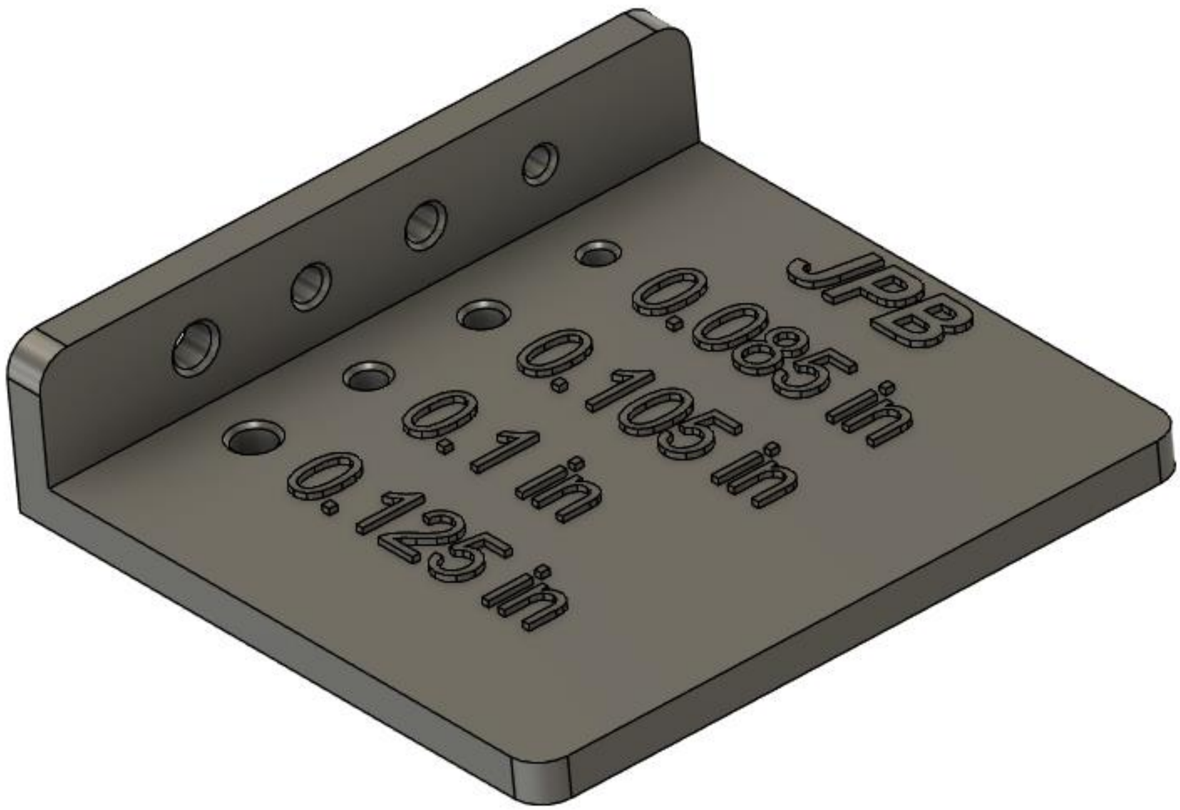
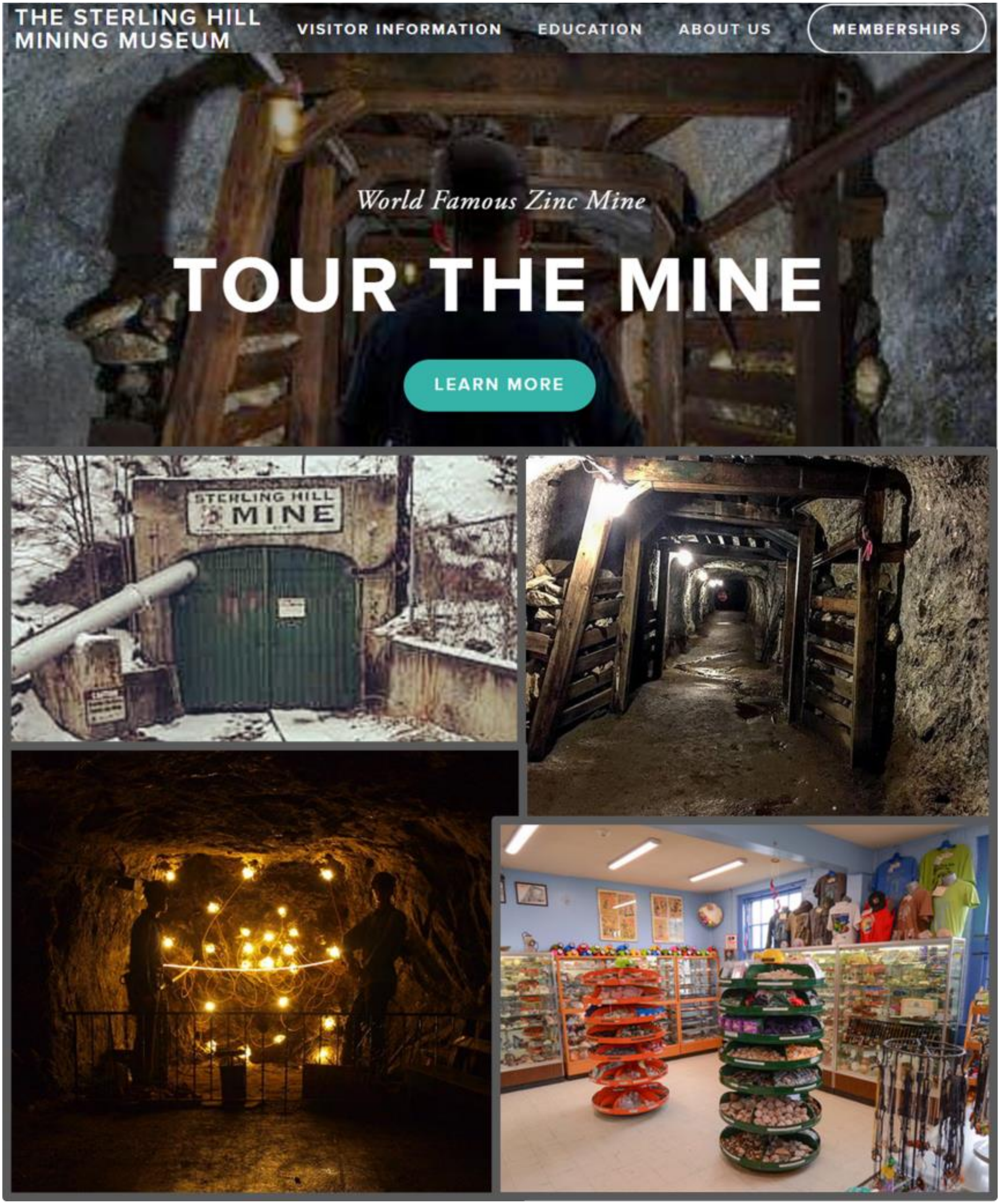
Make some nice holes.



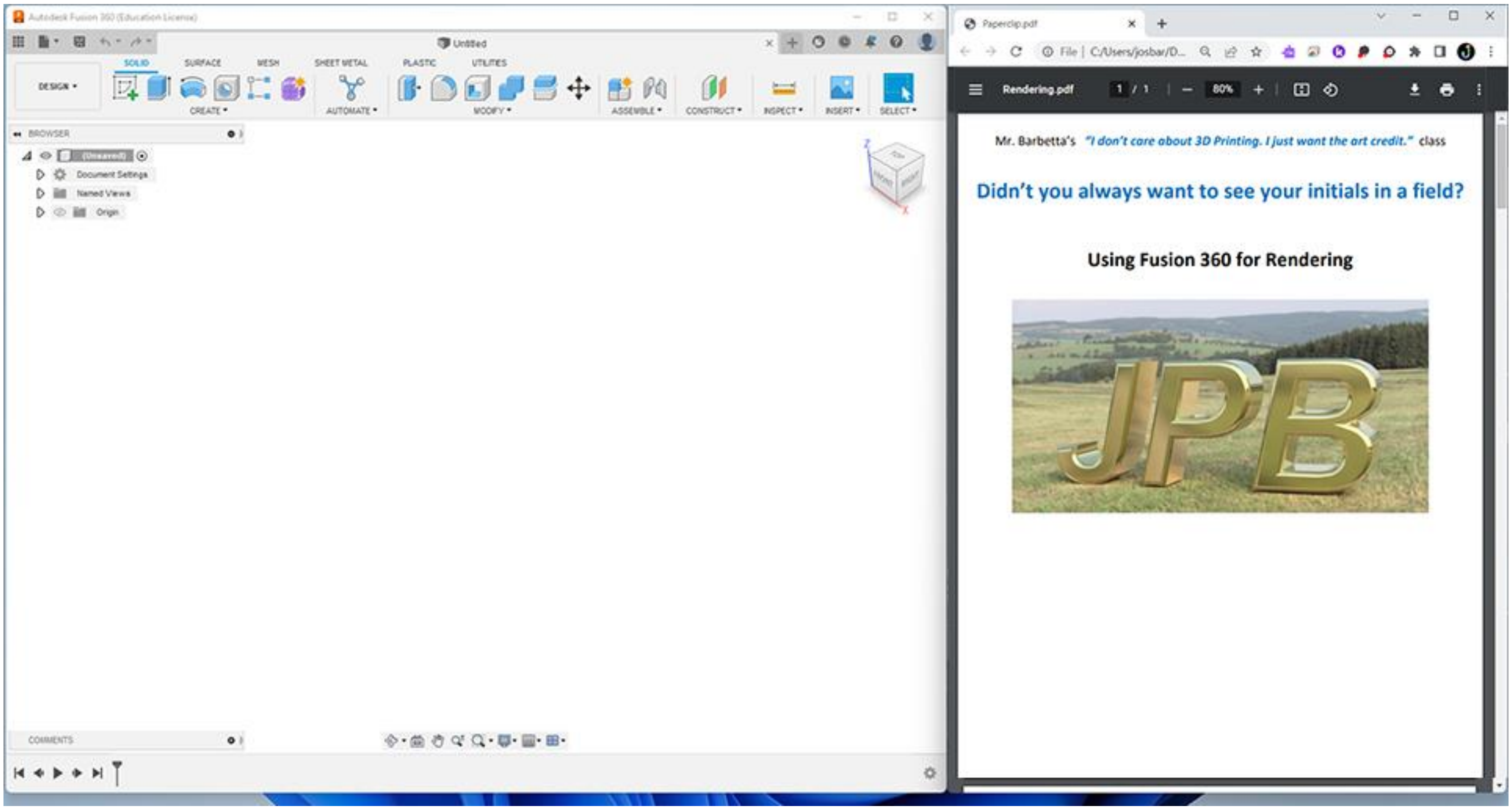
Today's lesson is sponsored by The Sterling Hill Mining Museum.



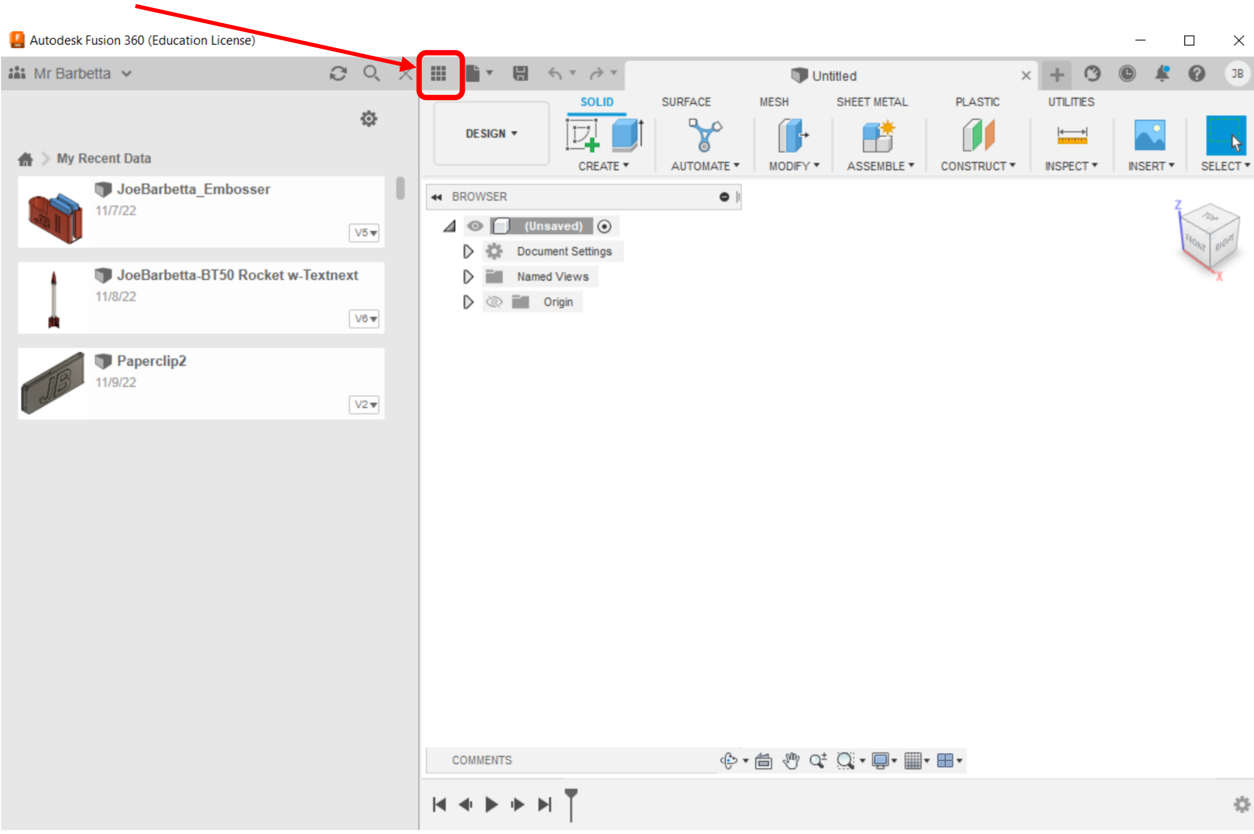
Contents

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%.



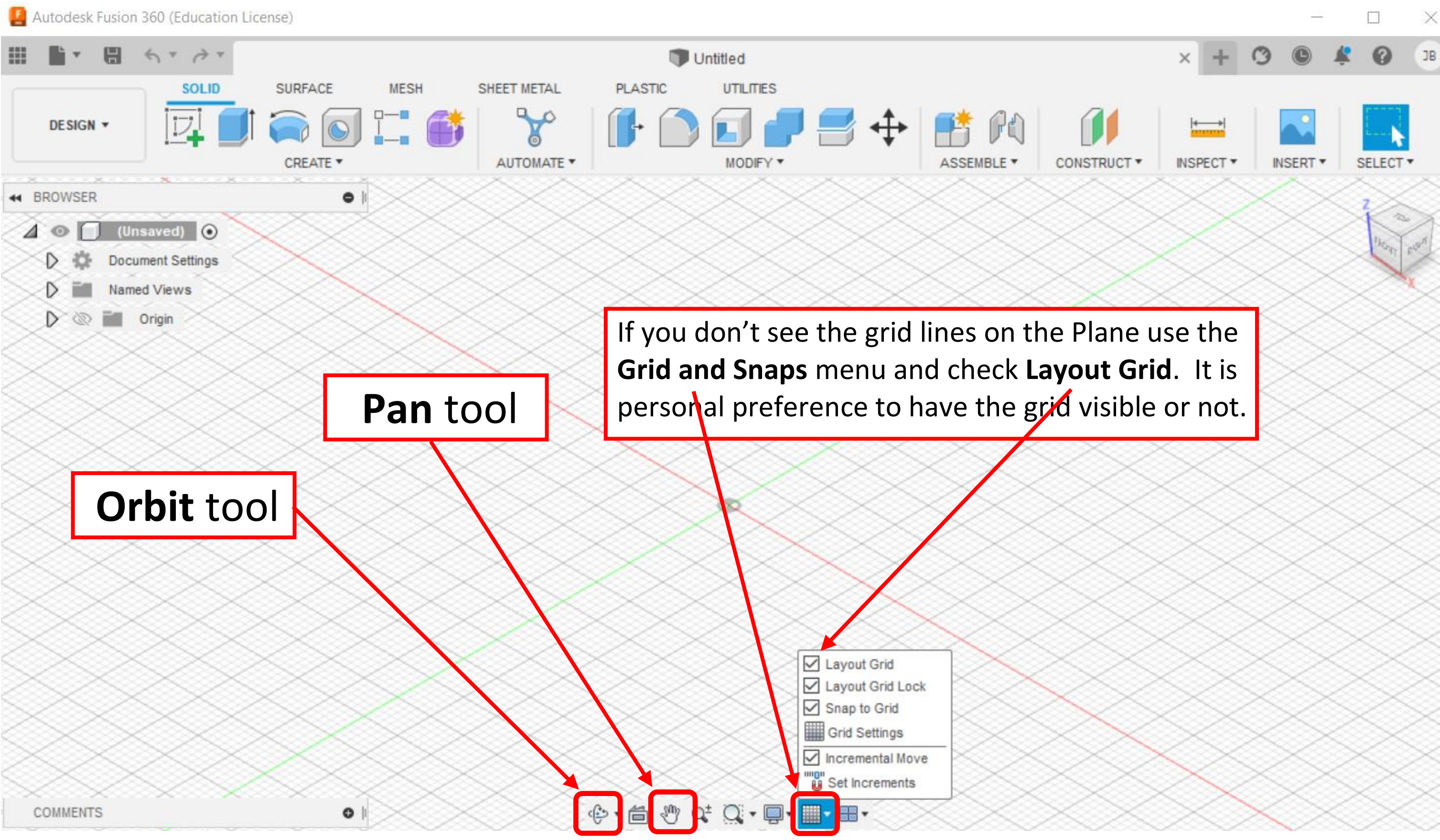
The Fusion 360 window will not allow its width to be reduced much so for smaller computer screens a trick is to click on the **Data Panel icon** and then move the window to the left with the Data Panel off the screen.



Changing the View of a Design

- 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.

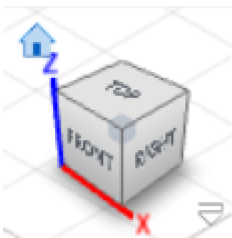


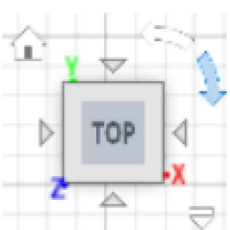
Here is a close-up of the View Cube at the top right of the window.

- 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





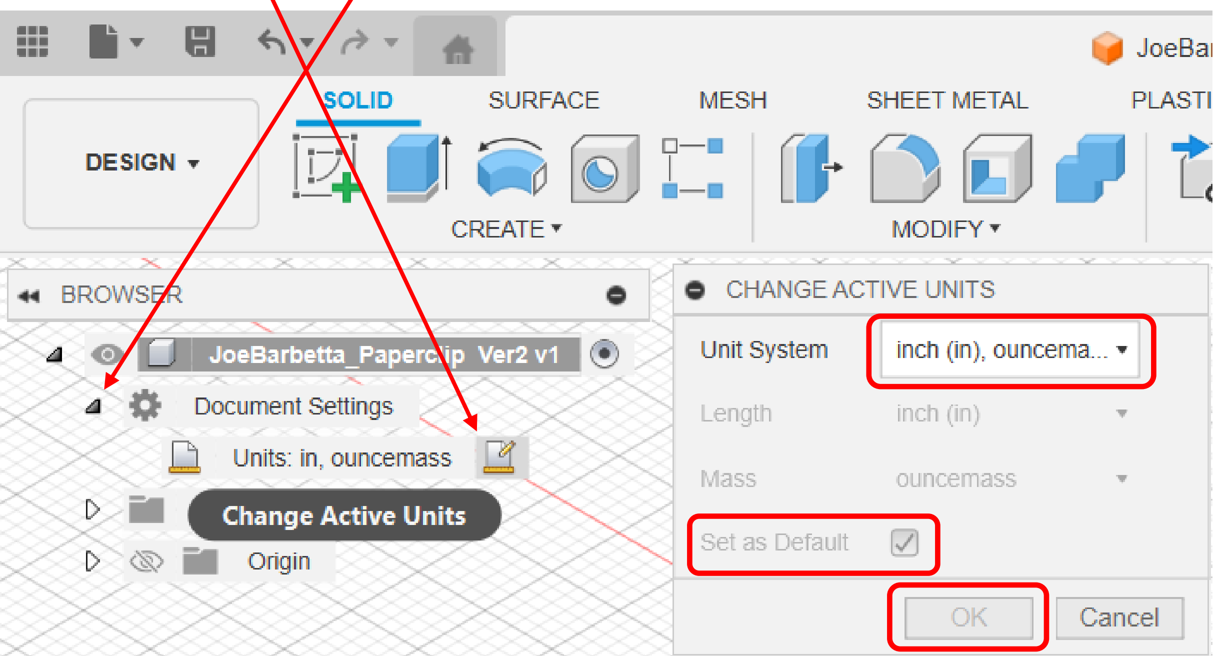
Starting a Design in Fusion (START HERE)

- 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 **_HoleGauge** e.g. **JoeBarbetta_HoleGauge** (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.

Why create a hole gauge?

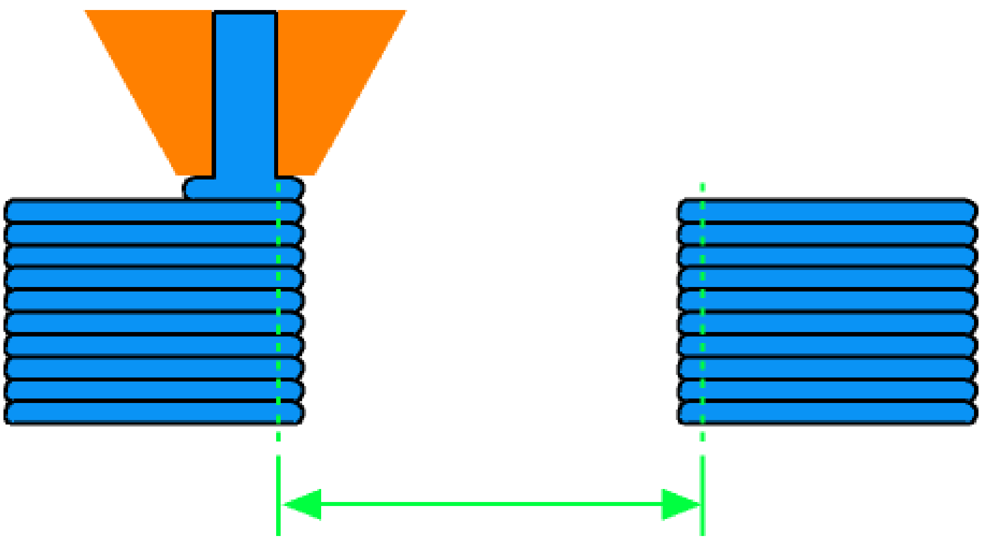
Whenever there are critical dimensions in a design for 3D printing, test prints should be done.

Imagine printing a component that takes hours to print and uses considerable plastic and then finding it must be scrapped because it doesn't fit with other components. There may be holes to accommodate screws, shafts, or other round components. To save time and plastic, a test print should be performed that uses the least amount of plastic to verify these critical dimensions. Dimensions can then be corrected in CAD before performing the final print.

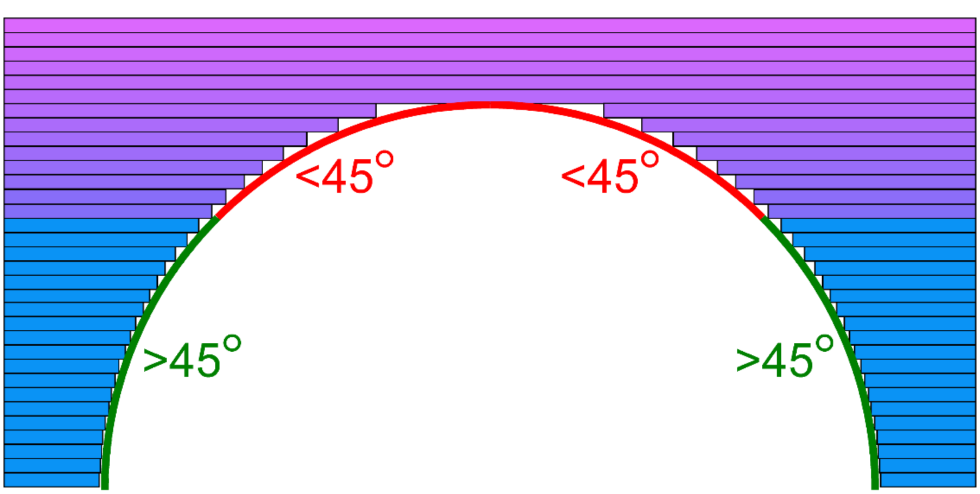
Note that there are settings in slicer programs, such as Ultimaker Cura, that can make some corrections. One such setting is **Horizontal Expansion**, however this will only help for vertical holes. It can also be argued that for **DFM (Design For Manufacturing)** considerations, the actual design should be adjusted to prevent errors due to invalid slicer options. For example, one may forget to adjust these slicer settings before performing the print, or they may be set and then applied to a future print, for which the settings are not appropriate.

See the following two sections at the end of this docuemnt for more information on holes and screw components.
"How holes can be made really accurate"
"McMaster-Carr screws for 3D printed components"

Below are illustrations of the mechanisms that can responsible for vertical and horizontal holes. The resulting dimensional errors can vary between printers and can also be influenced by variations in filament, ambient temperature, and slicer settings. Thus, one can appreciate the importatance of performing text prints.



For vertical holes, one mechanism that can be responsible for holes being printed smaller than specified, is the bulging of the plastic upon leaving the nozzle.

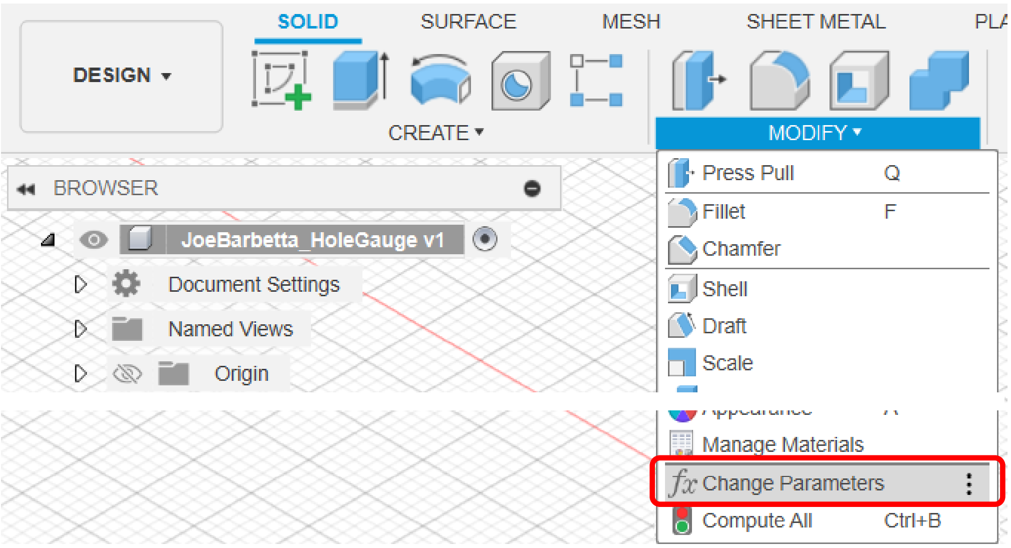


For horizontal holes, the top section of the hole has walls that violate the 45 degree rule. The top layers will "fall in" slightly, thus reducing the diameter when measured vertically.

Parametric Modelling

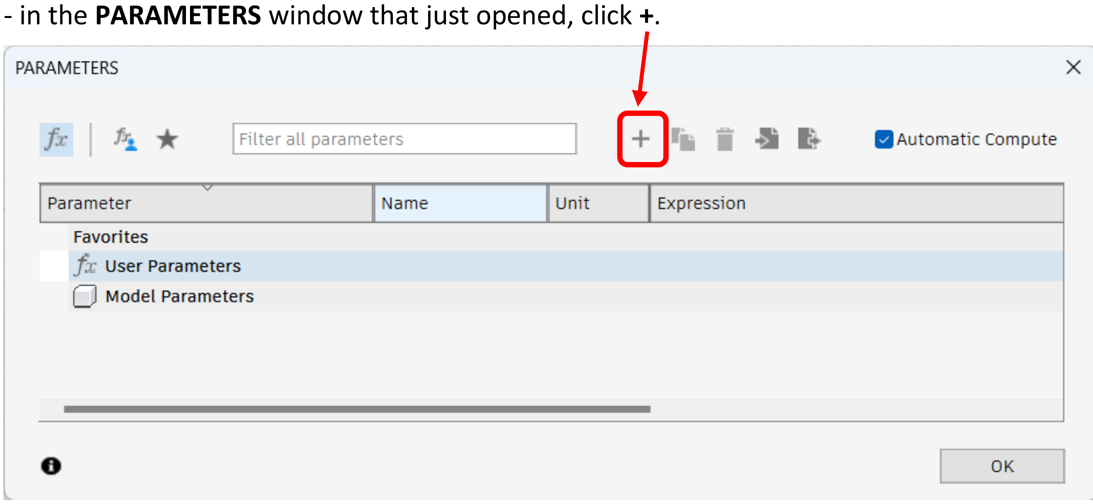
"Parametric Modelling" is a powerful feature, wherein variables can be created, which can then be used for dimensions. One can later change values using this window to make adjustments to a design. We will set a parameters for the Hole Diameters and other parameters to make it easier to accommodate other hole tests.

- from the **MODIFY** menu select **Change Parameters**
- If a window about **Parameteric Text** pops up click its **OK** button.

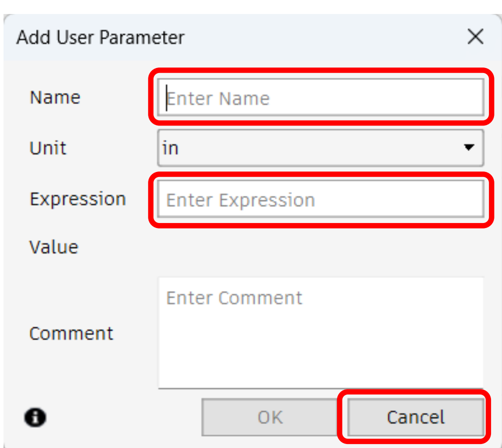


It's all the way at the bottom.

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

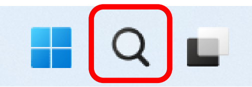


- In the pop-up window one can set the Name, Unit, and Expression. Click Cancel because we will use another method.



- In the lower Windows Task Bar click on the Search icon and enter Notepad in the search text box.

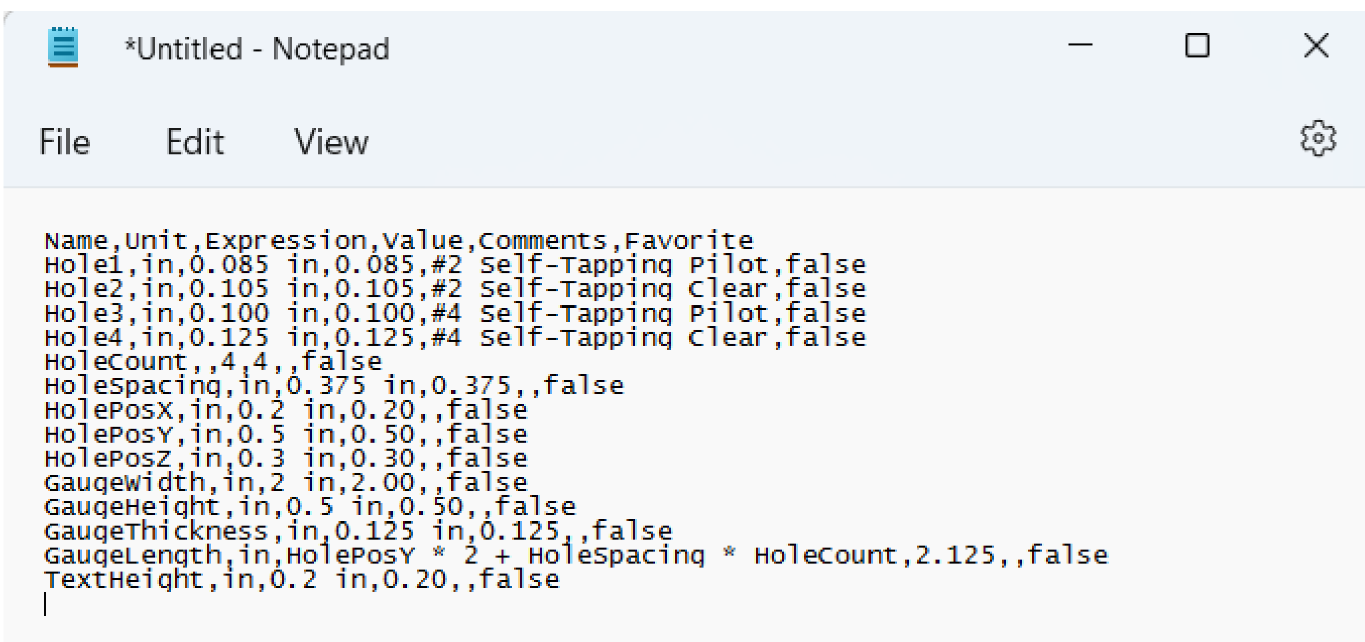
Note that if Notepad cannot be opened or if the following data cannot be copied, the values can be entered individually using the method previously shown. These steps are for using the Import feature.



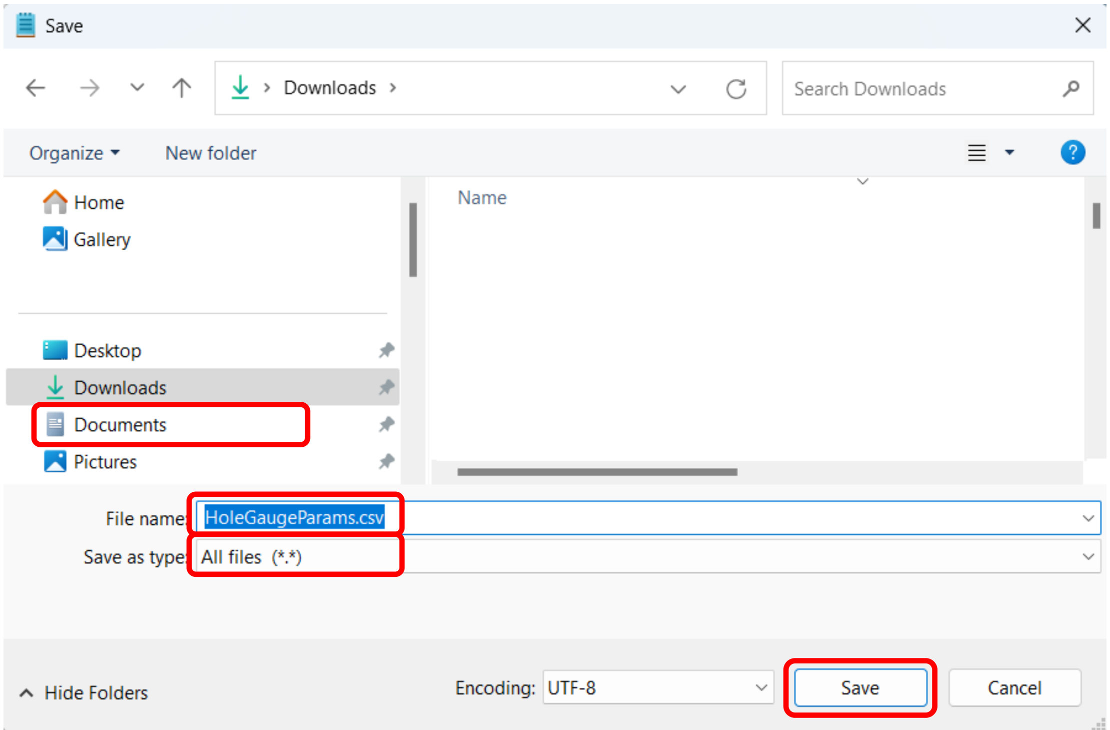
- select all of the text in the below box and right-click and select **Copy**.

```
Name,Unit,Expression,Value,Comments,Favorite
Hole1,in,0.085 in,0.085,#2 Self-Tapping Pilot,false
Hole2,in,0.105 in,0.105,#2 Self-Tapping Clear,false
Hole3,in,0.100 in,0.100,#4 Self-Tapping Pilot,false
Hole4,in,0.125 in,0.125,#4 Self-Tapping Clear,false
HoleCount,,4,4,,false
HoleSpacing,in,0.375 in,0.375,,false
HolePosX,in,0.2 in,0.20,,false
HolePosY,in,0.5 in,0.50,,false
HolePosZ,in,0.3 in,0.30,,false
GaugeWidth,in,2 in,2.00,,false
GaugeHeight,in,0.5 in,0.50,,false
GaugeThickness,in,0.125 in,0.125,,false
GaugeLength,in,HolePosY * 2 + HoleSpacing *
HoleCount,2.125,,false
TextHeight,in,0.2 in,0.20,,false
```

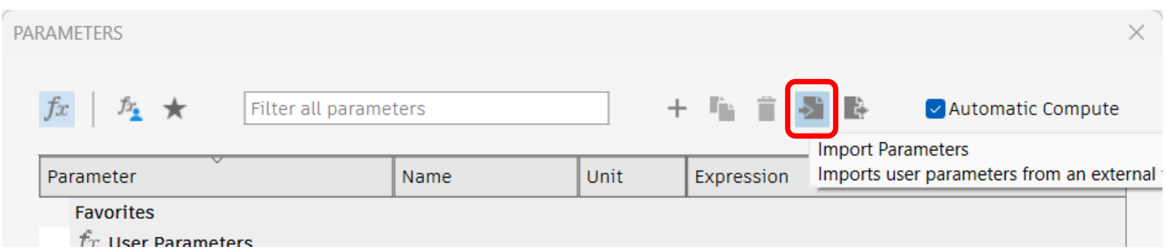
- In Notepad right-click and select **Paste**. Alternately, one can press **ctrl** and the **v** keys.



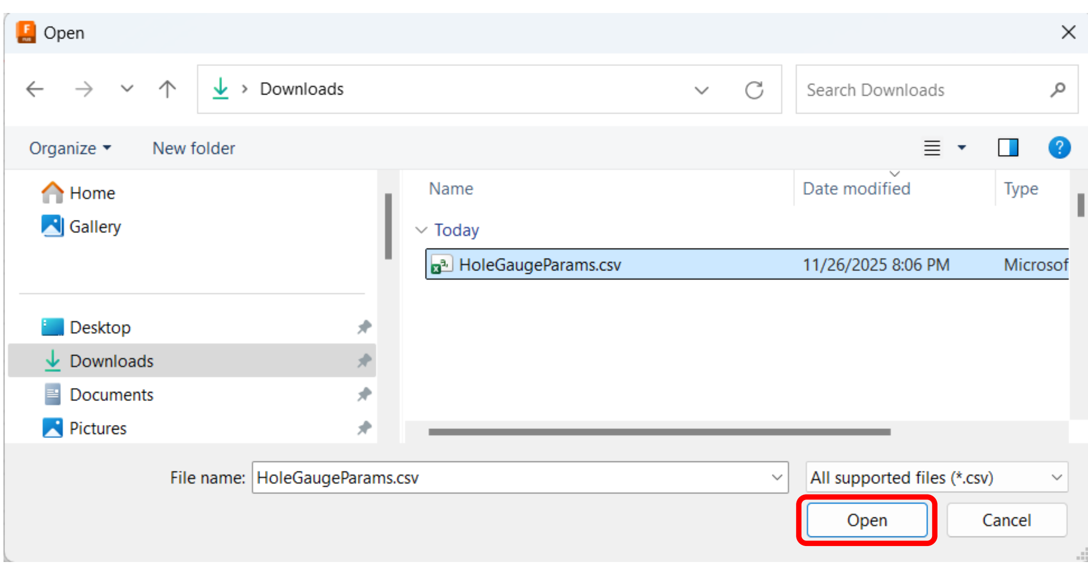
- from the **File** menu select **Save**
- select the **Downloads** folder
- change **Save as type** to **All files (*.*)**
- change the **File Name** to **HoleGaugeParams.csv**. csv stands for comma separated values
- click **Save**



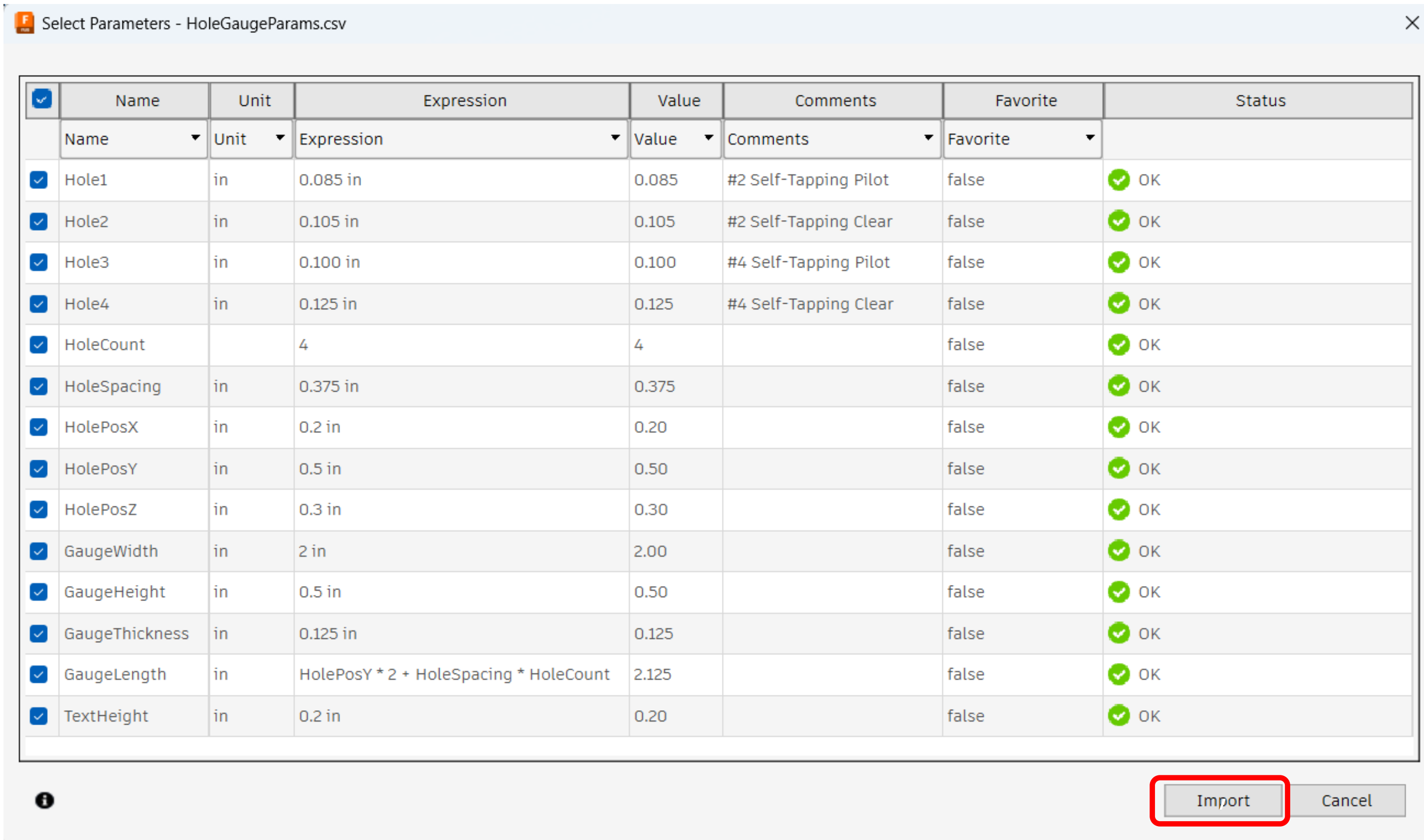
- in the PARAMETERS window click on the **Import Parameters** icon



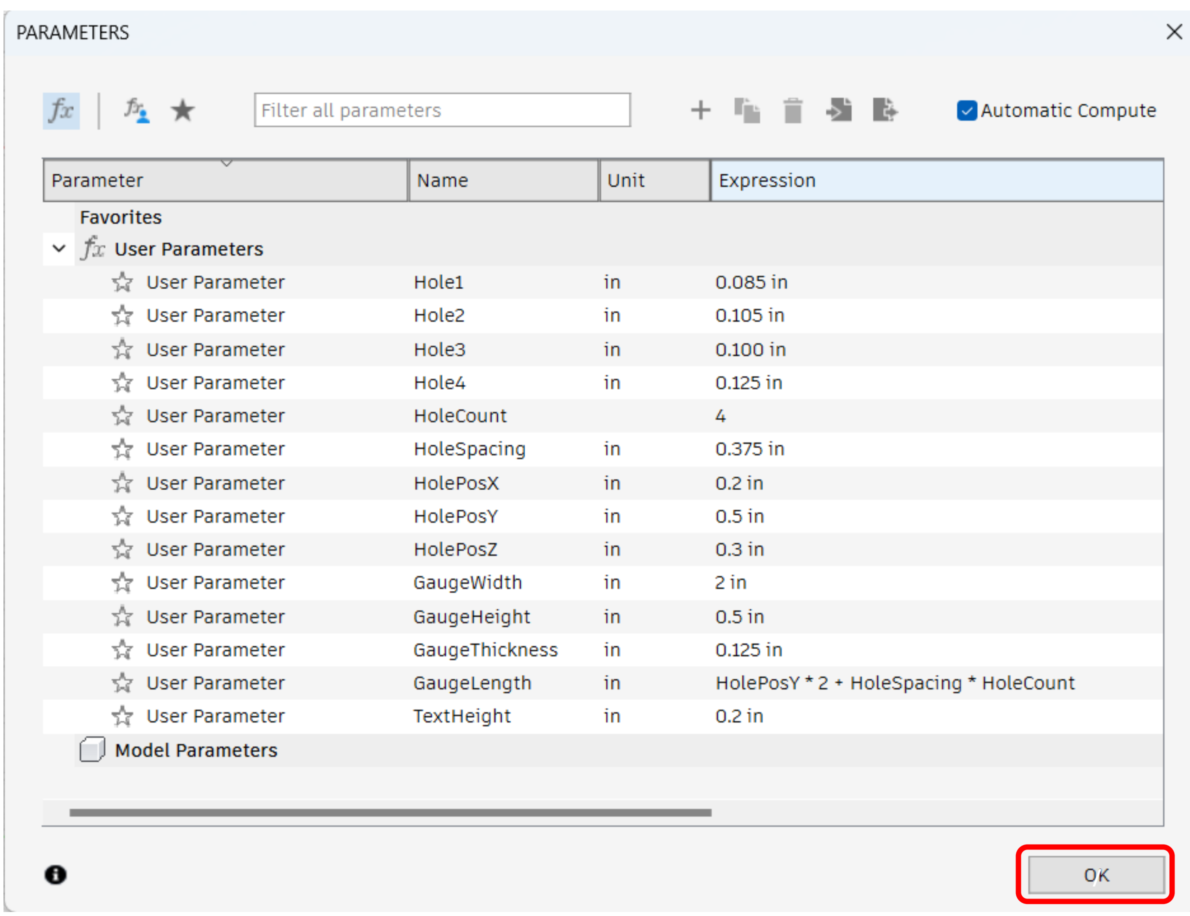
- select the **Downloads** folder and the file from Notepad. Click **Open**.



A screen will show, which lists all the parameters from the opened file. If Fusion detects any errors, they will be shown.
- click **Import**



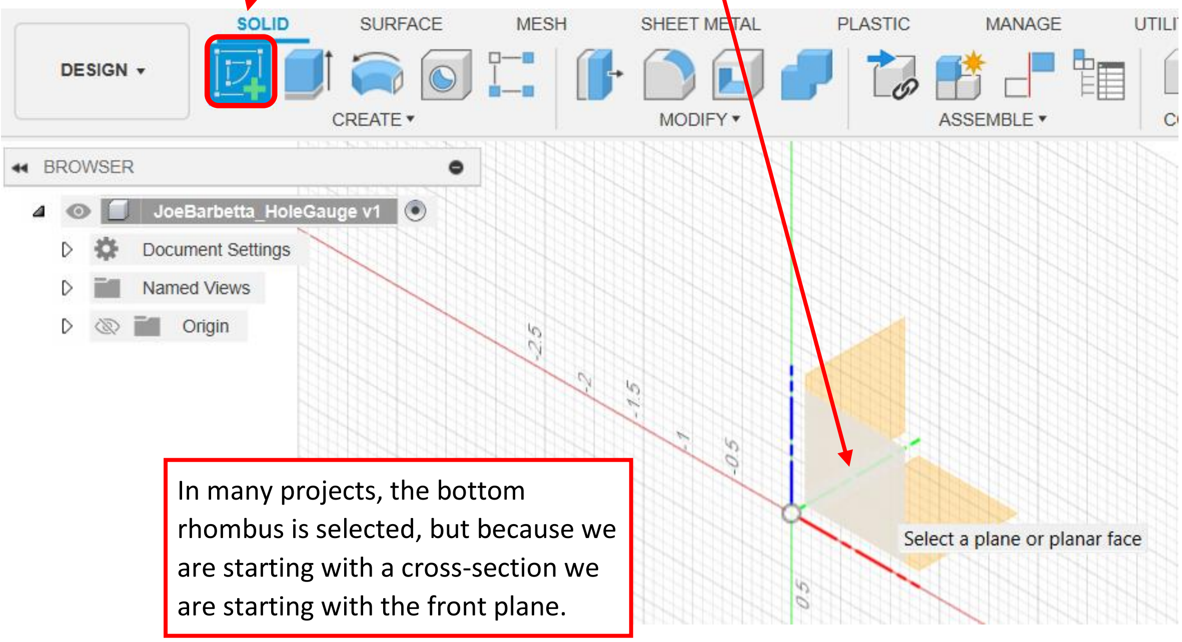
All the parameters should now show here. Click **OK**.



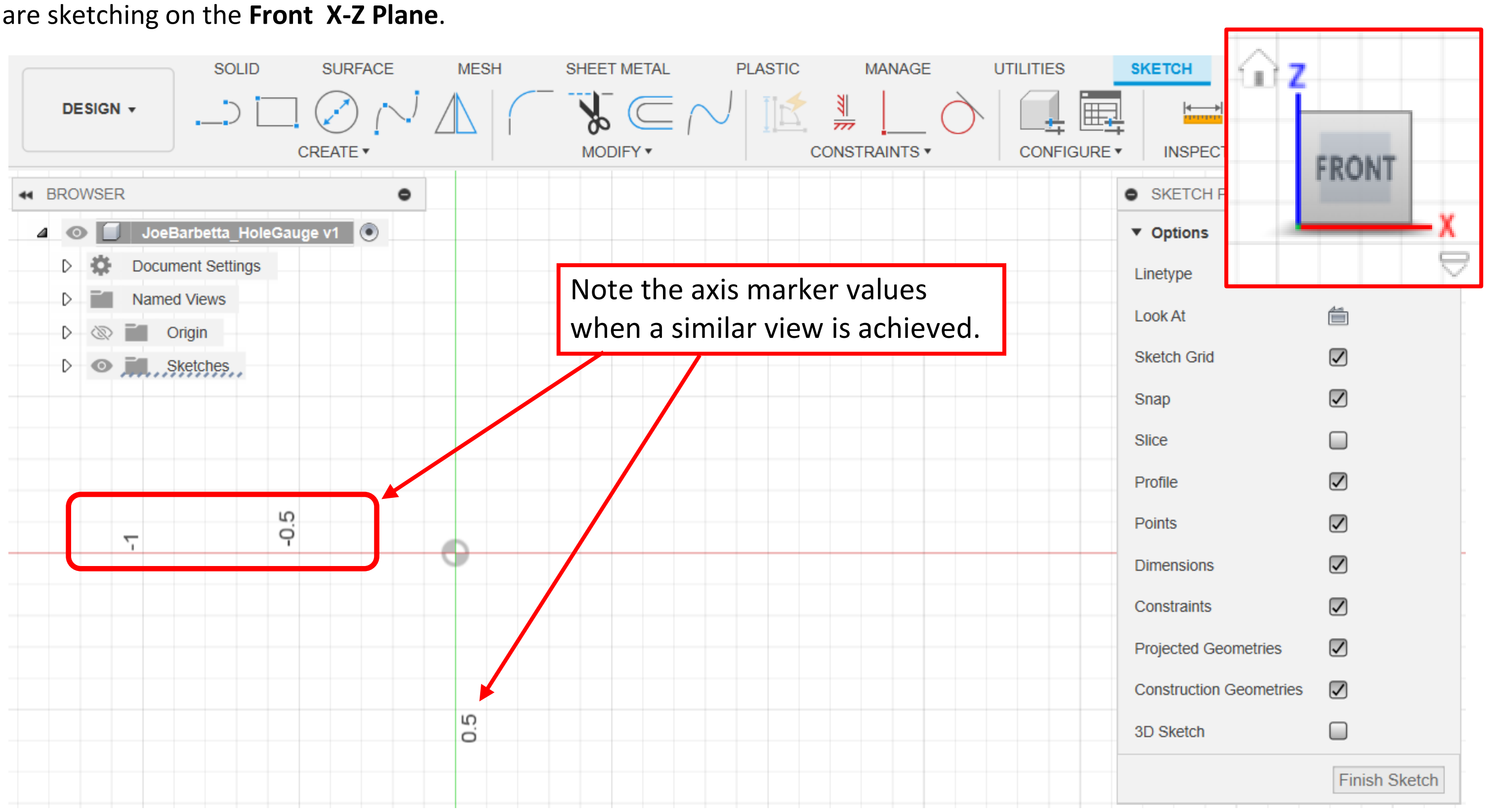
Creating the First Sketch

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

- 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.

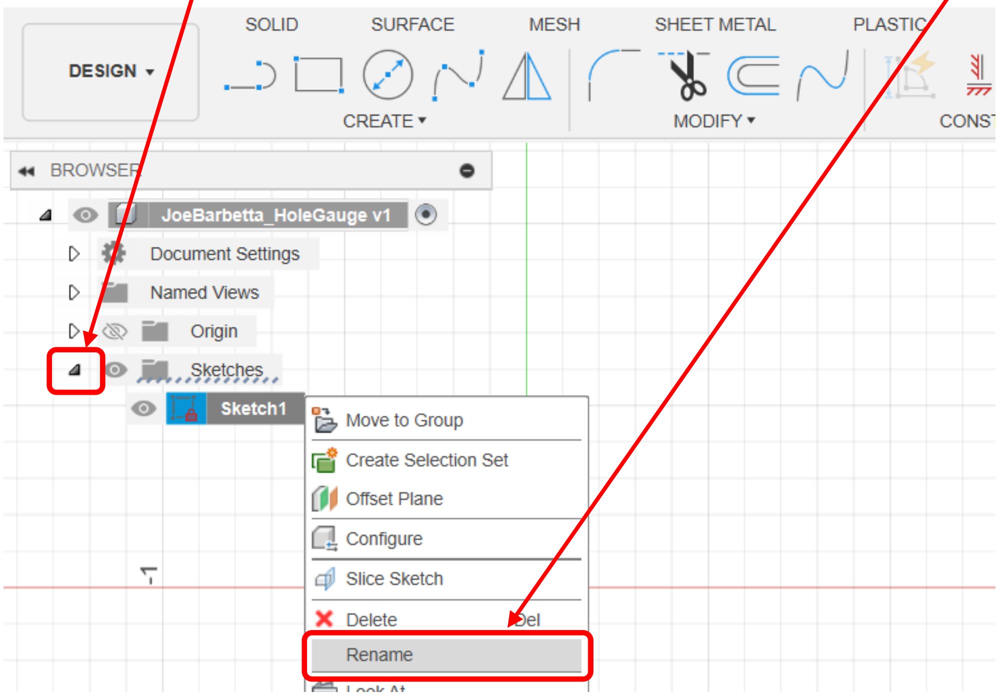


- zoom in as shown below. The scale labels can give an idea of how far one is zoomed in. The **View Cube** should indicate you are sketching on the **Front X-Z Plane**.

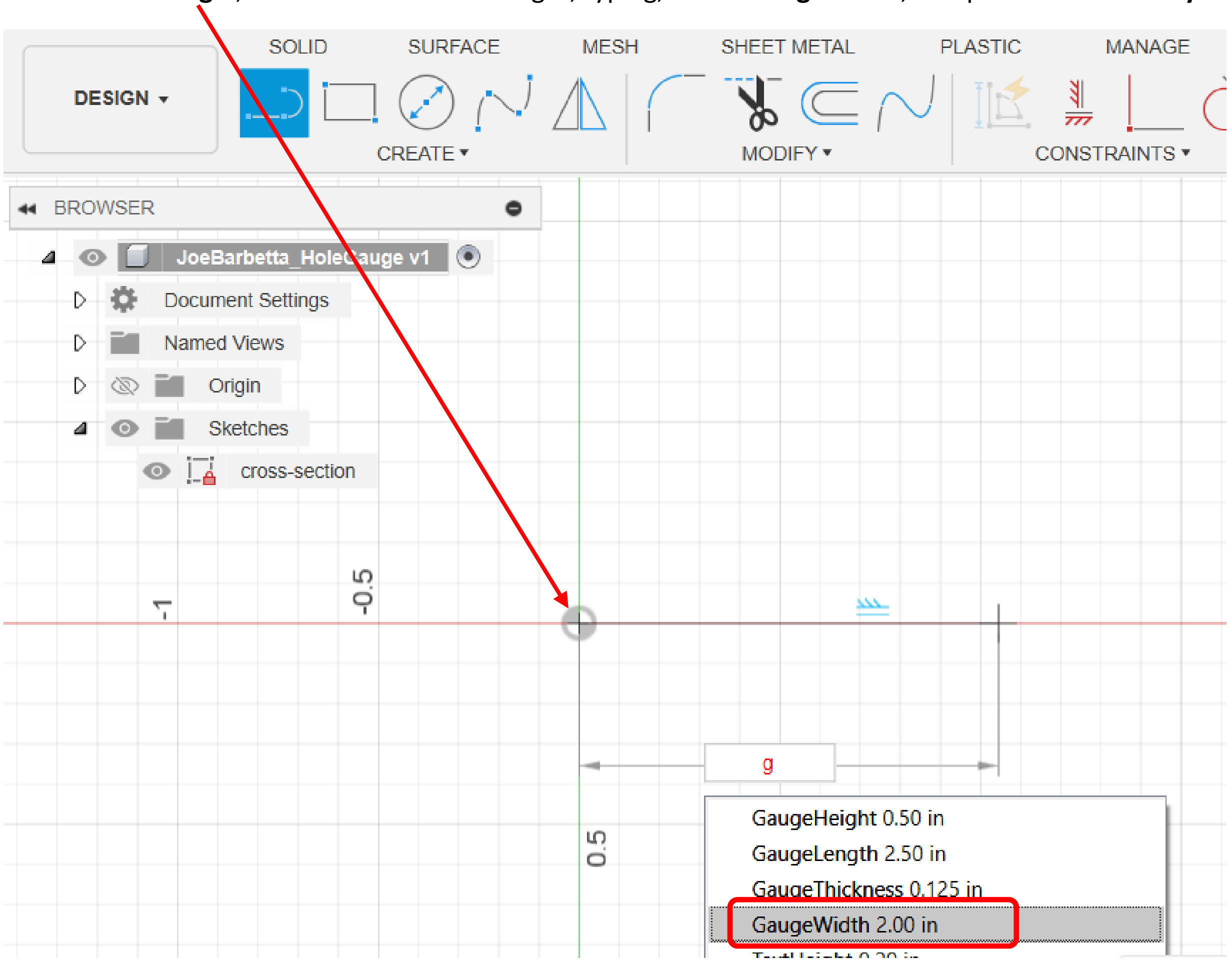


Whenever a new Sketch is created, it should be named.

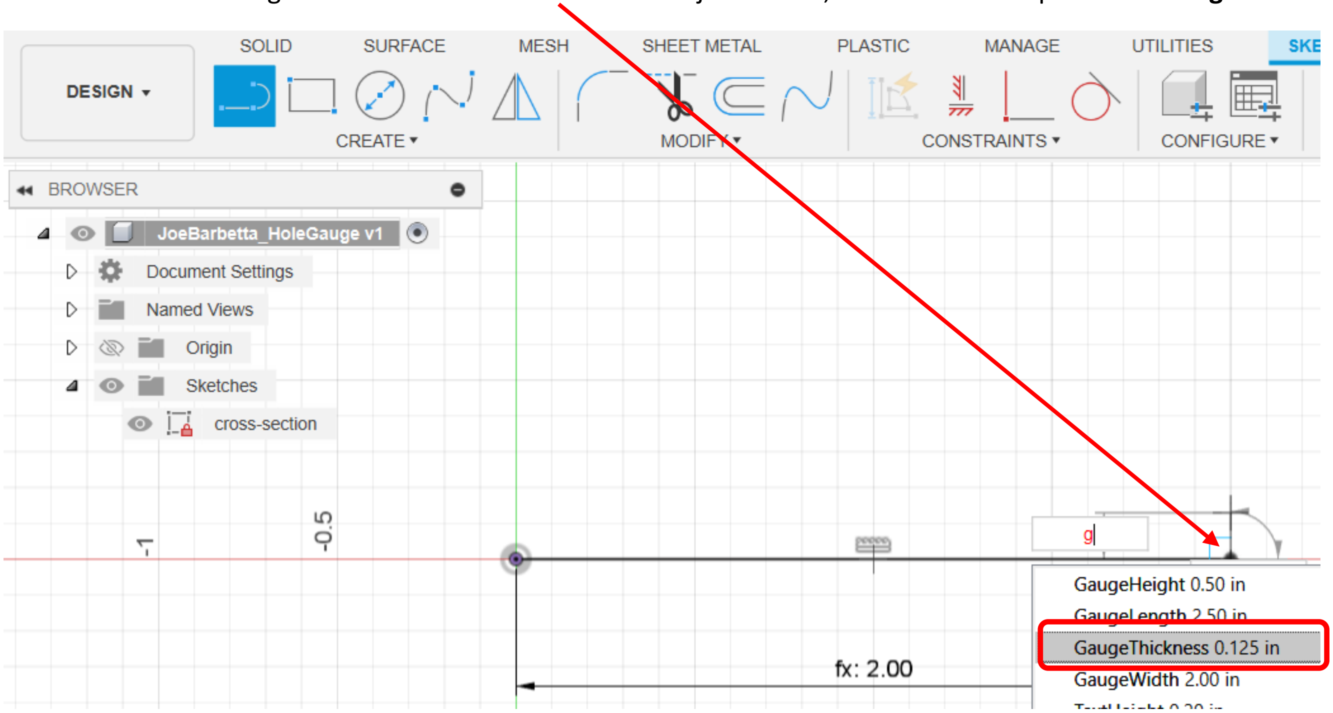
- click on the **arrow** to open the Sketches folder, **right-click** on the default name **Sketch1** and select **Rename**. Change the name to **cross-section**.



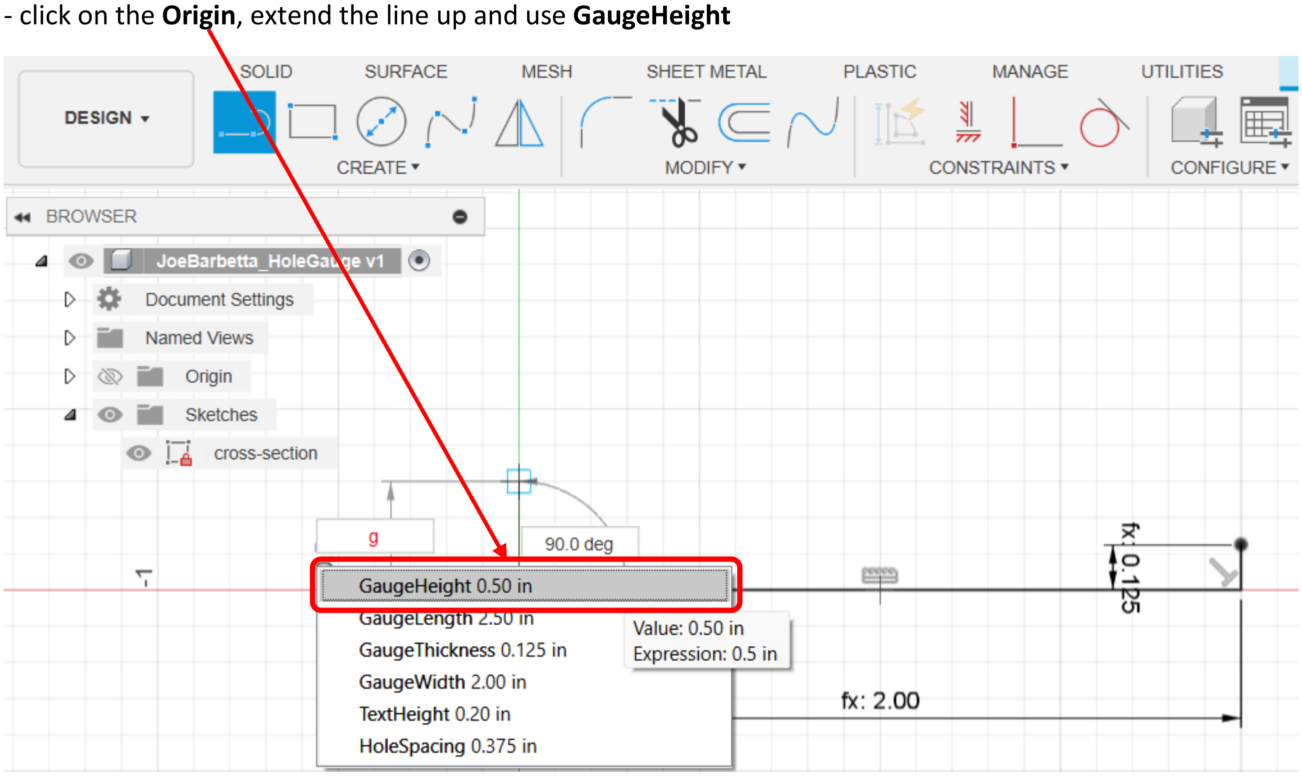
- select the **Line** tool
- click on the **Origin**, extend the line to the right, type g, select **GaugeWidth**, and press the **Enter key**.



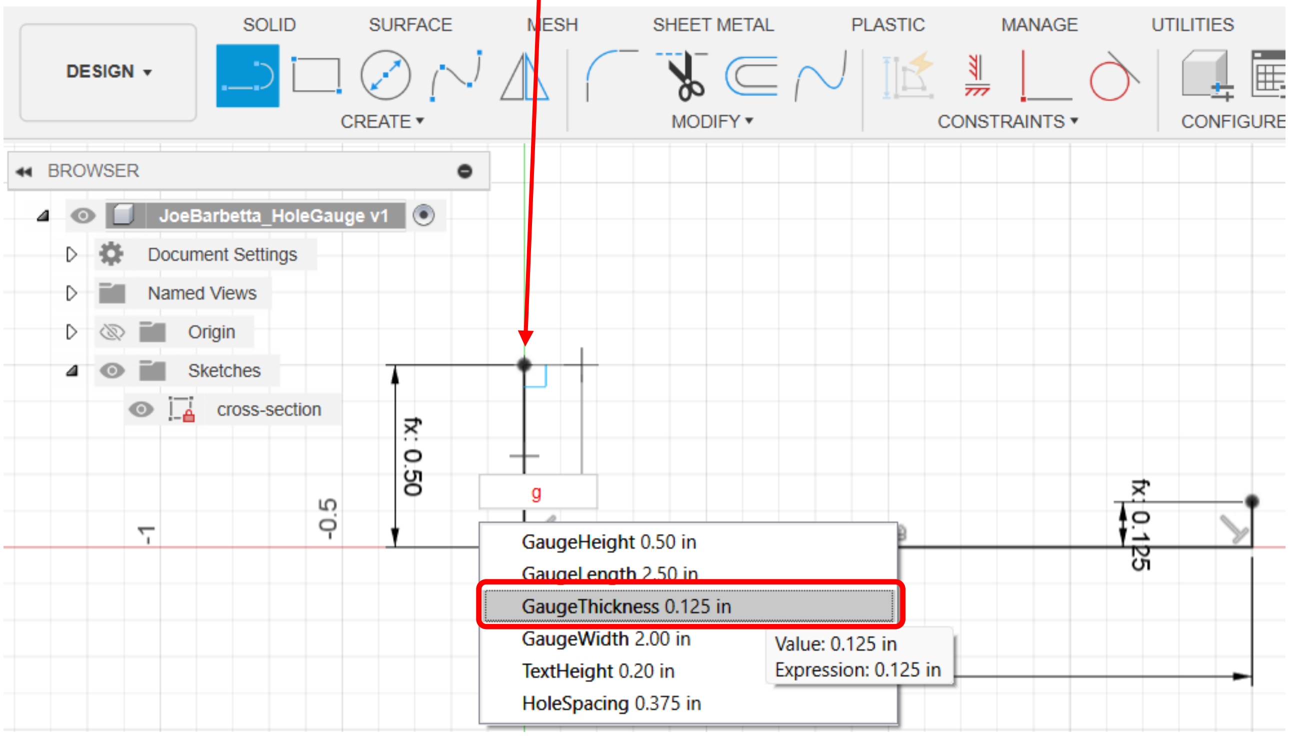
- select the **Line** tool again and click on the end of the line just drawn, extend the line up and use **GaugeThickness**.



- select the **Line** tool again
- click on the **Origin**, extend the line up and use **GaugeHeight**

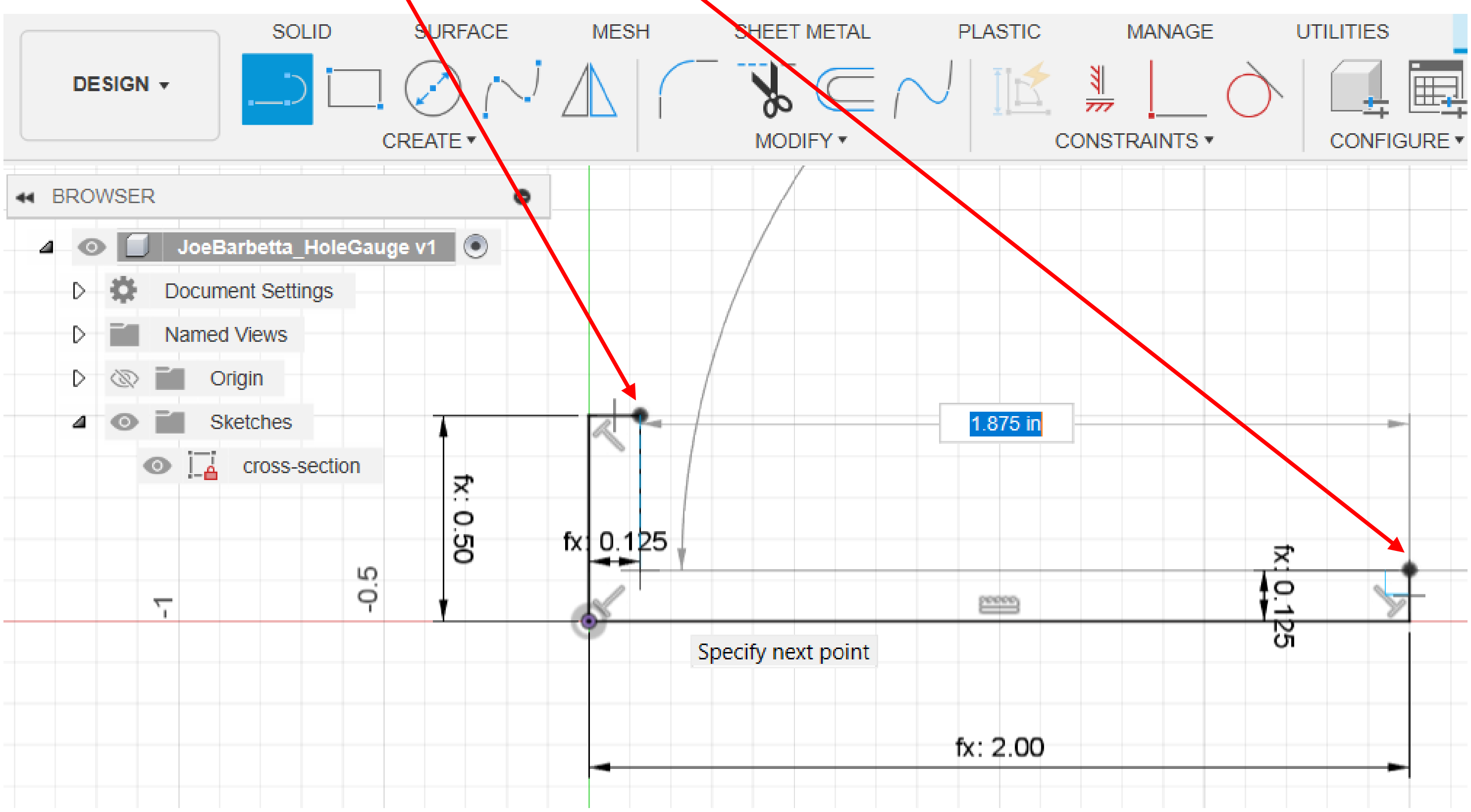


- select the **Line** tool again and click on the end of the line just drawn, extend the line to the right and use **GaugeThickness**.

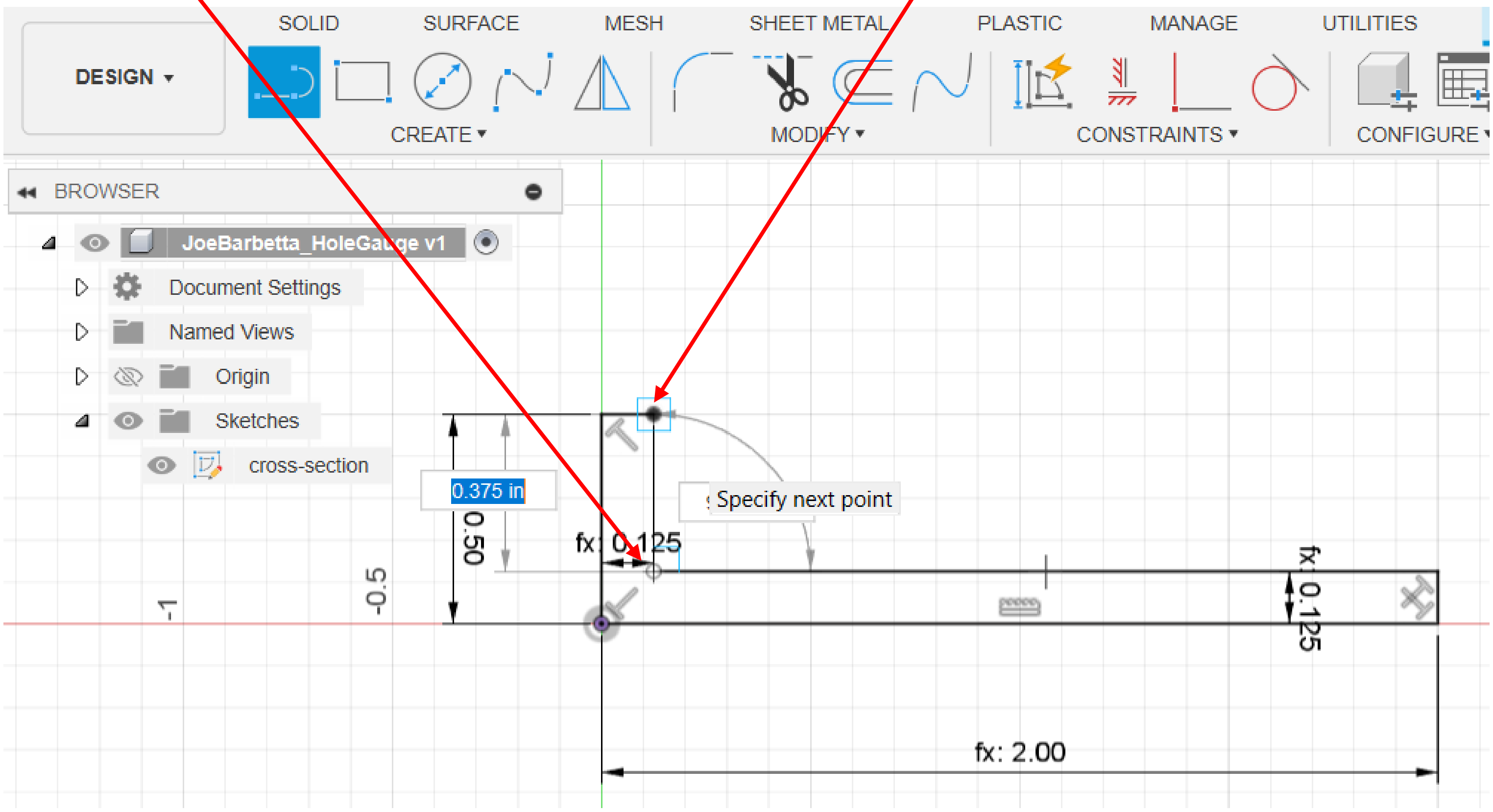


This next step is a little tricky.

- select the **Line** tool again and click on the top end of the right side vertical line
- drag the other end to the 2nd point indicated by the arrow, but don't click.
- drag this end downward and it should snap into a point where it is horizontal and aligned with the point above it.
- press the **Enter** key and the line should be complete. The 1.875 should disappear.



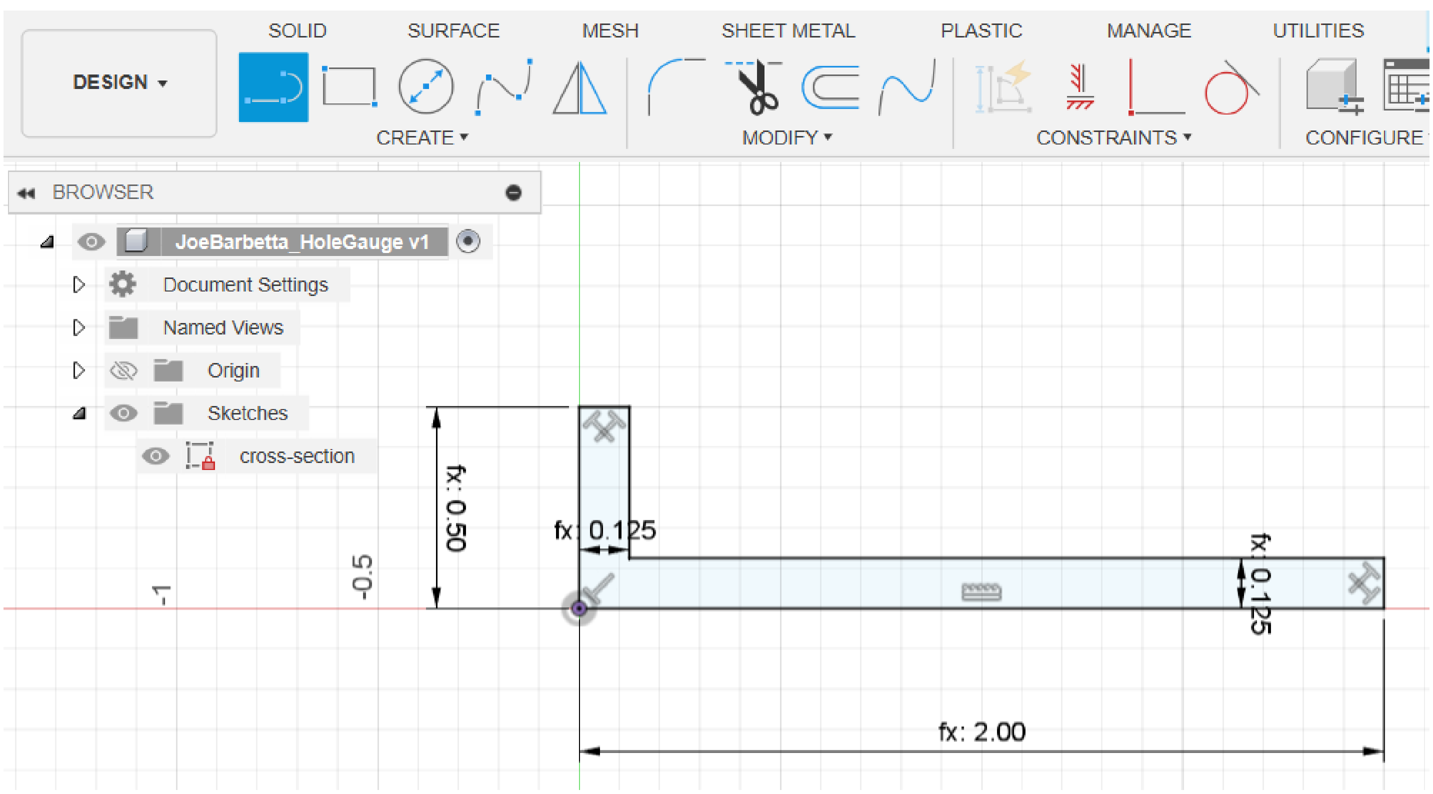
- select the **Line** tool again
- click on the **end** of the line just draw, **extend the line up**, and click on the **point above it**



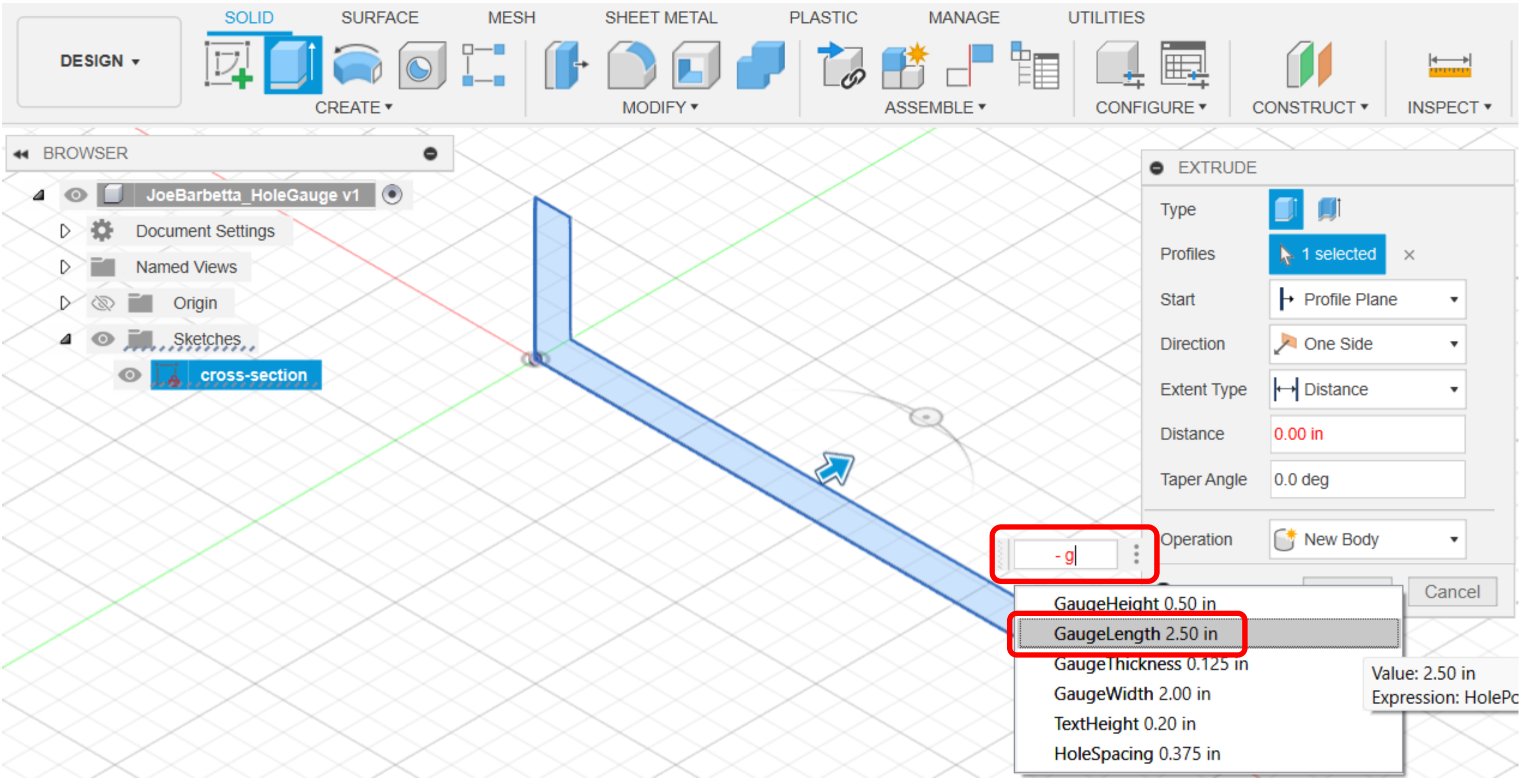
- yell "**I'm tired of using the line tool**"

You are done using the Line tool (for now). The thinned dimension lines may be in different places. You only care about the thicker lines. The profile should be filled in with light blue indicating that it is a closed shape.

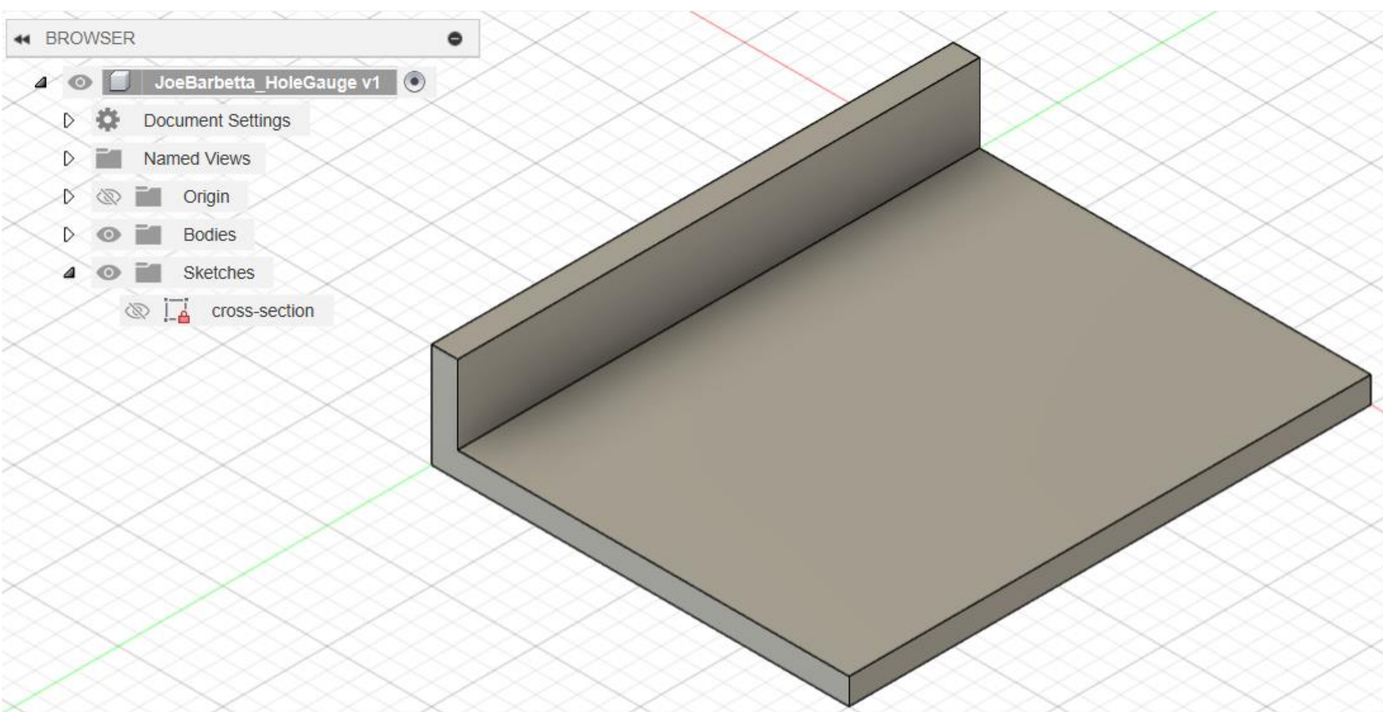
- click **Finish Sketch**



- click on the **Home icon** at the **View Cube**
- select the **Extrude** tool
- in the pop-up box type a **minus sign** and **g**, select **GaugeLength,** and click **OK**.



The profile will be extruded towards the bottom left. After returning to the Home view, it should look like that below.

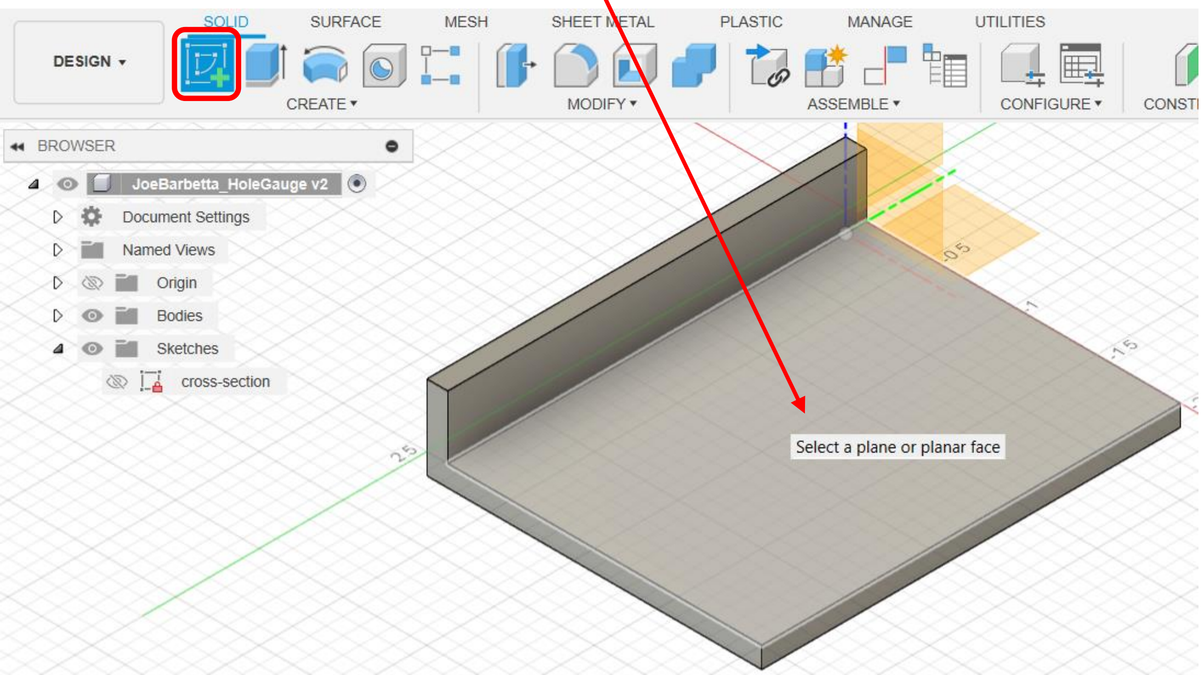


Using Construction Lines to position holes and text

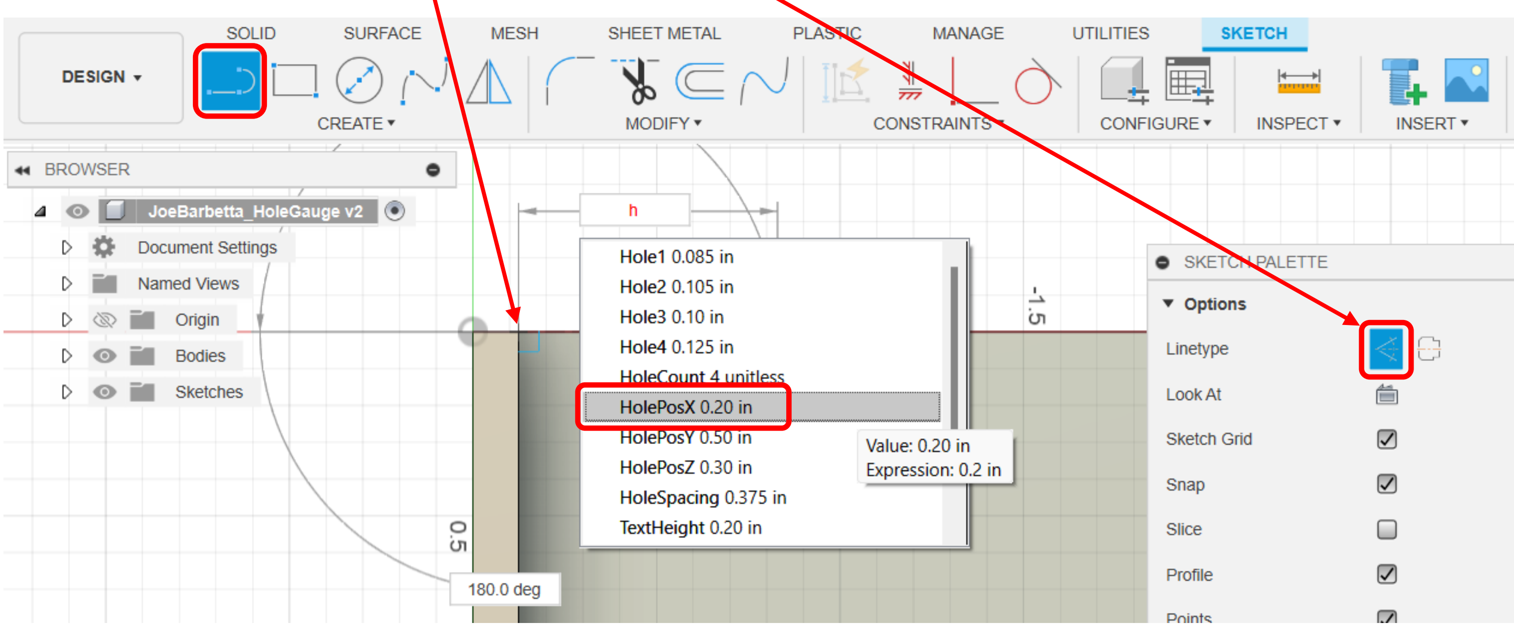
Construction lines are those created in CAD to define positions. The do not represent actual edges and profiles created by them cannot be extruded. They are commonly created with a dashed style.

With Fusion, an annoyance can be forgetting to turn off the Construction line style when creating normal lines. It is a good practice to disable the Construction line style when done creating Construction lines. Note that one can use normal lines for everything. It just looks better to use Construction lines at times.

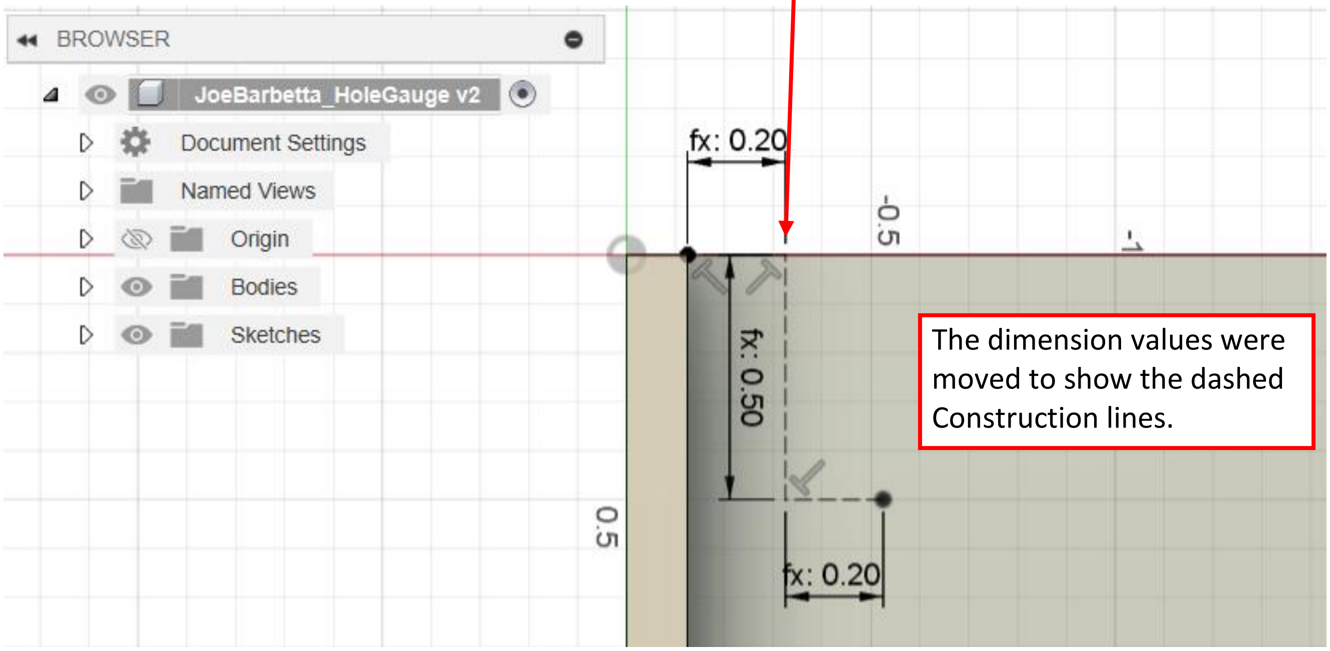
- select the **Create Sketch** tool and click on the surface of the gauge.



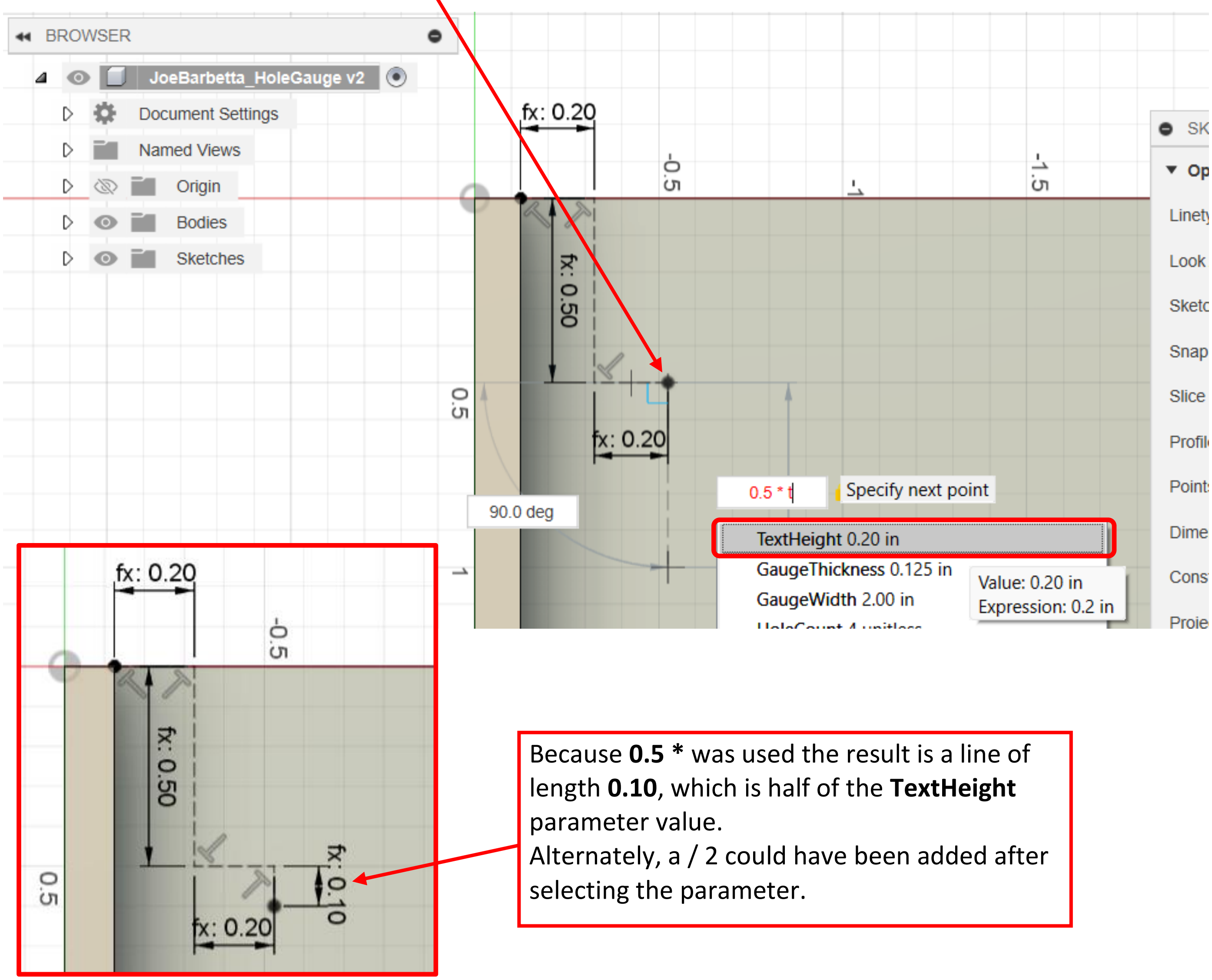
- click on the **Linetype** icon to highlight it to create **Construction** lines
- select the **Line** tool, click on the **corner**, extend the line to the right, type **h**, select **HolePosX**, and press the **Enter key**



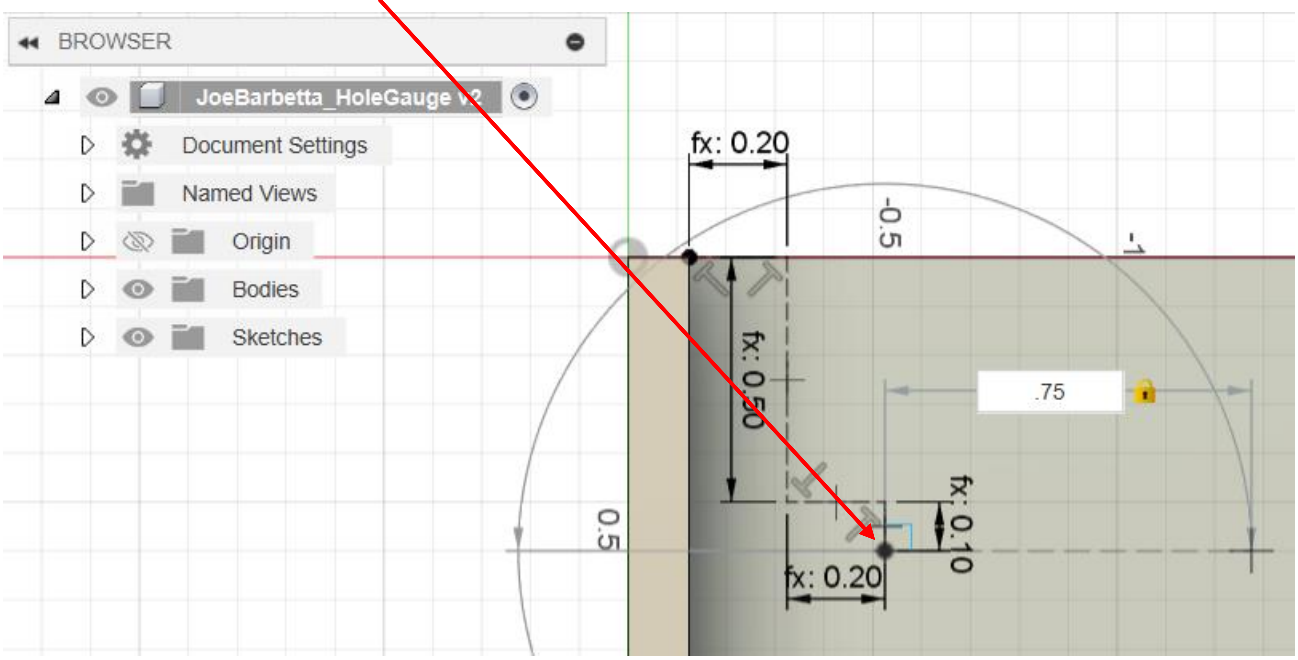
- use the **Line** tool again to create a line downward from the **last point** using **HolePosY**
- do so again to create a line to the right using **HolePosX** (Note that HolePosX is being used a 2nd time).



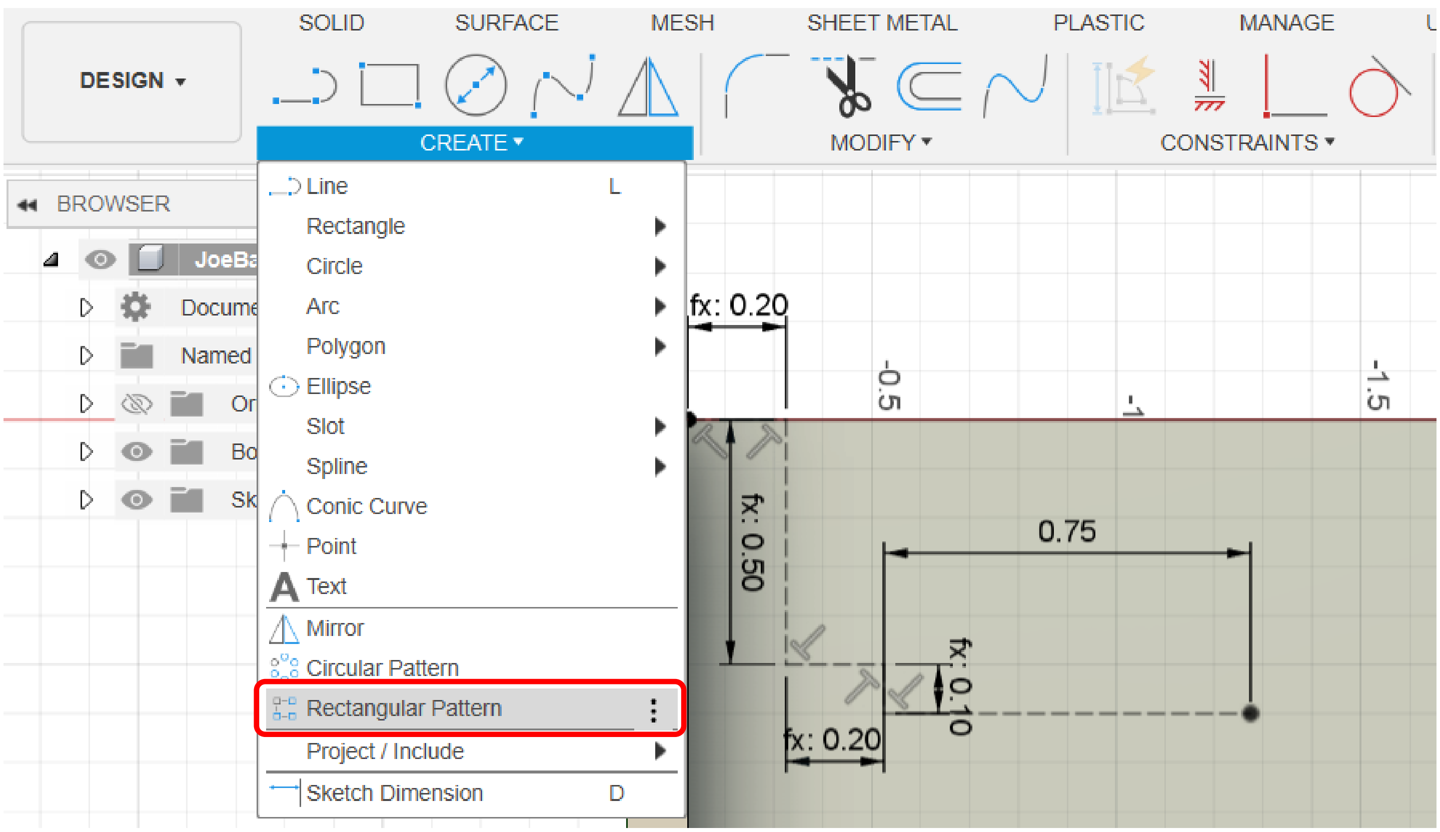
- extend a line **downward** from the **last point**, type **0.5 * t** (note the asteric), select **TextHeight**, and press the **Enter key**



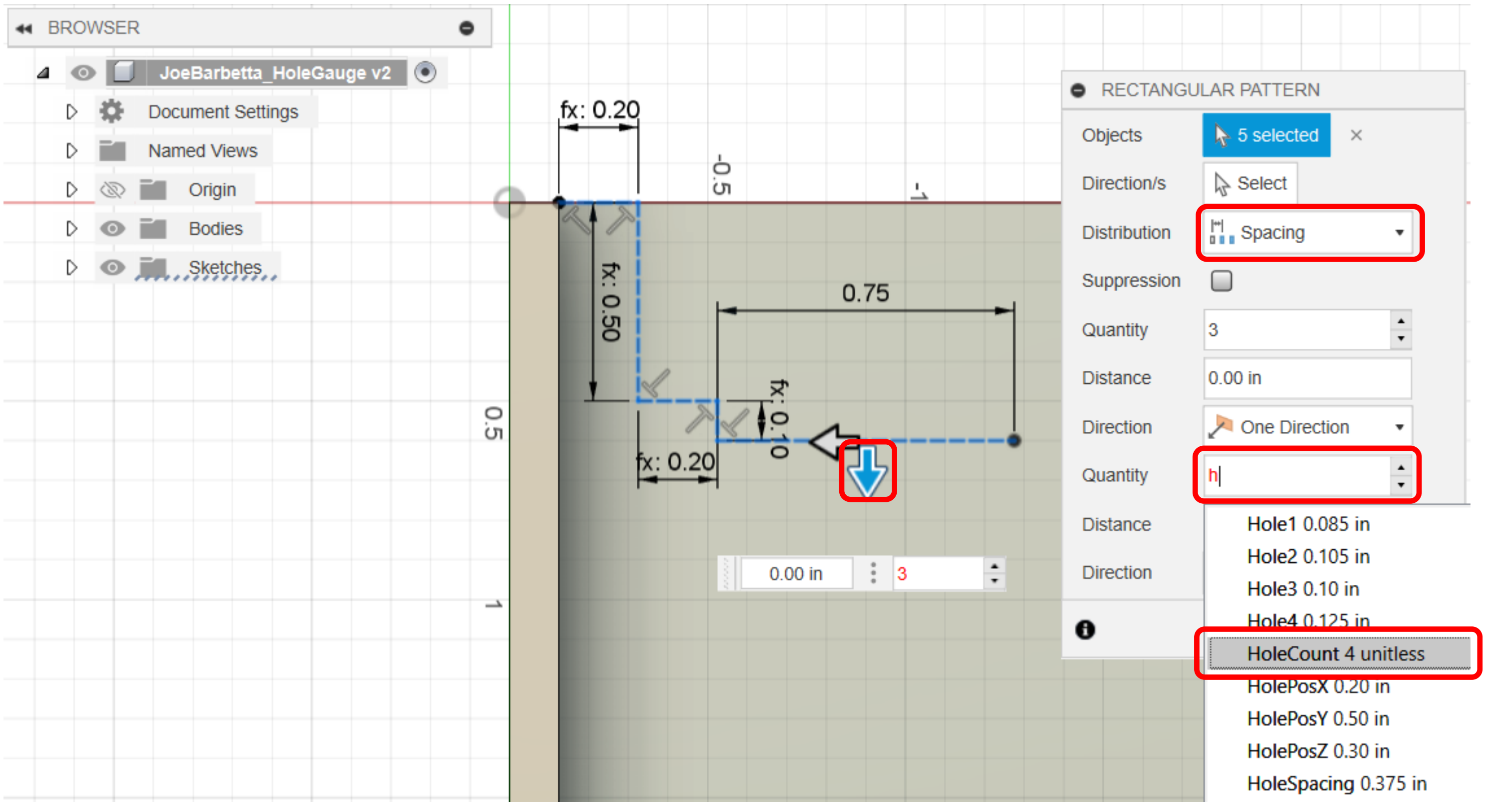
- extend a line from the **last point to the right** and enter **0.75**



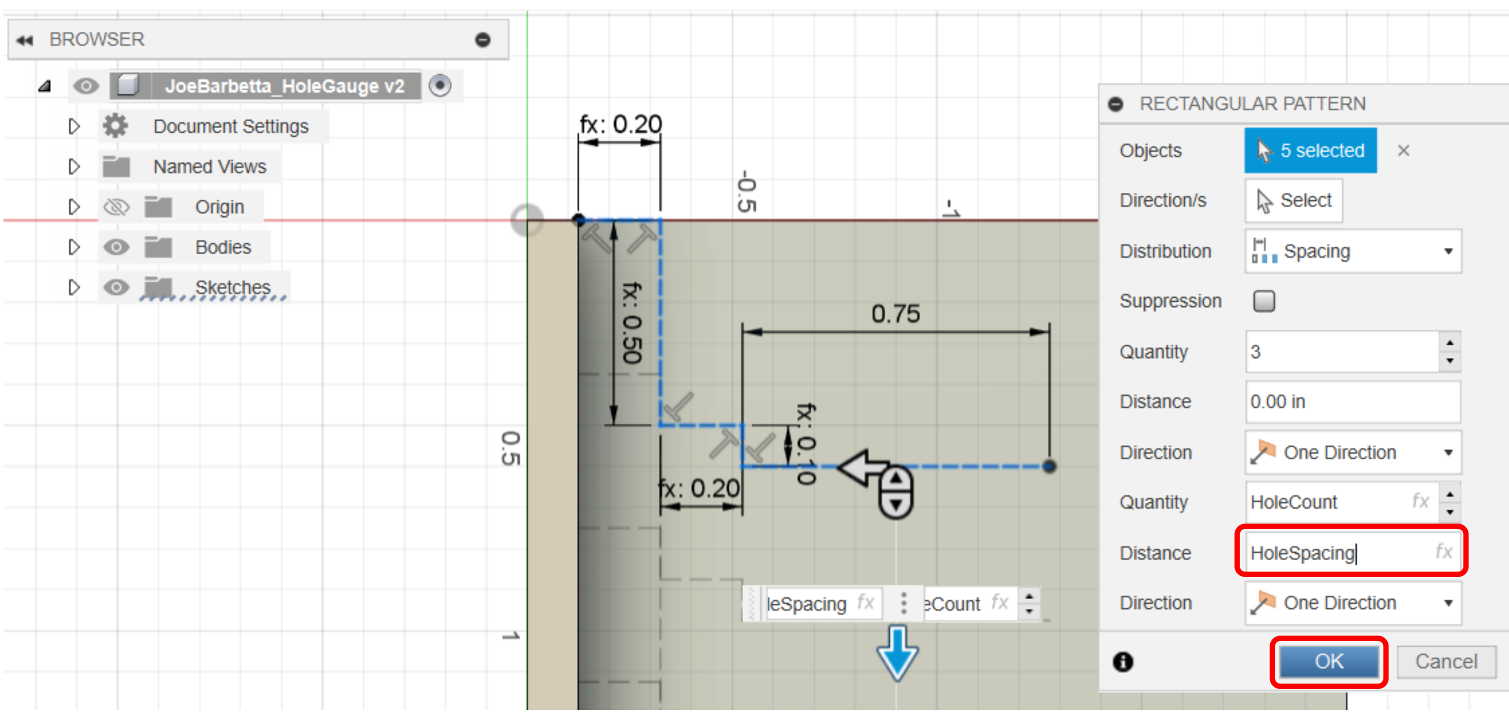
- from the **CREATE** menu select **Rectangular Pattern**



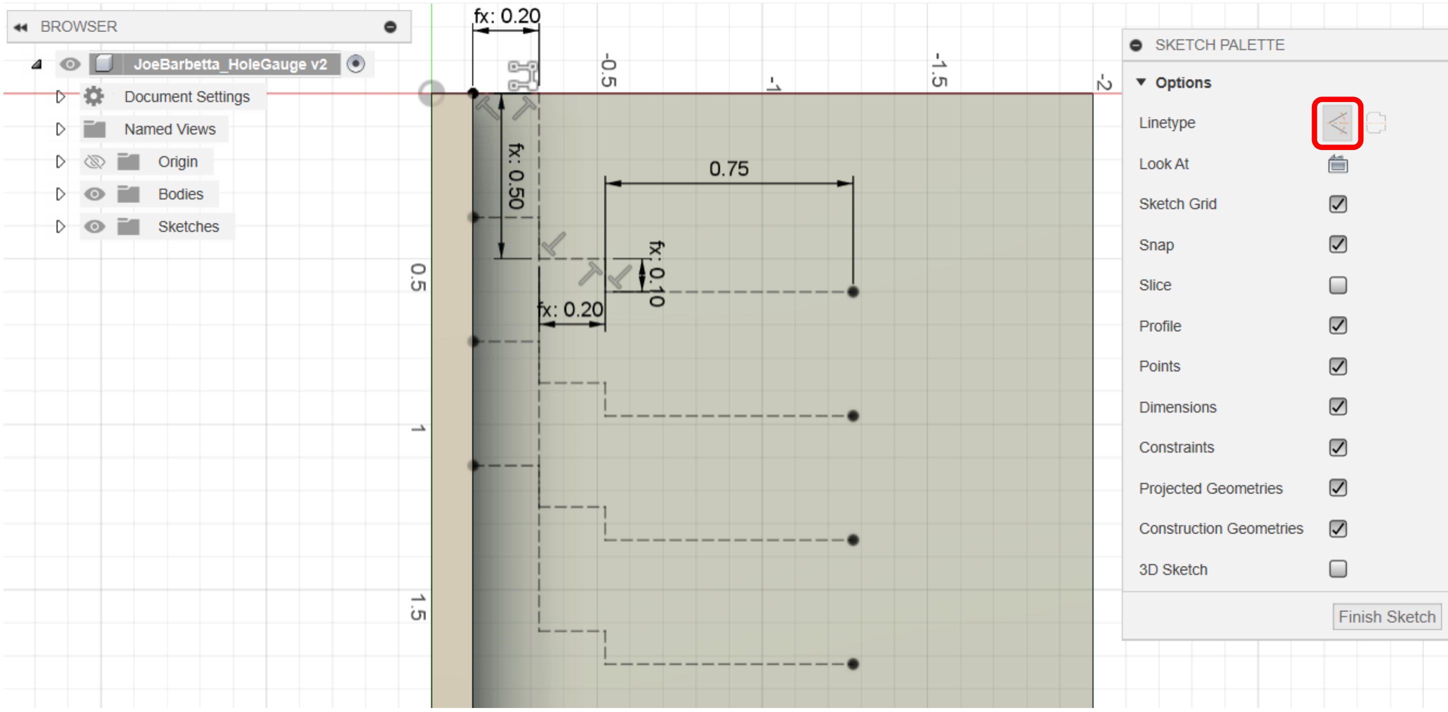
- double-click on **one of the dashed lines**
- set **Distribution** to **Spacing** and click on the **arrow pointing down**
- in the **lower Quantity box** type **h** and select **HoleCount**



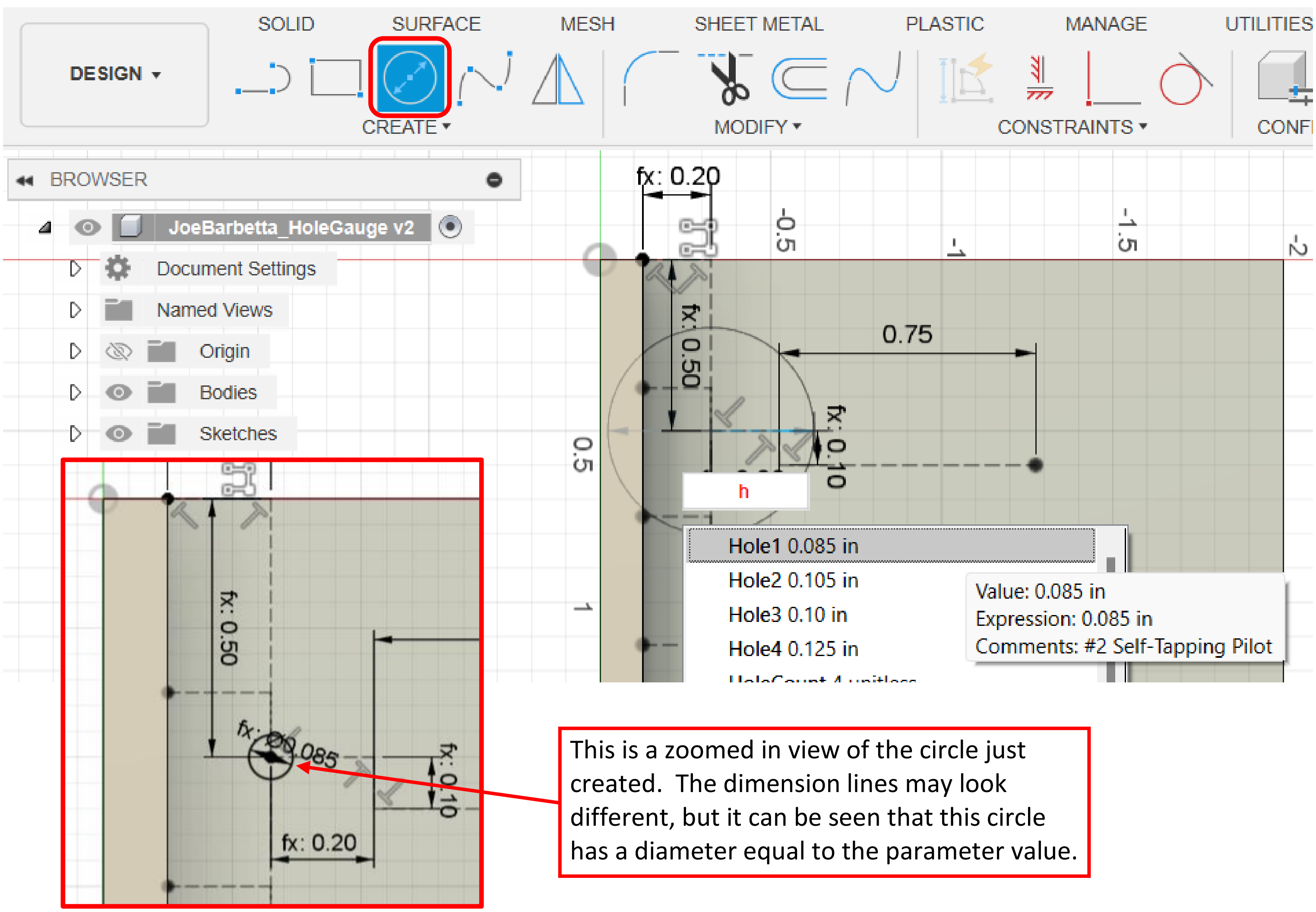
- in the **Distance** box type **h** and select **HoleSpacing**



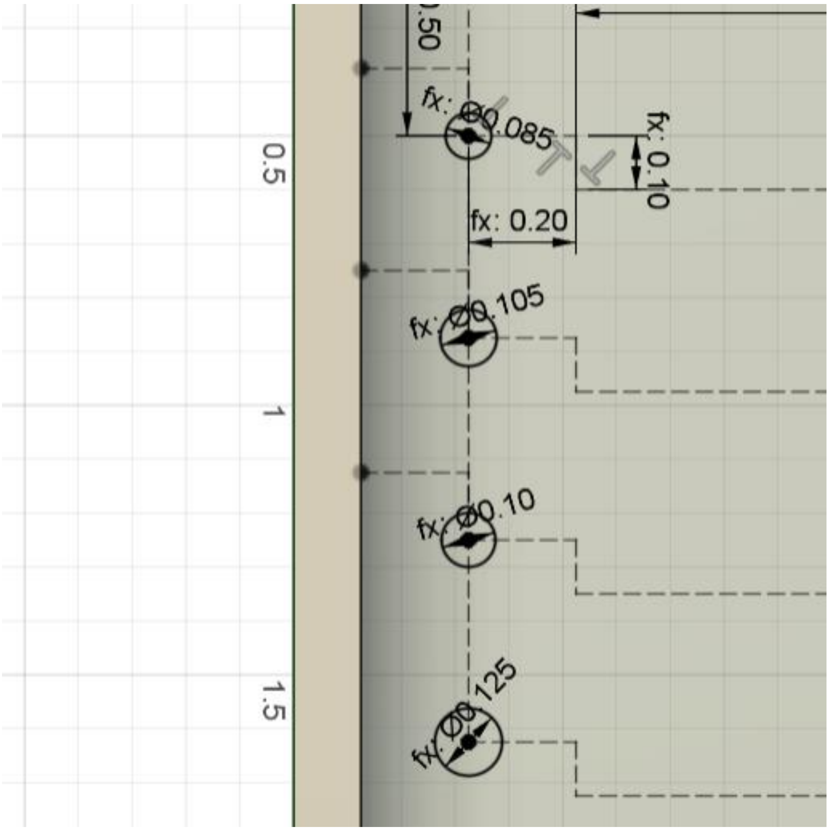
- click on the **Custruction** icon to undo the highlighting



- select the **Center Diameter Circle** icon (if it is not visible select it from the CREATE menu)
- click on the **point** indicated, extend the circle out, type **h**, select **Hole1**, and press the **Enter key**

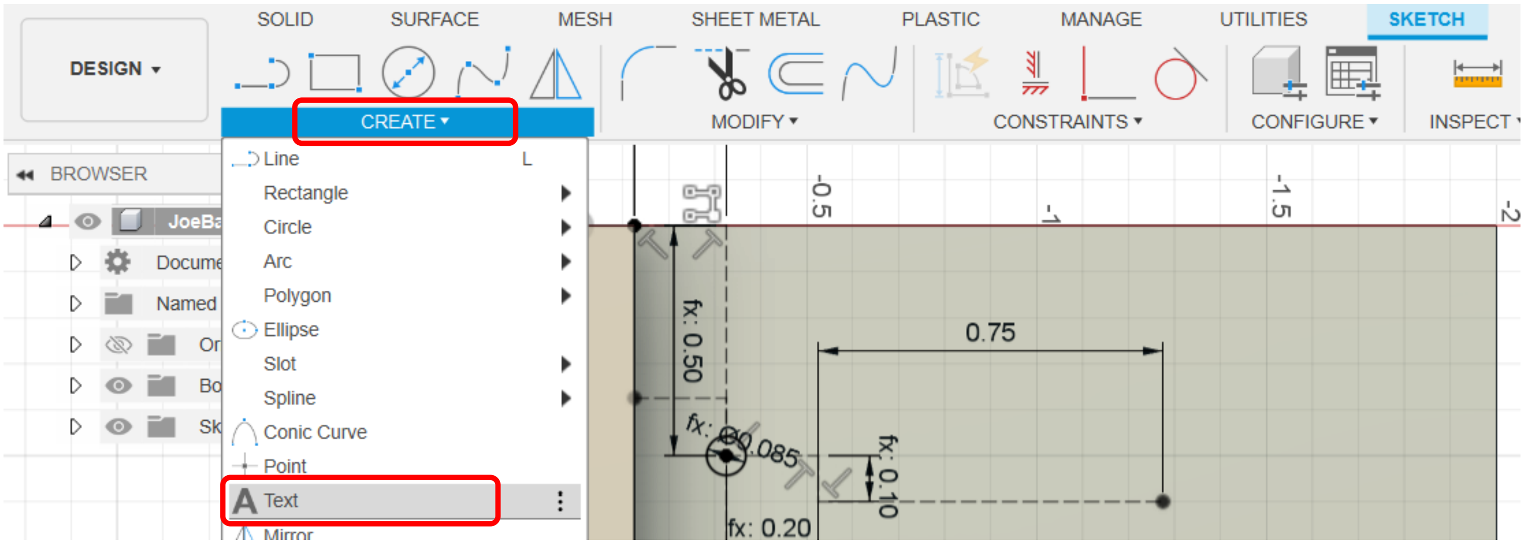


- create **3 more holes** using the values of **Hole2**, **Hole3**, and **Hole4**

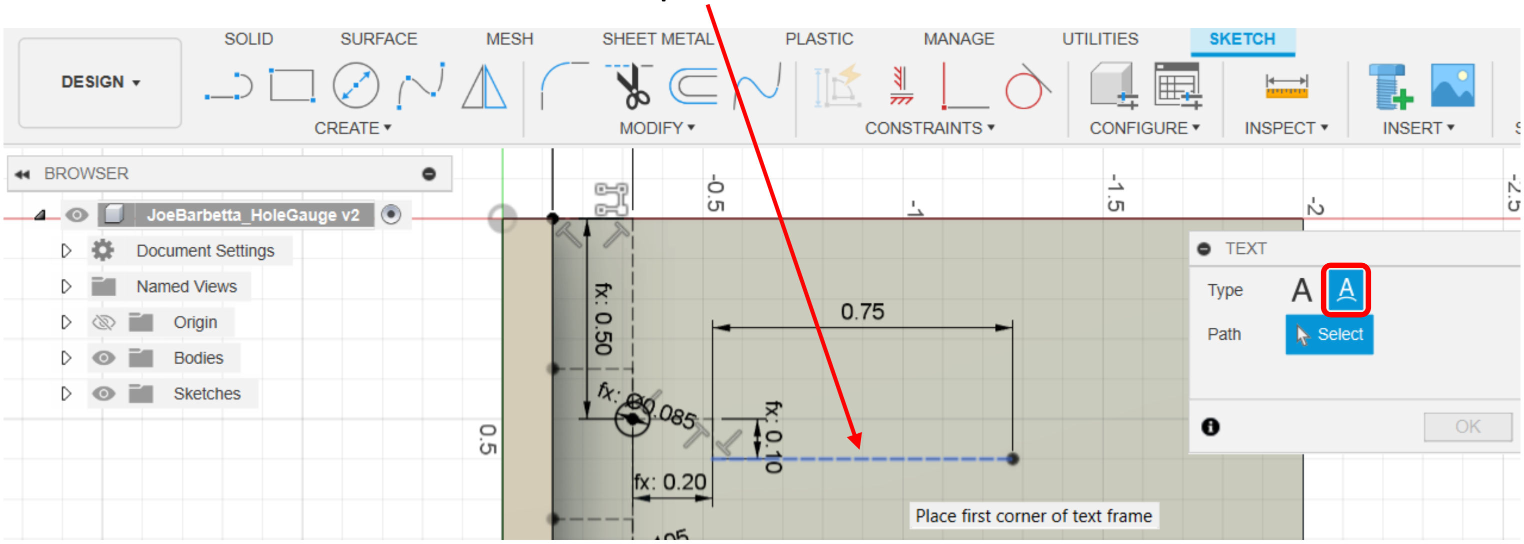


Adding hole diameter text

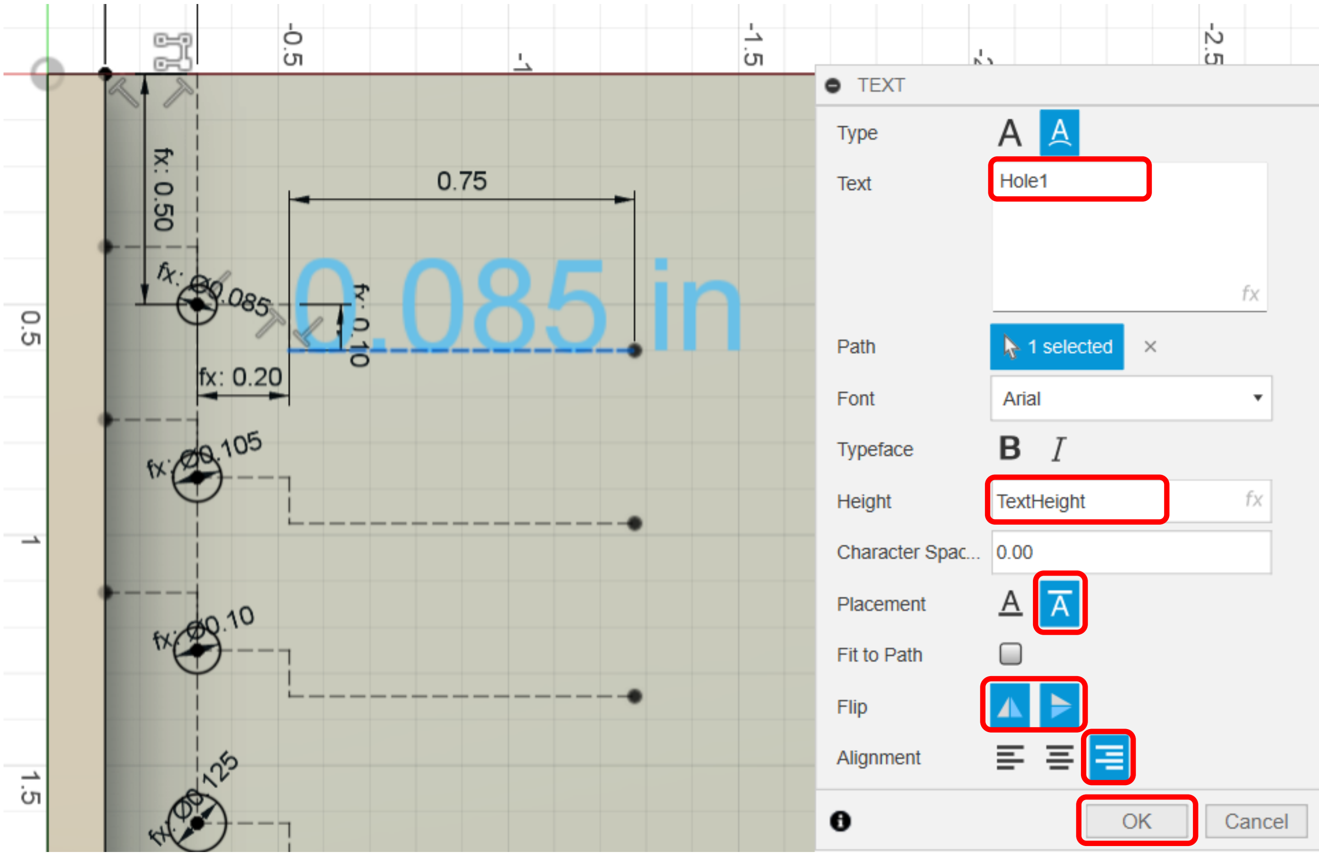
- from the **CREATE** menu select **Text**
- if a message window shows about **Parametric Text** click its OK button to close it.



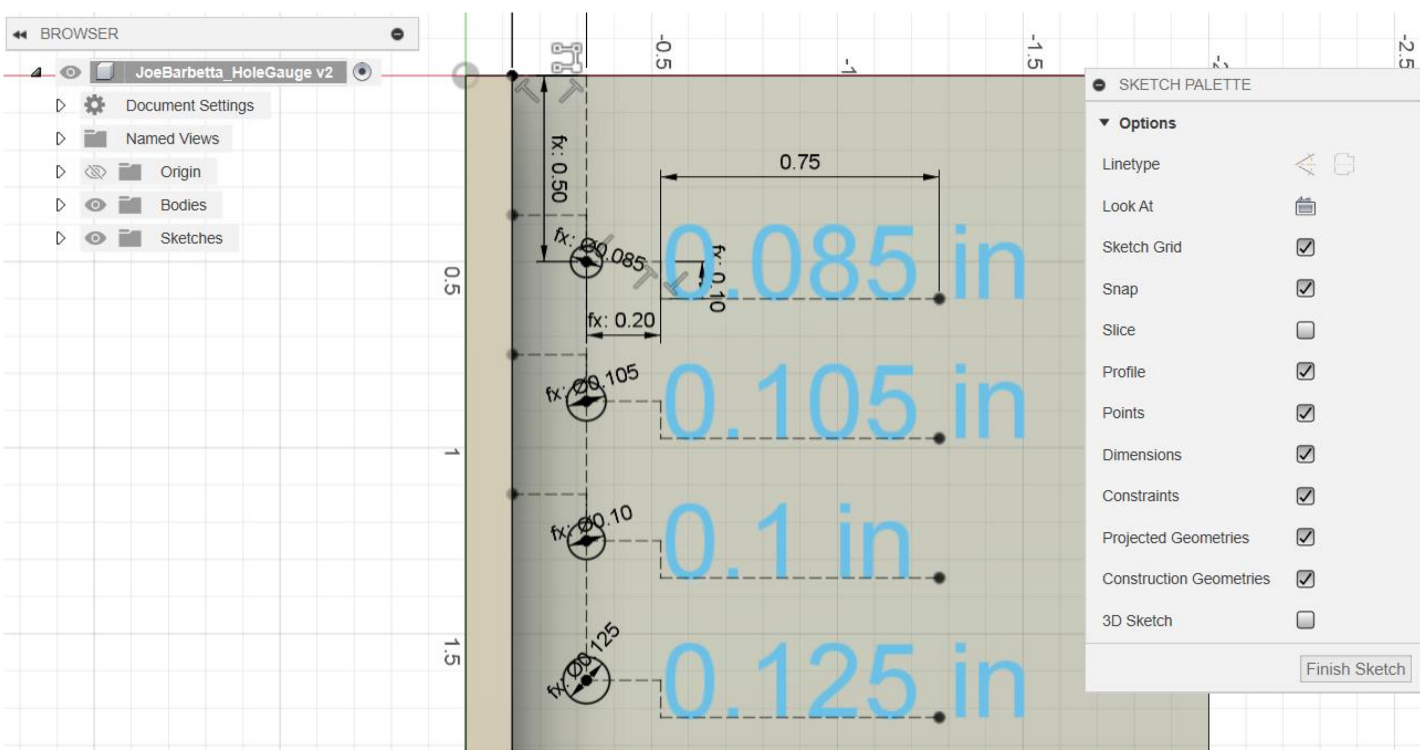
- click on the **Text on Path** icon and then click on the **topmost 0.75 line**



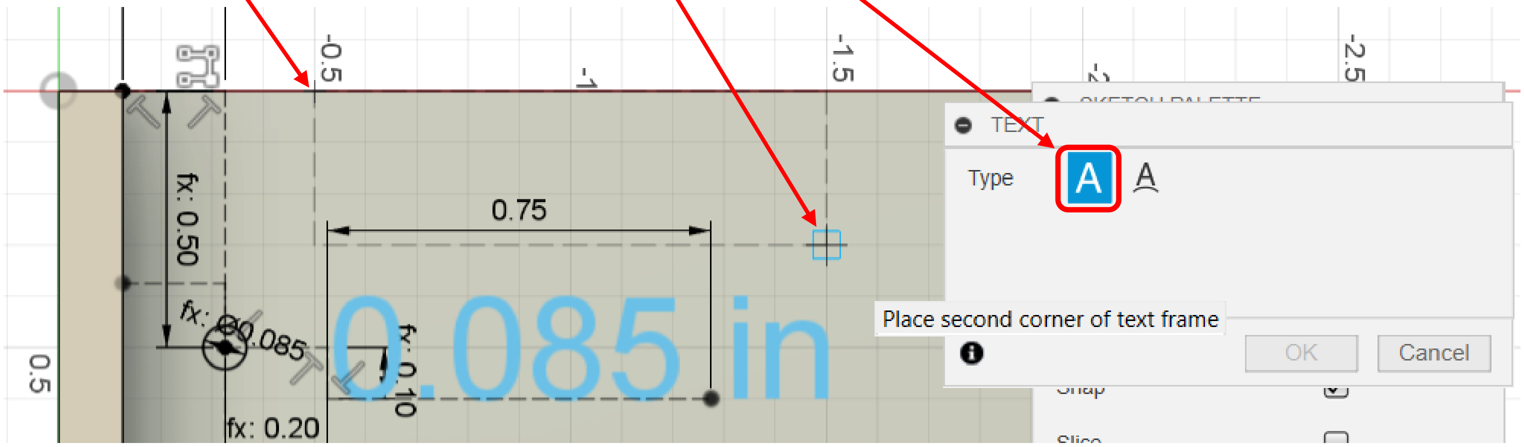
- in the Text box select the single quotes, type **h**, and select **Hole1**
- in the Height box type **t** and select **TextHeight**
- ensure that **Placement** is set as shown
- click on both **Flip** icons to select them
- click on the **right-justify Alignment** option
- click **OK**



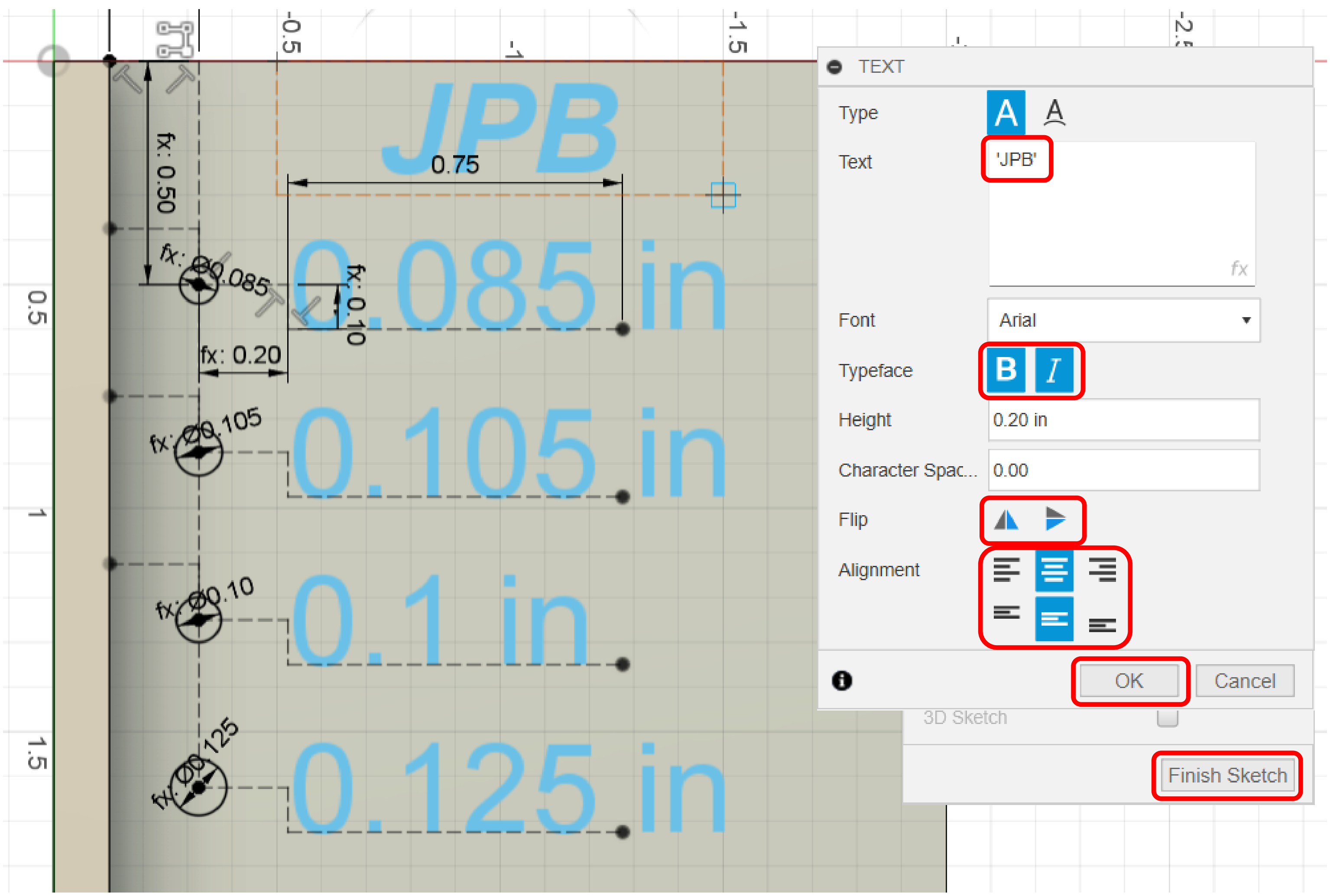
- use the **Text** tool 3 more times, using **Hole2**, **Hole3**, **Hole4**



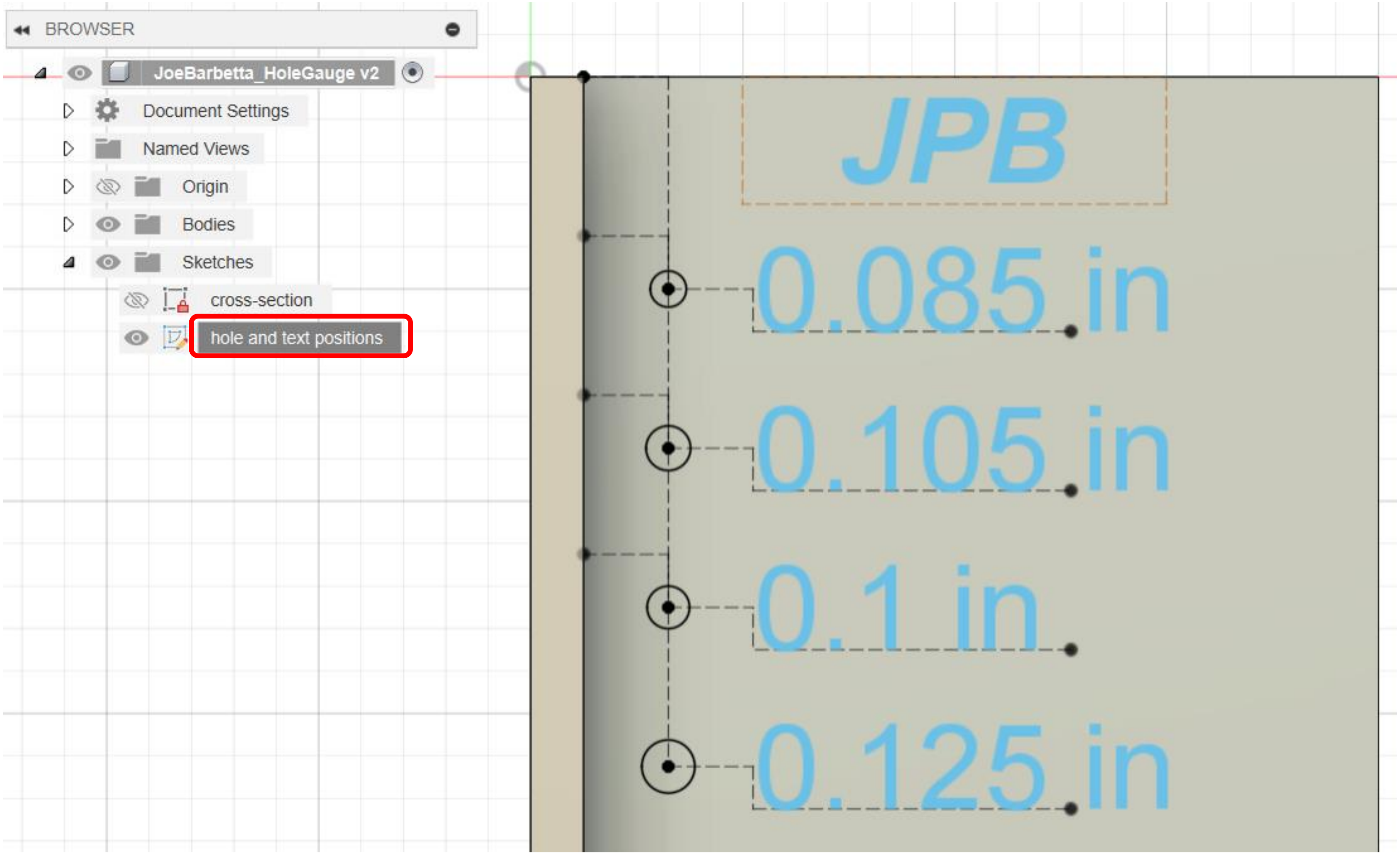
- select the **Text** tool again and this time select the regular **Text** icon
- click on the **1st point** to start the text frame rectangle
- extend the rectangle to the right and down to the **2nd point** and click. These locations are not critical.



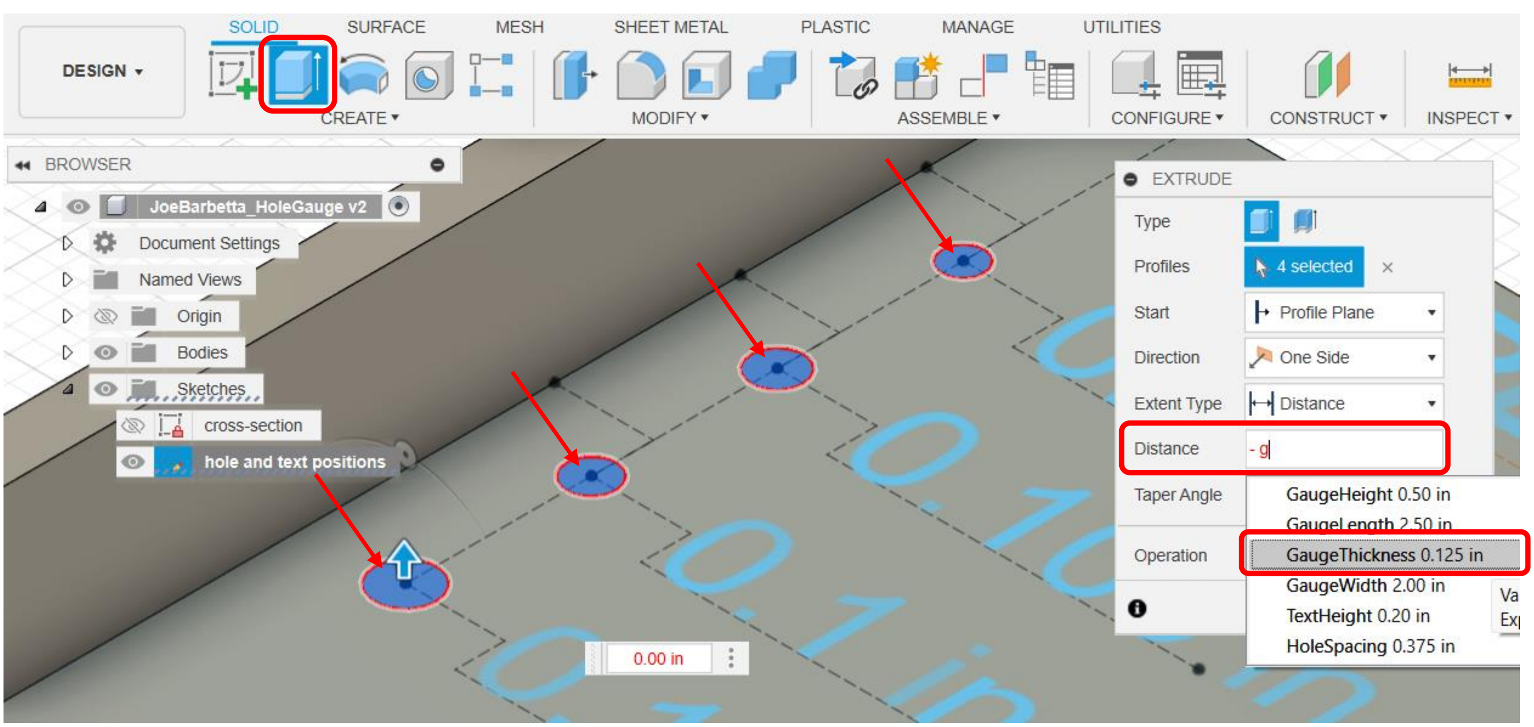
- enter your initials **between the single quotes**. **There must be a single quote before and after your initials.**
- set the **Typeface**, **Flip**, and **Alignment** options as shown.
- click **OK** and **Finish Sketch**



- rename the Sketch to **hole and text positions**

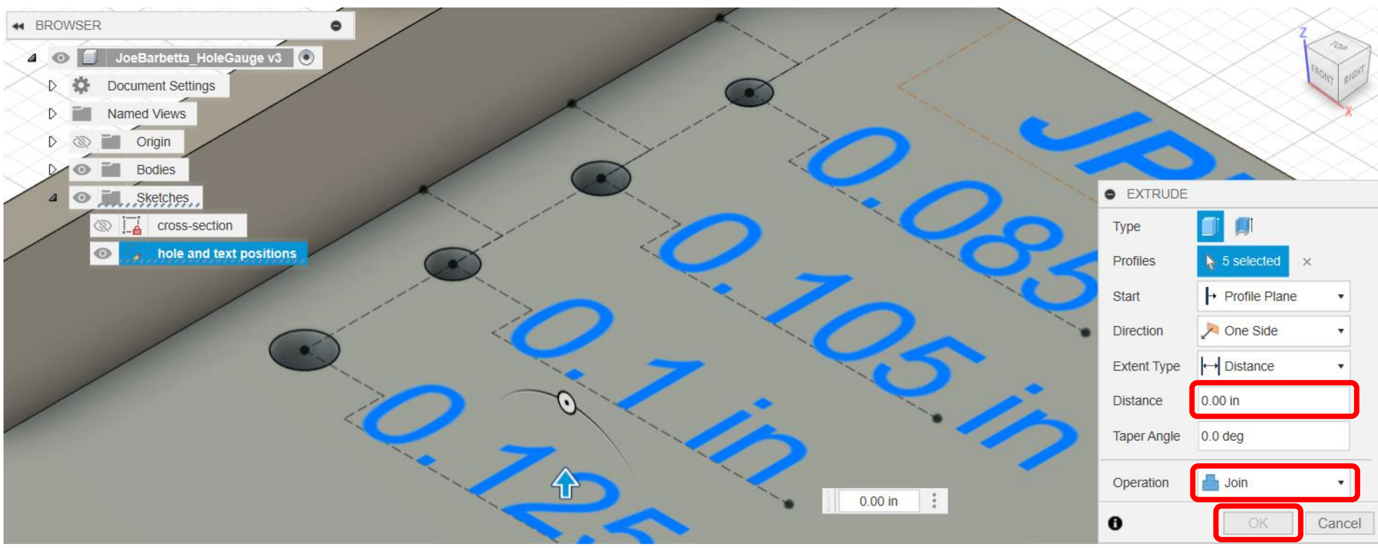


- click on the **Home** icon at the **View Cube** and Zoom in as shown below to access the 4 holes
- select the **Extrude** tool and click on the **inside of each circle** to turn it blue
- in the **Distance** box type **- g** (note the minus sign before g) and select **GaugeThickness**
- click **OK**

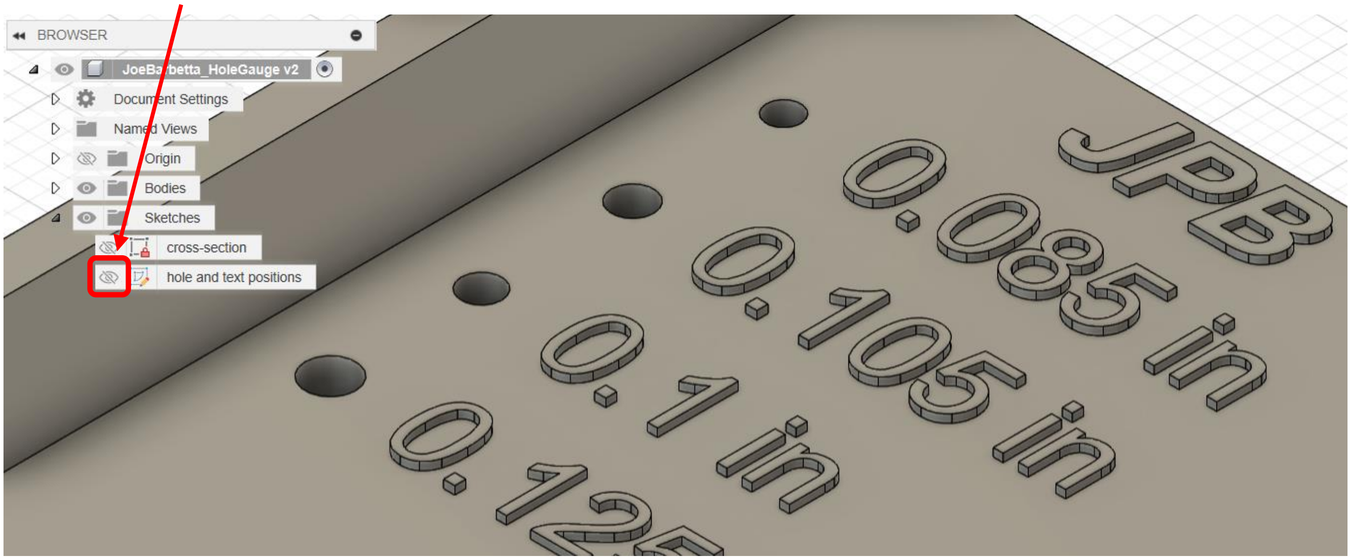


- click the **eye** icon next to **hole and text positions** to make the text visible again

- holding the **shift key down**, click on the **5 text items** to highlight them dark blue
- click on the **Extrude** tool, ensure the Operation is **Join**, enter **0.02** in the **Distance** box and click **OK**



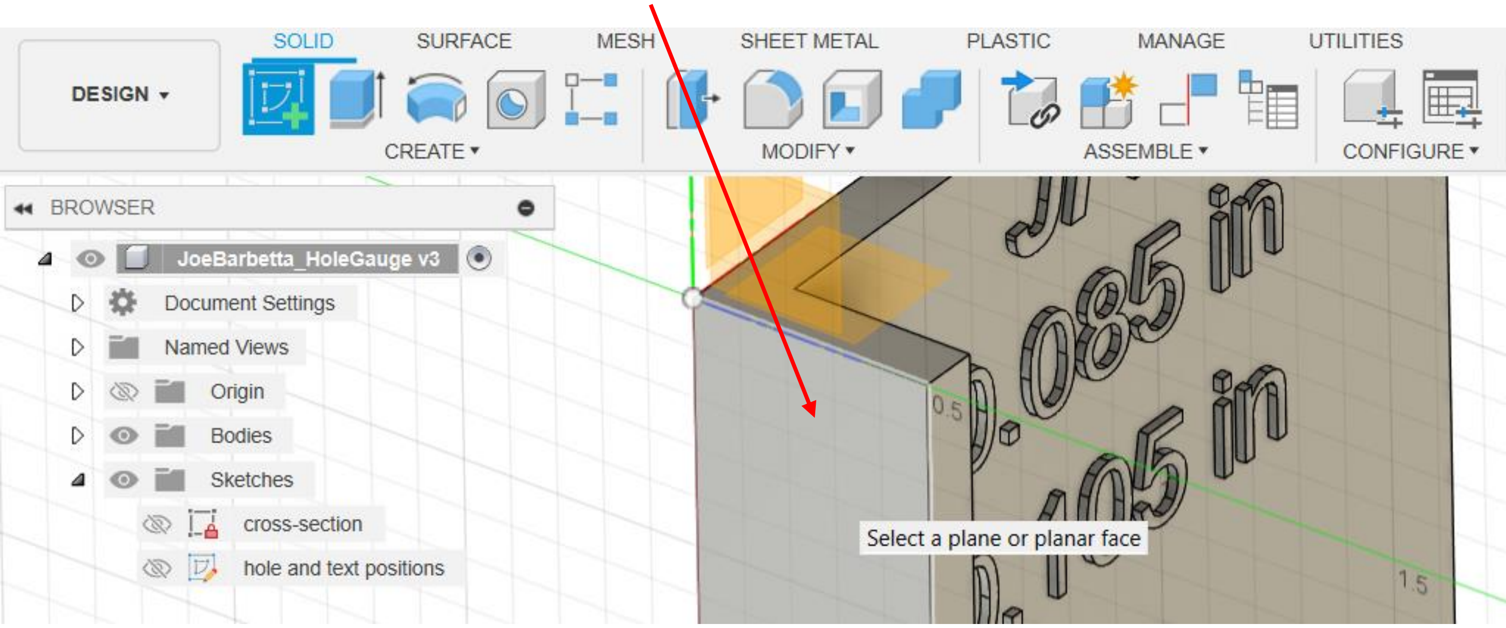
- click on the **eye** icon to hide the sketch lines and text



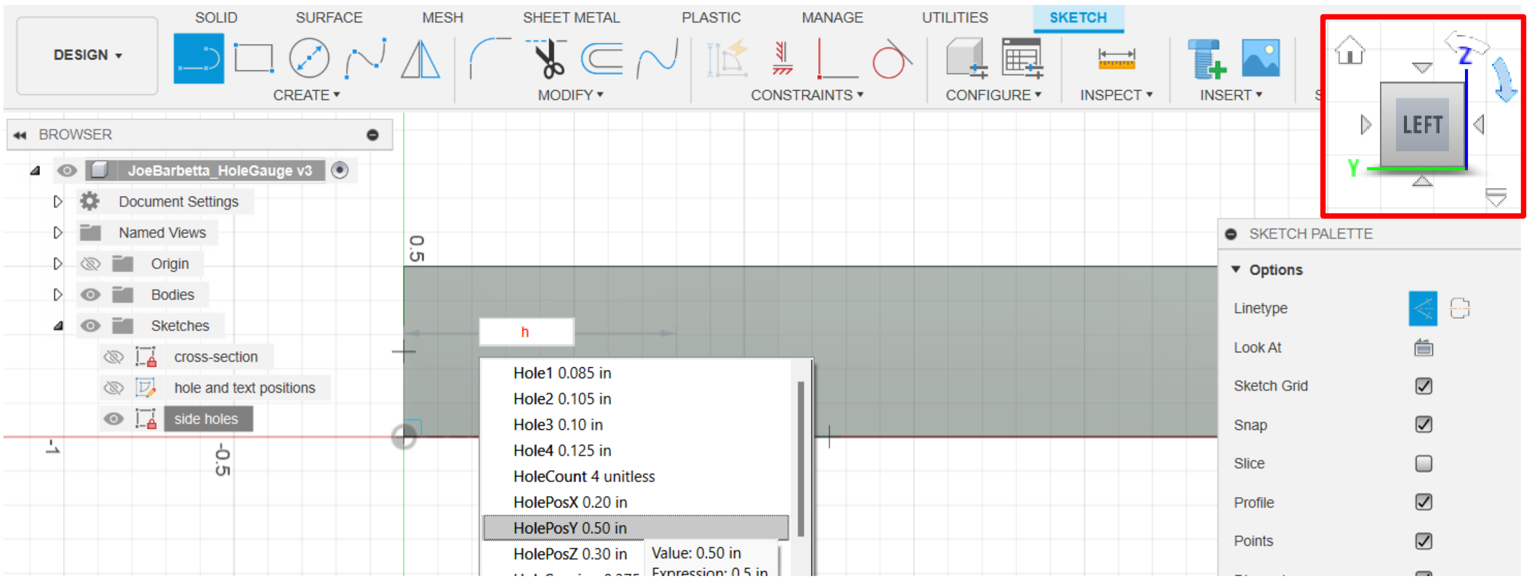
Creating the horizontal holes

With 3D printing, the resulting hole diameters can differ from that specified in CAD. The variance can also differ for vertical vs horizontal holes. The gauge will have both to determine how each differs from the specified diameter.

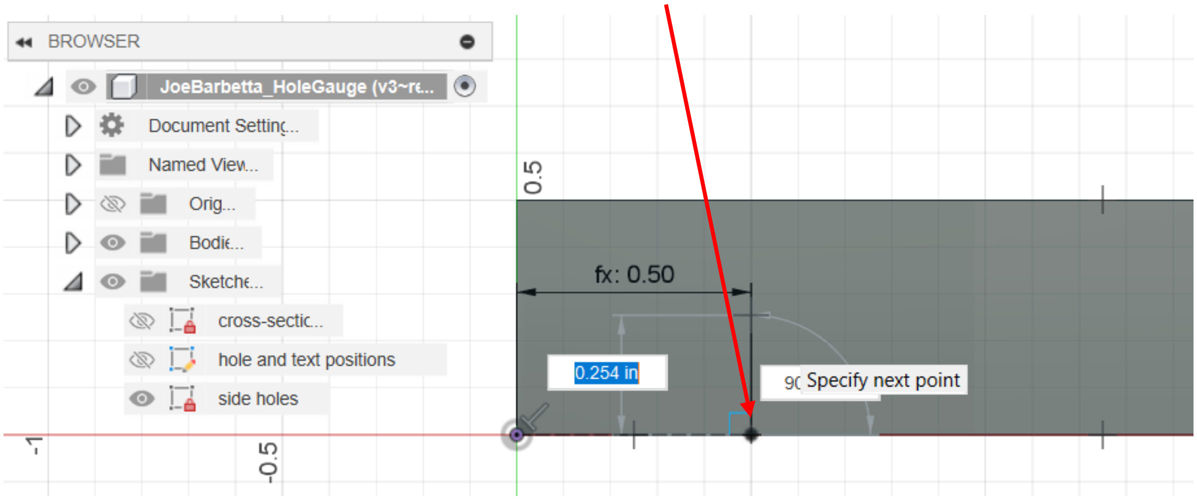
- use the **View Cube** to achieve a view similar to that below
- click on the **Create Sketch** tool and click on the **side surface**



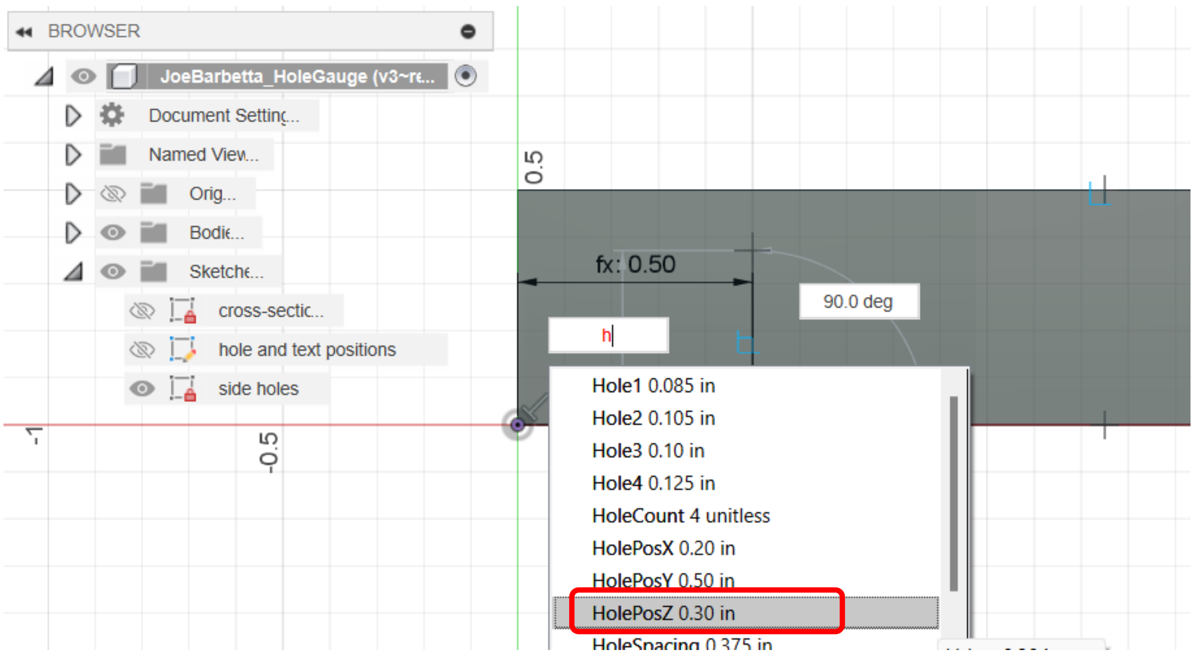
- if the gauge is not horizontal, as shown below, use a **curved arrow** at the **View Cube** to rotate the view
- zoom in to achieve a view similar to that below
- select the **Line** tool and click on the **Construction** LineType icon
- start the line at the **Origin**, extend it to the right, type **h**, select **HolePosY**, and press the **Enter key**



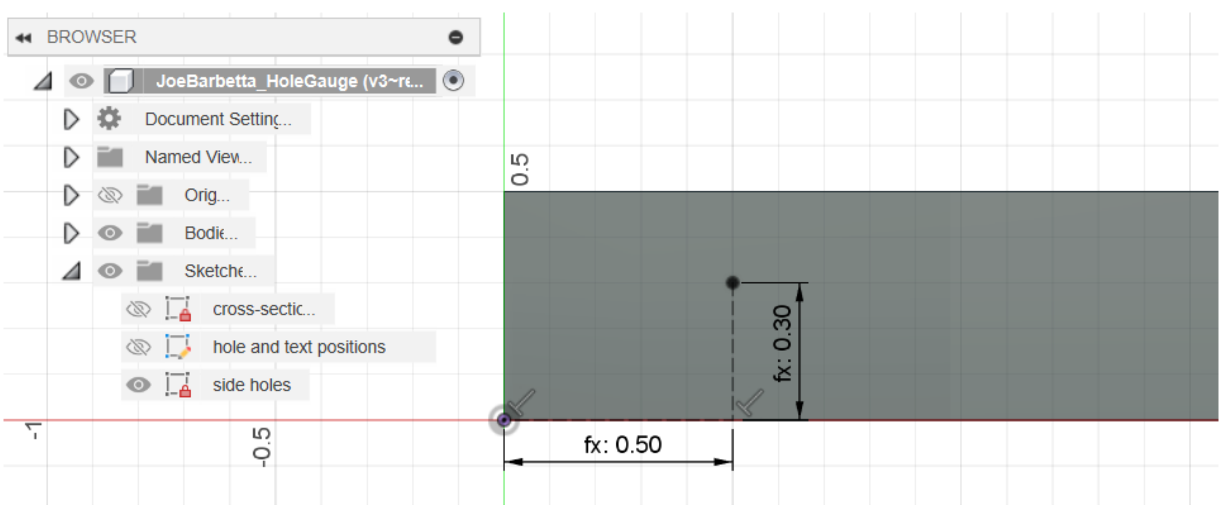
- using the **Line** tool again, start a line at the **end of the last line** and **extend upward**



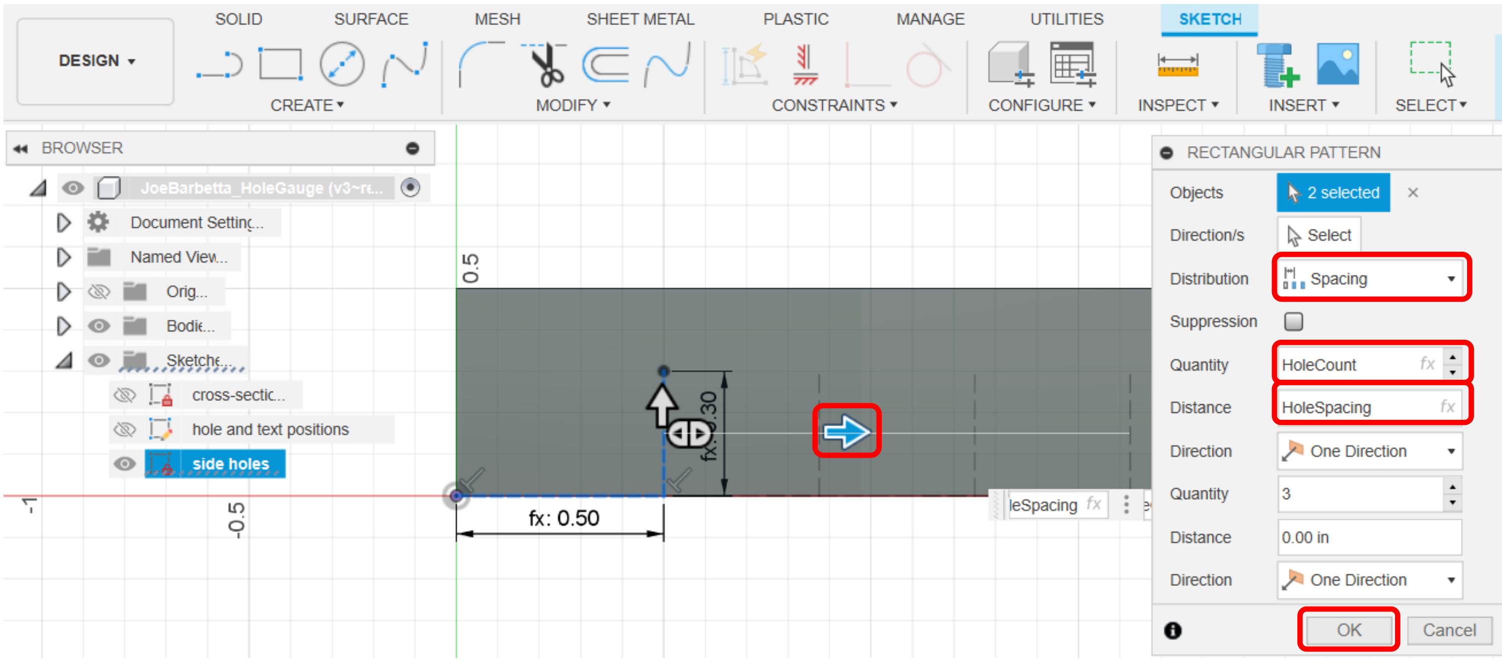
- type **h**, select **HolePosZ**, and press the **Enter key**



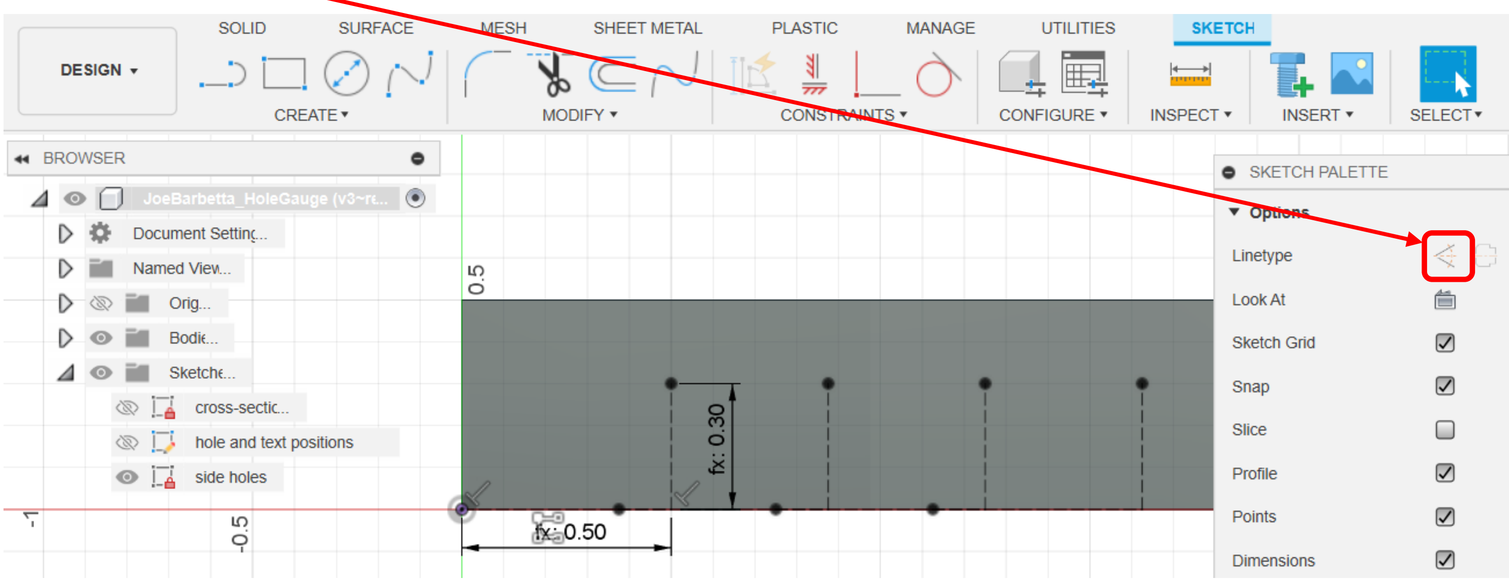
The result should look like that below. It is fine if the dimension lines are placed differently.



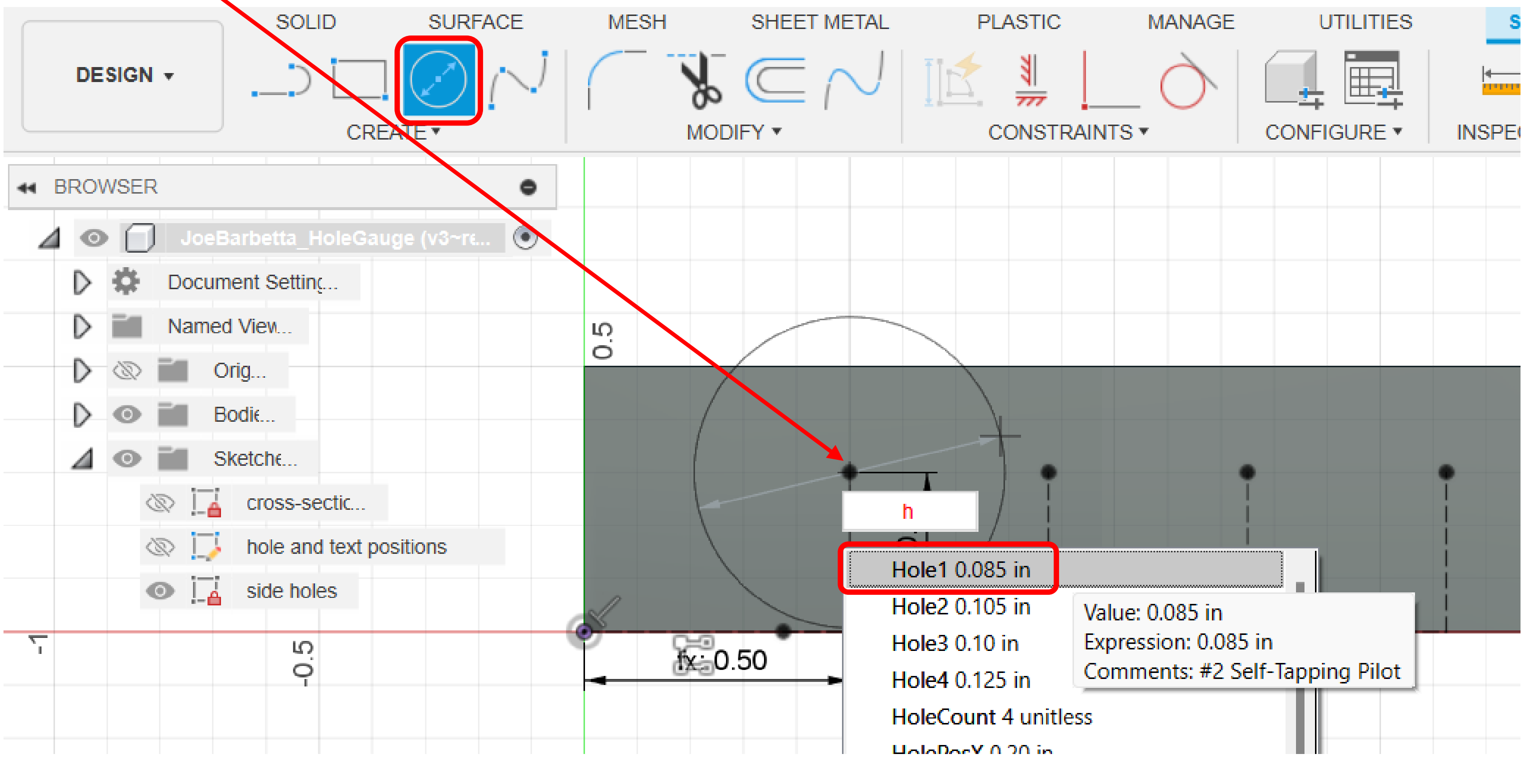
- from the **CREATE** menu select **Rectangular Pattern**
- double-click on the **dashed line** just created
- click on **the horizontal Move** arrow
- ensure **Distribution** is set to **Spacing**
- for the 1st **Quantity** type **h** and select **HoleCount**
- for the 1st **Distance** type **h** and select **HoleSpacing**
- click **OK**



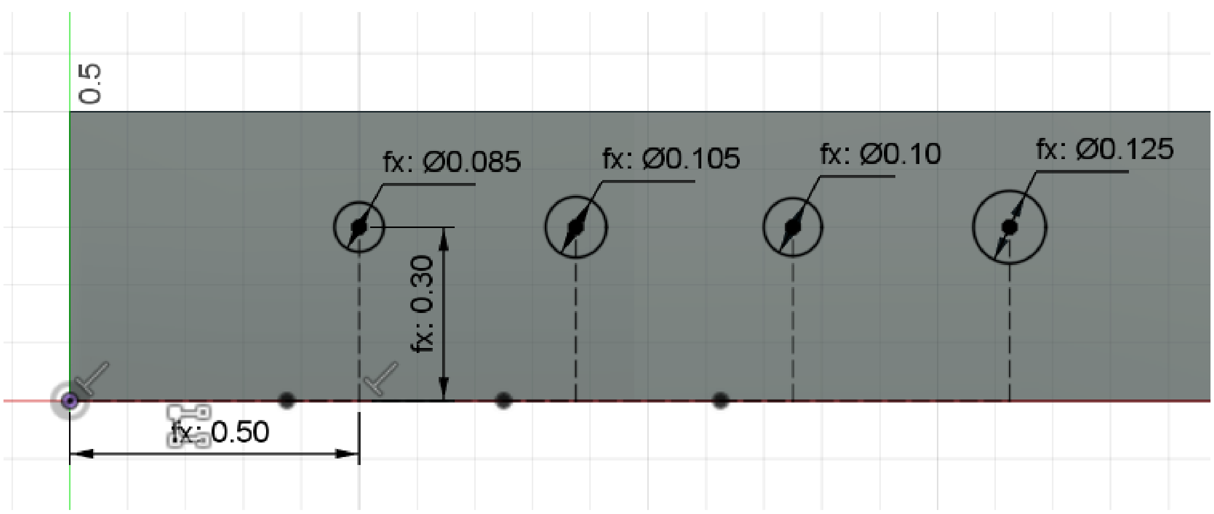
- click on the **Construction** icon to turn off the highlighting



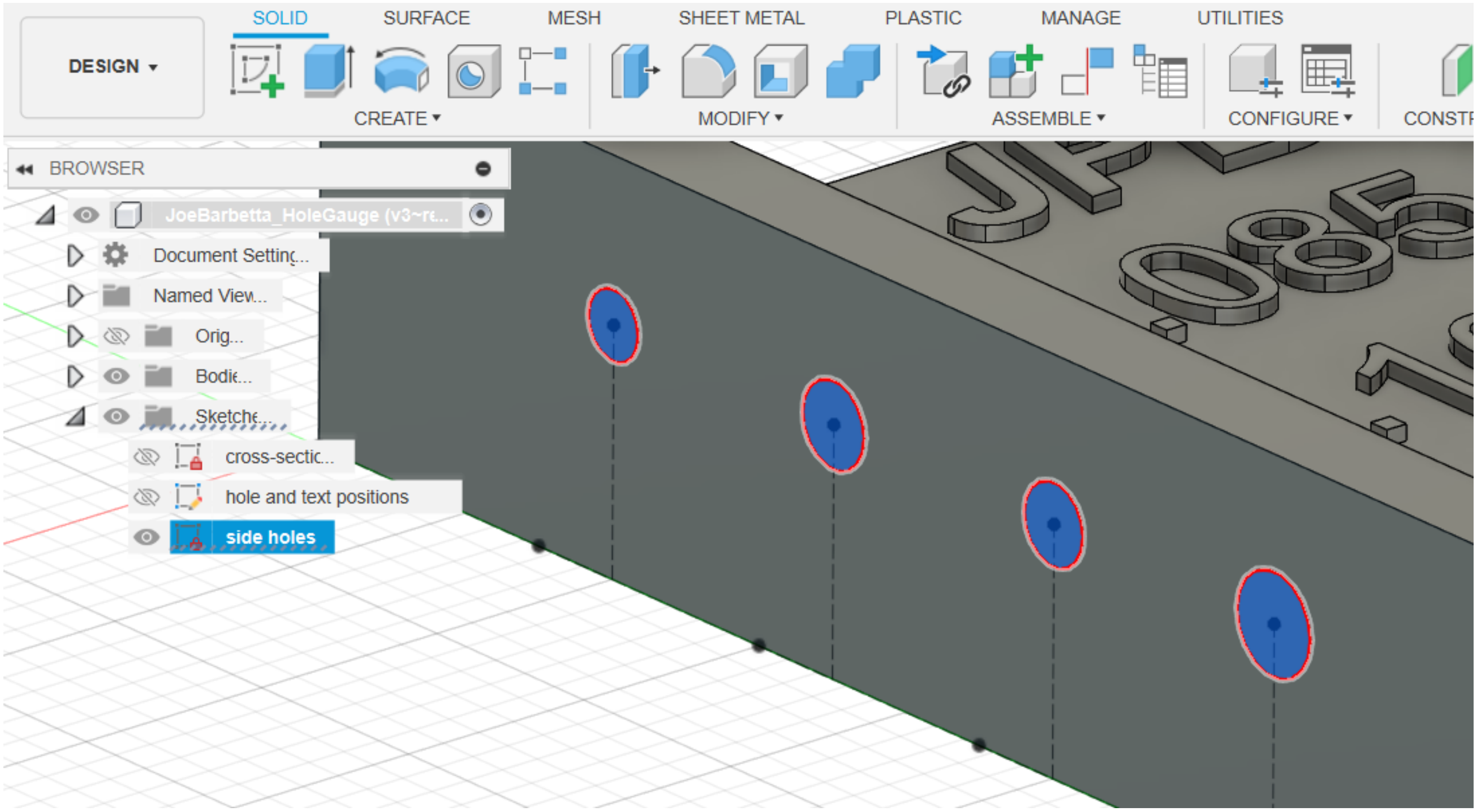
- select the **Center Diameter Circle** icon (if it is not visible select it from the CREATE menu)
- click on the **point** indicated, extend the circle out, type **h**, select **Hole1**, and press the **Enter key**



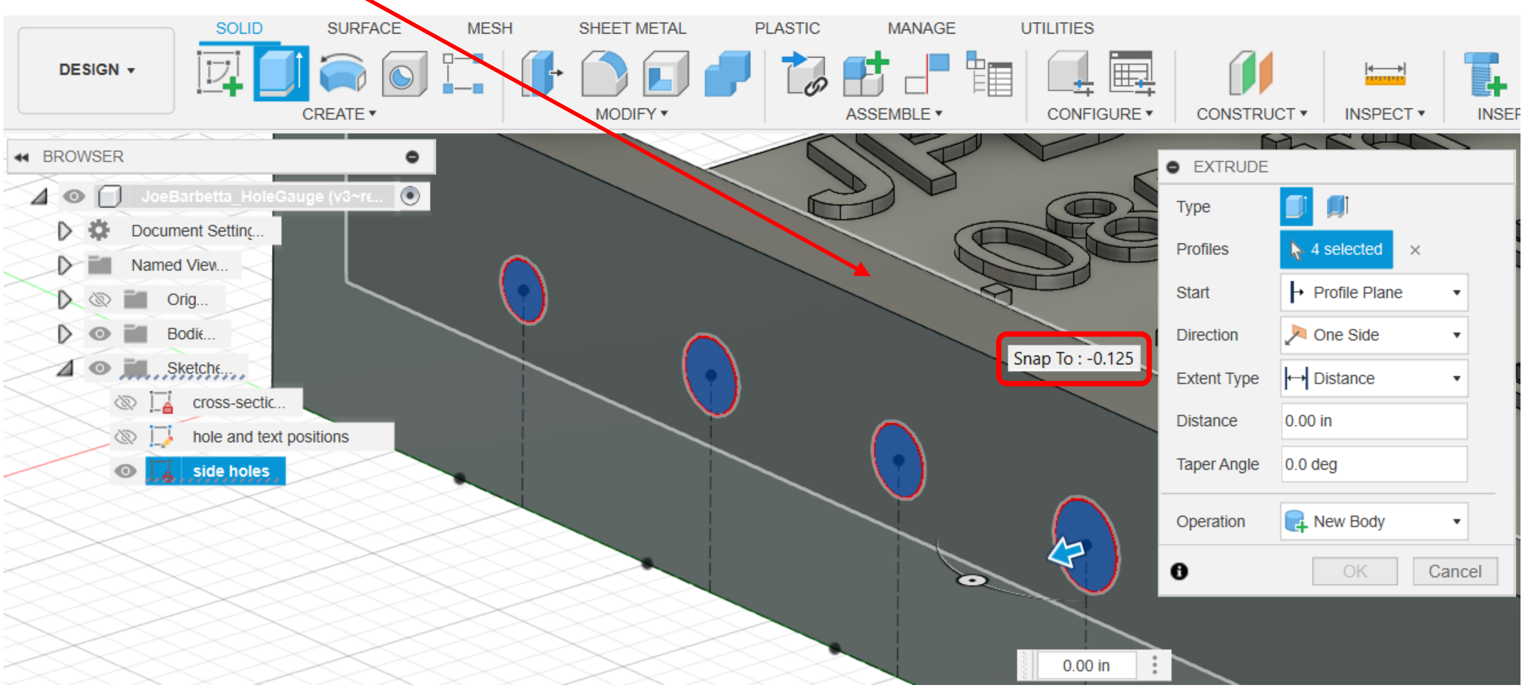
- create circles at the top ends of the other 3 lines using **Hole2**, **Hole2**, and **Hole3**
- for each hole, click on the hole diameter dimension and drag it up and to the right to position them as shown
- click **Finish Sketch**



- adjust the view and zoom into the side to access the holes
- hold the **shift key** and click on **the interior of each circle** to turn it dark blue

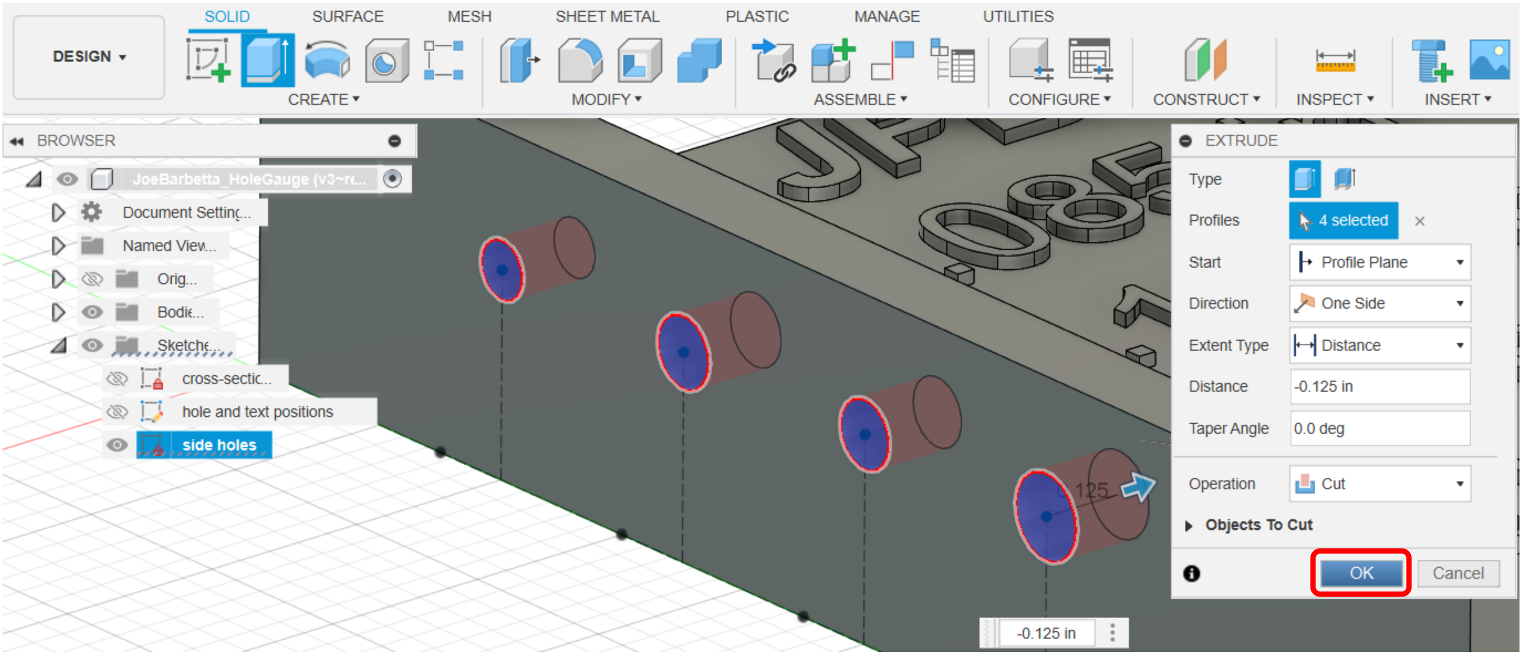


- select the **Extrude** tool
- hover over the **top surface**, which should cause the rear surface to turn dark gray and a **Snap to: -0.125** note to show
- click on the **top surface**

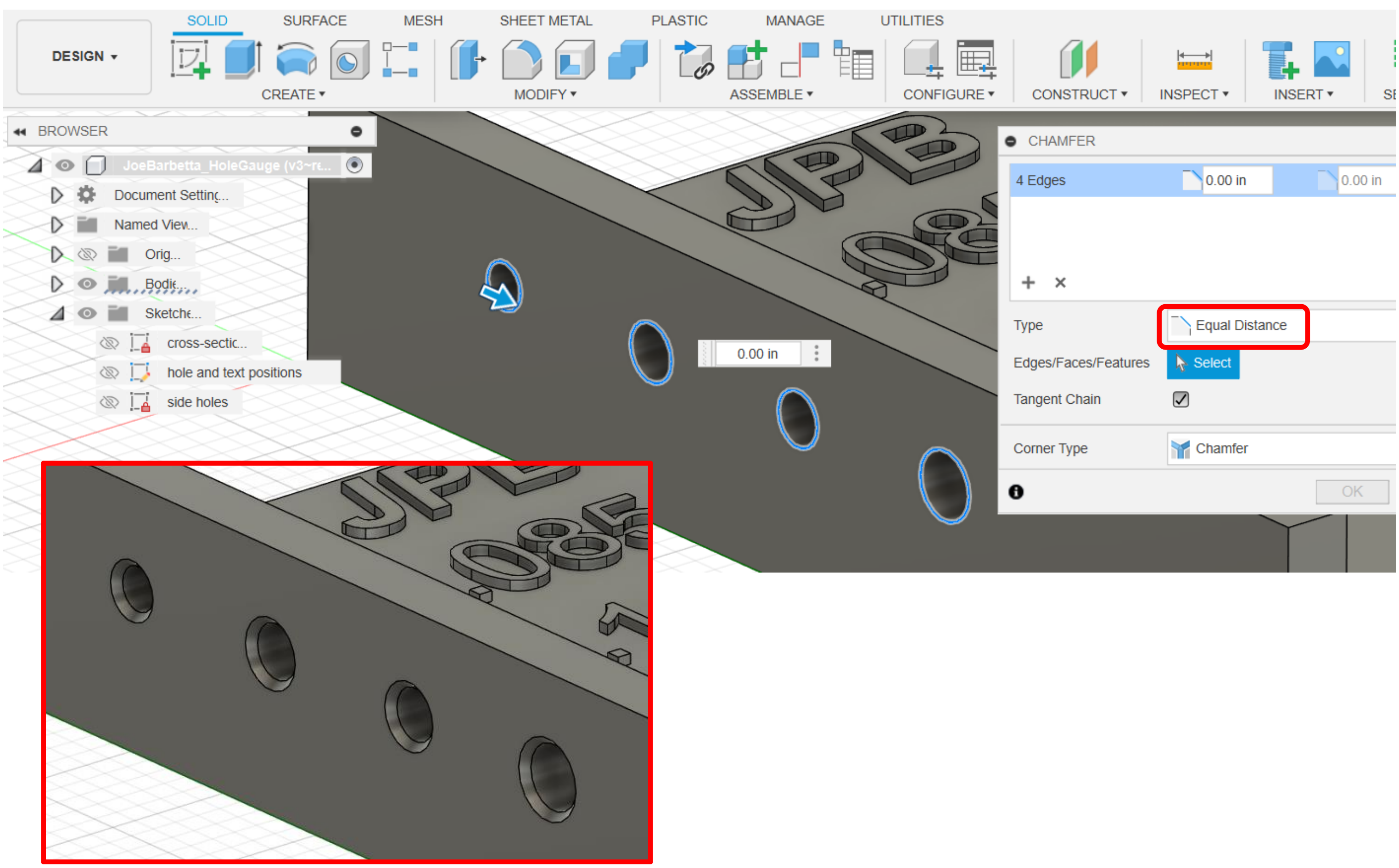


- click **OK**

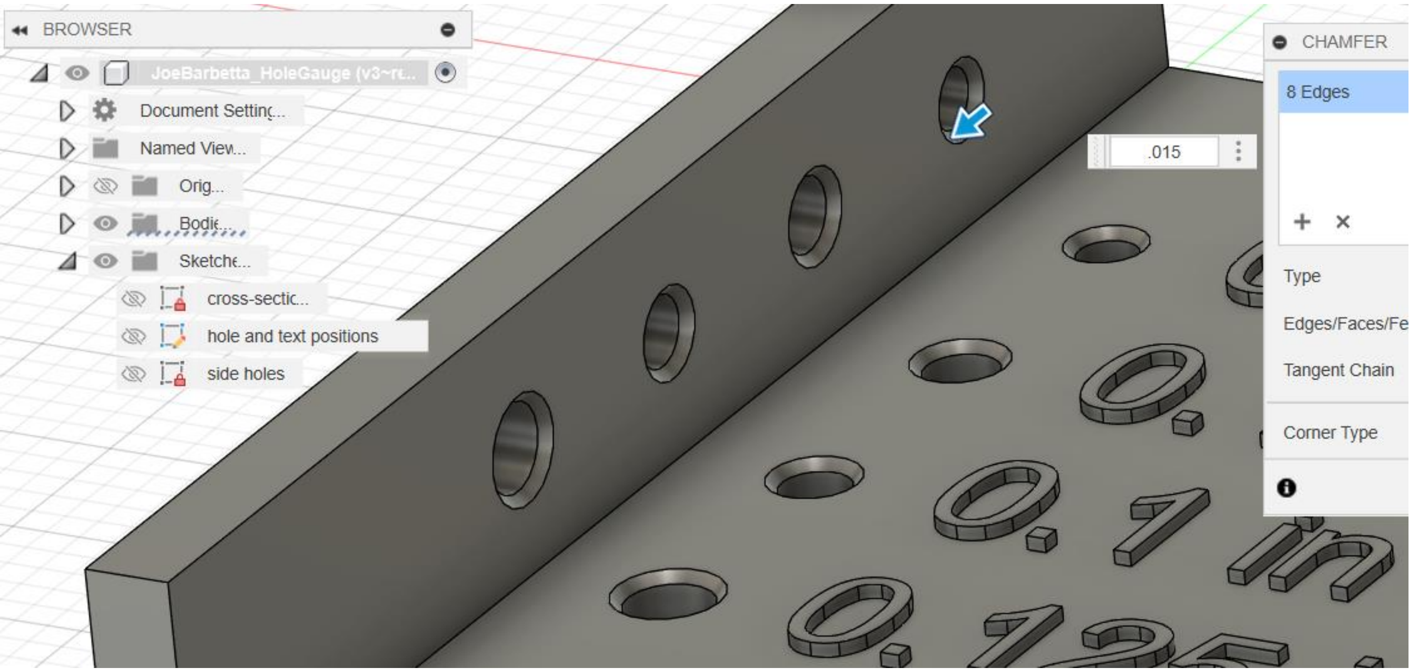
Note that when the vertical holes were extruded previously, **- GaugeThickness** was used. It could have been used here as well. However, a different method was used to show an alternative method to achieve the same result.



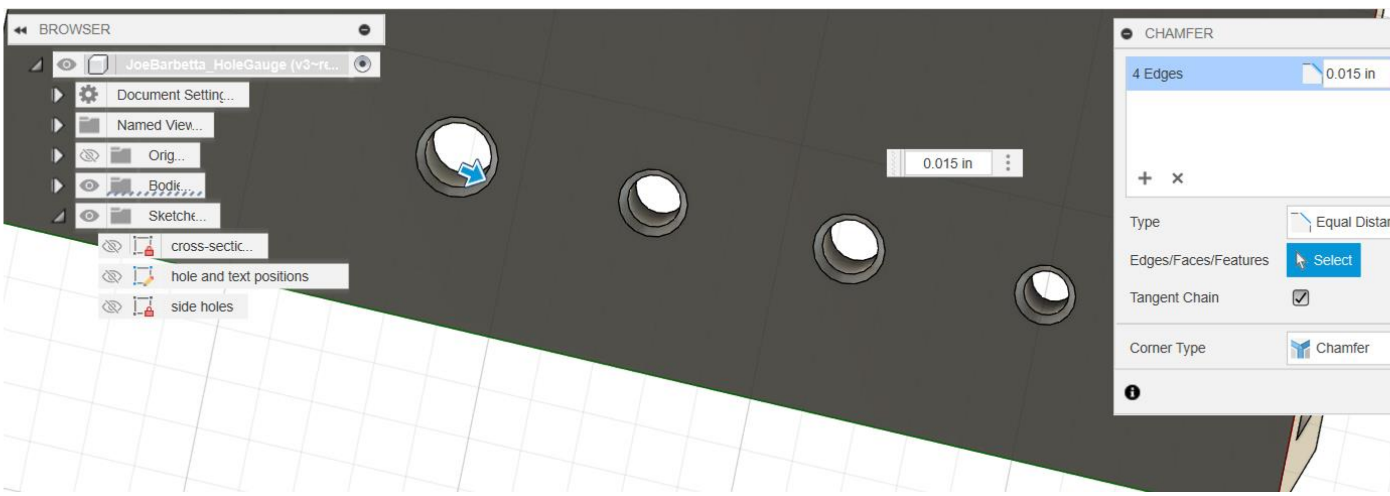
- from the **MODIFY** menu select the **Chamfer** tool
- ensure the **Type** is set to **Equal Distance**
- click on the **edge of each circle** to cause them to turn blue
- enter **0.015** and click **OK**. The inset picture shows the result.



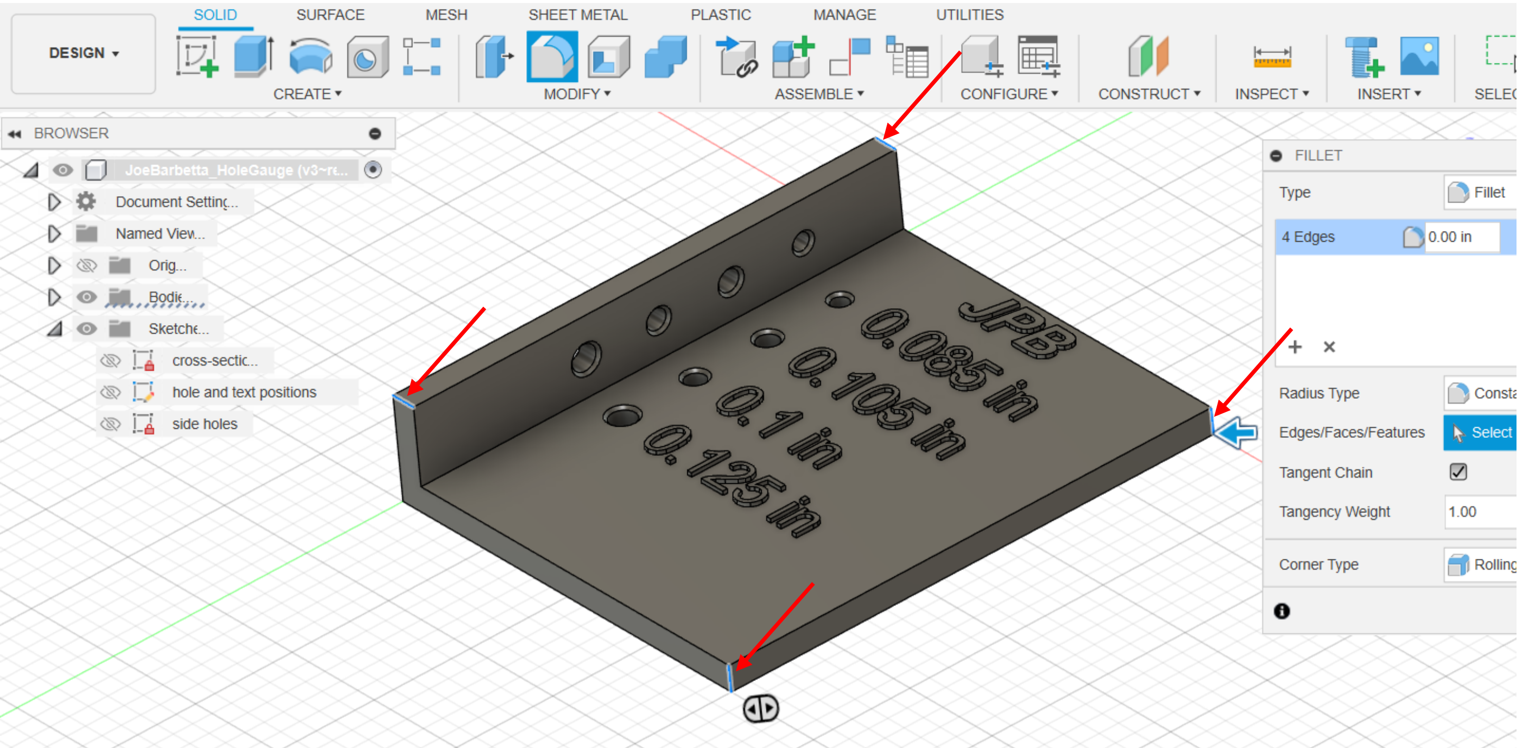
- perform the same **Chamfer** operation on the other side of the horizontal holes and the tops of the vertical holes.



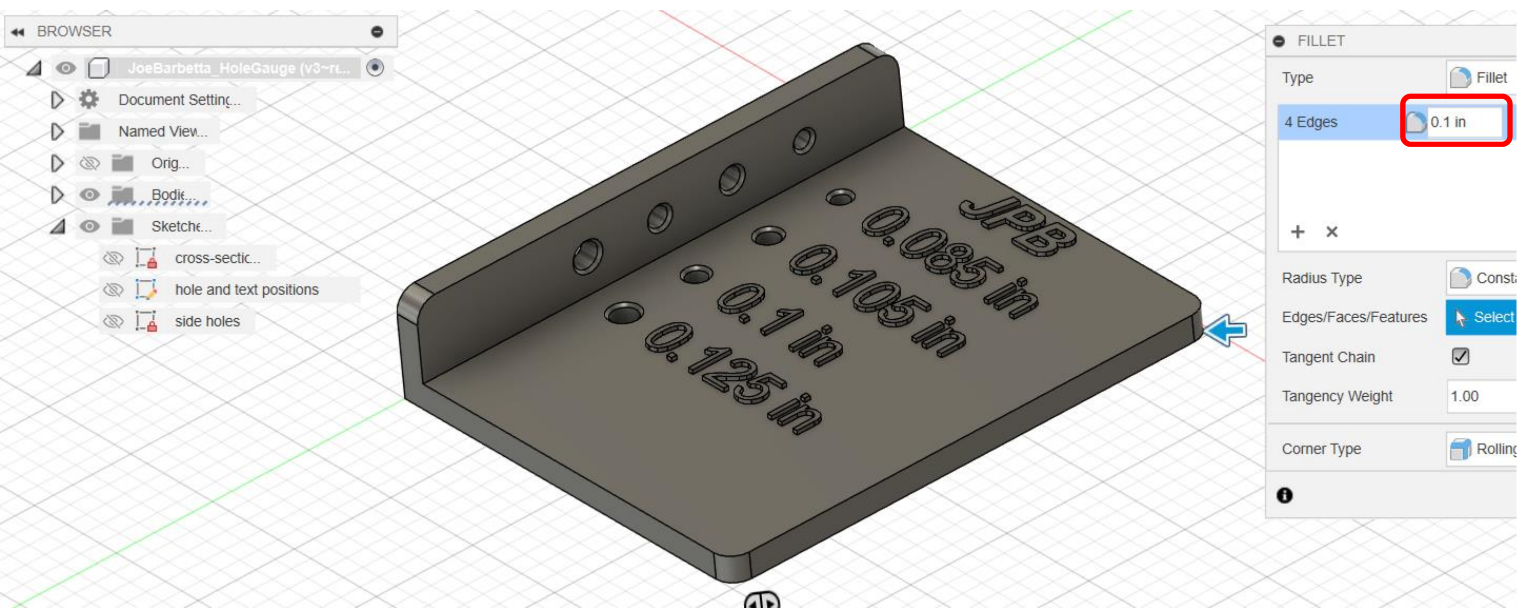
- adjust the view to access the underside of the gauge and **Chamfer** these hole edges as well



- select the **Fillet** tool. **Pronounce Fillet with a hard t, not like a fillet of fish!** If the Fillet tool is not visible, find it in the MODIFY menu.
- click on the **4 small edges** as shown



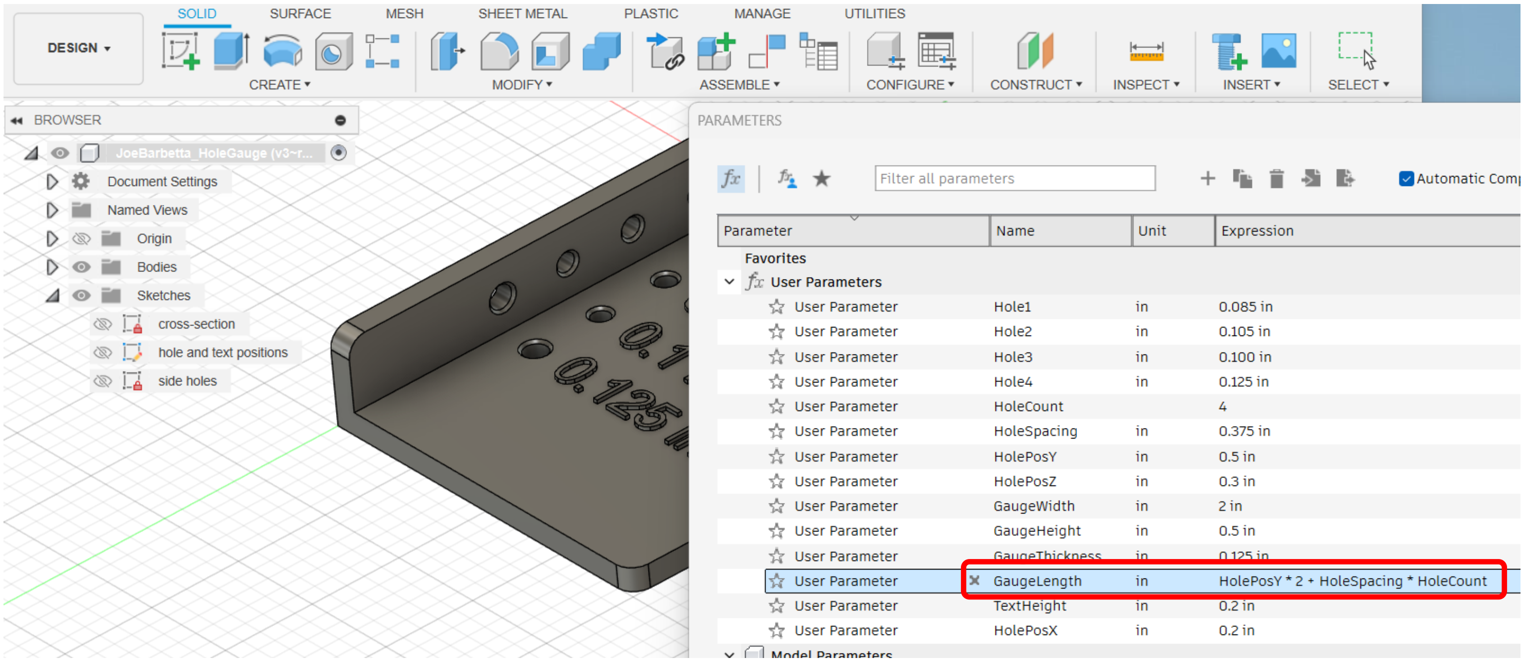
- enter **0.1** and click **OK**



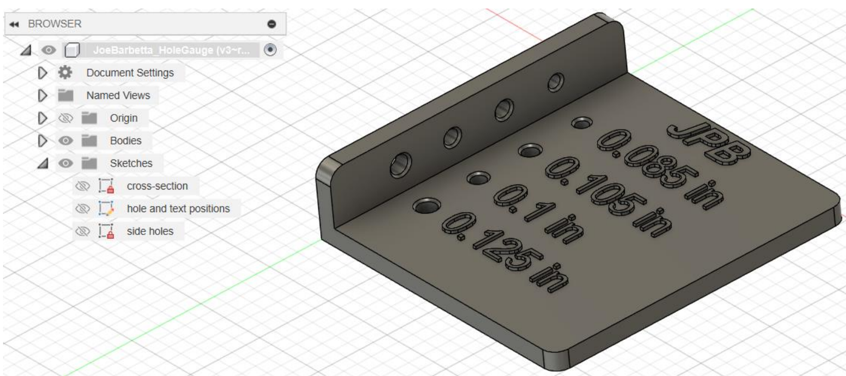
Adjusting Parameters

The gauge looks longer than it should be. Let's shorten it.

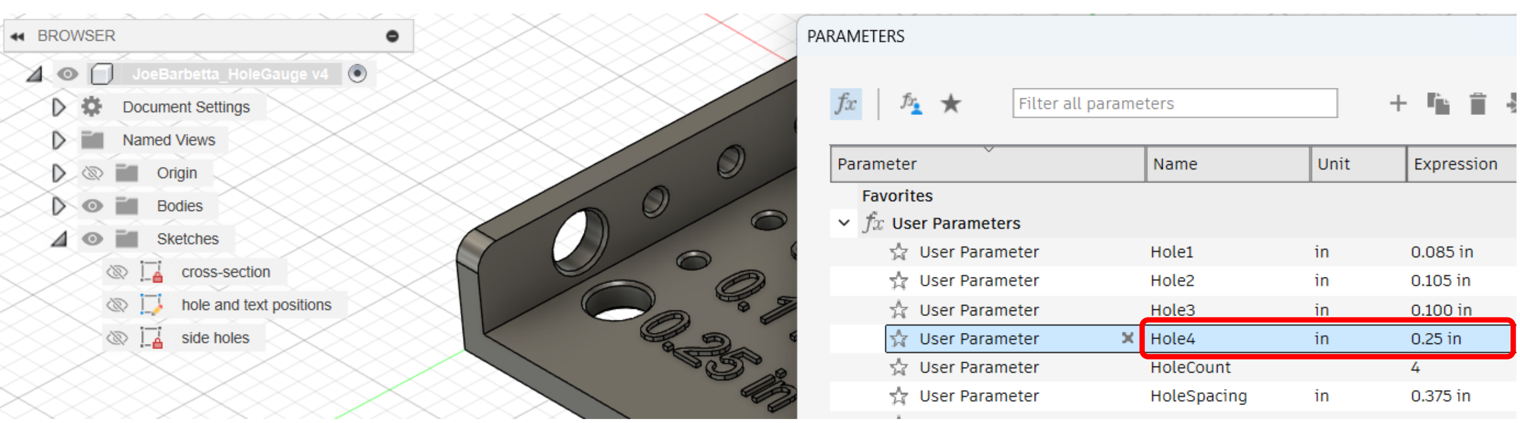
- from the **MODIFY** menu select **Change Parameters**, which is near the end of the menu
- click on the Expression for **GaugeLength**, which should be **HolePosY * 2 + HoleSpacing * HoleCount**
- add **Parentheses** and **- 1** to change it to **HolePosY * 2 + HoleSpacing * (HoleCount - 1)**
- click **OK** at the bottom of the PARAMETERS window



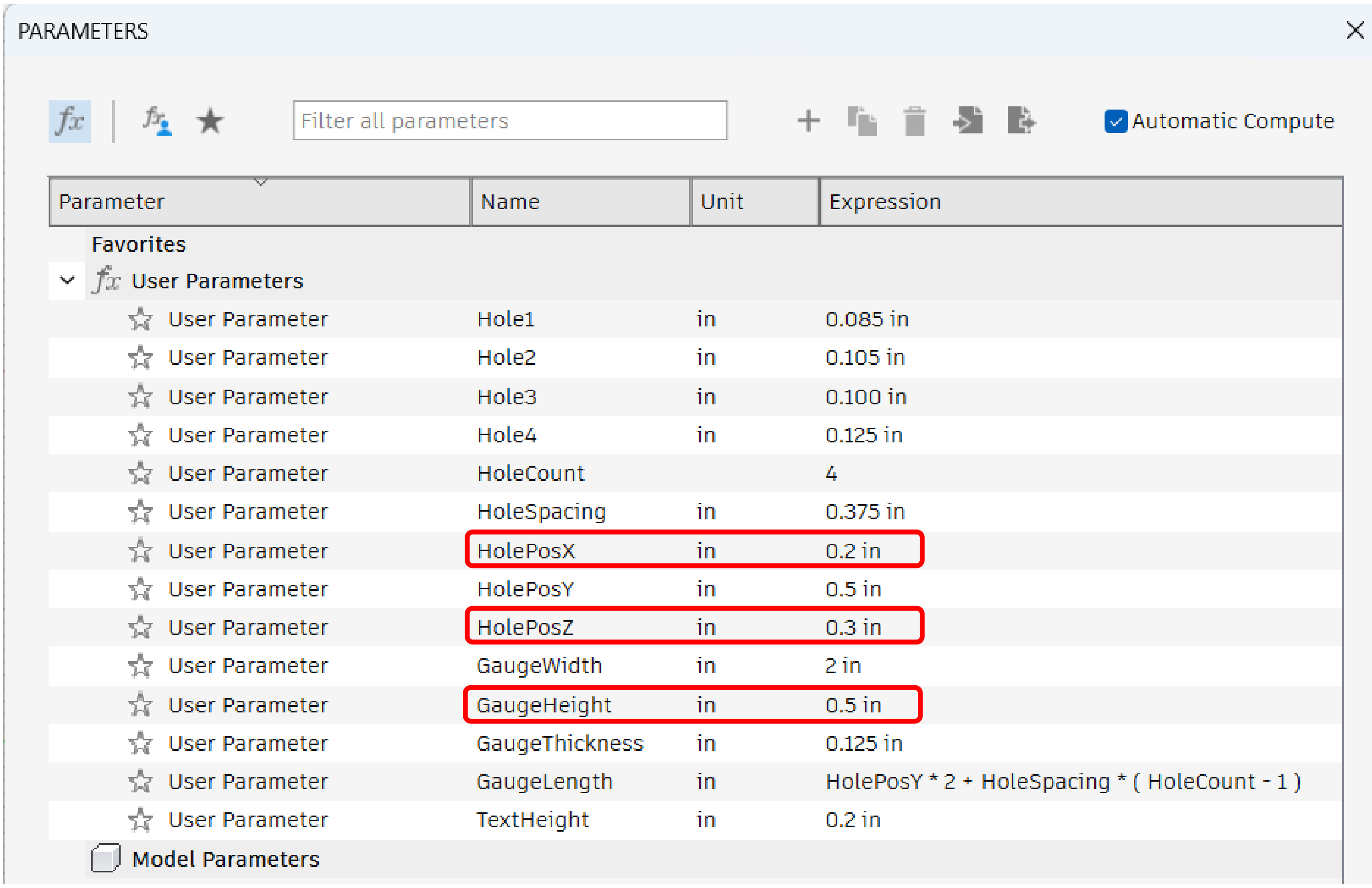
The length is now shorter.



- open Change Paremeters again and change the Expression for **Hole4** from **0.125** to **0.25** and see how the diameter of both the horizontal and vertical hole changes, as well as the text. Change it back to **0.125** and see everything change back.



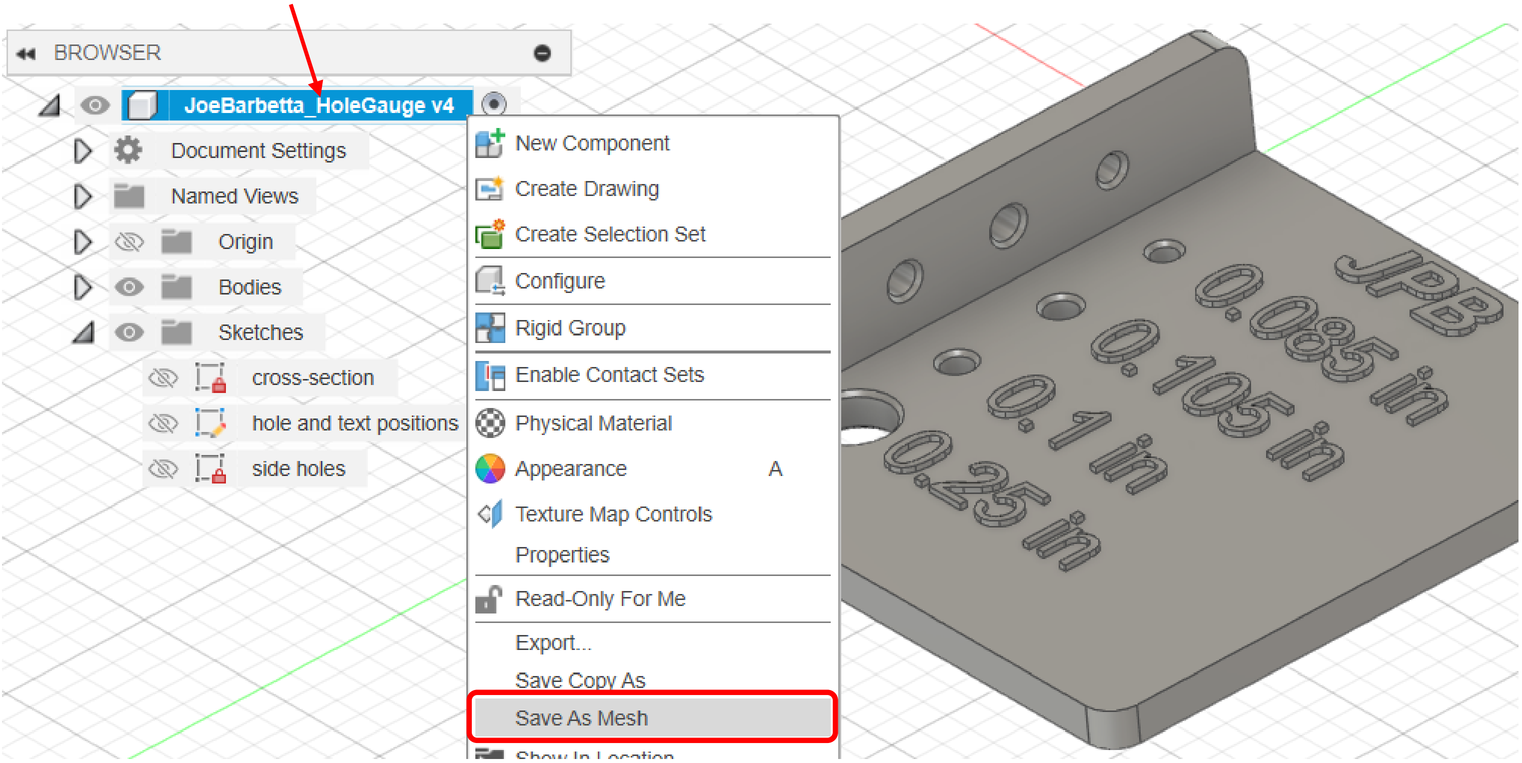
For hole diameters larger than 0.25, the horizontal holes will need to be shifted away from the wall and the height of the wall will need to be increased. The parameters **HolePosX**, **HolePosZ**, and **GaugeHeight** will need to be increased. One can use trial and error to adjust the values.



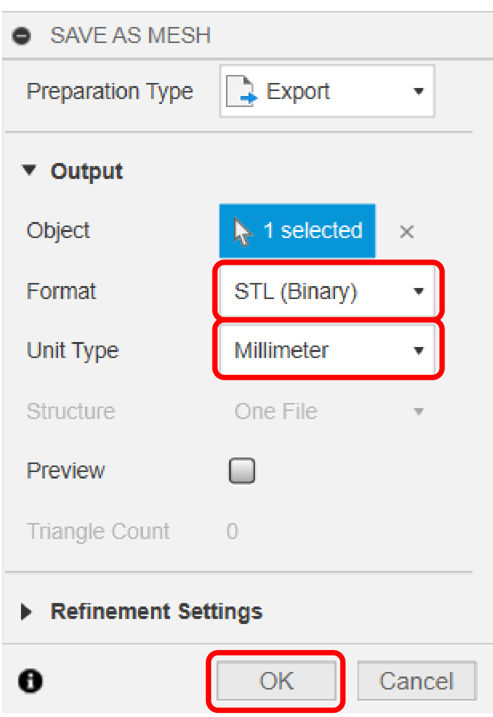
Parameter	Name	Unit	Expression
Favorites			
User Parameters			
User Parameter	Hole1	in	0.085 in
User Parameter	Hole2	in	0.105 in
User Parameter	Hole3	in	0.100 in
User Parameter	Hole4	in	0.125 in
User Parameter	HoleCount		4
User Parameter	HoleSpacing	in	0.375 in
User Parameter	HolePosX	in	0.2 in
User Parameter	HolePosY	in	0.5 in
User Parameter	HolePosZ	in	0.3 in
User Parameter	GaugeWidth	in	2 in
User Parameter	GaugeHeight	in	0.5 in
User Parameter	GaugeThickness	in	0.125 in
User Parameter	GaugeLength	in	HolePosY * 2 + HoleSpacing * (HoleCount - 1)
User Parameter	TextHeight	in	0.2 in
Model Parameters			

Exporting a STL File

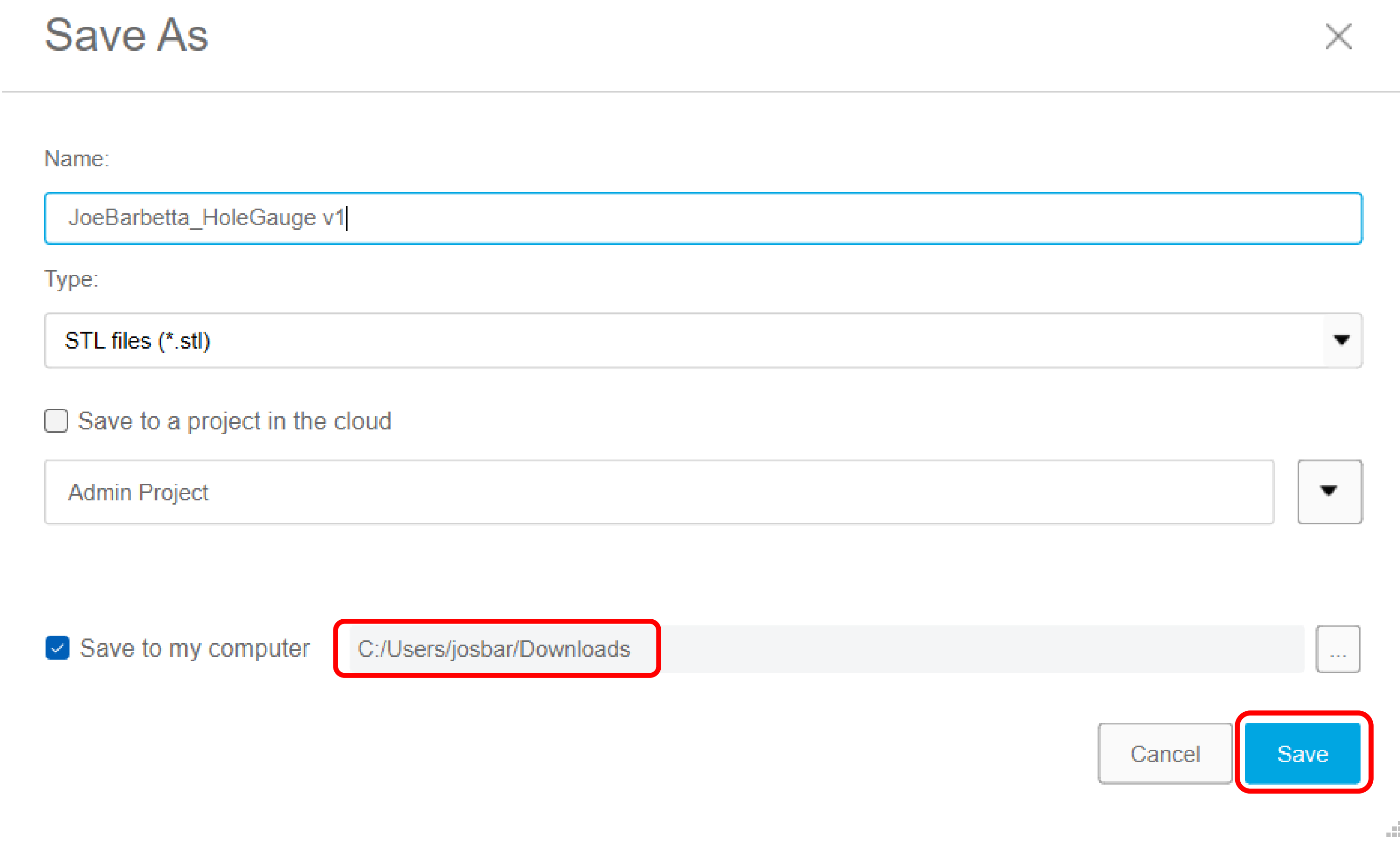
- right-click on the **project name** and select **Save As Mesh**



- set the parameters as shown and click **OK**



- click on **Save**



How holes can be made really accurate

One method to use involves designing the hole so that it prints slightly smaller, e.g. 0.005", and then use a typical drill bit on a drill press to finish the hole. Especially if the plastic is PLA, which has a low melting point, the drill must be done slowly. Try this on some practice holes to get a feel for how slow the drilling should be. Note that this applies to the **RPM** and **feed speed**. The **feed speed** is the **downward** speed on the drill bit.

For very accurate holes with good surface finishes, reamers are used to "open" a hole to its final diameter. The hole is first drilled a few thousandths smaller. They are accurately machined and their cost reflects this. Most reamers have straight flutes, as opposed to the spiral flutes of drill bits.

If one visits **McMaster.com** and enters **Reamers** in the search box and clicks on **Round Shank**, you will be presented with **2,623** different reamers. **Buy them all!**

Scroll down to the **0.125 (1/8 inch)** reamers and note how there are reamers with that exact diameters, but also sizes slightly smaller and larger to accommodate using a press fit or a loose fit on a shaft or pin. Of course, one needs to account for the tolerance of shafts or pins as well.

Of course for plastic and most metals, High-Speed Steel (the same material used in most drill bits) can be used.

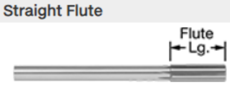
Cobalt and Carbide options are available for hardened steels.

2,623 Products — How can we improve? | Print | Forward

Reamers
Round Shank

Round Shank

Straight Flute



Reamer Dia.	Material	Lg. Flute	Lg. Overall	No. of Flutes	Spiral Direction	Cutting Dia. Tolerance	For Use On		Each
Inch									
0.1243"	High-Speed Steel	7/8"	3 1/2"	4	—	0" to 0.0002"	Aluminum, Brass, Bronze, Iron, Plastic, Stainless Steel, Steel	2777A16	24.67
0.1245"	High-Speed Steel	7/8"	3 1/2"	4	—	0" to 0.0002"	Aluminum, Brass, Bronze, Iron, Plastic, Stainless Steel, Steel	8803A252	20.07
0.1245"	Cobalt Steel	7/8"	3 1/2"	4	—	0" to 0.0002"	Aluminum, Brass, Bronze, Iron, Nickel, Plastic, Stainless Steel, Steel, Titanium, Tool Steel, Hardened Steel	8324A43	24.45
0.1245"	Carbide	5/8"	2 1/4"	4	—	0" to 0.0002"	Aluminum, Brass, Bronze, Fiberglass, Iron, Nickel, Plastic, Stainless Steel, Steel, Titanium, Tool Steel, Hardened Steel	8307A188	35.99
0.1248"	High-Speed Steel	7/8"	3 1/2"	4	—	0" to 0.0002"	Aluminum, Brass, Bronze, Iron, Plastic, Stainless Steel, Steel	2777A17	24.15
0.1250" (1/8")	High-Speed Steel	7/8"	3 1/2"	4	—	0" to 0.0002"	Aluminum, Brass, Bronze, Iron, Plastic, Stainless Steel, Steel	2995A61	20.32
0.1250" (1/8")	Cobalt Steel	7/8"	3 1/2"	4	—	0" to 0.0002"	Aluminum, Brass, Bronze, Iron, Nickel, Plastic, Stainless Steel, Steel, Titanium, Tool Steel, Hardened Steel	2975A22	23.62
0.1253"	High-Speed Steel	7/8"	3 1/2"	4	—	0" to 0.0002"	Aluminum, Brass, Bronze, Iron, Plastic, Stainless Steel, Steel	2777A171	24.67
0.1255"	High-Speed Steel	7/8"	3 1/2"	4	—	0" to 0.0002"	Aluminum, Brass, Bronze, Iron, Plastic, Stainless Steel, Steel	8803A253	19.30
0.1255"	Cobalt Steel	7/8"	3 1/2"	4	—	0" to 0.0002"	Aluminum, Brass, Bronze, Iron, Nickel, Plastic, Stainless Steel, Steel, Titanium, Tool Steel, Hardened Steel	8324A44	33.02
0.1256"	High-Speed Steel	7/8"	3 1/2"	4	—	0" to 0.0002"	Aluminum, Brass, Bronze, Iron, Plastic, Stainless Steel, Steel	2777A18	24.67
0.1257"	High-Speed Steel	7/8"	3 1/2"	4	—	0" to 0.0002"	Aluminum, Brass, Bronze, Iron, Plastic, Stainless Steel, Steel	2777A19	24.67
0.1265"	High-Speed Steel	7/8"	3 1/2"	4	—	0" to 0.0002"	Aluminum, Brass, Bronze, Iron, Plastic, Stainless Steel, Steel	8803A254	18.84

McMaster-Carr screws for 3D printed components

Self-threading screws are convenient for attaching 3D printed parts. Note that this differs from machine screws that need a nut or a threaded hole. Note that a hole can be tapped into a 3D printed part to create threads to accommodate a machine screw. However, this has to be done slowly and the tap hole size is important. A machine screw can also be used with a nut. One can attempt to 3D print the threads, but this works poorly for small hole sizes.

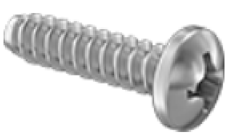
McMaster does sell some self-threading screws specifically for plastic, but some of them are expensive. Sheet Metal screws work fine and **Blunt Head** screws are preferred because they don't have the sharp points of regular sheet matal screws.

Here is a screenshot of the **Steel** screws from sizes **2 to 8** from McMaster followed by a screenshot of **18-8 Stainless Steel** screws. The great majority of Steel screws are Zinc-plated, as these are for corrosion prevention. **Stainless steel** may still be preferred for applications where parts may be exposed to water. Typically, any Stainless Steel component will be more expensive than Steel, however, sometimes with small screws, stainless steel may actually be cheaper. This may be due to the fact that they sell more of a certain type of screw, thus it can make sense to check both for the cheaper option.

Note that there are often screws available in **316 Stainless Steel**, which has better corrosion resistance compared to 18-8, but is more expensive, and available is less sizes. Sometimes 316 is used for marine applications subjected to salt water.

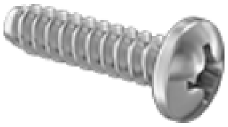
44 Products

Steel Rounded Head Blunt Screws for Sheet Metal



	Head							
Lg.	Dia.	Ht.	Drive Size	Drill Bit Size	Approximate Threads per Inch	Pkg. Qty.		Pkg.
Zinc-Plated Steel								
No. 2								
3/16"	0.167"	0.062"	No. 1	No. 48	32	100	90056A075	4.93
1/4"	0.167"	0.062"	No. 1	No. 48	32	100	90056A077	5.00
5/16"	0.167"	0.062"	No. 1	No. 48	32	100	90056A078	9.09
3/8"	0.167"	0.062"	No. 1	No. 48	32	100	90056A079	4.78
No. 4								
3/16"	0.219"	0.08"	No. 1	No. 44	24	100	90056A105	3.93
1/4"	0.219"	0.08"	No. 1	No. 44	24	100	90056A106	3.93
5/16"	0.219"	0.08"	No. 1	No. 44	24	100	90056A107	4.04
3/8"	0.219"	0.08"	No. 1	No. 44	24	100	90056A108	4.04
1/2"	0.219"	0.08"	No. 1	No. 44	24	100	90056A110	4.27
No. 6								
3/16"	0.27"	0.097"	No. 2	No. 32	20	100	90056A143	4.56
1/4"	0.27"	0.097"	No. 2	No. 32	20	100	90056A144	4.56
5/16"	0.27"	0.097"	No. 2	No. 32	20	100	90056A145	6.31
3/8"	0.27"	0.097"	No. 2	No. 32	20	100	90056A146	5.80
1/2"	0.27"	0.097"	No. 2	No. 32	20	100	90056A148	4.75
5/8"	0.27"	0.097"	No. 2	No. 32	20	100	90056A150	5.53
3/4"	0.27"	0.097"	No. 2	No. 32	20	100	90056A151	5.27
No. 8								
1/4"	0.322"	0.115"	No. 2	No. 29	18	100	90056A190	8.55
3/8"	0.322"	0.115"	No. 2	No. 29	18	100	90056A192	5.51
1/2"	0.322"	0.115"	No. 2	No. 29	18	100	90056A194	9.07
5/8"	0.322"	0.115"	No. 2	No. 29	18	100	90056A196	6.24
3/4"	0.322"	0.115"	No. 2	No. 29	18	100	90056A197	6.76
1"	0.322"	0.115"	No. 2	No. 29	18	100	90056A199	7.11

18-8 Stainless Steel Rounded Head Blunt Screws for Sheet Metal



18-8 stainless steel screws have good chemical resistance and may be mildly magnetic. Often referred to as Type B thread-forming screws, they require a drilled hole and are typically used in 0.050"-0.200" material. Length is measured from under head.

Lg.	Head Dia.	Head Ht.	Drive Size	Drill Bit Size	Approximate Threads per Inch	Pkg. Qty.		Pkg.
18-8 Stainless Steel								
No. 2								
1/8"	0.167"	0.053"	No. 1	No. 48	32	50	92525A102	$6.03
3/16"	0.167"	0.053"	No. 1	No. 48	32	50	92525A106	6.22
1/4"	0.167"	0.053"	No. 1	No. 48	32	100	92525A110	5.14
5/16"	0.167"	0.053"	No. 1	No. 48	32	100	92525A114	5.34
3/8"	0.167"	0.053"	No. 1	No. 48	32	100	92525A118	5.69
1/2"	0.167"	0.062"	No. 1	No. 48	32	50	92525A121	9.69
5/8"	0.167"	0.062"	No. 1	No. 48	32	100	92525A146	5.59
3/4"	0.167"	0.062"	No. 1	No. 48	32	25	92525A122	7.24
1"	0.167"	0.062"	No. 1	No. 48	32	25	92525A123	7.34
No. 4								
3/16"	0.219"	0.08"	No. 1	No. 44	24	50	92525A198	3.52
1/4"	0.219"	0.08"	No. 1	No. 44	24	100	92525A201	4.90
5/16"	0.219"	0.08"	No. 1	No. 44	24	100	92525A203	5.04
3/8"	0.219"	0.08"	No. 1	No. 44	24	100	92525A205	5.30
7/16"	0.219"	0.08"	No. 1	No. 44	24	25	92525A124	6.14
1/2"	0.219"	0.08"	No. 1	No. 44	24	100	92525A207	5.84
5/8"	0.219"	0.08"	No. 1	No. 44	24	100	92525A209	6.61
3/4"	0.219"	0.08"	No. 1	No. 44	24	100	92525A213	6.96
7/8"	0.219"	0.08"	No. 1	No. 44	24	50	92525A125	16.73
1"	0.219"	0.08"	No. 1	No. 44	24	25	92525A126	8.61
1 1/4"	0.219"	0.08"	No. 1	No. 44	24	25	92525A127	7.85
1 1/2"	0.219"	0.08"	No. 1	No. 44	24	25	92525A128	11.62
1 3/4"	0.219"	0.08"	No. 1	No. 44	24	10	92525A129	5.83
2"	0.219"	0.08"	No. 1	No. 44	24	10	92525A131	6.17
No. 6								
3/16"	0.27"	0.097"	No. 2	No. 32	20	50	92525A308	9.41
1/4"	0.27"	0.097"	No. 2	No. 32	20	100	92525A311	6.21
5/16"	0.27"	0.097"	No. 2	No. 32	20	100	92525A313	6.69
3/8"	0.27"	0.097"	No. 2	No. 32	20	100	92525A315	7.28
7/16"	0.27"	0.097"	No. 2	No. 32	20	25	92525A132	6.80
1/2"	0.27"	0.097"	No. 2	No. 32	20	100	92525A317	7.50
5/8"	0.27"	0.097"	No. 2	No. 32	20	100	92525A319	8.57
3/4"	0.27"	0.097"	No. 2	No. 32	20	100	92525A323	8.31
7/8"	0.27"	0.097"	No. 2	No. 32	20	100	92525A147	8.35
1"	0.27"	0.097"	No. 2	No. 32	20	100	92525A148	8.69
1 1/4"	0.27"	0.097"	No. 2	No. 32	20	25	92525A133	12.07
1 1/2"	0.27"	0.097"	No. 2	No. 32	20	25	92525A134	9.92
No. 7								
3/8"	0.296"	0.106"	No. 2	No. 30	19	50	92525A135	10.53
No. 8								
1/4"	0.322"	0.115"	No. 2	No. 29	18	100	92525A420	8.99
5/16"	0.322"	0.115"	No. 2	No. 29	18	100	92525A422	9.08
3/8"	0.322"	0.115"	No. 2	No. 29	18	100	92525A424	9.86
7/16"	0.322"	0.115"	No. 2	No. 29	18	25	92525A136	13.67
1/2"	0.322"	0.115"	No. 2	No. 29	18	100	92525A426	10.22
5/8"	0.322"	0.115"	No. 2	No. 29	18	100	92525A428	11.73
3/4"	0.322"	0.115"	No. 2	No. 29	18	100	92525A430	12.68
7/8"	0.322"	0.115"	No. 2	No. 29	18	100	92525A149	13.13
1"	0.322"	0.115"	No. 2	No. 29	18	100	92525A440	14.51
1 1/4"	0.322"	0.115"	No. 2	No. 29	18	50	92525A451	9.20
1 1/2"	0.322"	0.115"	No. 2	No. 29	18	50	92525A151	9.60
1 3/4"	0.322"	0.115"	No. 2	No. 29	18	10	92525A137	8.26
2"	0.322"	0.115"	No. 2	No. 29	18	5	92525A138	6.82