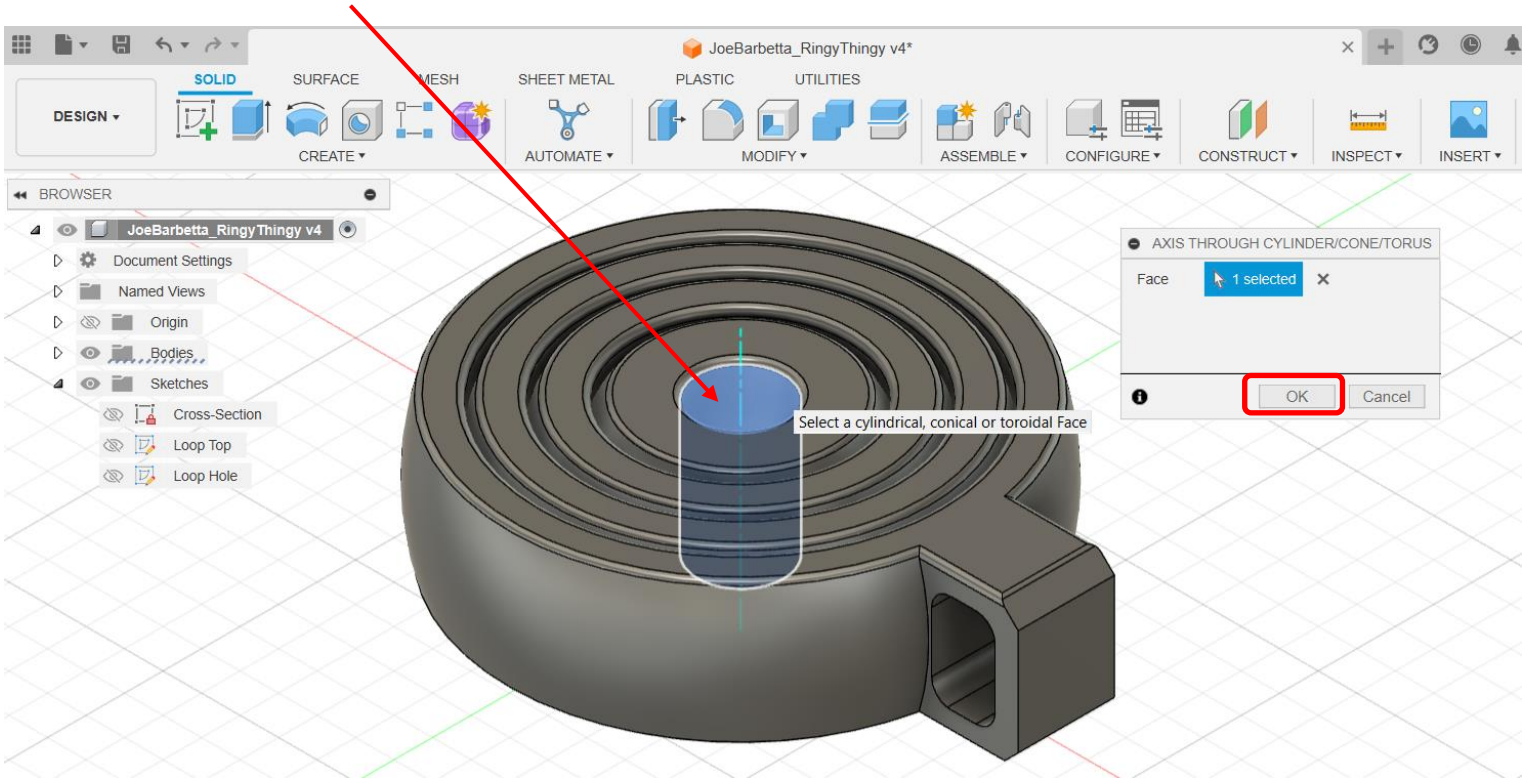
Adding Test to a Curved Surface

It is fairly easy to add text to a flat surface. By using some of the additional extrude settings, one can extrude text to follow a curved surface.

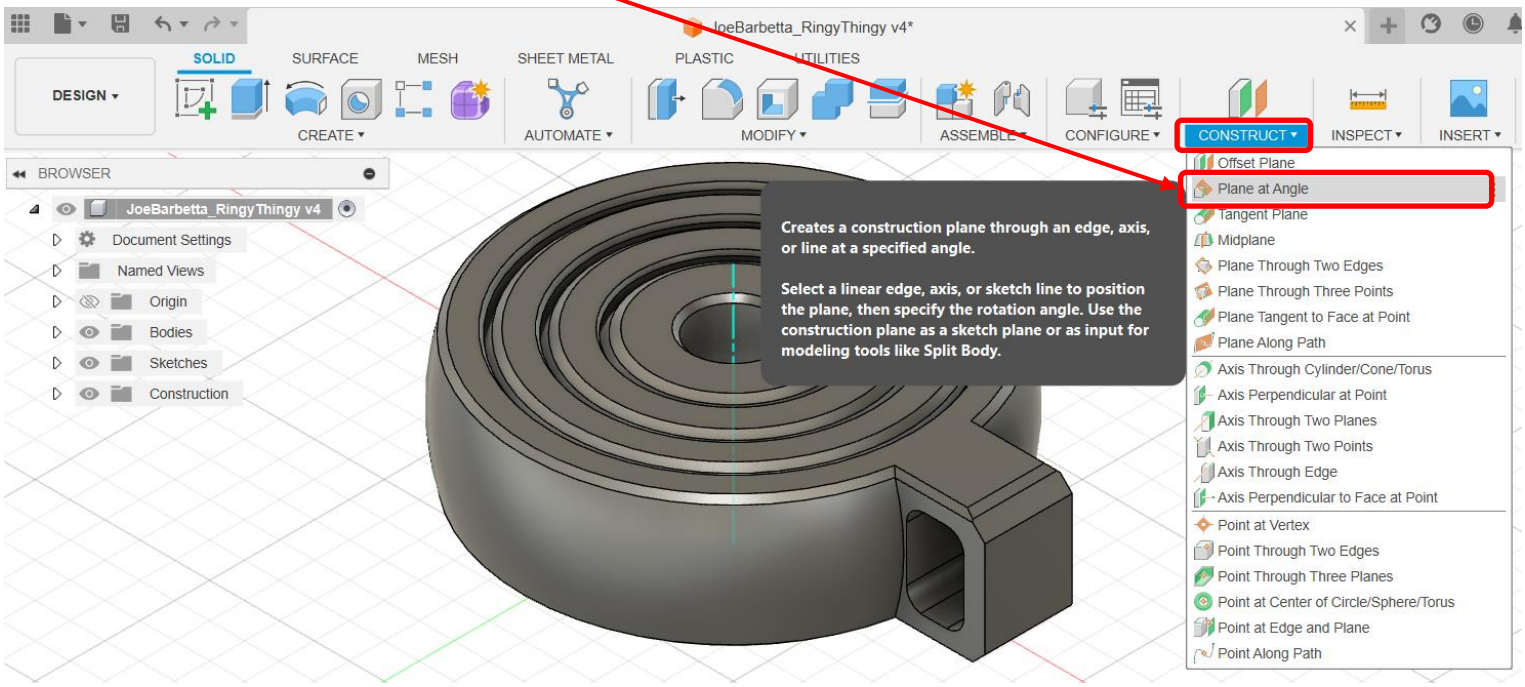
- select the **Home** view
- from the **CONSTRUCT** menu select **Axis Through Cylinder/Cone/Torus**



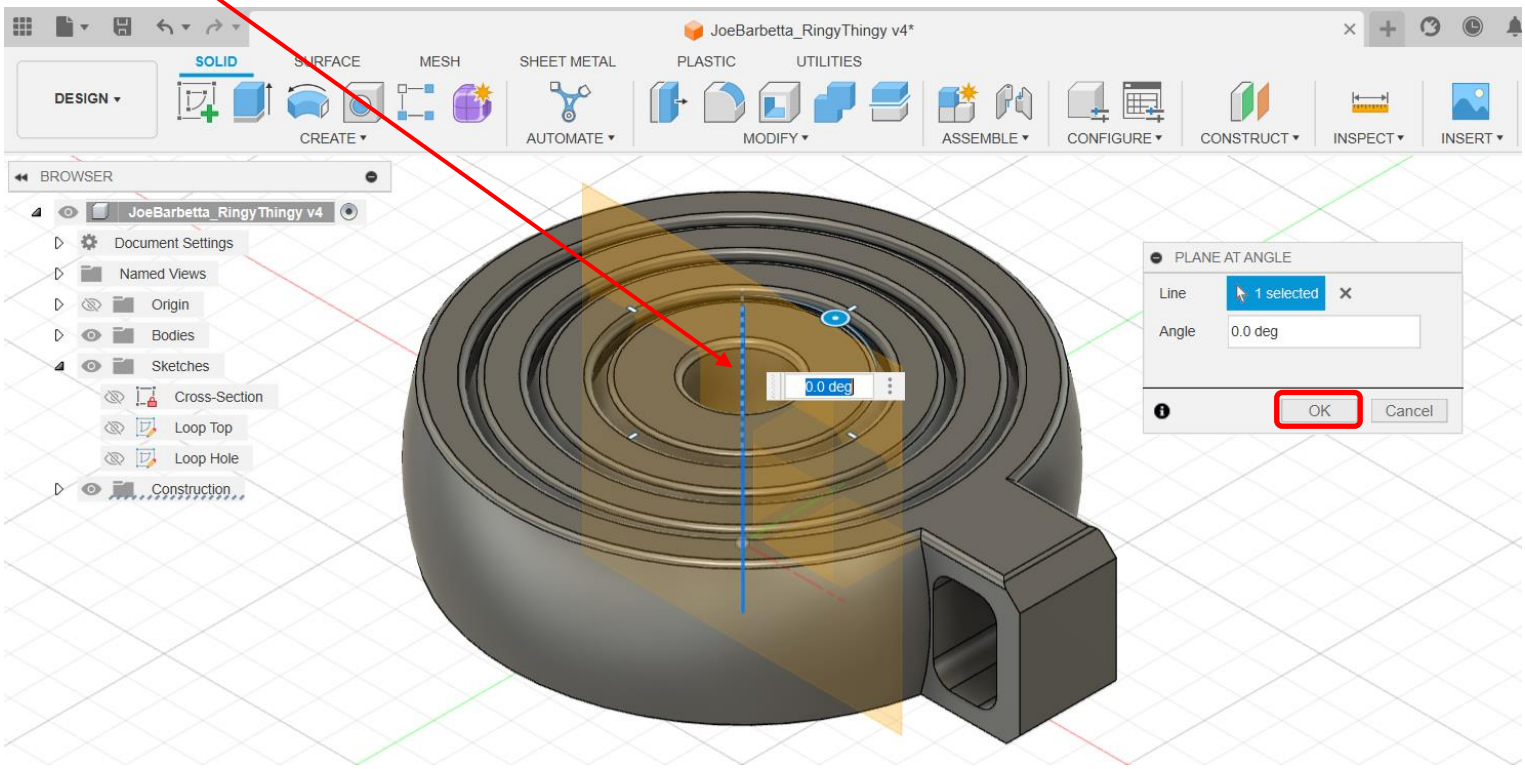
- click on the **inside of the inner hole** and then click **OK**



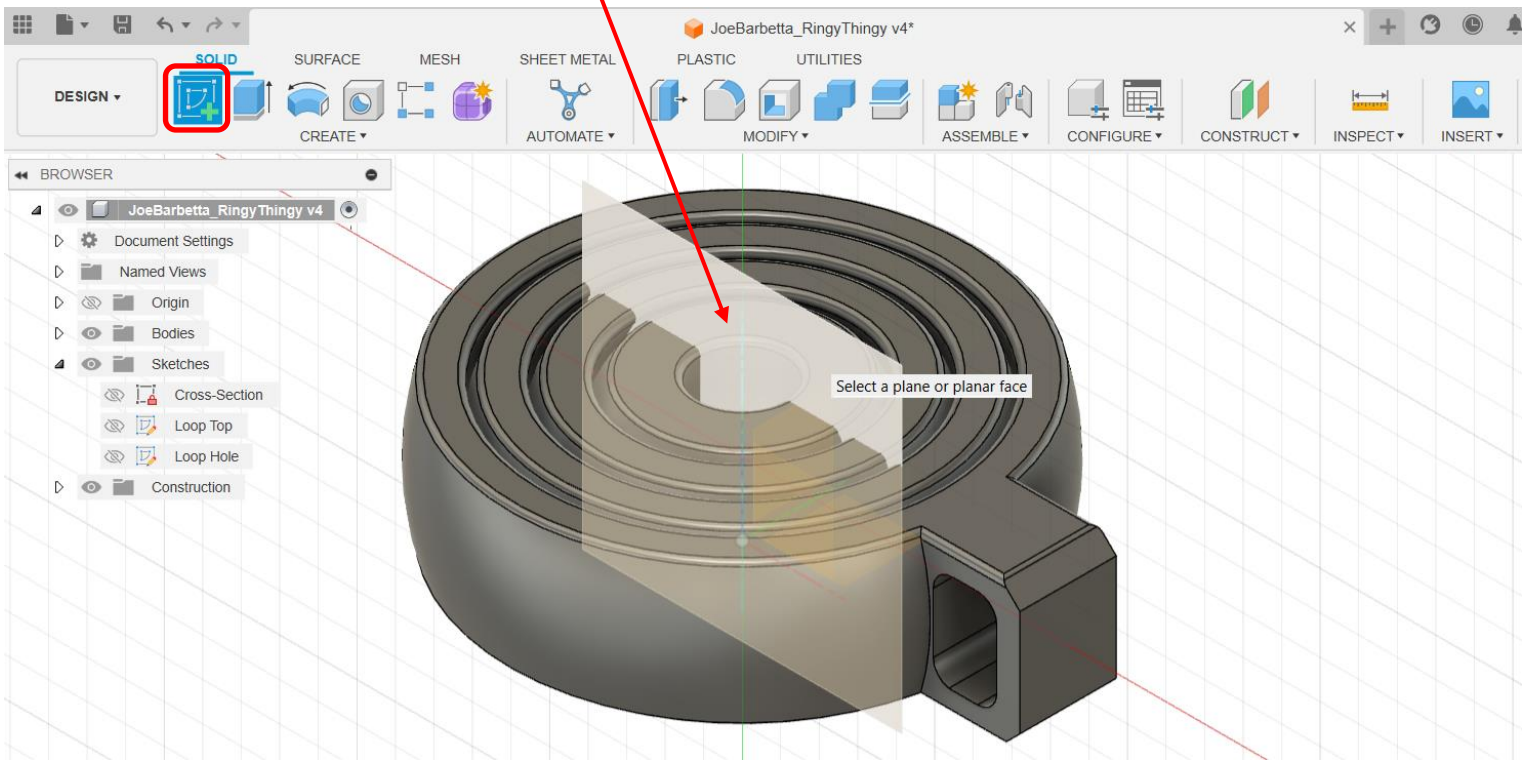
- from the **CONSTRUCT** menu select **Plane at Angle**



- click on the **Axis** just created, which should cause the orange plane to show, and click **OK**

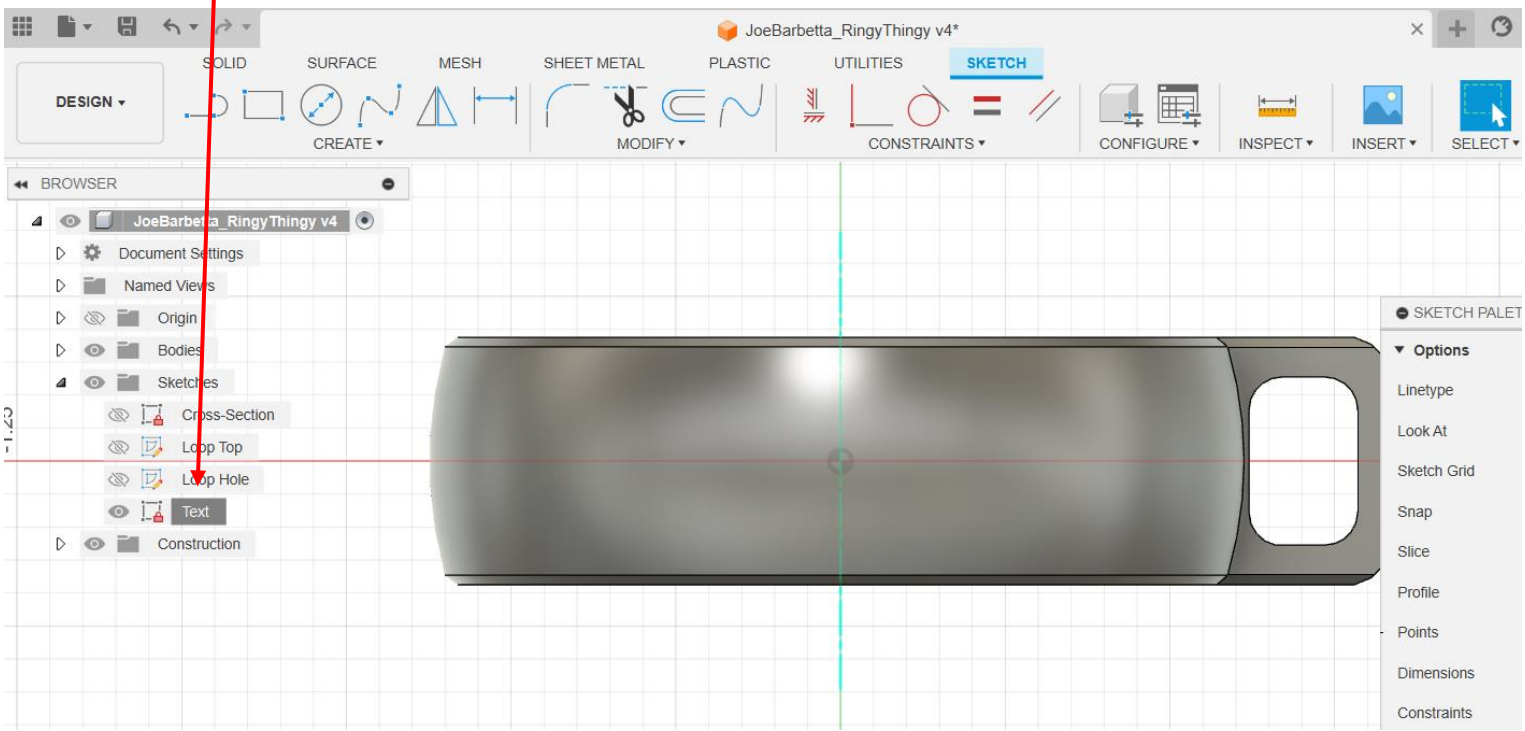


- select the **Create Sketch** tool and click on the **plane** just created

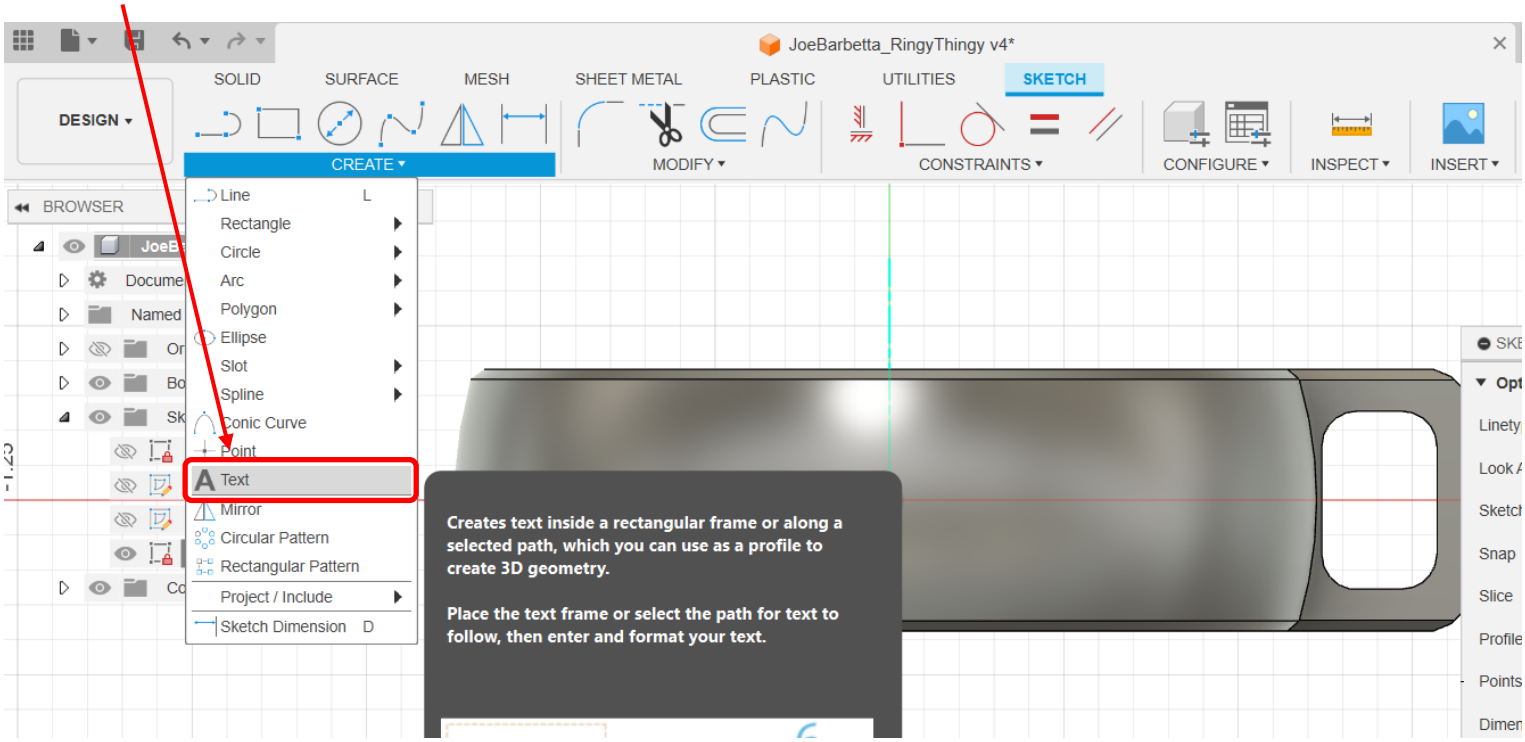


- rename the **Sketch** to **Text**

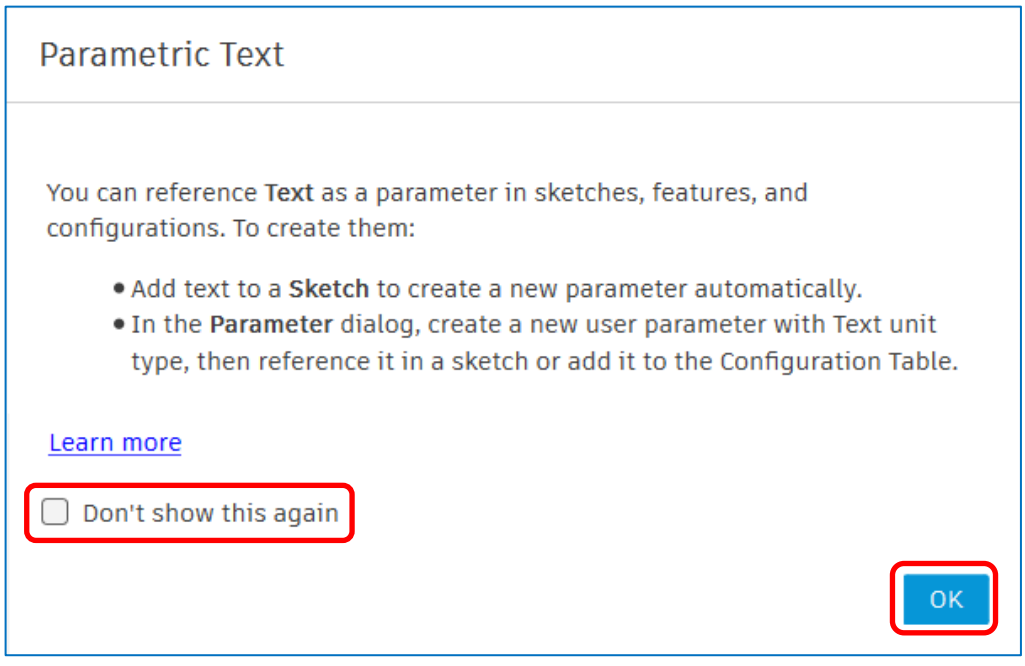
- zoom in and position the view to look similar to that below. Note that the loop is on the right.



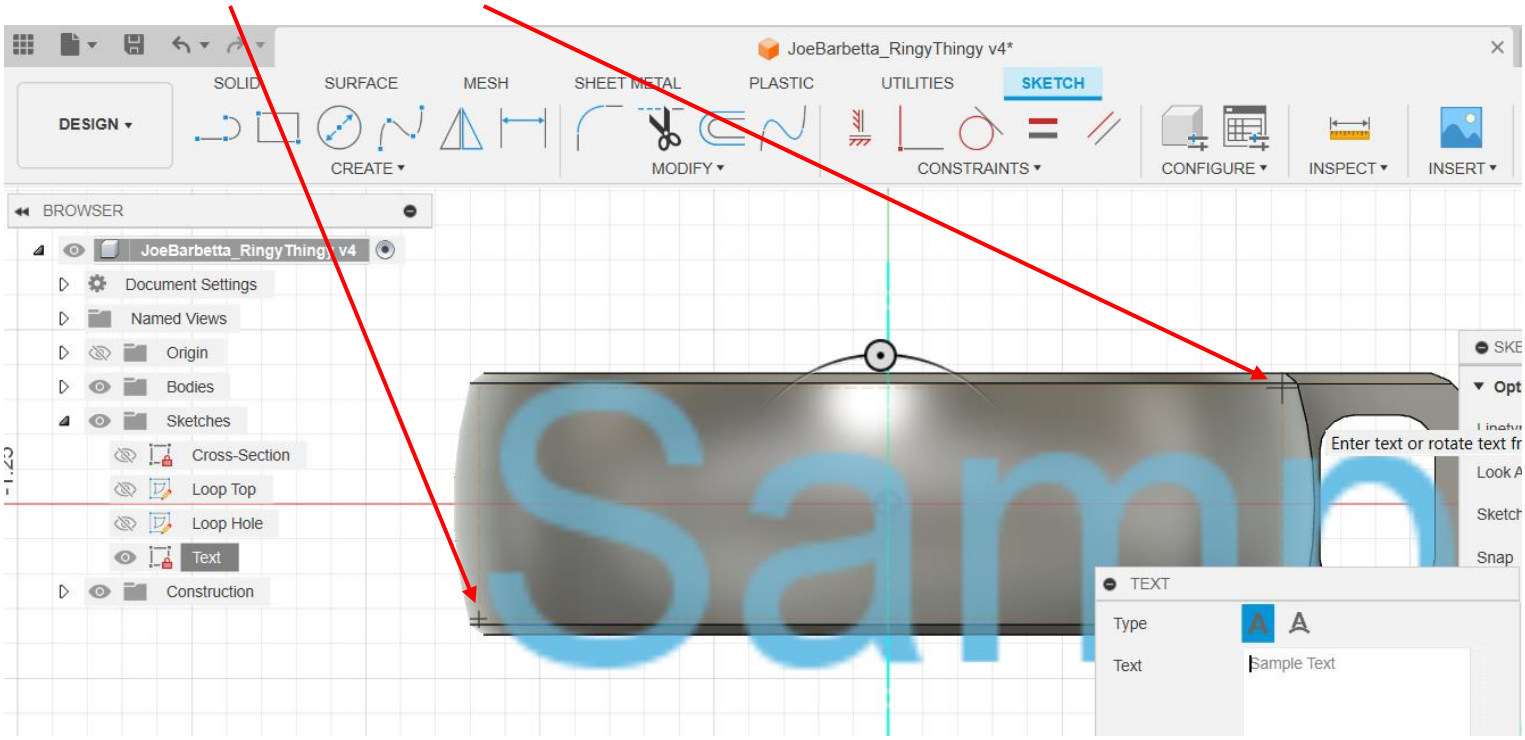
- select **Text** from the **CREATE** menu



- select the **Text** tool in the **CREATE** pull-down menu
- if this window like this pops up **check the Don't show this again** check box and then click **OK**. It essentially announces a new feature where a Parameter can be used to specify the text. It's a feature that we will Not be using.



- click on the **bottom-left** and then **top-right** of the Ringy Thingy, which should cause the **TEXT window** to open



- enter your three initials in the **Text box**

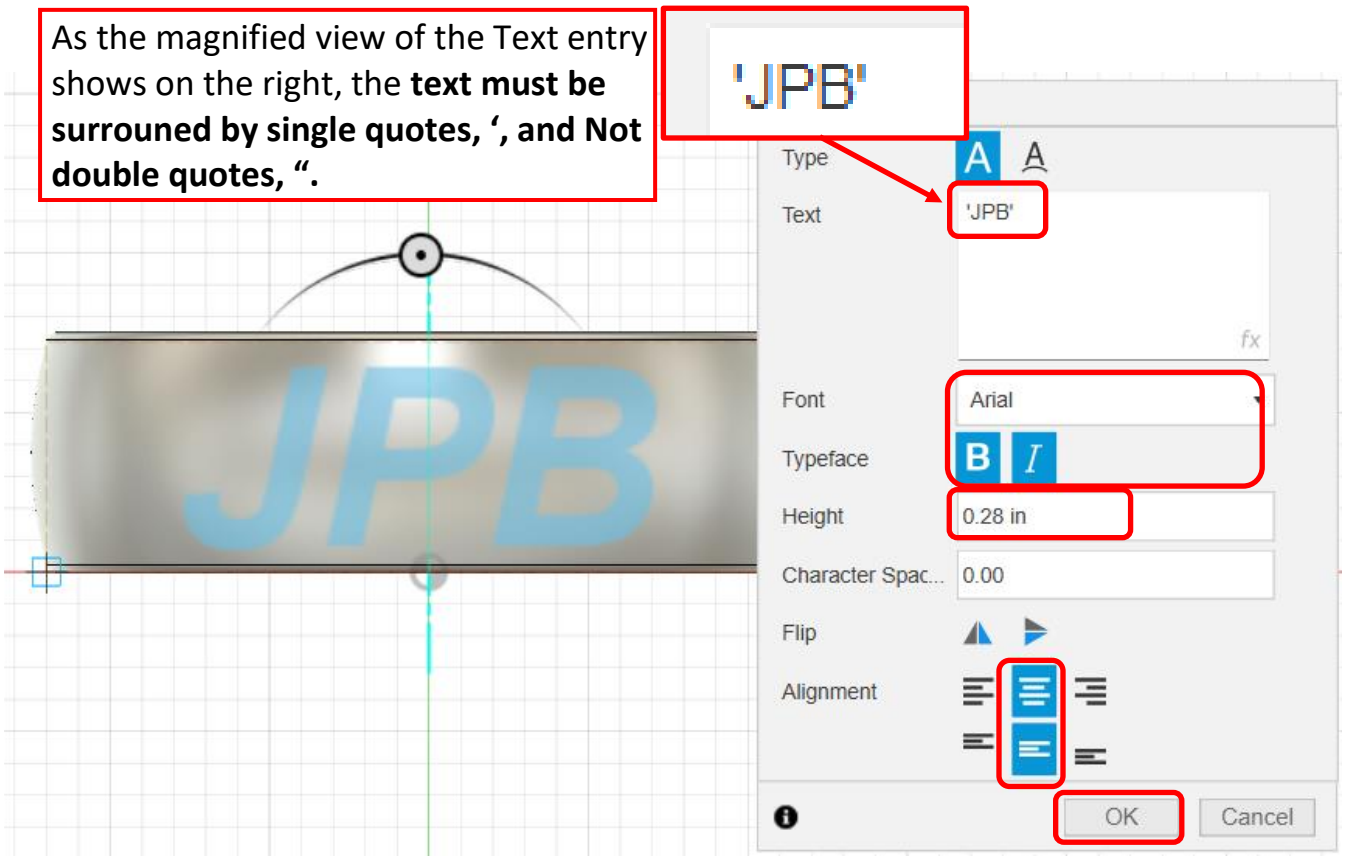
- set the **Height to 0.28**

- click on the **Bold** and **Italic** options if desired and change the **Font** if desired. Use a "simple" font that **doesn't have serifs**, which are the small lines at the ends of letter strokes. Note small text will not 3D print well.

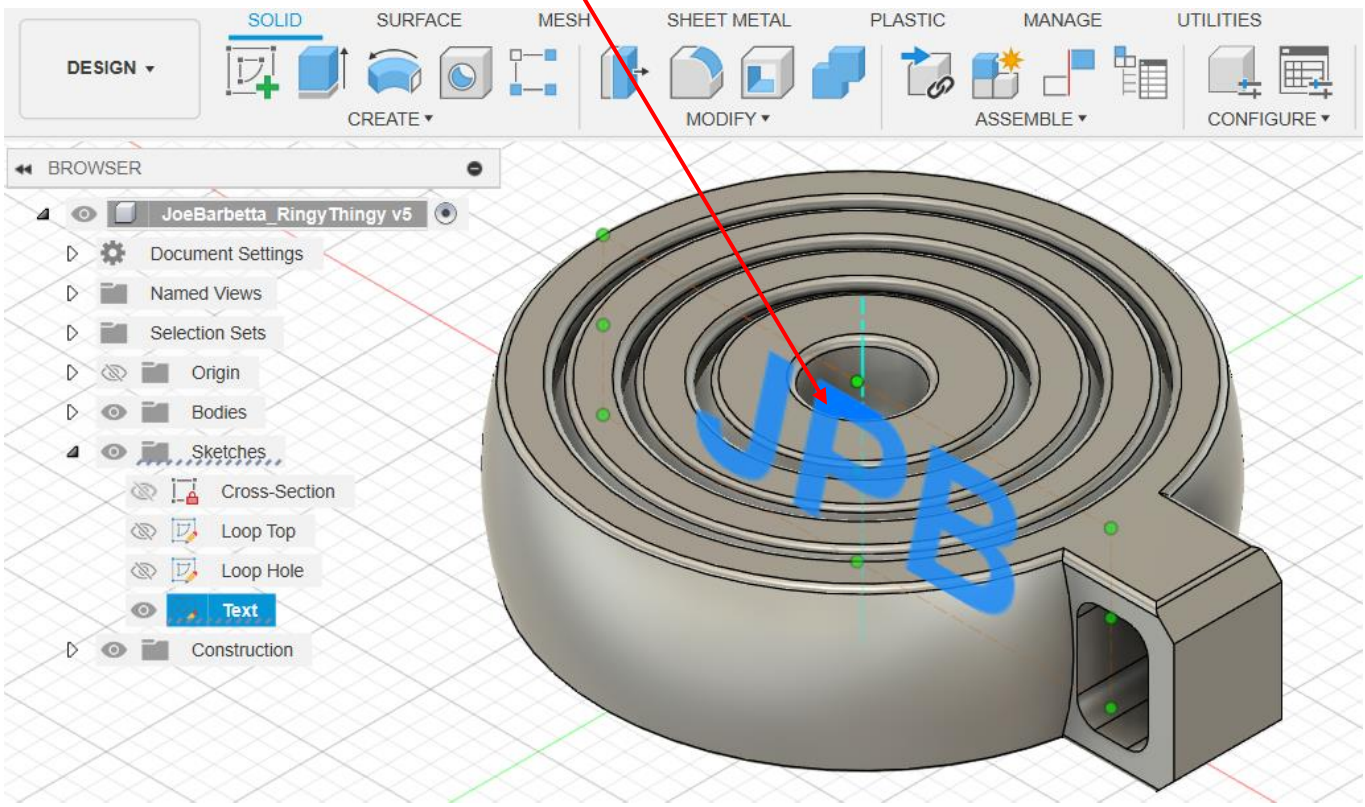
- click on the **two middle Alignment options**

- click **OK** when done and then **Finish Sketch**

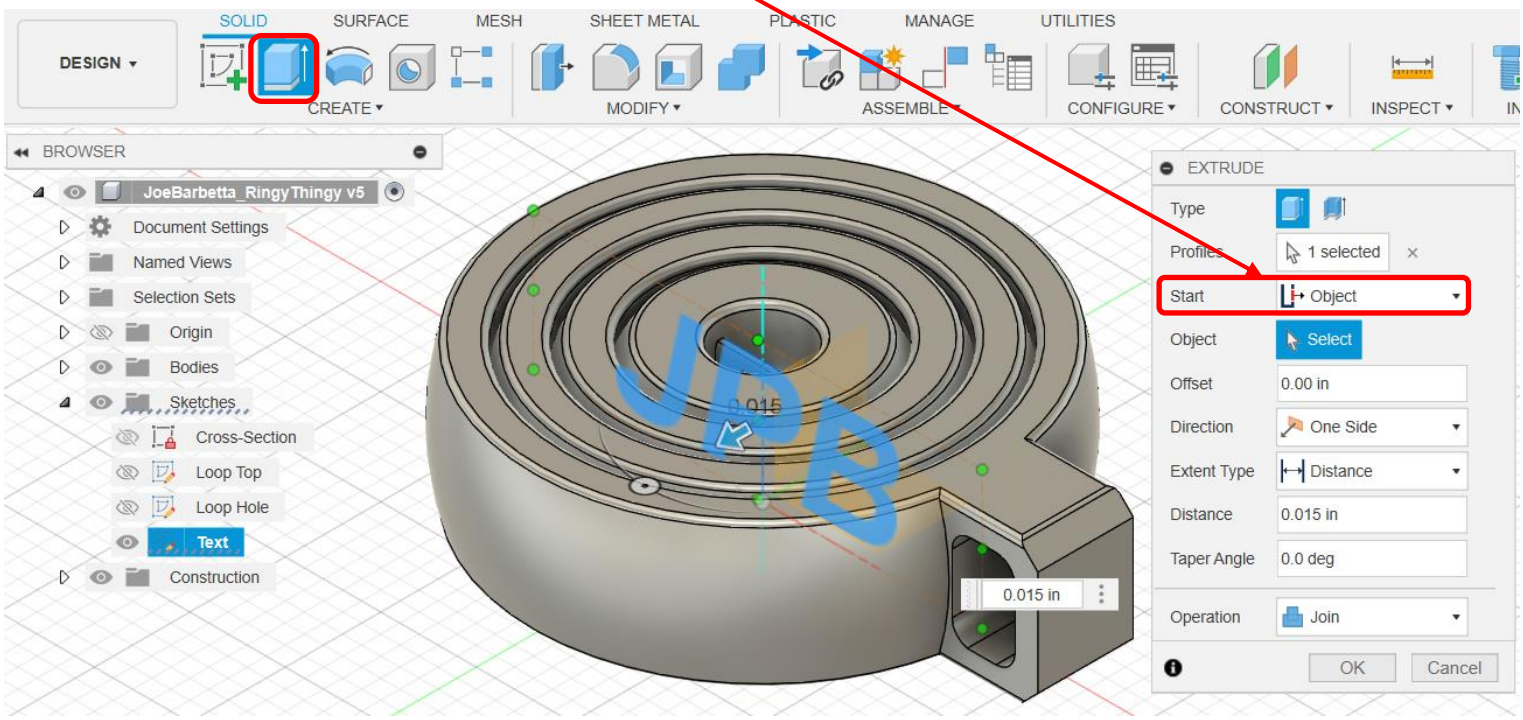
As the magnified view of the Text entry shows on the right, the **text must be surrouned by single quotes, ‘, and Not double quotes, “.**



- select the **Home** view and **click on a letter in the hole**. Unfortunately, a letter cannot be clicked on "through" the object. The view can be rotated slightly, if a letter cannot be clicked on.



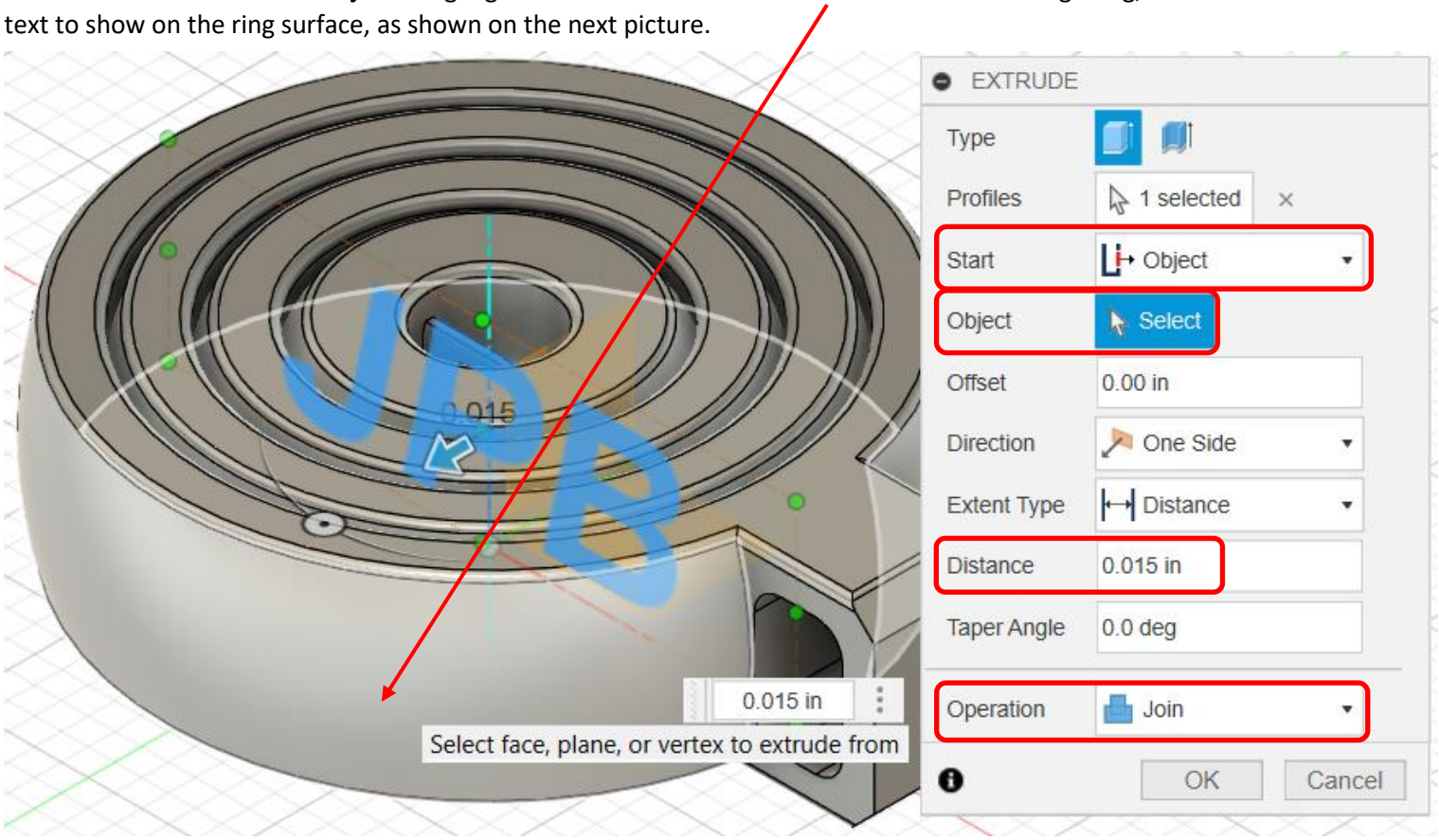
- select the **Extrude** tool and change the **Start** option to **Object**



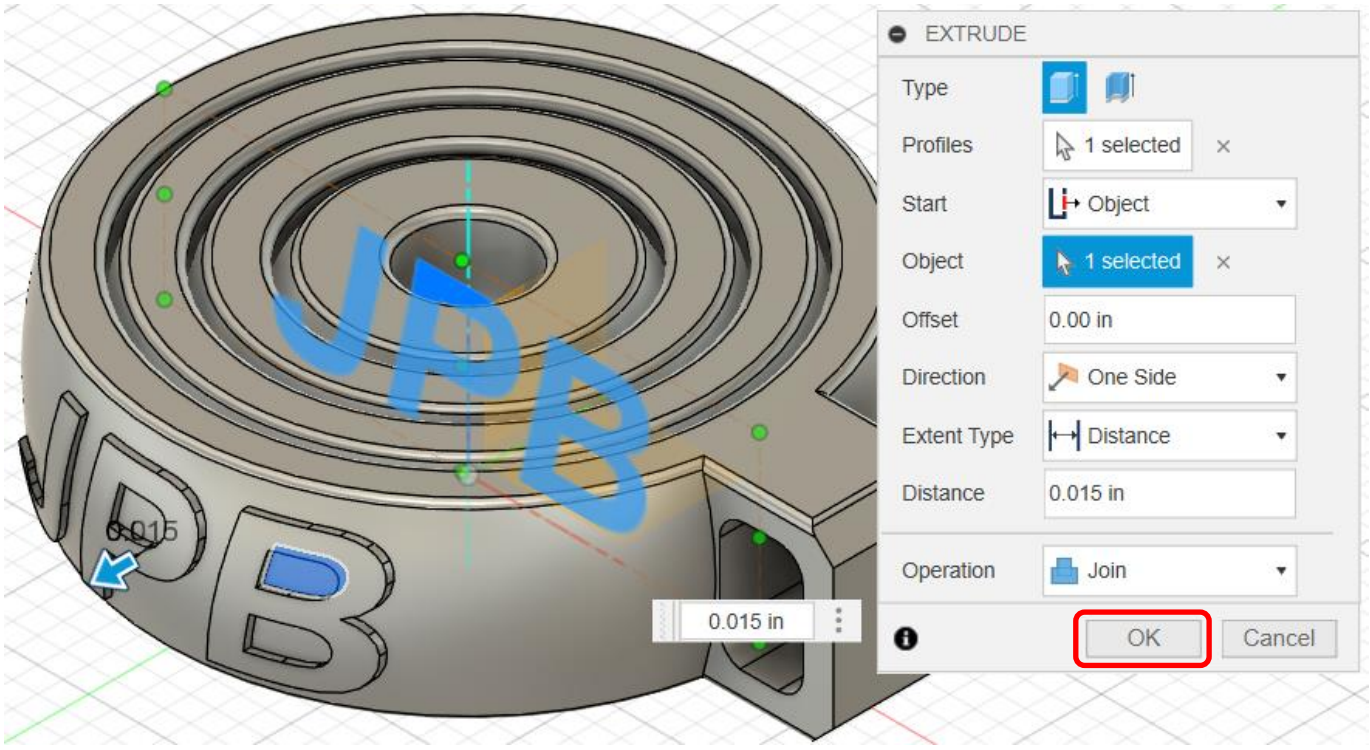
- type **0.015** in the **Distance** box

- ensure the **Operation** is **Join**

- ensure that **Select** next to **Object** is highlighted blue and click on the **outer surface** of the large ring, which should cause the text to show on the ring surface, as shown on the next picture.



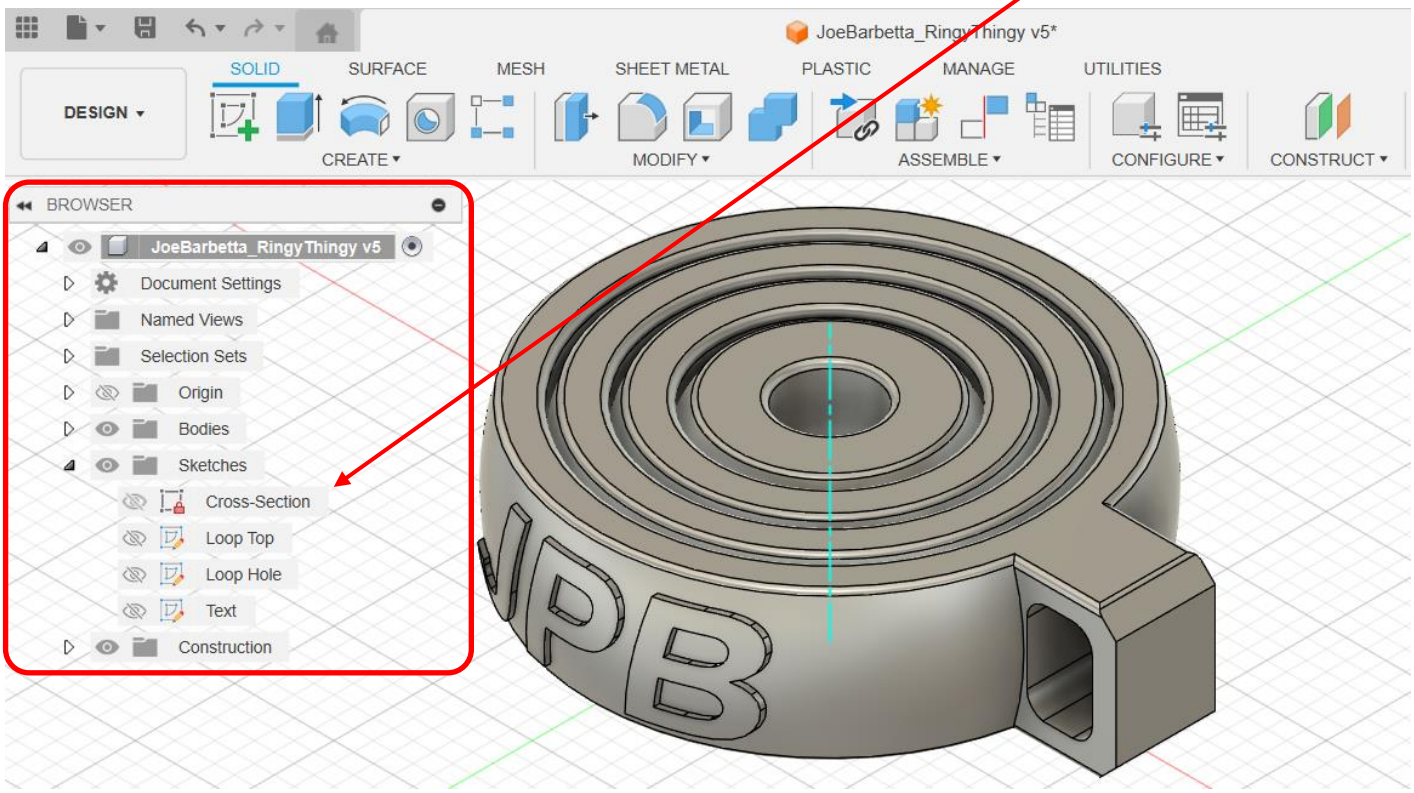
- if the text looks to be properly extruded on the surface, click **OK**. If not verify the settings. There also a few fonts that will not extrude. One can use Undo to get back to the Text settings.

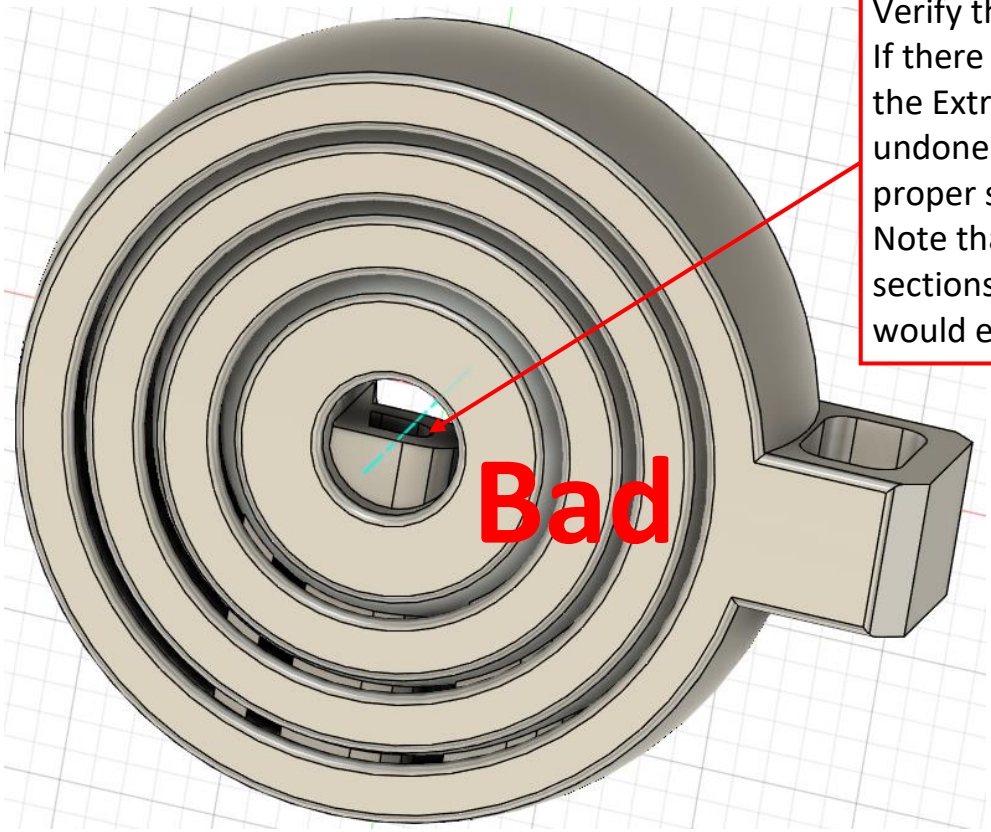


- press **Shift, Windows key, and S** and select a region that includes the BROWSER region with the **4 Sketches shown**

- when the bottom-right Snipping tool opens, click on it and then the top-right **Save-As** icon (or use the Ctrl and s keys) to save the **.PNG file**. By default the file should save to the **Downloads folder**.

- **If the Snipping tool window doesn't open** start a Google Doc, use Paste (Ctrl and v), and then download as a .pdf.

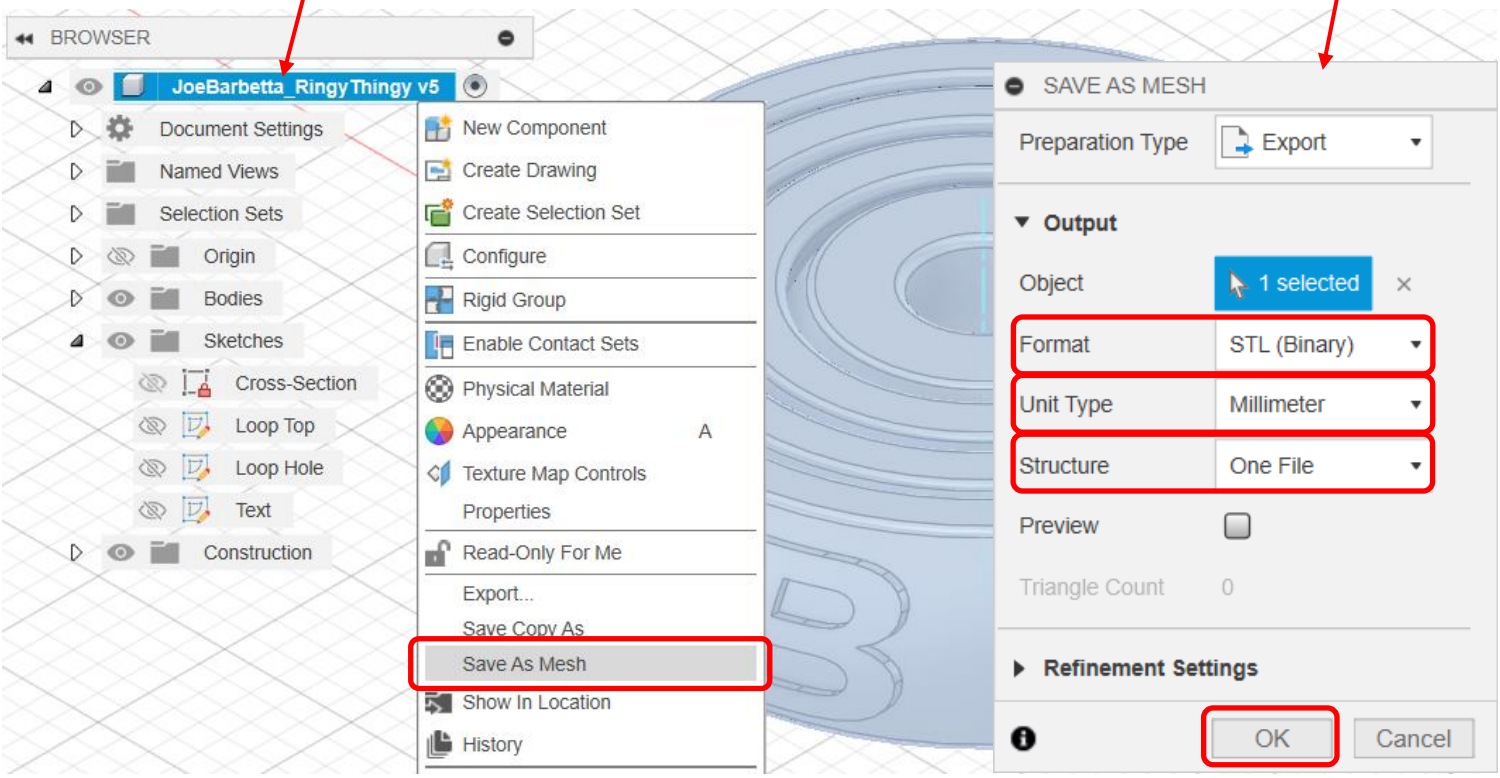




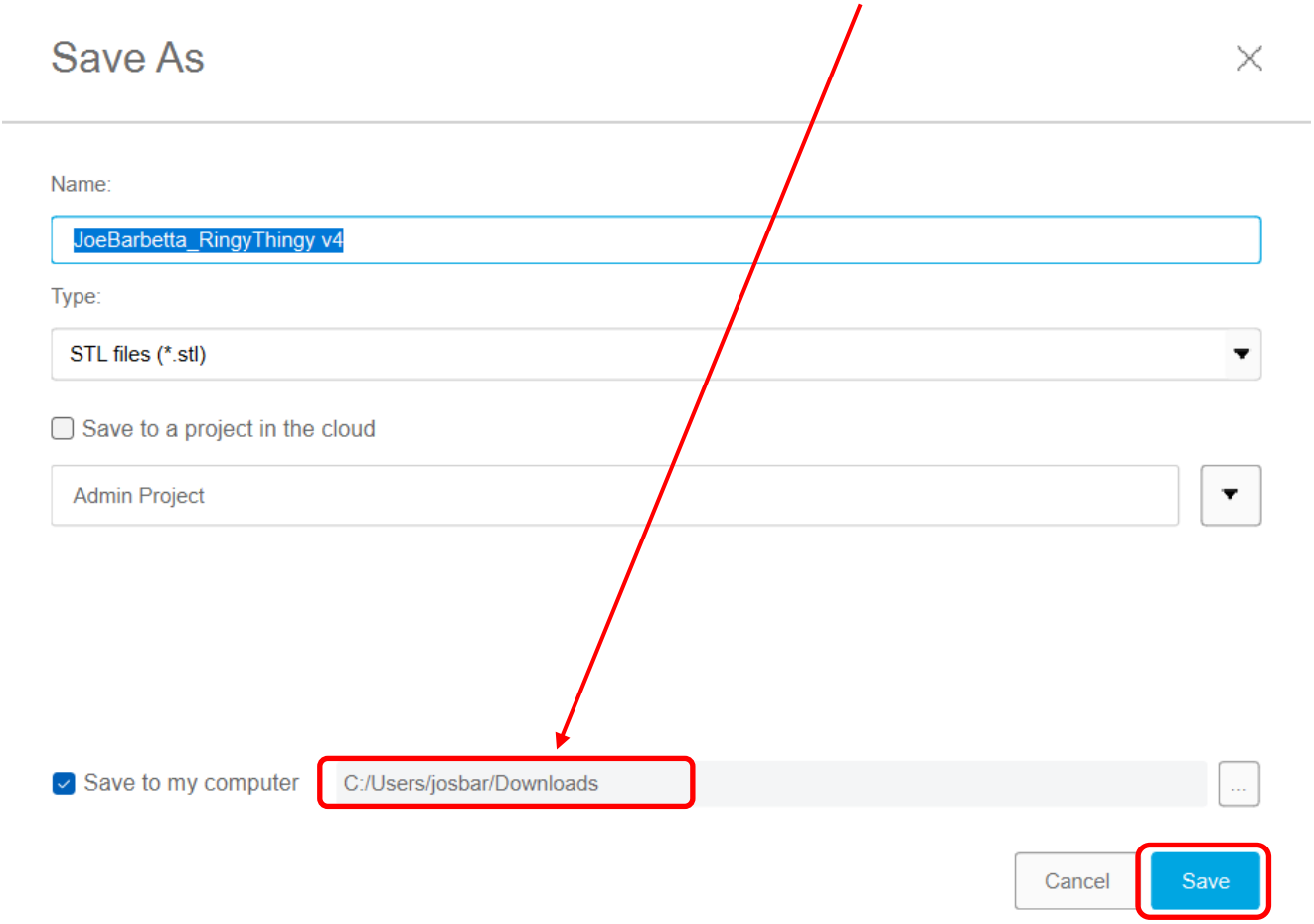
Verify that there is **No text in the hole**. If there is text in the hole, as shown, the Extrude operation should be undone and then redone with the proper settings.
Note that there shouldn't be text sections visible between the rings. This would end up fusing the rings together.

Creating a .STL File

- right-click on the **Project Name** (which should include your name) and select **Save As Mesh** and **ensure the settings match** those shown. Click **OK**.



- click **Save**. Note that, be defualt, the file should be saved to the **Downloads folder**.



Using the Cura slicer software

If you are doing this for an assignment you don't need to do the following. You are done. Mr. Barbetta will load the Ringy-Thingy .STL files of many students into Cura to allow the whole group of Ringy-Thingys to print overnight.

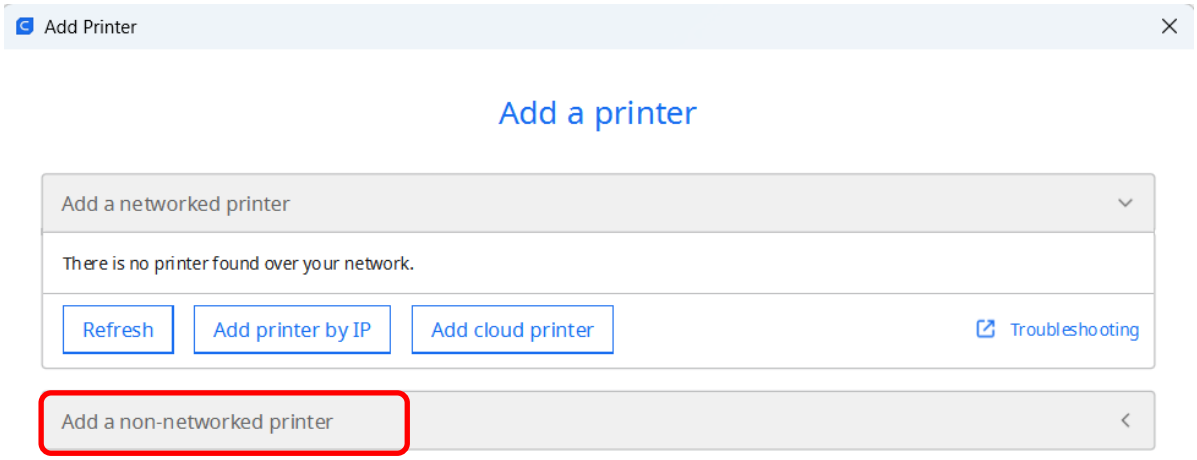
If you will be printing this on your own, the following pages will provide guidance on using settings in Cura to best print a Ringy-Thingy.

Because Ultimaker updates their Cura software at times, there is a folder and document on Schoology titled "Getting Started with Cura" to help one get started and skip the annoying screens that try to get you to crate an account.

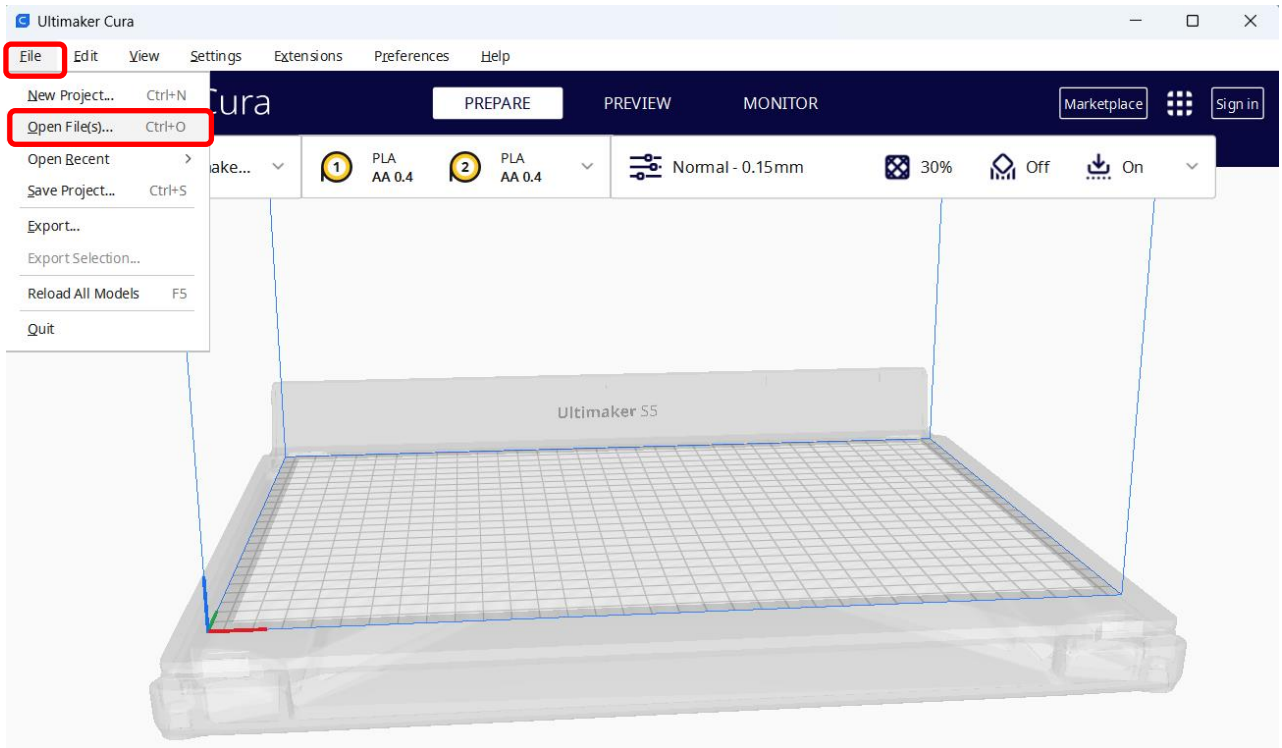
This document was created using Cura version 4.13.2

If you don't have access to the aforementioned document, Run Cura and do your best to get through the annoying screens. Part of the process will be clicking on **Skip** buttons to get past some.

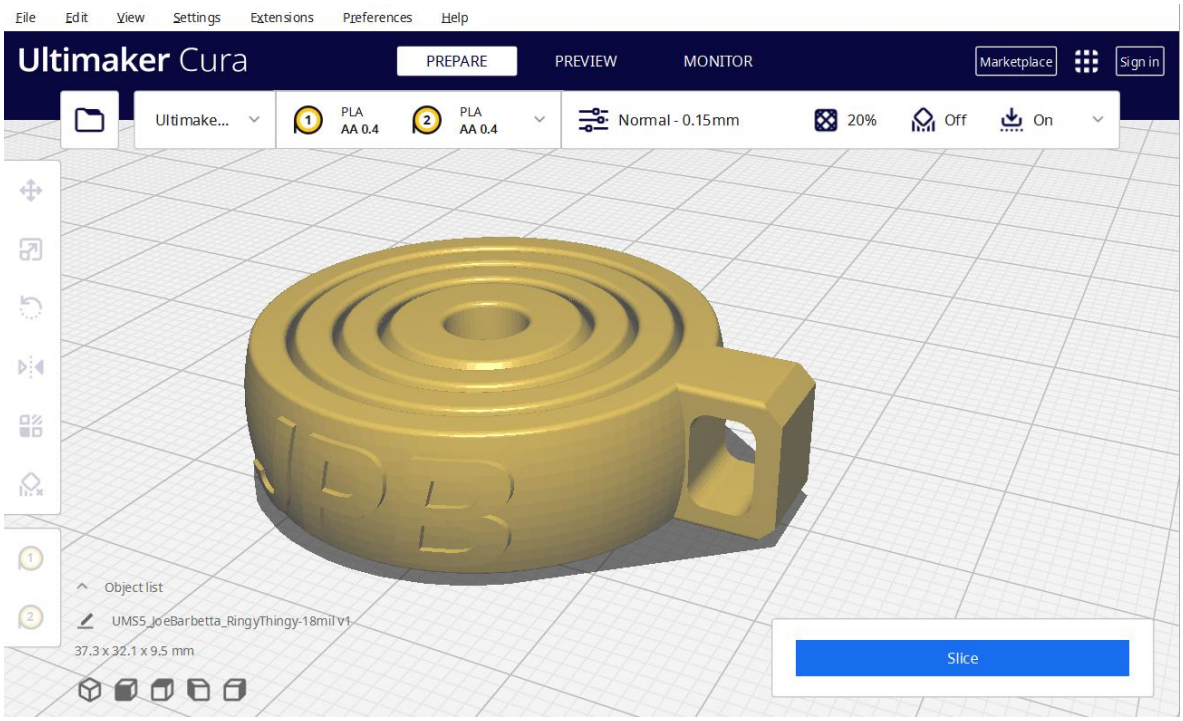
You may get prompted to **Add a printed**. Select **Add a non-networked printer** and select **Ultimaker S5**, which may be the first printer listed.



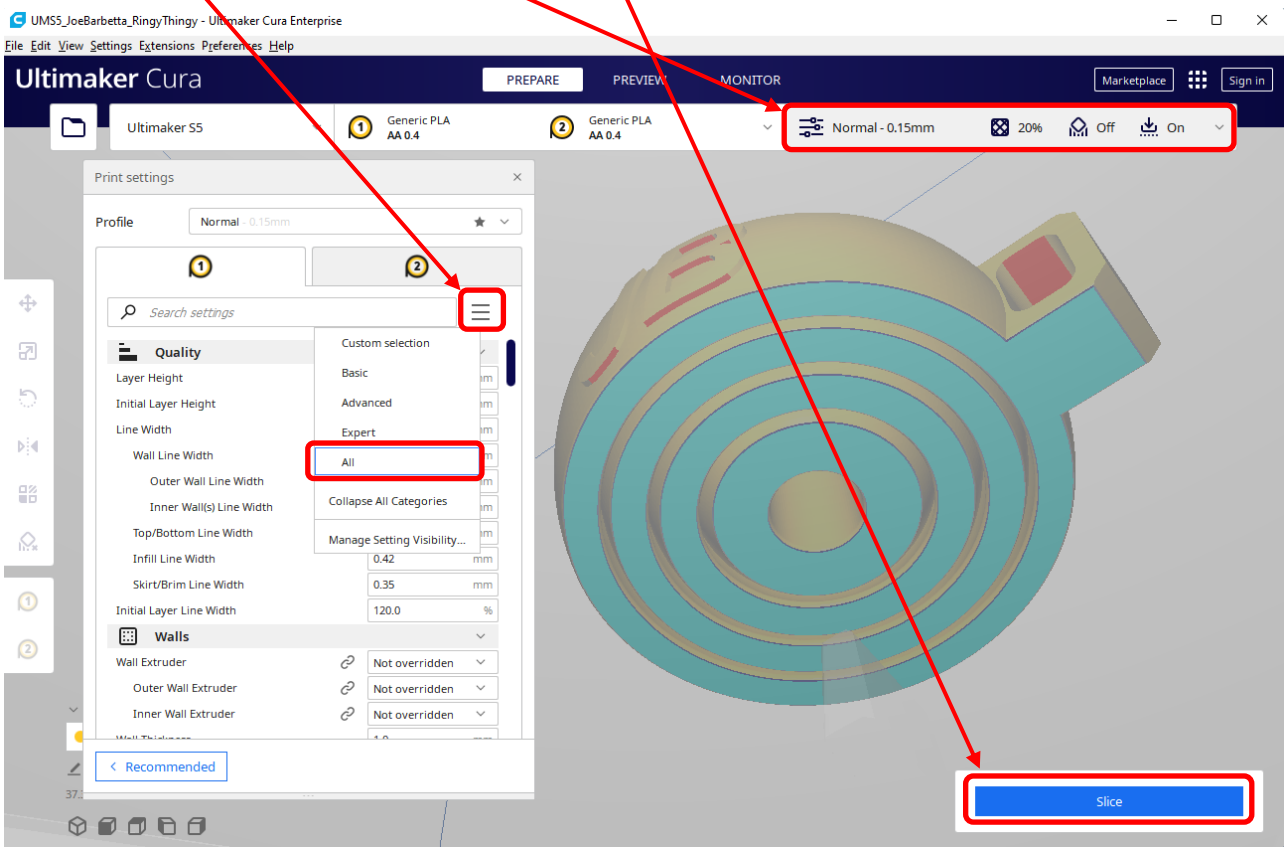
- select **Open Files(s)…** from the **File** menu and navigate to your .STL file



- turn the **mouse wheel to Zoom** in and **hold down the mouse wheel to pan** for shifting the view.

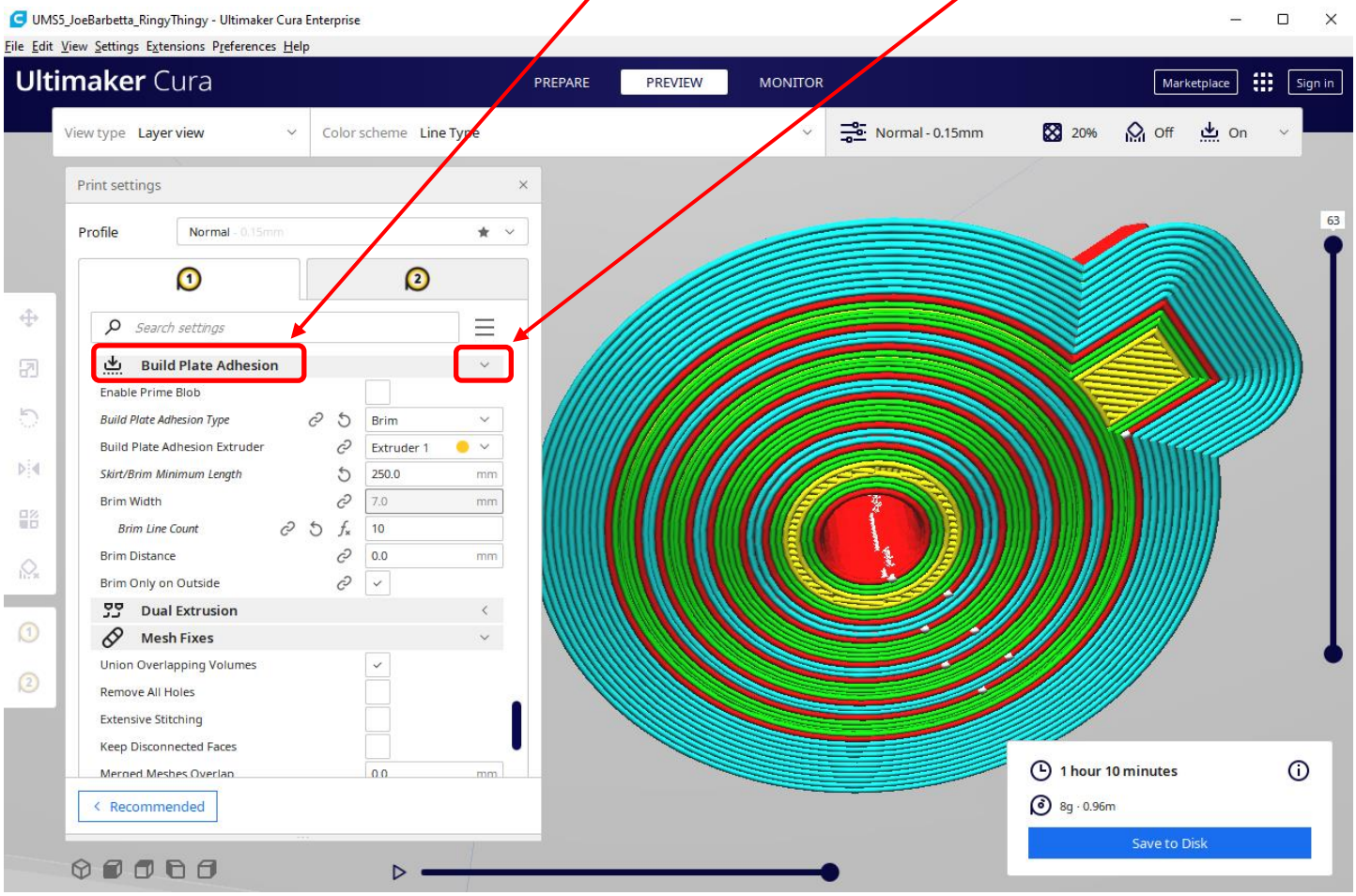


- **hold down the right mouse button to rotate the view** so that the underside of the Ringy-Thingy is visible.
- click **anywhere on the settings area** to open the Print settings window
- click on the **3 bars** and select **All**. Then click the **Slice** button.

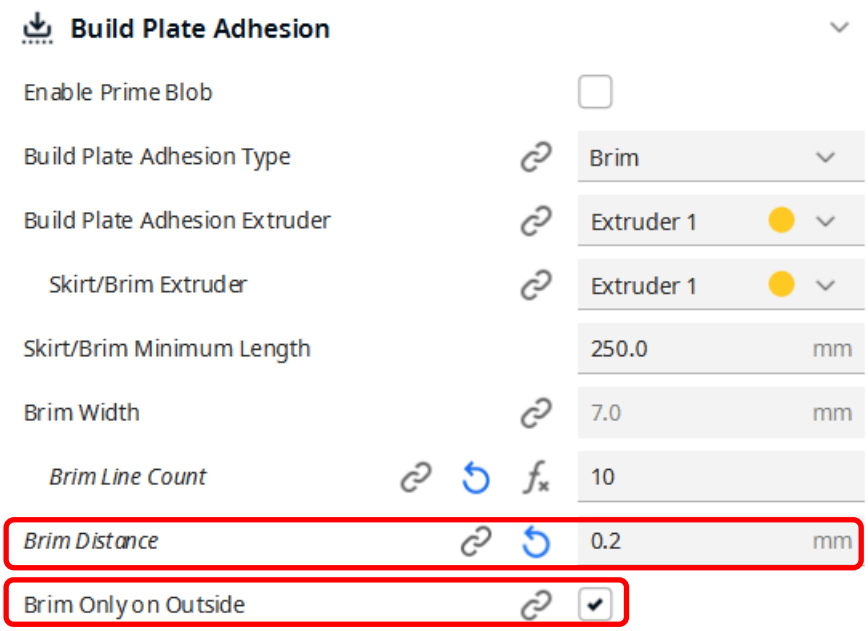


- click on the top **PREVIEW** button to view the resultant slicing. The blue lines shown around the bottom is the **Brim**. This is a single layer of plastic printed around an object to help the print stay on the build plate. If it doesn't show, settings will be changed to create a brim.

- scroll through the setting categories to find **Build Plate Adhesion** and click on the **Expand Arrow** to open its settings.

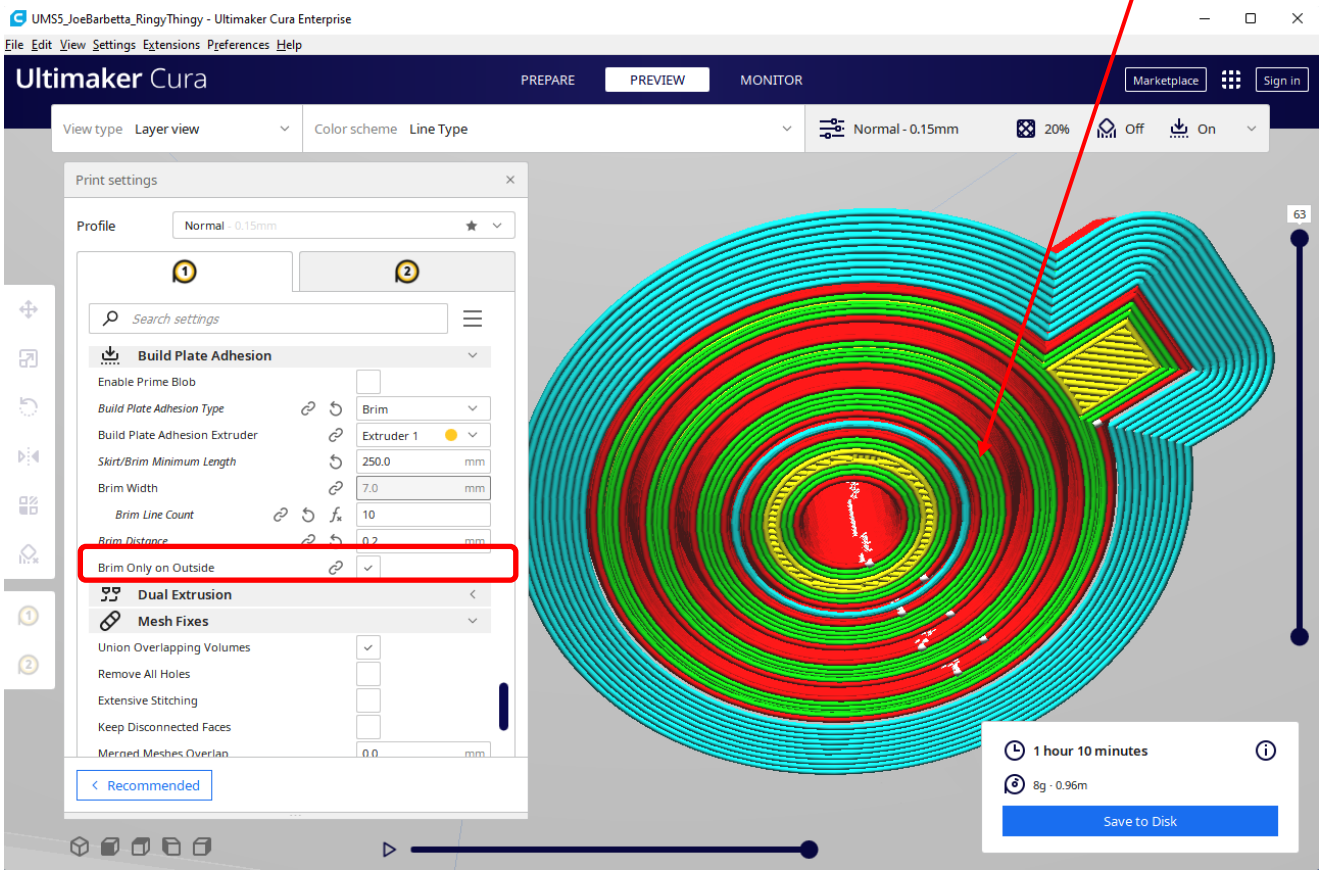


- ensure the settings are set as below. The last two settings are ones that are the most important.
- click the **Slice** button again and after any further adjustments



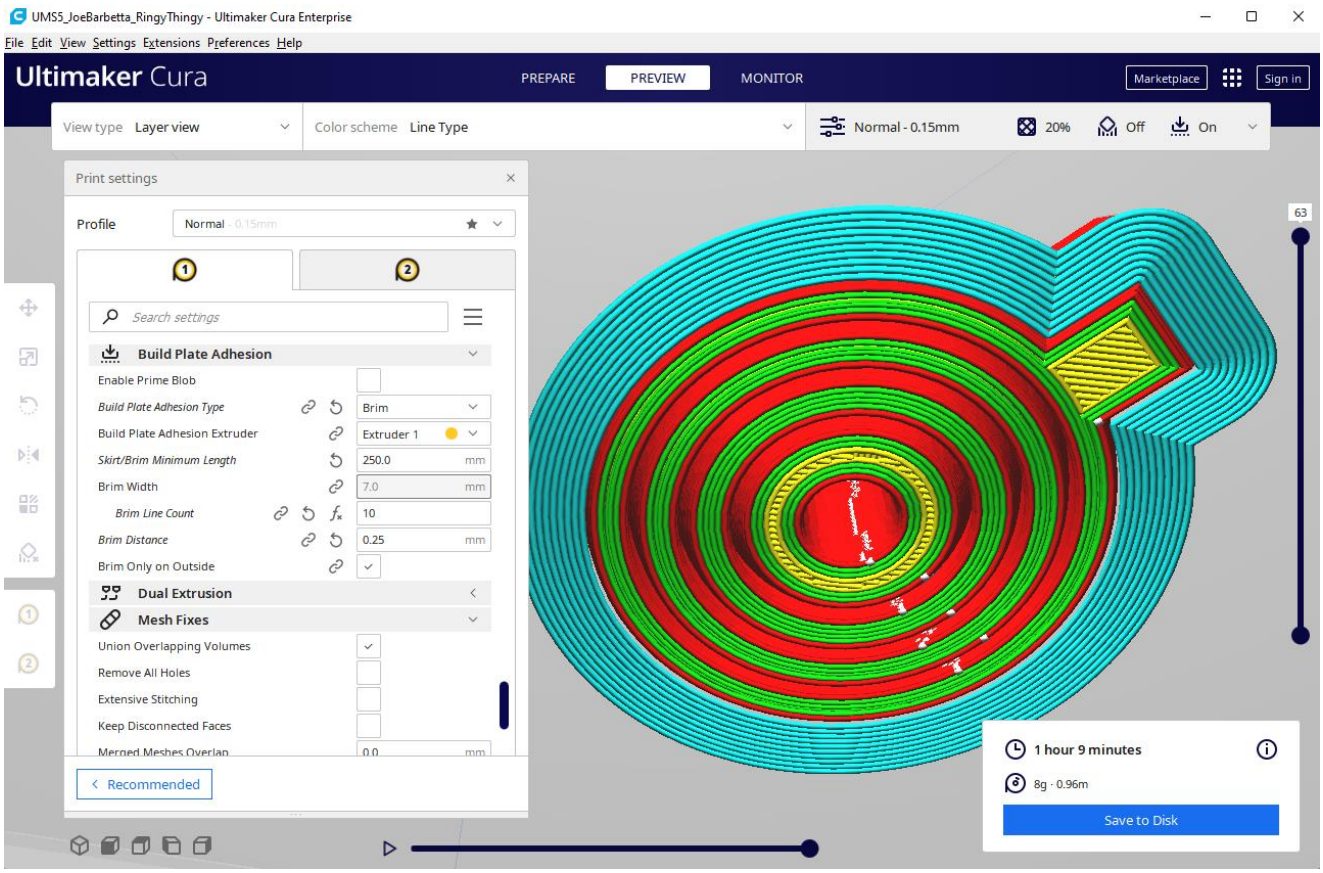
- ensure there are **No "inner" blue circles** between ring sections. Below is an example with a blue circle that needs to be fixed.

- **if there are any blue lines increase the Brim Distance by 0.01 mm**, for example from 0.2 to 0.21, and **Slice** again.



Here is an example where a Brim Distance was reached, wherein there are no inner blue rings.

With **Cura** version **4.13.2**, a **Brim Distance** of **0.25** caused all inner brim rings to disappear. See notes on next page.



When using **Cura** version **5.11.0** it was found that a **Brim Distance** of **0.38** was needed for all the inner bring rings to disappear. A brim distance this large may negate the effectiveness of the brim to increase adhesion. Note that Ultimaker does offer previous versions of Cura to be downloaded. Below are notes if one wishes to use a updated version such as **5.11.0** and one will have to do some experimentation, as the influence of settings and defaults can change with future versions as well.

It also seems that with version **5.11.0** the defaults for Horizontal Expansion and Initial Layer Horizontal Expansion are not 0 as they are with version **4.13.2**. The defaults were set as shown below.

Horizontal Expansion = -0.015 (0.0006")

Initial Layer Horizontal Expansion = -0.095 (0.0037")

Horizontal Expansion values can also affect the influence of Brim Distance on inner brim rings.

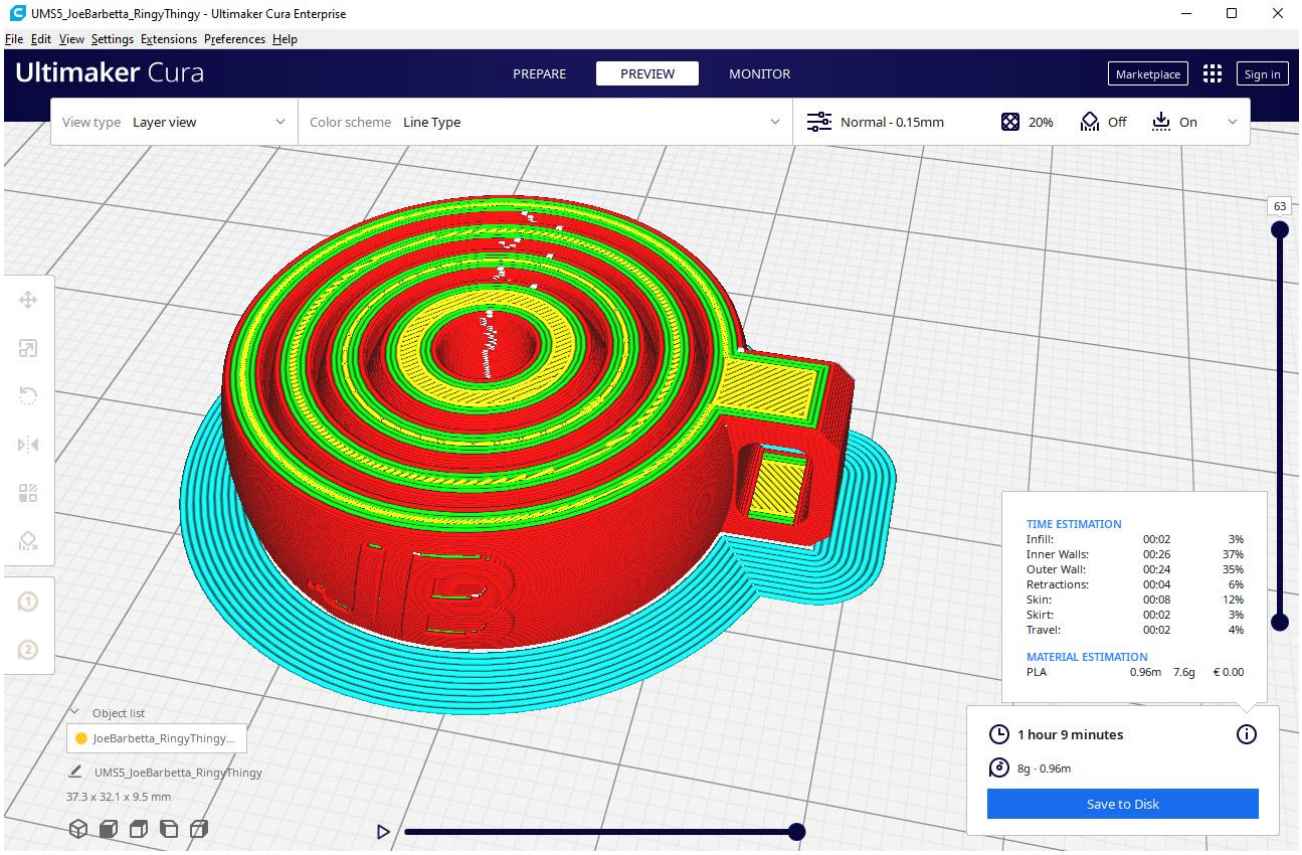
It was found that for version **5.11.0** setting the **Initial Layer Line Width** to **120%** allowed a **Brim Distance** of **0.36** to remove all brim rings.

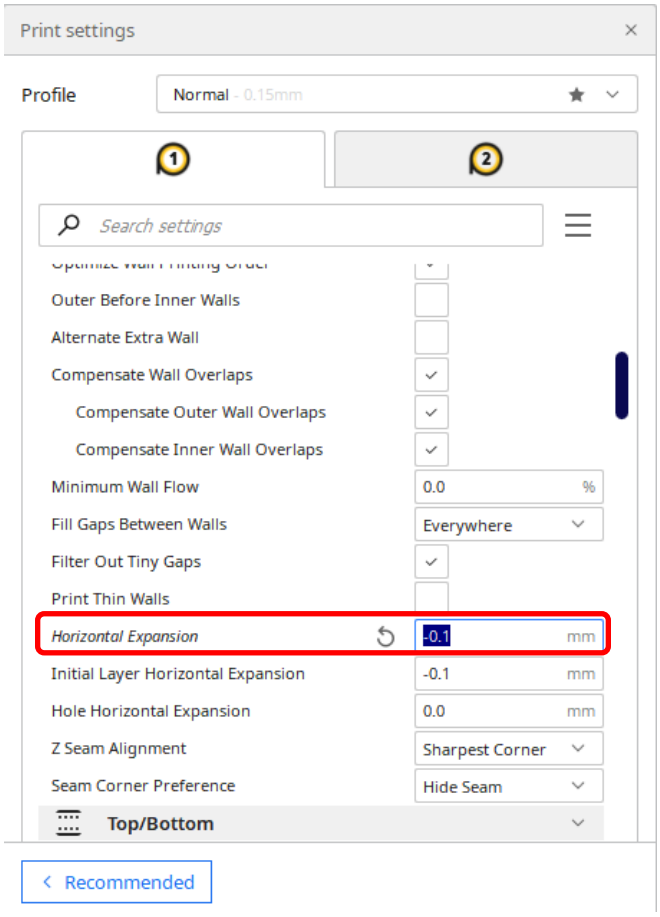
The reason for not having any inner brim rings is to ensure the free movement of the rings.

Continued on the next page.

Here is the Ringy-Thingy returned to its top view.

The purpose of the previous steps to ensure that there were no inner blue rings is to prevent ring sections from getting stuck together. Inner blue rings indicate that the brim layer exists between ring sections, which will cause them to stick. Having the brim only around the Ringy-Thingy should be sufficient to prevent the object from detaching from the build plate.





If rings are sticking together or falling out.

In the **Parameters** set early in the design, there was a **Ring Clearance** parameter set to 0.016. This value can be **increased** if rings are sticking together or **decreased** in rings are falling out.

If one only has the .STL file and not the Fusion 360 file, there are Cura adjustments that can be tried. Note that **after adjustments, the Slice button must be clicked** again.

In the **Walls category**, there is a **Horizontal Expansion** setting, which should be 0 by default.
A negative value, such as -0.1 as shown will enlarge the spacing between rings to prevent sticking. However, too much spacing will cause rings to fall out.
A positive value can be tried if rings fall out.
Note that one is trying to achieve a balance between rings not sticking together and not falling out. Smaller values, ie 0.05, can also be tried.

Playing with the Windows 3D Viewer

The Windows 3D Viewer was included with Windows 10. **If using Windows 11, one needs to download it from the Windows Store.**

If you are using Windows, **double-click on the .STL file** you just created. The 3D Viewer should open.

You have to play with this! Try different **Themes**. **Rotate the light** source. Select a **Quick Animation**.

Yell **"Wow this is neat!"**