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

# Dress up your ID

## Design a 3D Printed *ID Frame*

# Today's Lesson is Sponsored by DIGGERLAND in West Berlin, NJ

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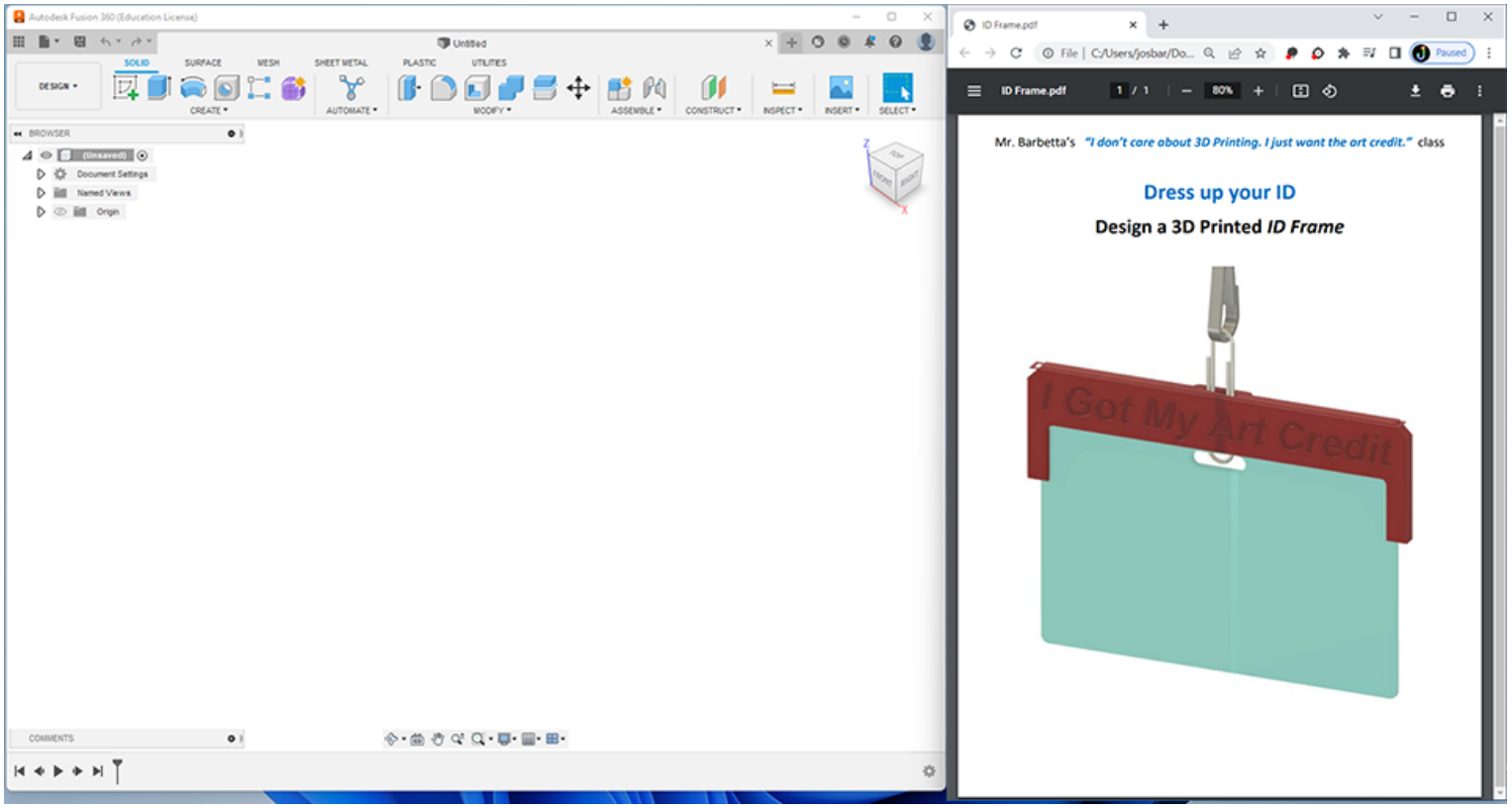
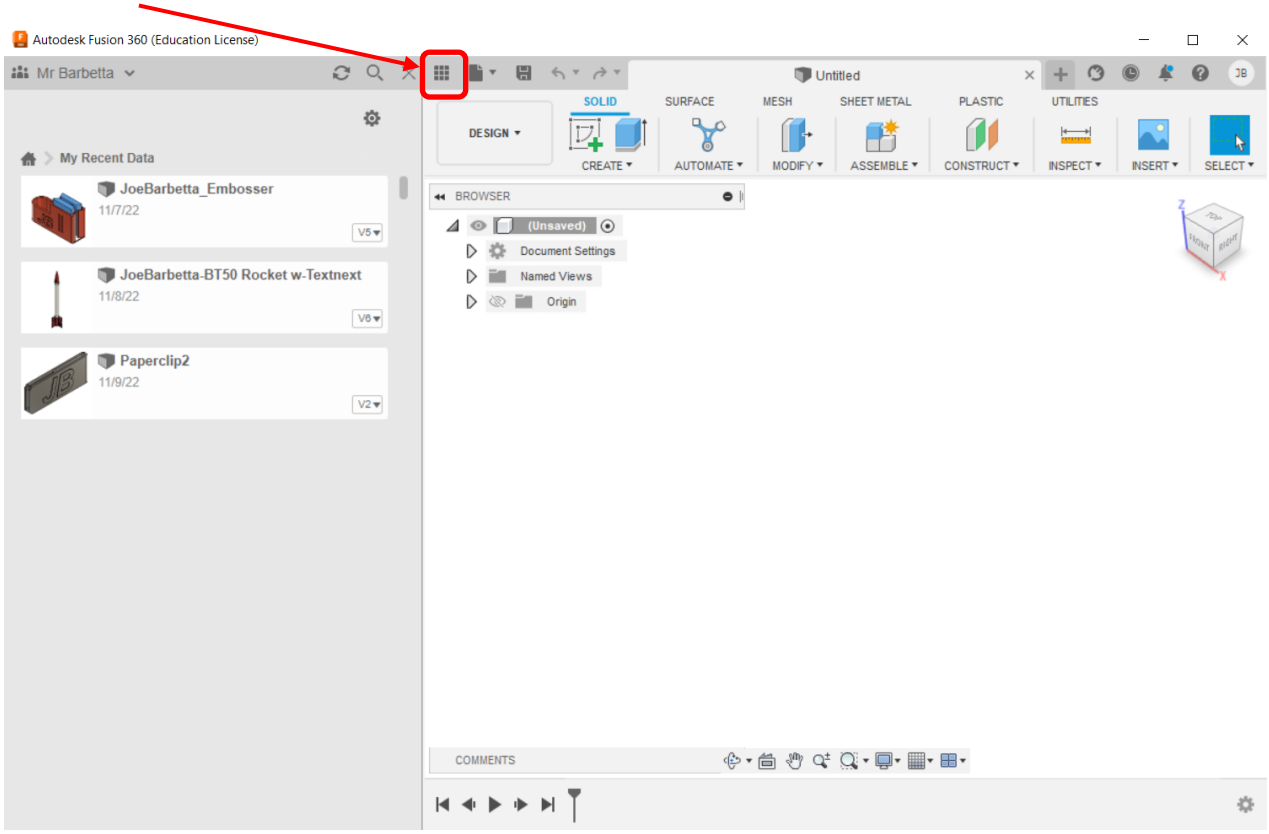
# Contents

# Using This Document

The best way to follow this document is to **reduce the width of the Fusion 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.



## Considerations for DFM (Design For Manufacturing)

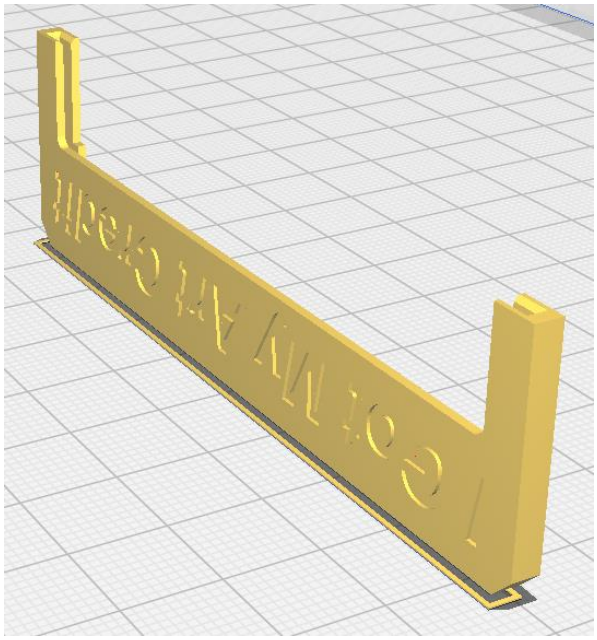
**This page if for information. The actual instructions begin on page 7 (Starting a Design in Fusion).**

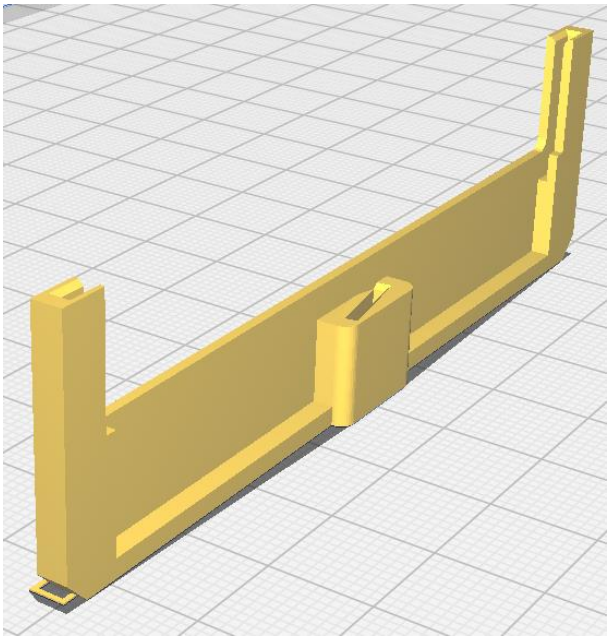
With a design that targets 3D Printing, a major consideration is the print orientation. The printing starts by printing the first layer on the Print Bed (also called the Build Plate), which is representing by the grid. This is the front and back of the design in the Cura Slicer program. The printer then prints layer upon layer. For this design a layer thickness of 0.15 mm was chosen, which results in 176 layers.

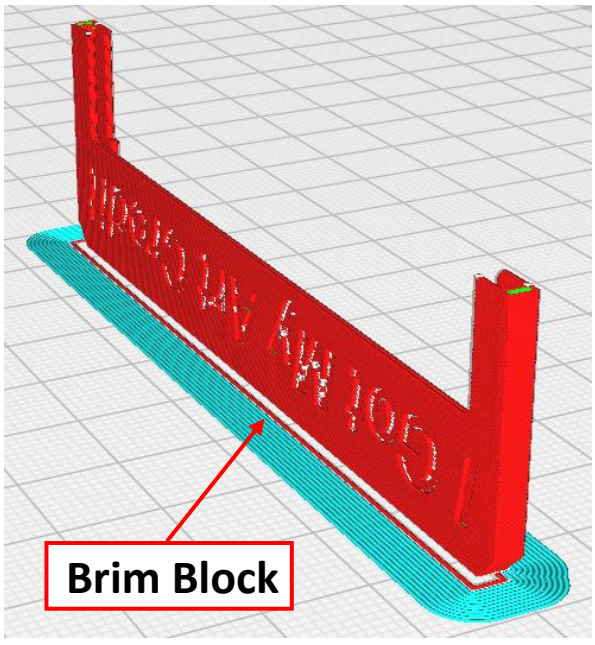
We are essentially printing the frame upside down and this is the only orientation so that the print doesn't have any overhangs, except for that at the corners. However, the corner overhangs still adhere to the 3D Printing 45 Degree Rule, which is discussed later in this document.

By eliminating overhangs, there is no need for *Supports*. 3D Printed Supports can be generated by the slicer program to allow the printing of overhangs; however, they can be time consuming to remove and degrade the print surfaces that they support.

The vertical orientation also minimizes the area of the print bed that each frame occupies, thus allowing more frames to be printed at one time.








Another design consideration concerns the **Brim**.

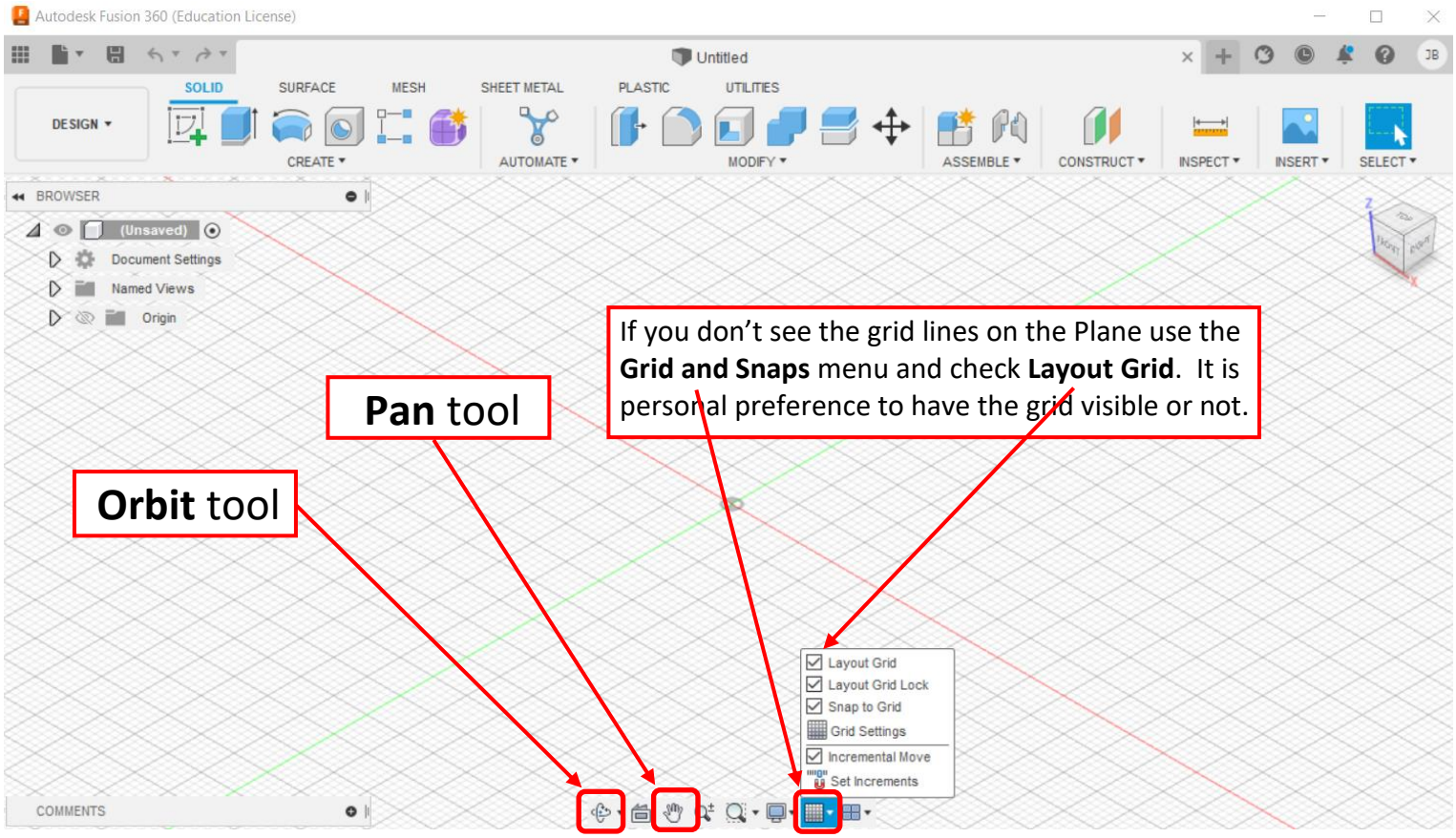
By default, the Cura Slicer software will generate an extension of the first layer around the bottom of parts. This aids "**bed adhesion**" by preventing sections of the first layer from separating from the build plate. After printing is finished, the brim is removed by hand.

When the Brim is removed the edges around the part will not be "clean". We can ensure a clean edge at the front of the frame by adding a **"blocking"** member shown as the thin edge extending slightly out from the front of the frame.

# 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

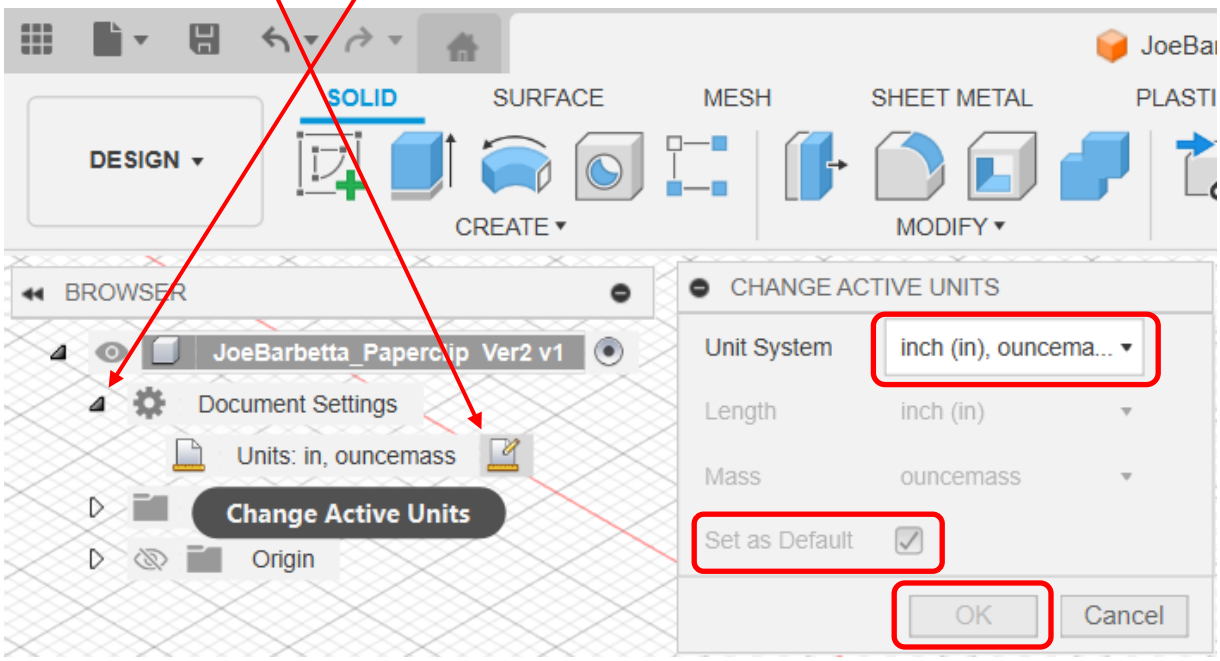
# Starting a Design in Fusion

- 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 **_IDFrame** e.g. **JoeBarbetta_IDFrame** (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 360 on a different computer, your projects will be available.

As you work you may want to occasionally save your work in case Fusion crashes.

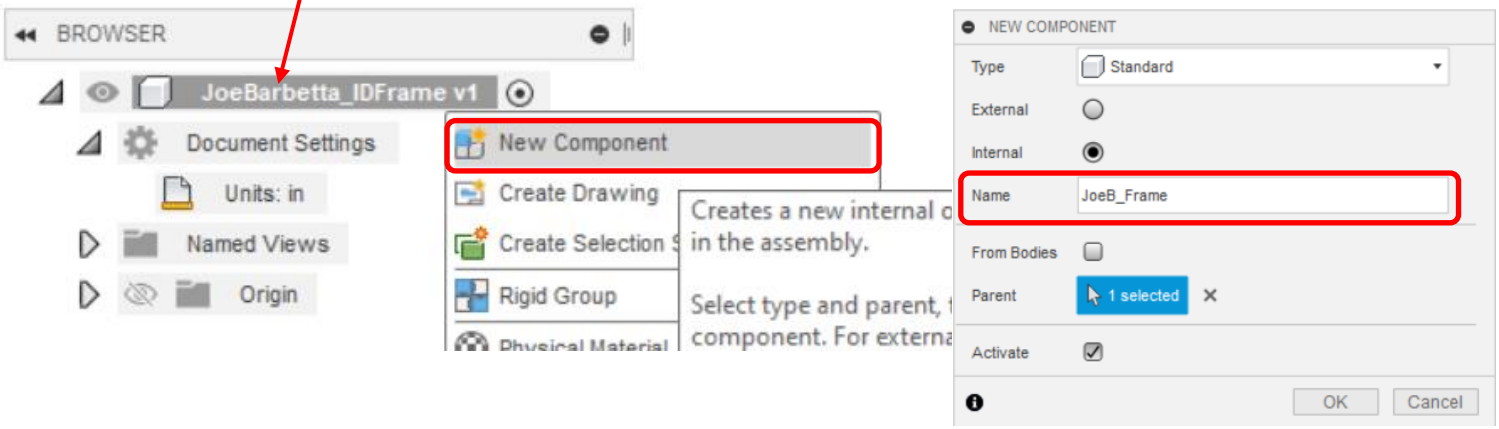
- in the left **"BROWSER"** click the **arrow next to Document Settings**
- click on the **edit icon** that appears to the left when you hover over **Units**
- ensure **Active Units** are set to **Units: in, ouncemass** and click **OK**. You can also enable **Set as Default** if it is not grayed out.



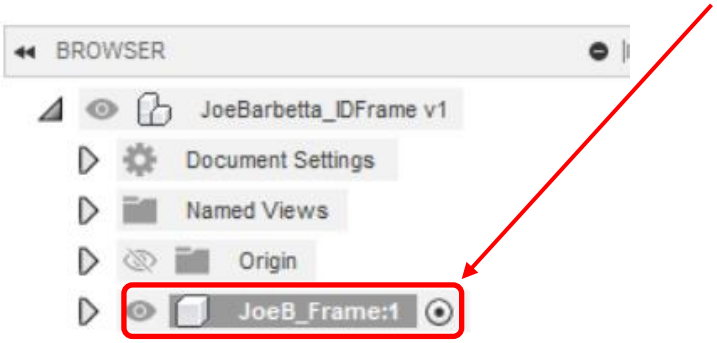
## Creating a New Component

To keep a project organized it is recommended to create a new Component for each part.

- right-click on the **Project Name** at the top of the BROWSER and select **New Component**
- set **Name** as **Your first name and last name initial followed by _Frame** e.g. **JoeB_Frame** and click **OK**

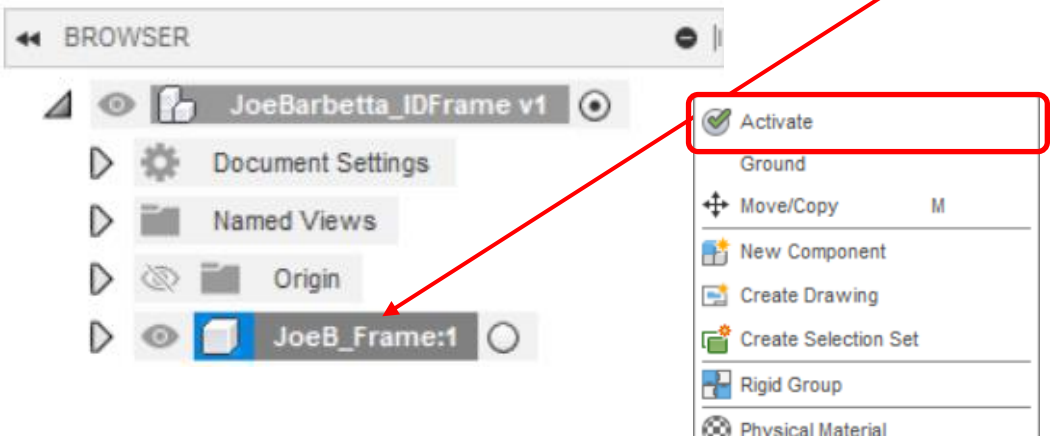



The new *Component* should show in the *Browser*.
Note that the area around the name is darkened and the circle with the dot. This indicates that it is the ***Active Component***.




# One reason to hate Fusion!

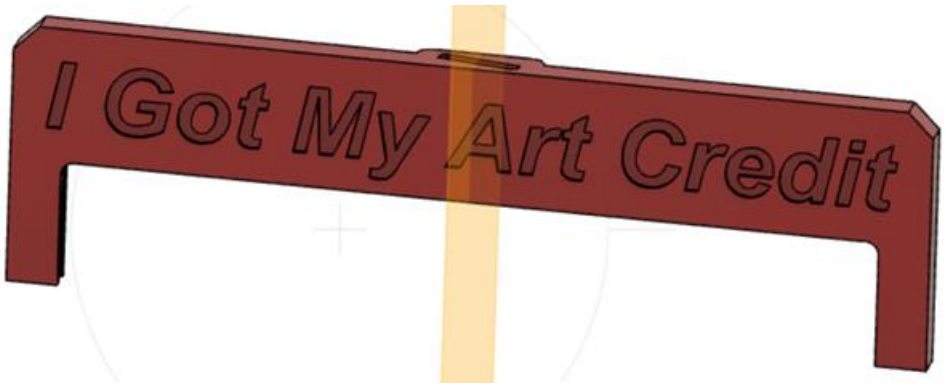
When a project is saved and then reopened, the Component that was Active is no longer Active.
If one wants to continue working on a Component, it must be reactivated by **right-clicking on the Component Name** and selecting **Activate**. One can also click on the circle to the right of the Component name.



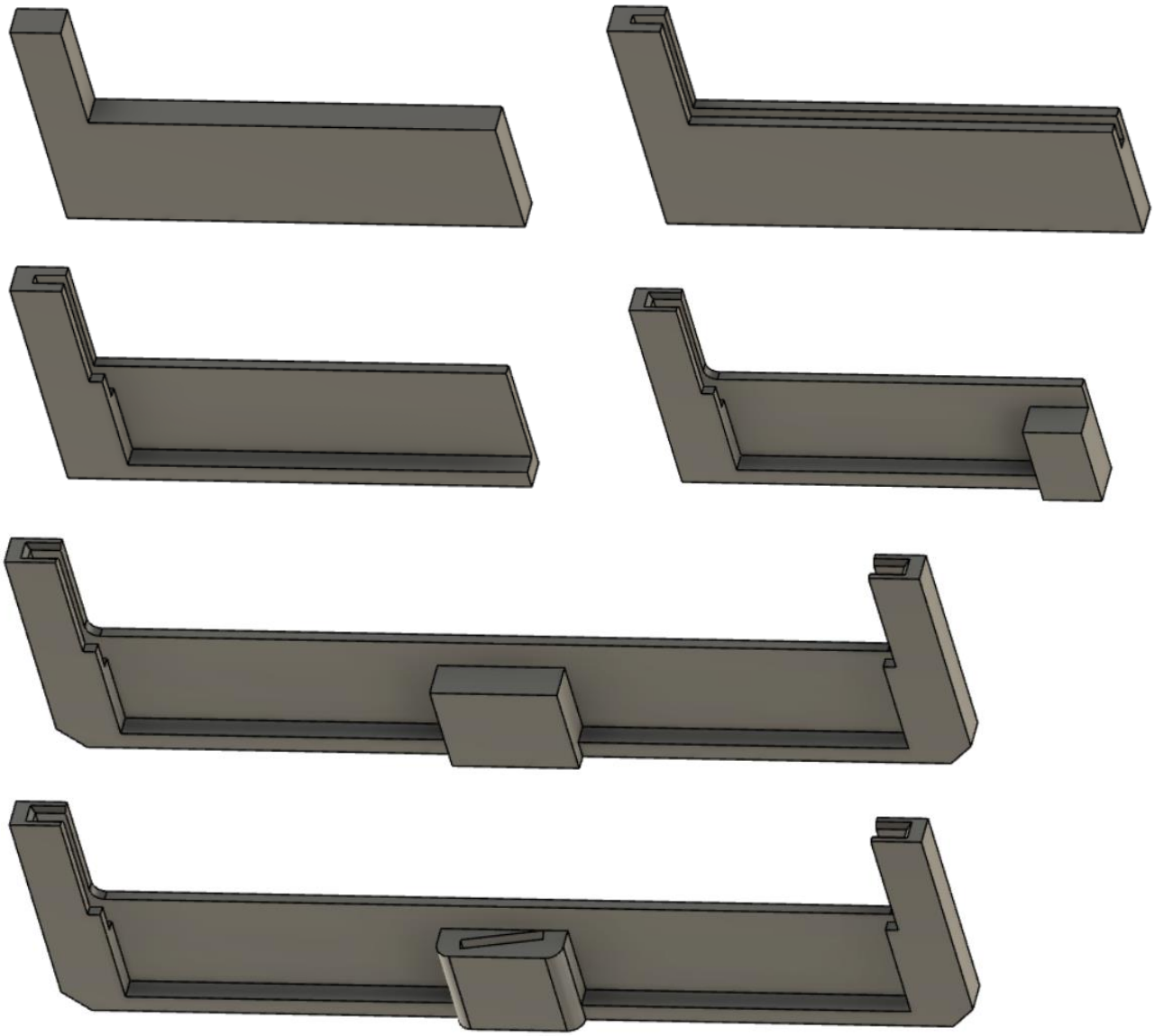
# Strategizing the CAD Process

**The CAD (Computer Aided Design) process itself involves a lot of creativity** because various strategies can be used to arrive at the exact same result. One useful feature that most CAD software has is the ability to design half of the object and then at a later point in the process to **Mirror** the half to arrive at the full object.

This object is mostly symmetrical along the plane shown and we will start by designing the left half.



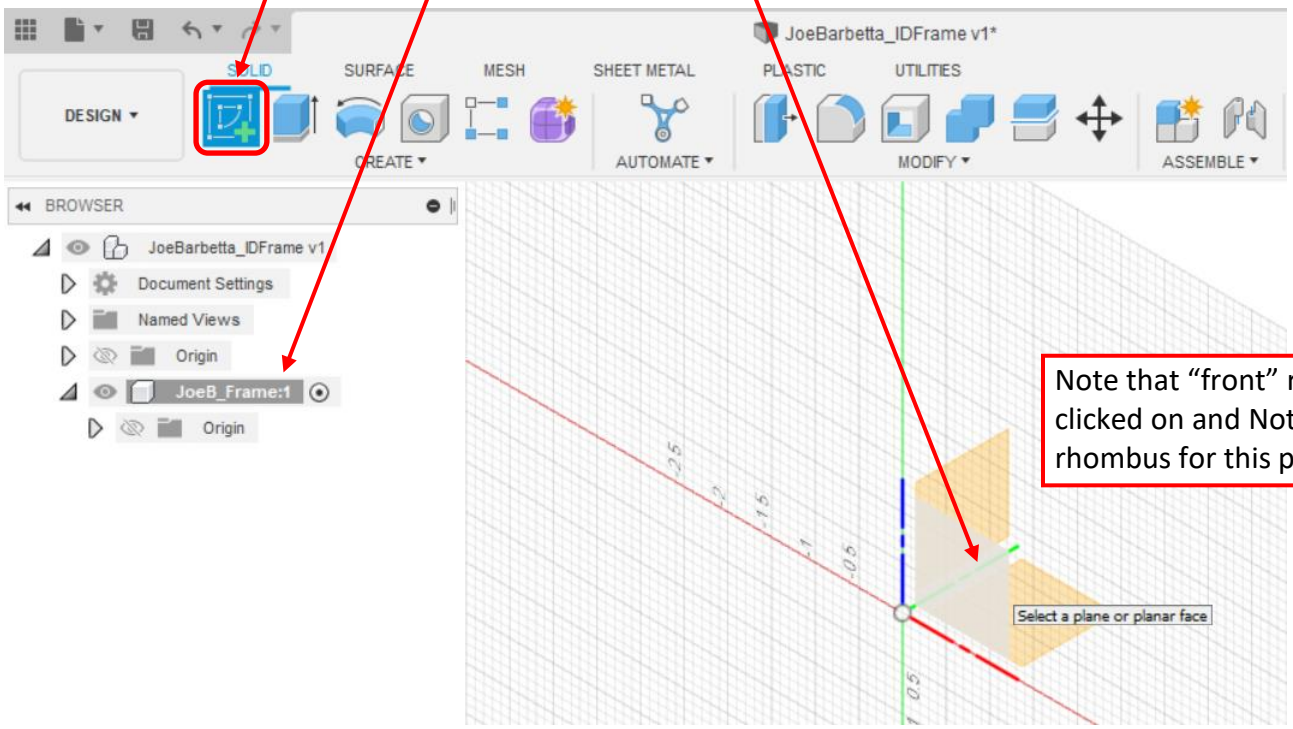

Below is a summary of the transitions from a simple shape to the point before the text is added. The rest of this document provides the details for these steps. There can be many different paths that can be chosen to arrive at the final design. The general methodology here is cutting away sections from the original L shape.



# Creating the First Sketch

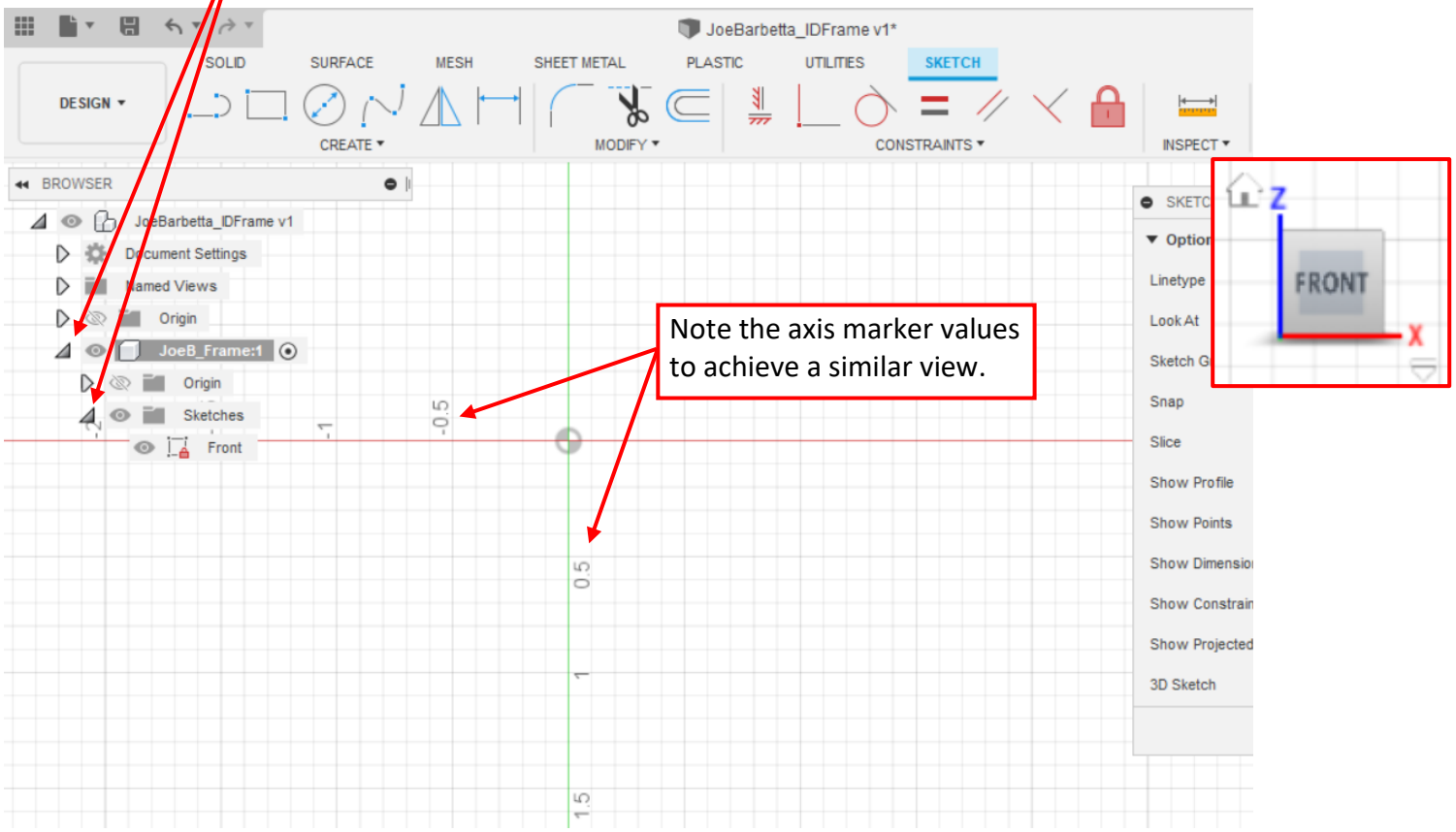
- ensure that the **new component is Active** (has a dot in its circle)
- select the top **Create Sketch** tool and click on the **front rhombus** to select the X-Z Plane.

If a tool can't be found, one can always look in the **CREATE** and **MODIFY** menus for it.




Note that "front" rhombus is clicked on and Not the "bottom" rhombus for this project.

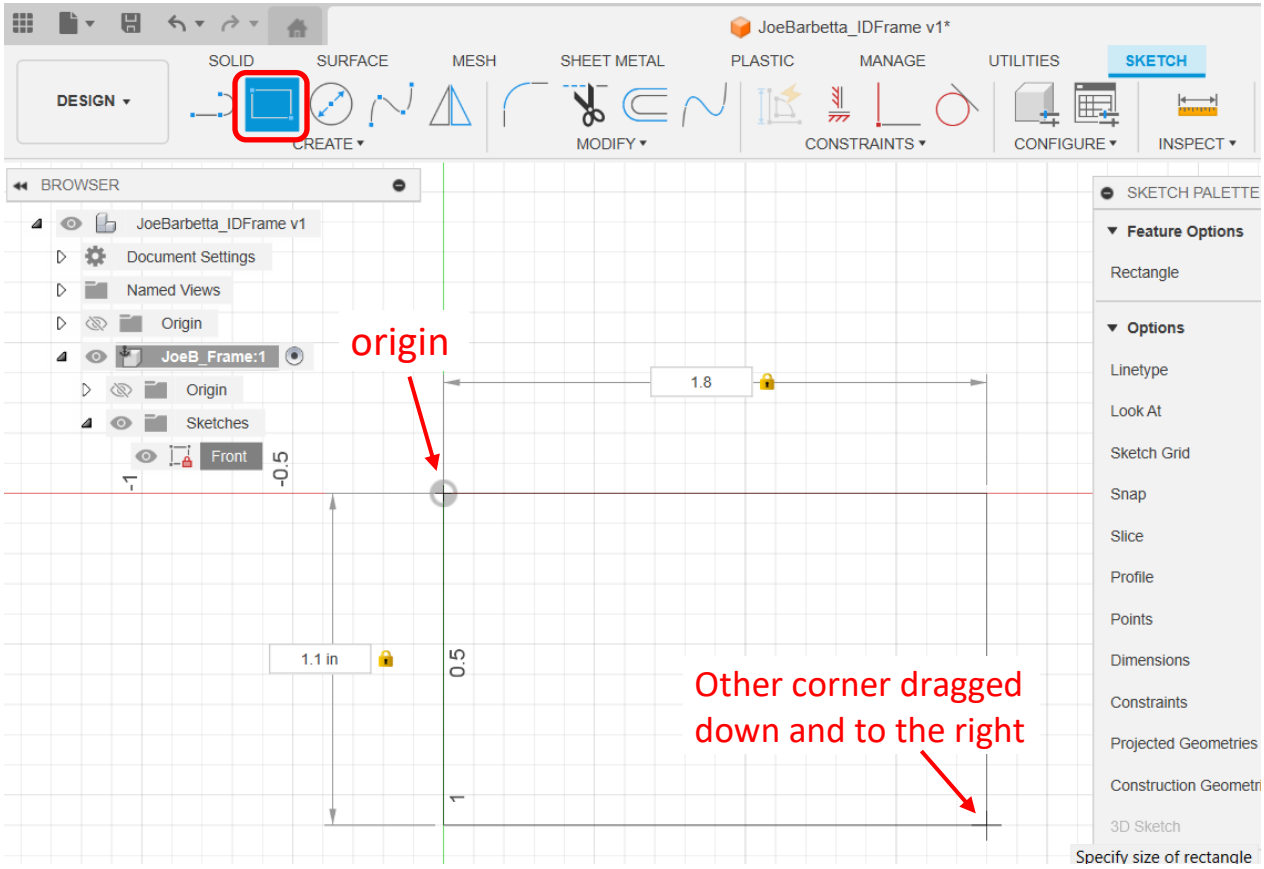
- ensure the upper right **View Cube** displays **FRONT** as shown. If not, return to the previous step.
- **zoom** and use the Pan (hand icon) if needed to adjust the view to be similar to that below
- click on the **Expand Arrows** to open both the Component and Sketch Folder
- right-click on the default Sketch Name, Sketch1, select **Rename**, and change the name to **Front**



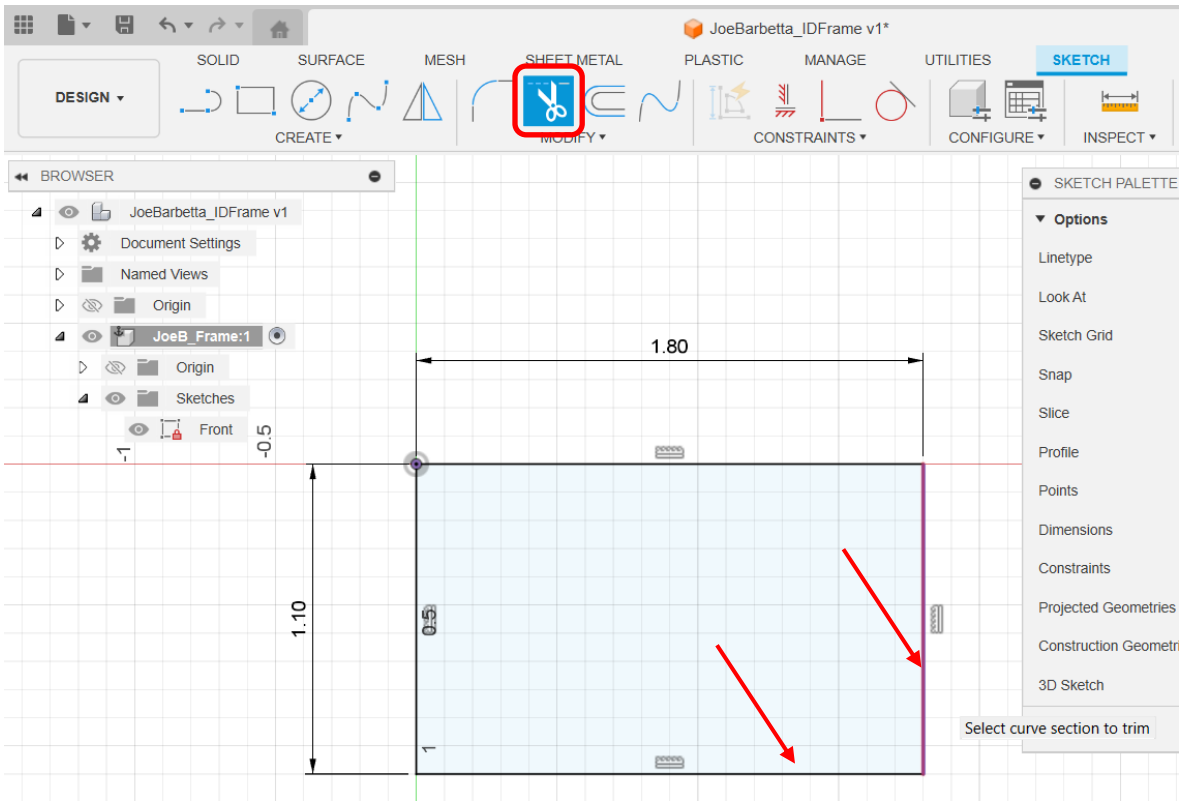

Note the axis marker values to achieve a similar view.

- select the **Rectangle** tool
- click on the **Origin** to start the rectangle and drag the other corner down and to the right.
- type **1.1** for the height, press the Tab key, type **1.8** for the width and then press the **Enter key**.

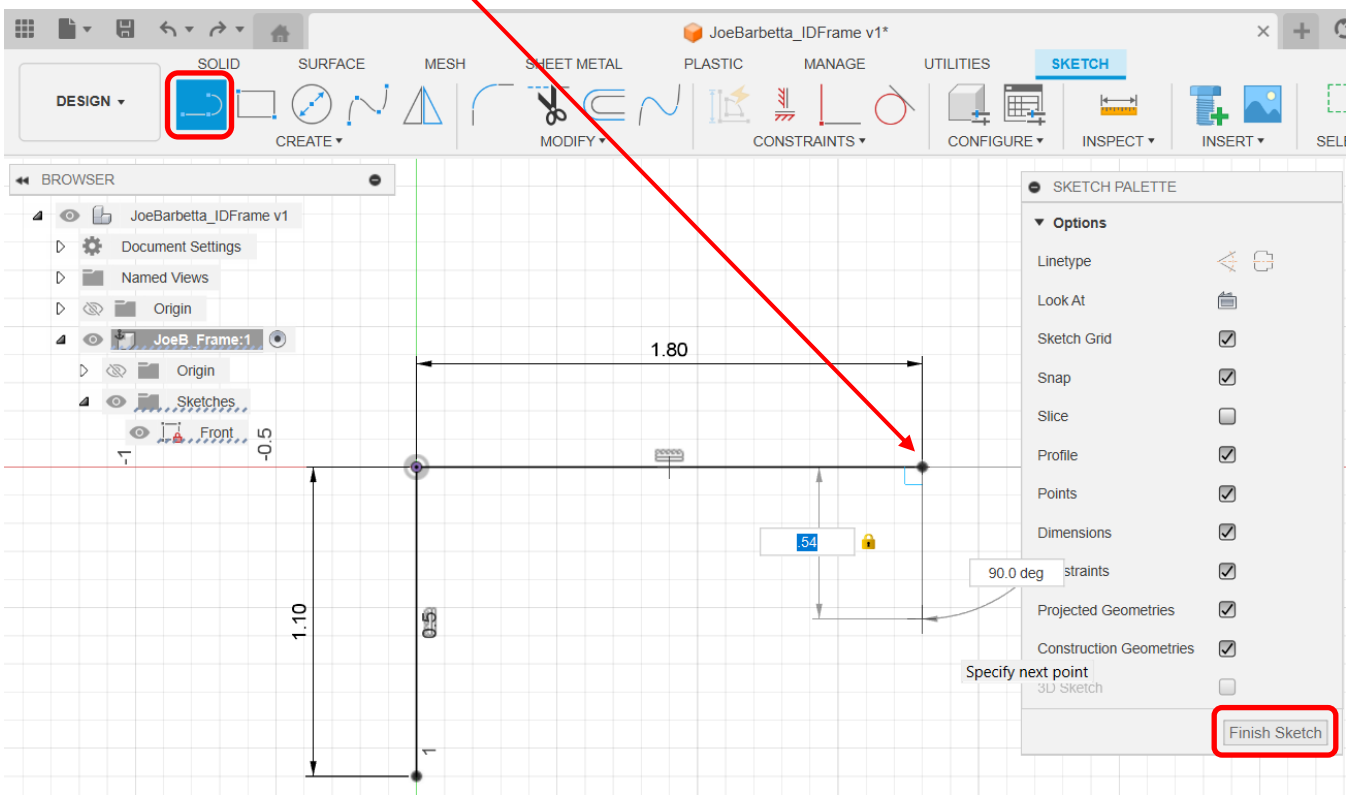
Note how the **Tab key** allows one to jump between multiple dimensions of an item being drawn.




- select the top **Trim** tool and click on the **bottom** and **right edges** of the rectangle to delete these edges.

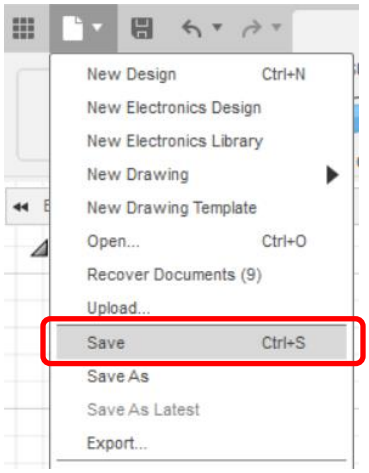


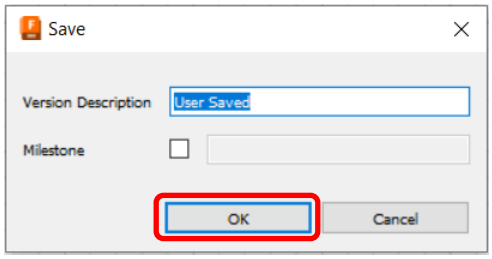
- select the top **Line** tool
- click at the **end of the top line** as shown, extend the line down, type **0.54**, and then the **Enter key**. Click **Finish Sketch**.

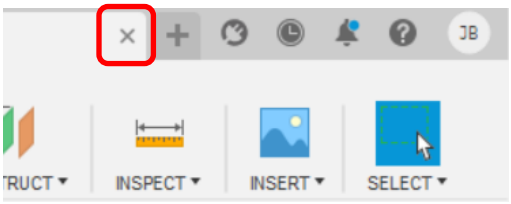



## Saving and Reopening a Project

- even though you are far from done select **Save** from the top **File** menu
- click **OK** in the Save popup window. The Version Description can be kept at its default.
- close the Project by clicking on the **X** on its top tab

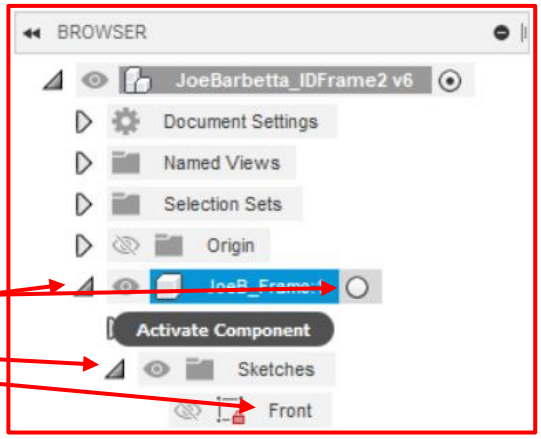


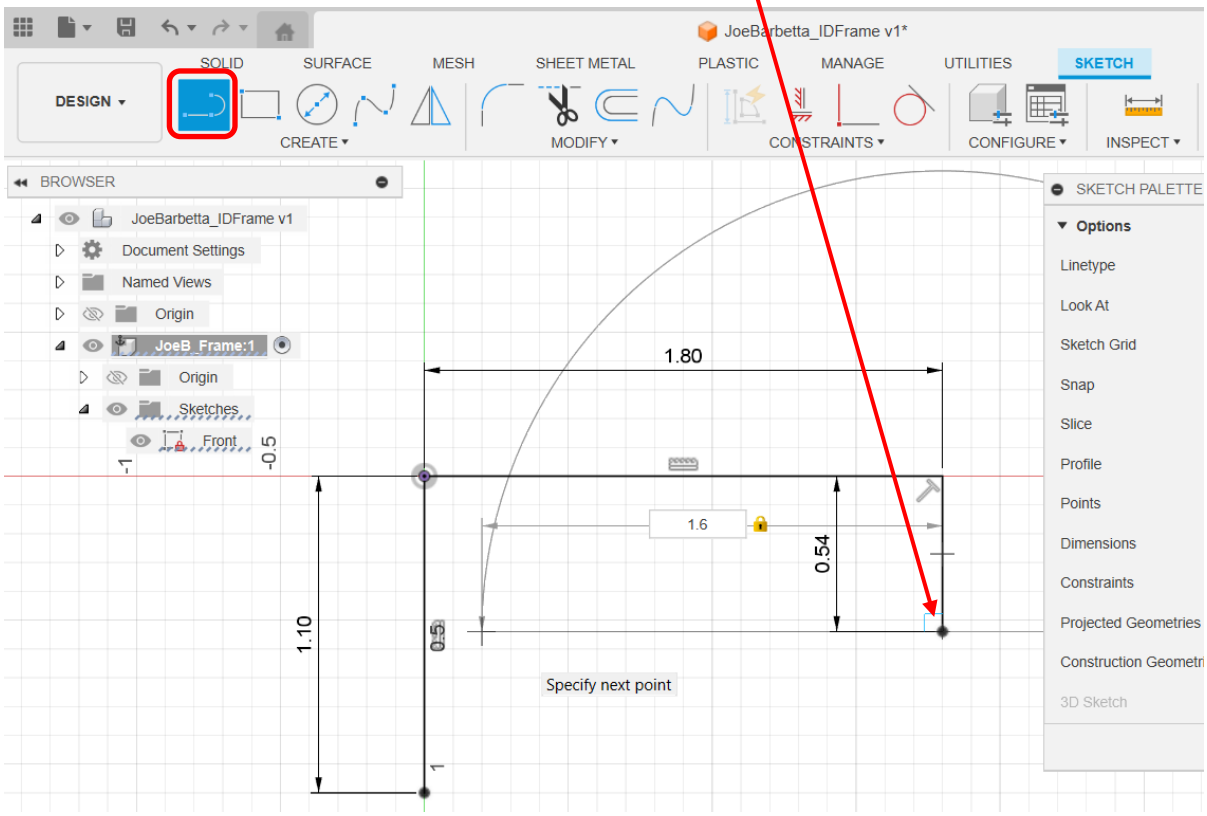

- select **Open…** from the **File** menu and open your project
Note that the component last worked on is no longer Active and the Sketches folder is closed.

- click on the **circle** next to your **Frame** Component to make it **Active**
- click on the **Expand Arrows** to view the **Sketches**
- right-click on the **Front** Sketch and select **Edit Sketch** to continue working on it

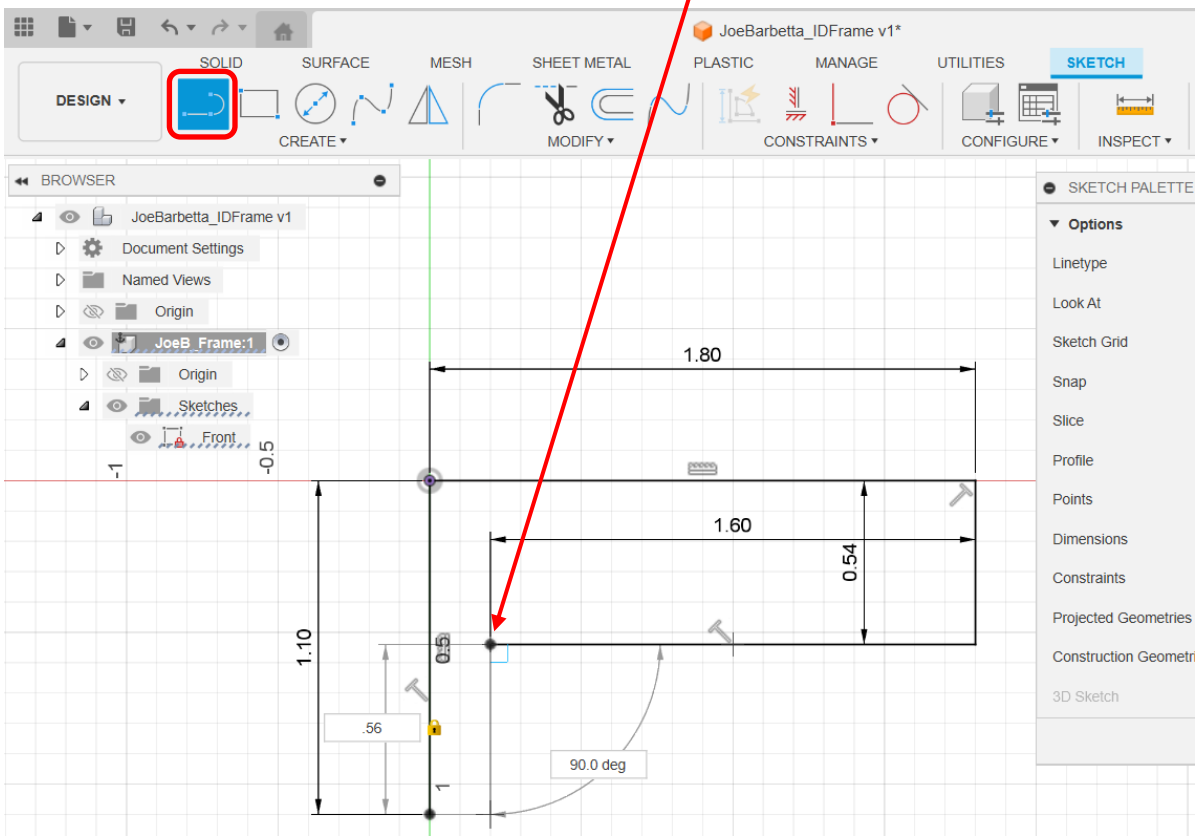


**You will need to make the Frame Active each time you open your project.**

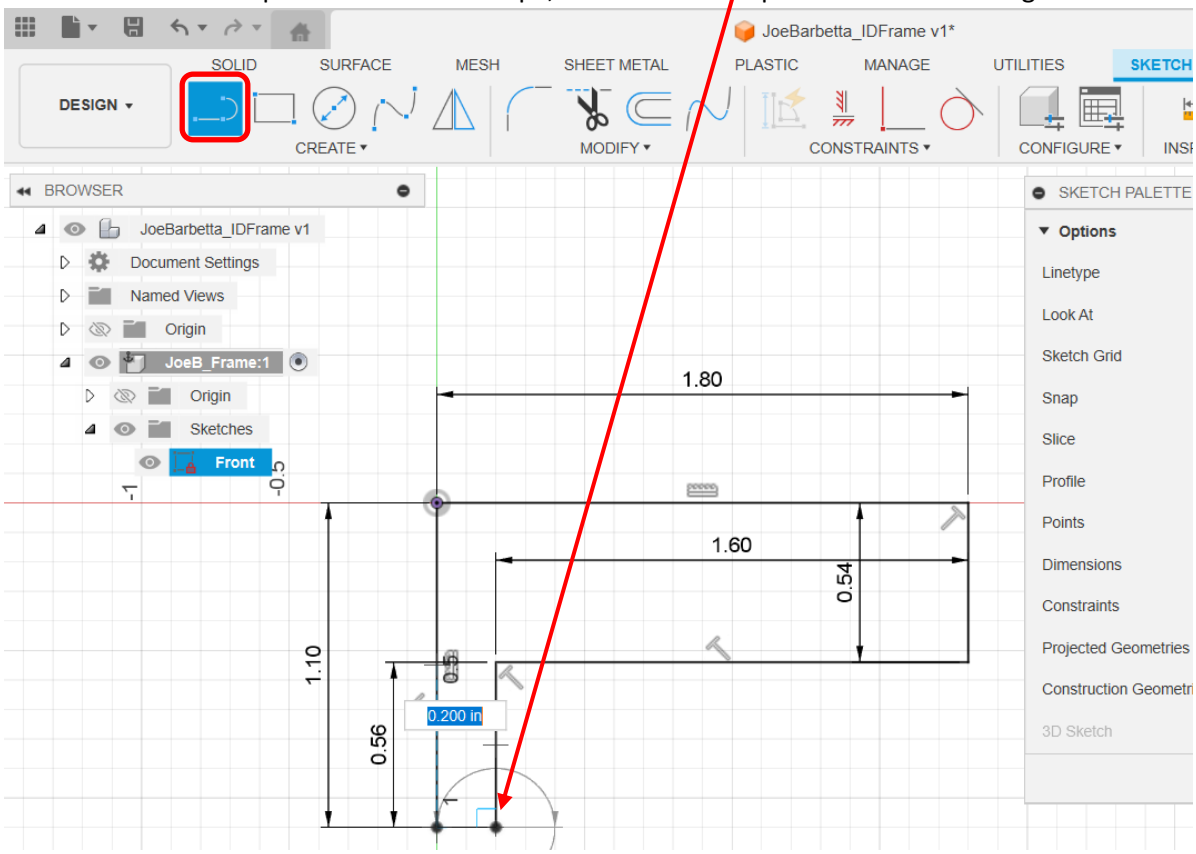
- select the **Line** tool and click on the **end of the last line drawn**
- **extend the line to the left** (keeping it horizontal), type **1.6** and then the **Enter key**.



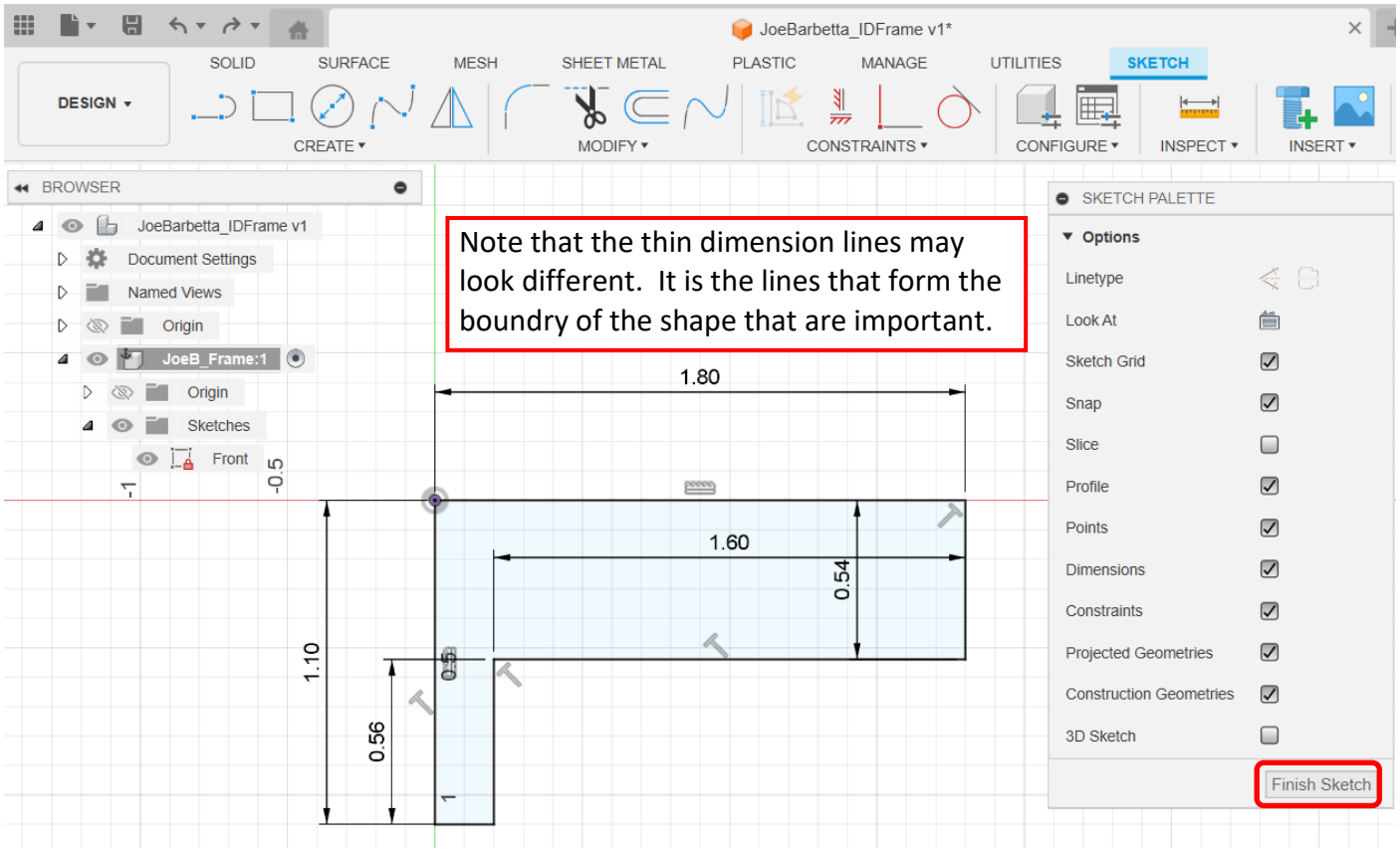

- select the **Line** tool and click on the **end of the last line drawn**
- **extend the line down** (keeping it vertical), type **0.56,** and then the **Enter key**.



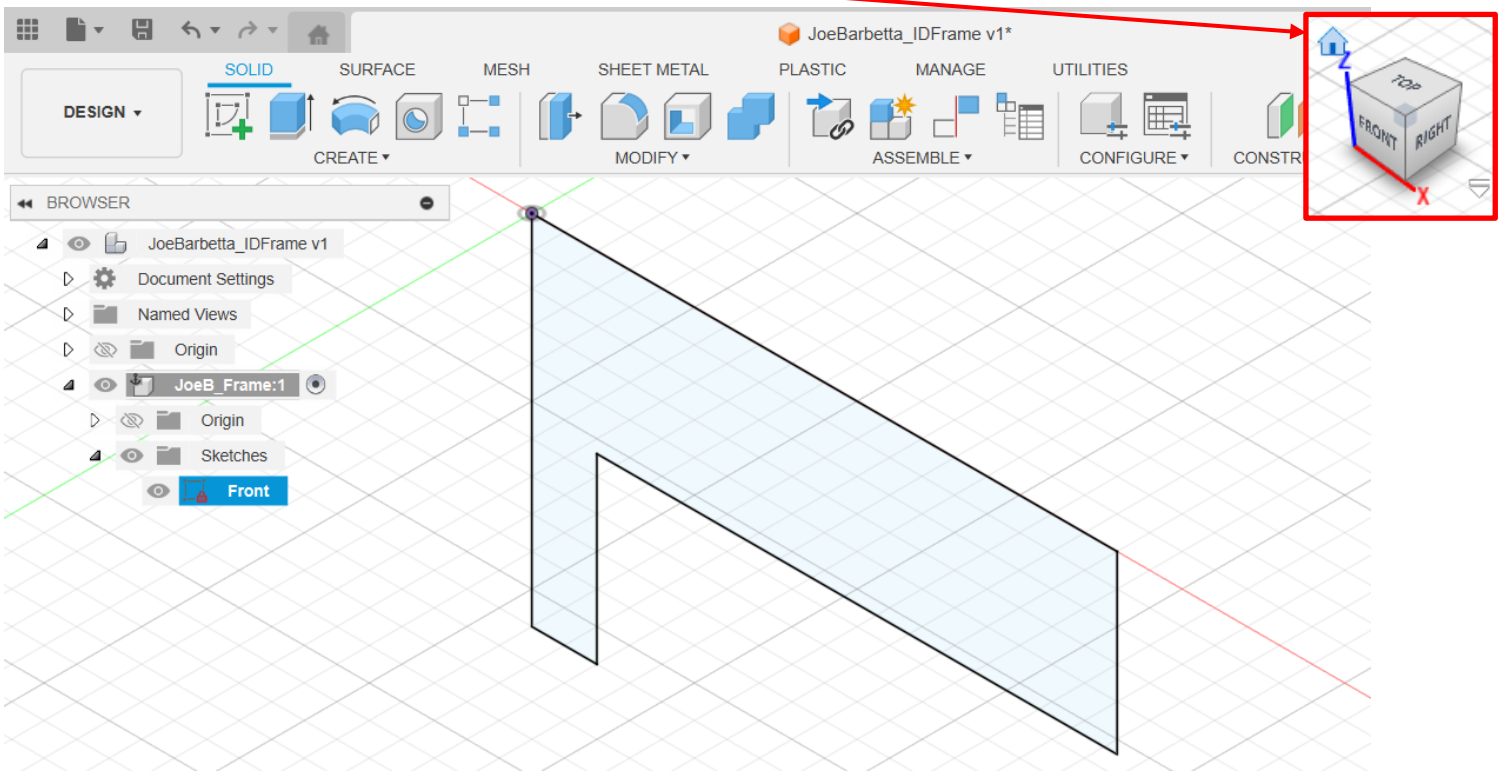
- **Yell out "I am sick of using the Line Tool!"**
- select the **Line** tool again. Click on the **end of the last line drawn** and extend it to the left.
- when it reaches the point to close the shape, **click** and the shape should fill in with light blue.



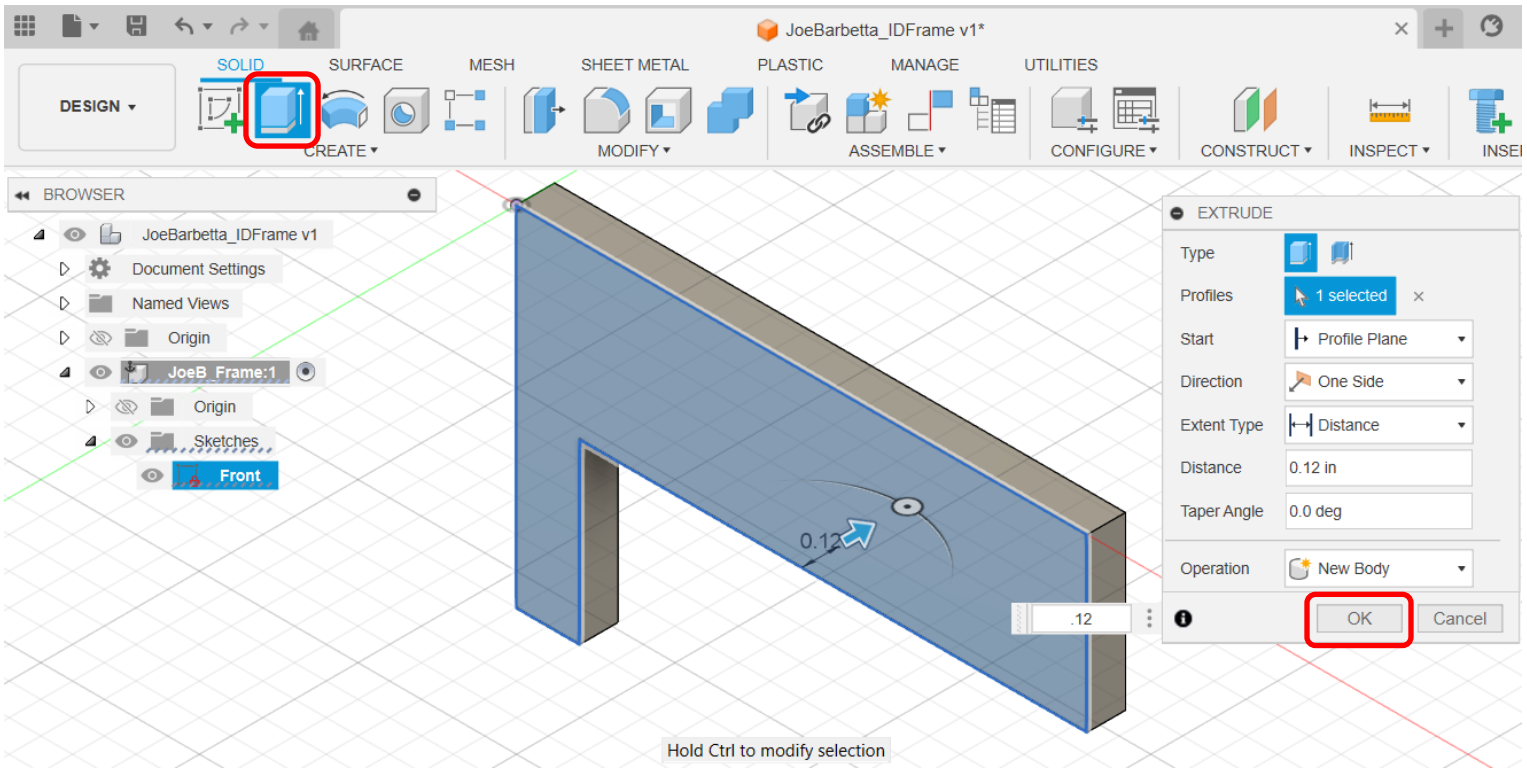

The Sketch should look similar to this. Note that the thin dimension lines may look different.
- **Yell "This was a pain in the butt!"** and click **Finish Sketch**.



- click on the **Home** icon at the **View Cube**

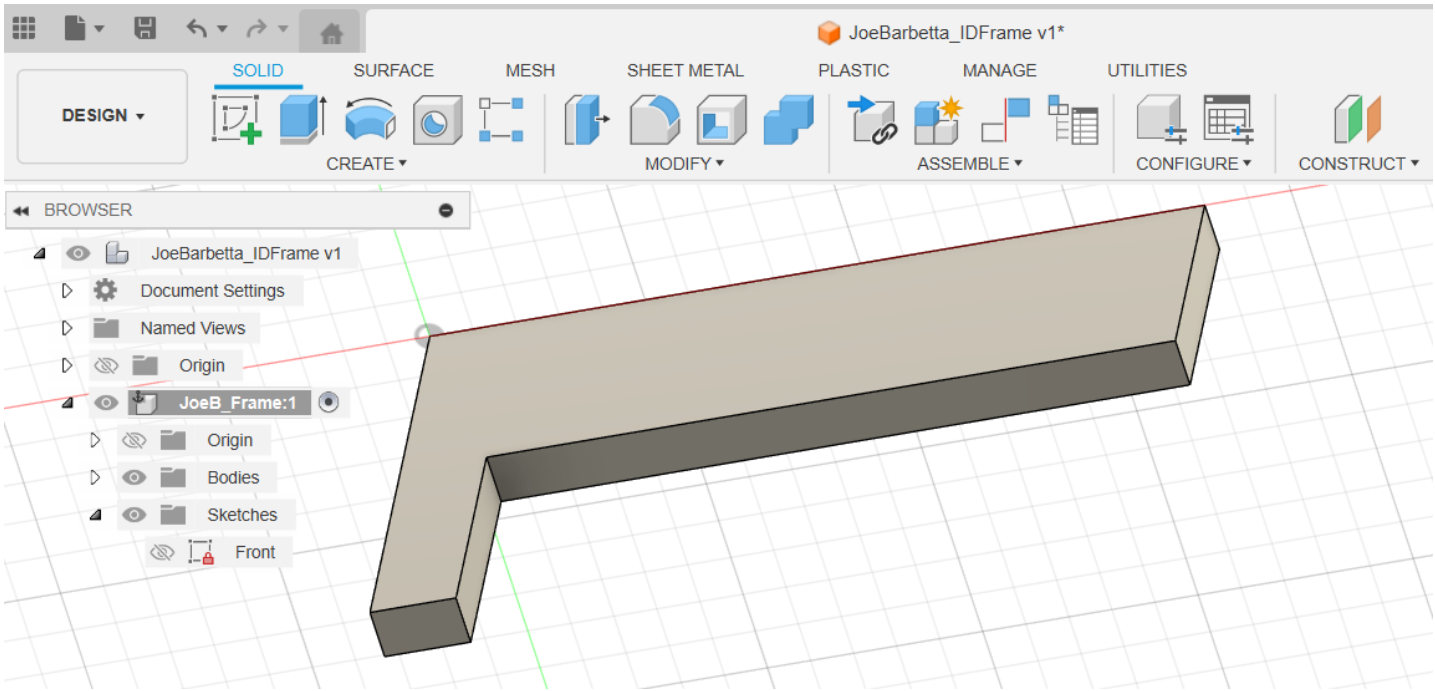



- click on the **Extrude** tool
- type **0.12** and click **OK**.

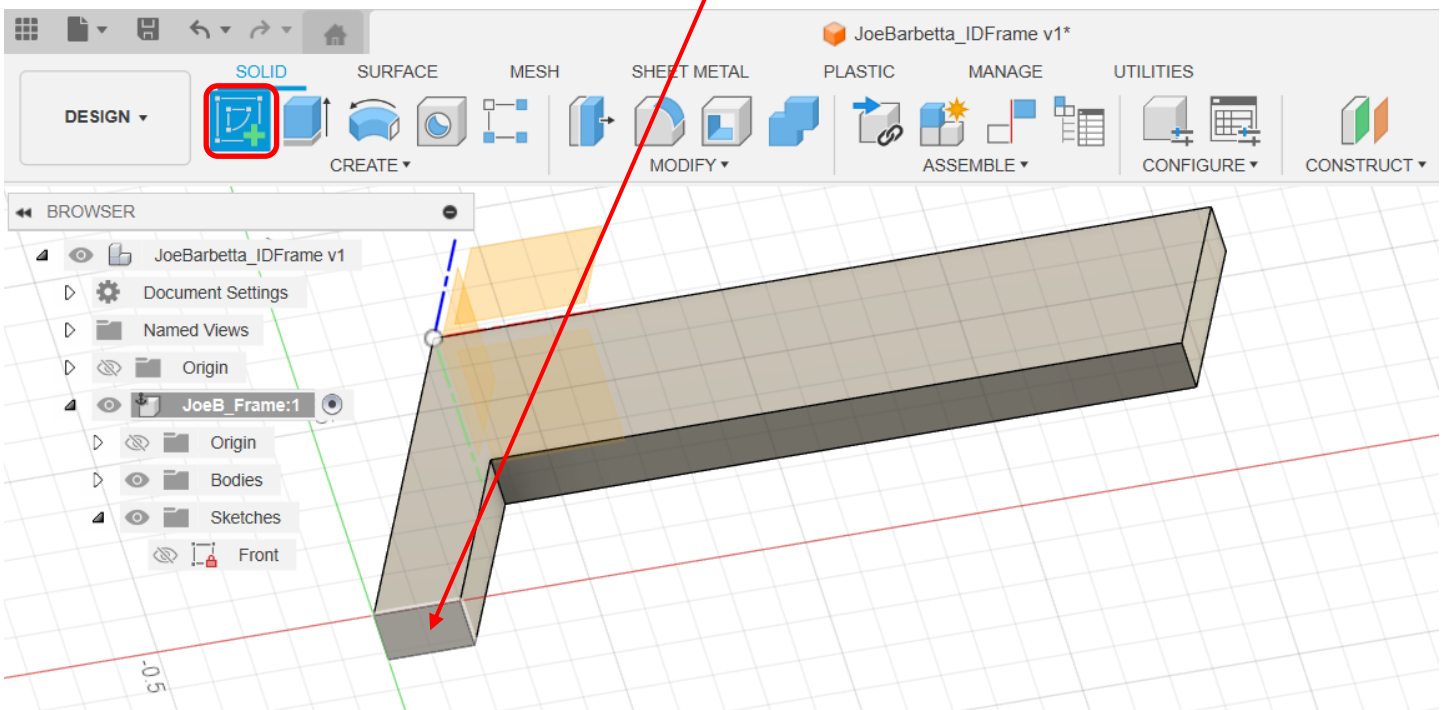


Now we need to create the slot that the ID will slide into.

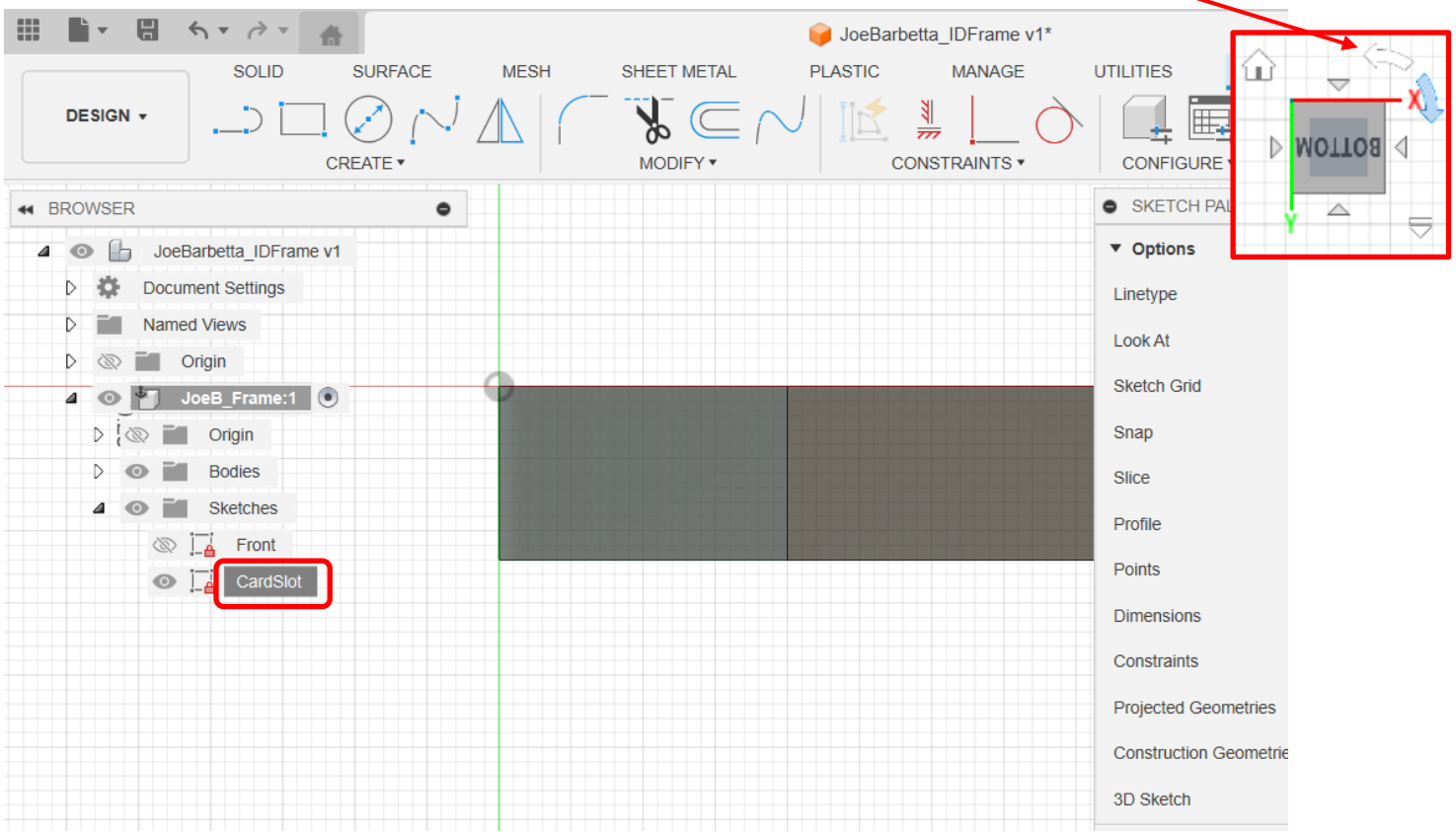
- by holding the **left mouse button down** on the **View Cube** and turning it, adjust the view similar to that shown below



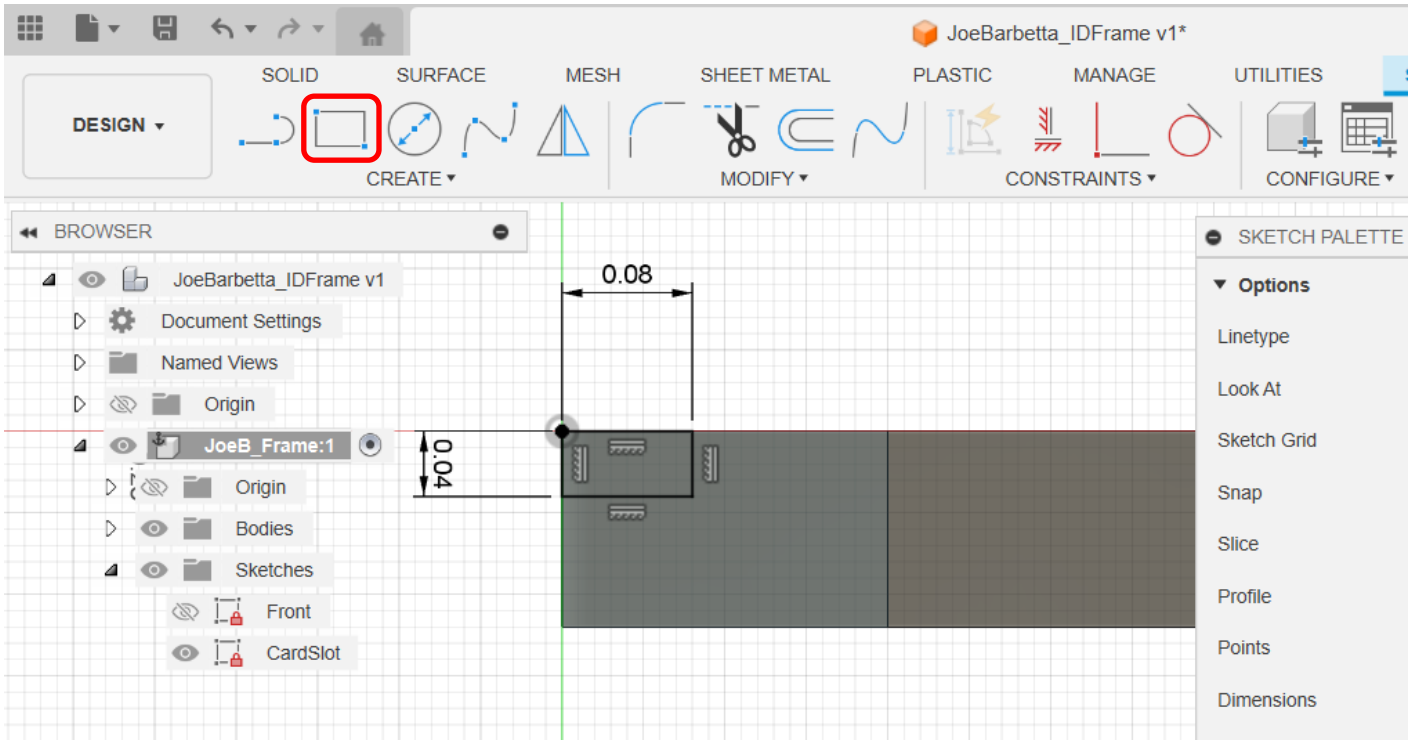

- click on the **Create Sketch** tool, hover over the **small rectangular Face**, which will turn it a lighter color as shown



- **zoom in** so that the view look similar to that below
- you may need to rotate the view using the **curved arrows at the upper right of the View Cube**. If the curved arrows do not appear, click on the **BOTTOM** face of the View Cube.
- right-click on the new Sketch Name and select Rename to change the name to **CardSlot**

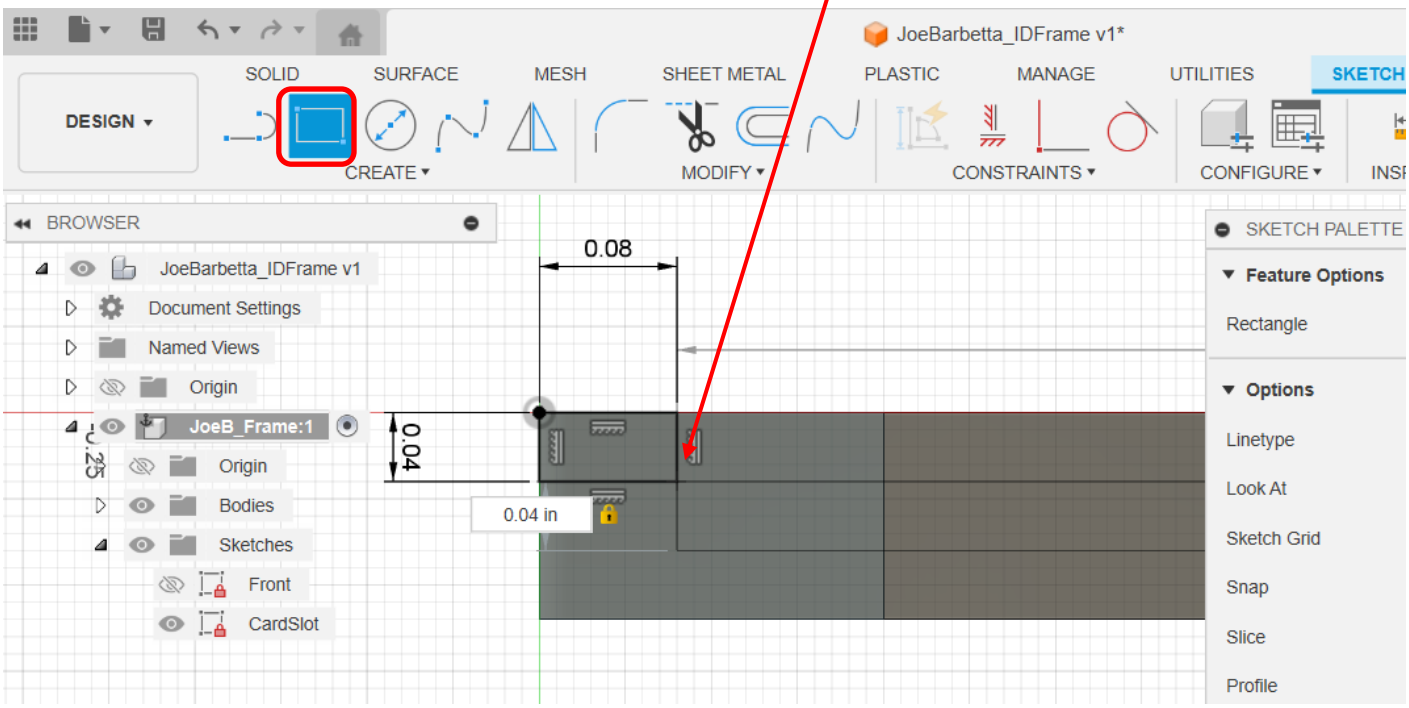



- click on the **Rectangle** tool and starting at the the top left corner create a rectangle with a height of **0.04** and width of **0.08**. You can use the **Tab key** to switch between the two dimensions.

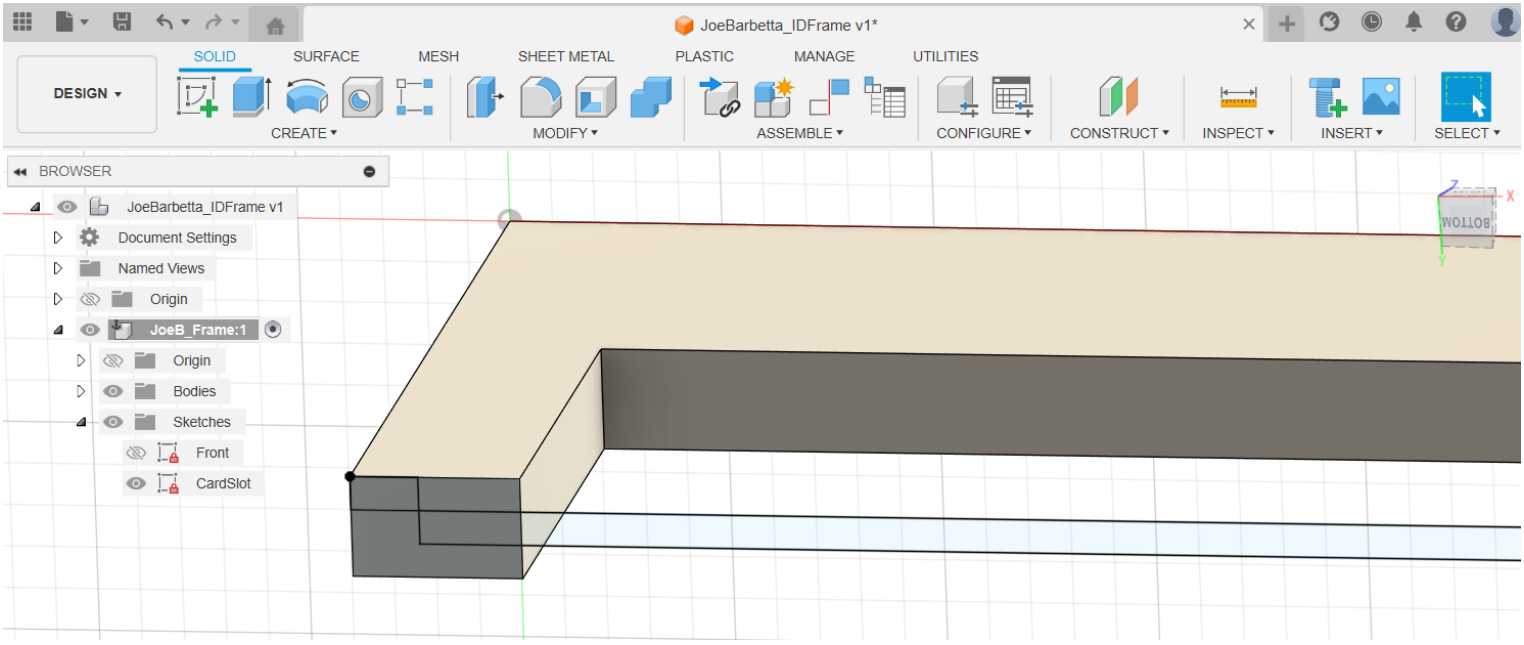


A Fusion professional may tell you that *Construction Lines* should have been used for the 0.04 x 0.08 rectangle, but you can say **“Dude. I’m just trying to get my art credit.”**

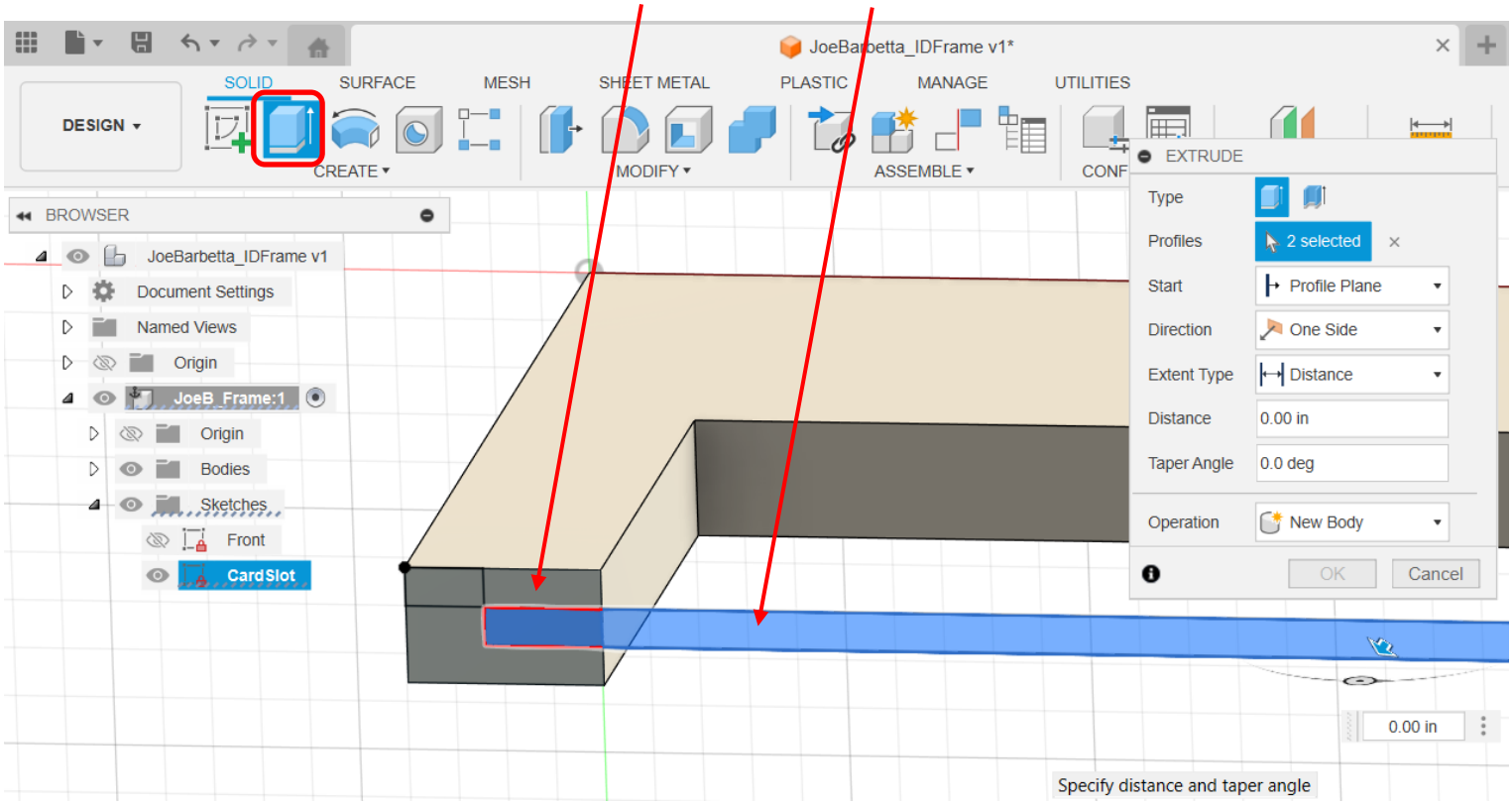
- click on the **Rectangle** tool again and start a rectangle from the **bottom right of the 1st rectangle** and set its height to **0.04** and width to **1.72**. Note that the 1.72 dimension will not show because it is off the screen to the right.
- click **Finish Sketch**



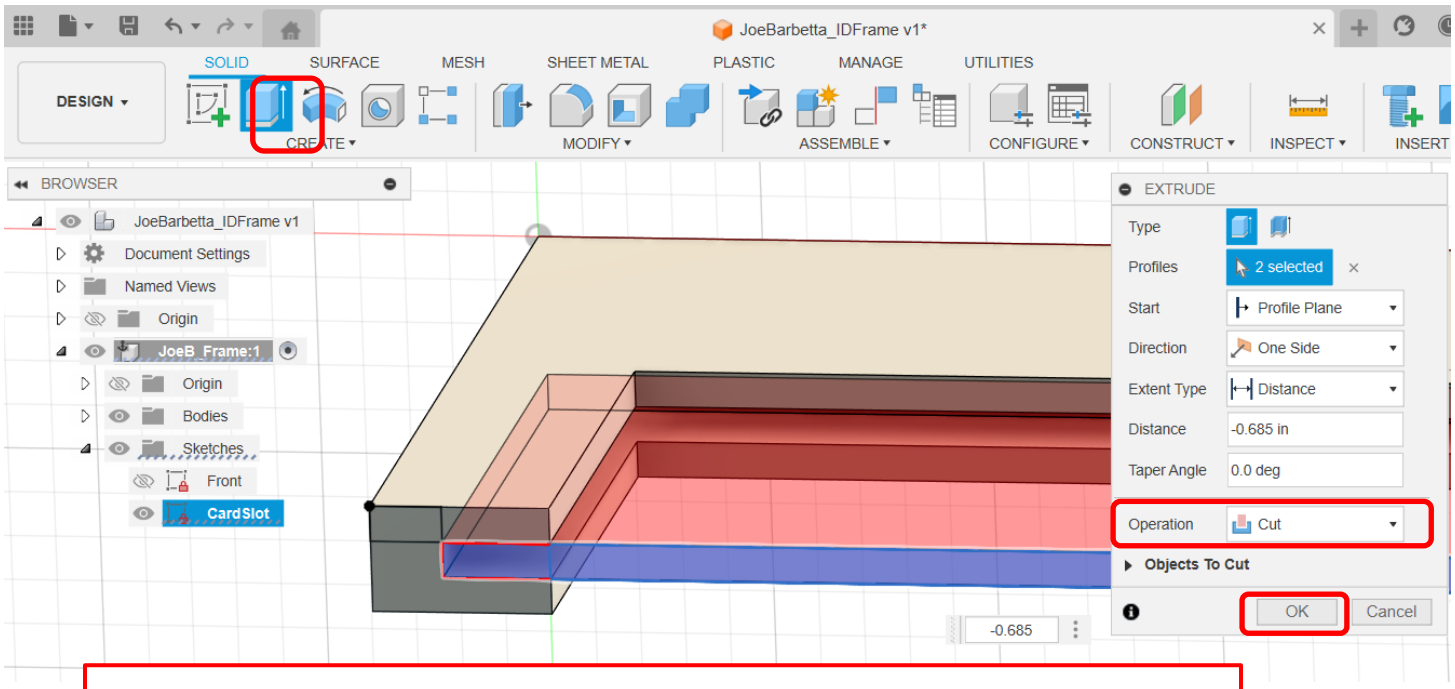

- use the View Cube to attain a view similar to that below.

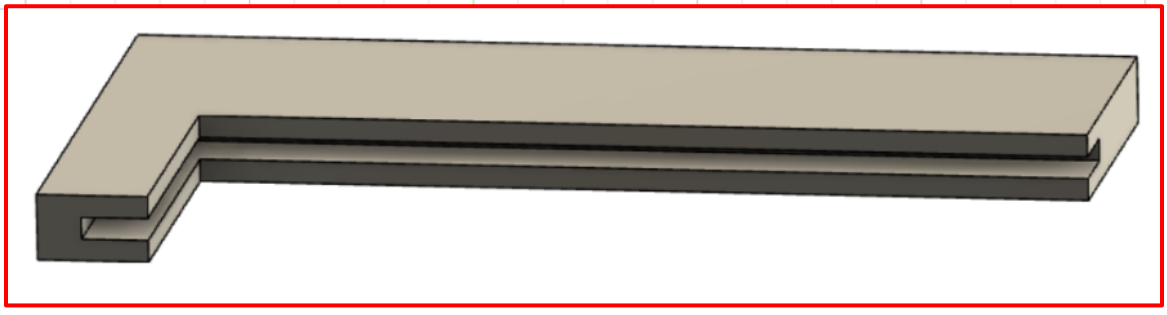


- click on the **Extrude** tool and click on **both the smaller left and larger right interiors** of the rectangle.



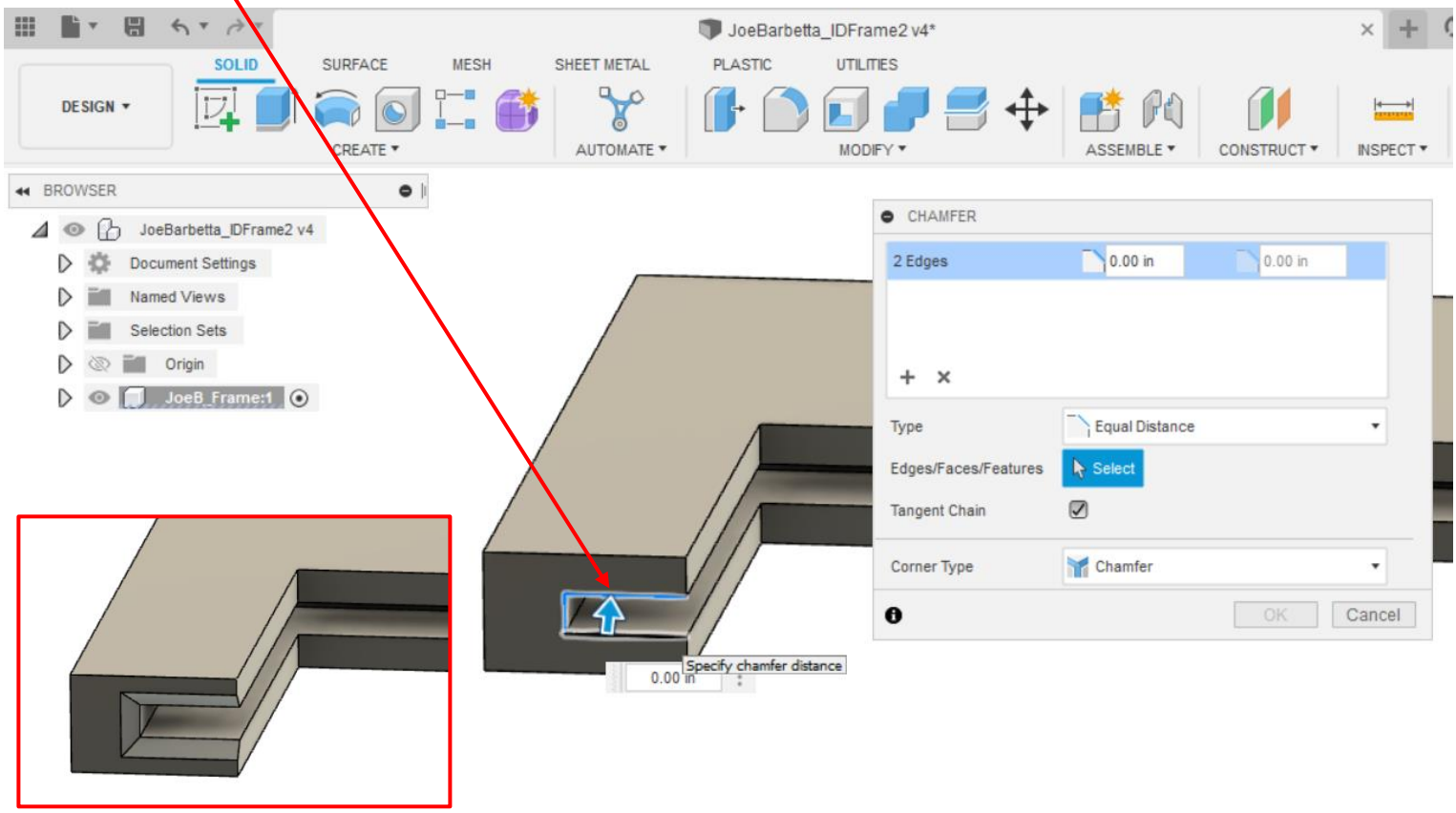

- type **-0.685** (note the minus sign).
- ensure that **Operation** is set to **Cut** and then click **OK**. The result should be that of the inset picture.



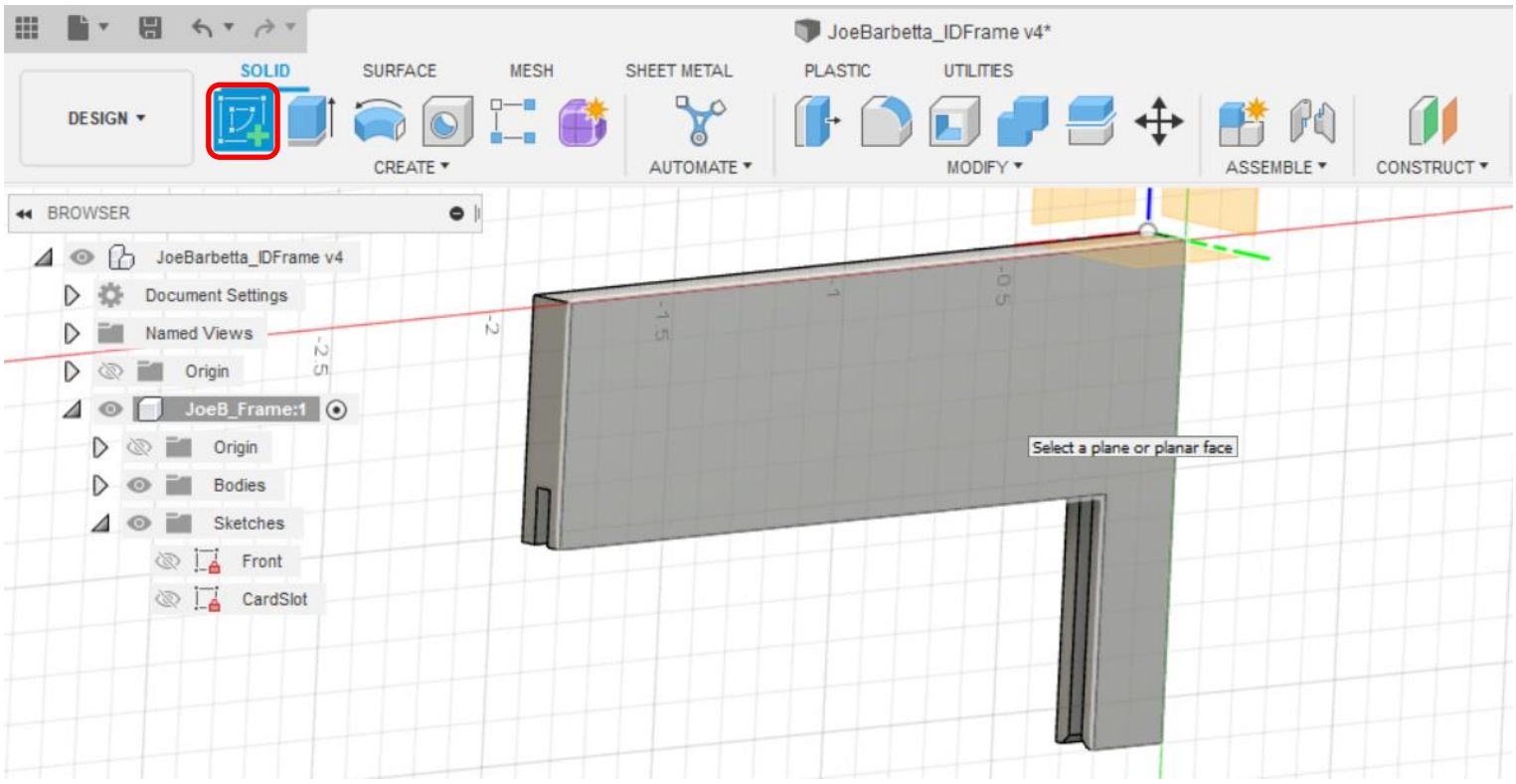



- zoom in to the end of the frame and from the **MODIFY** pull-down menu select **Chamfer**
- click on the **3 Edges** around the slot, type **0.02**, and click **OK**. The result should look like the inset picture.

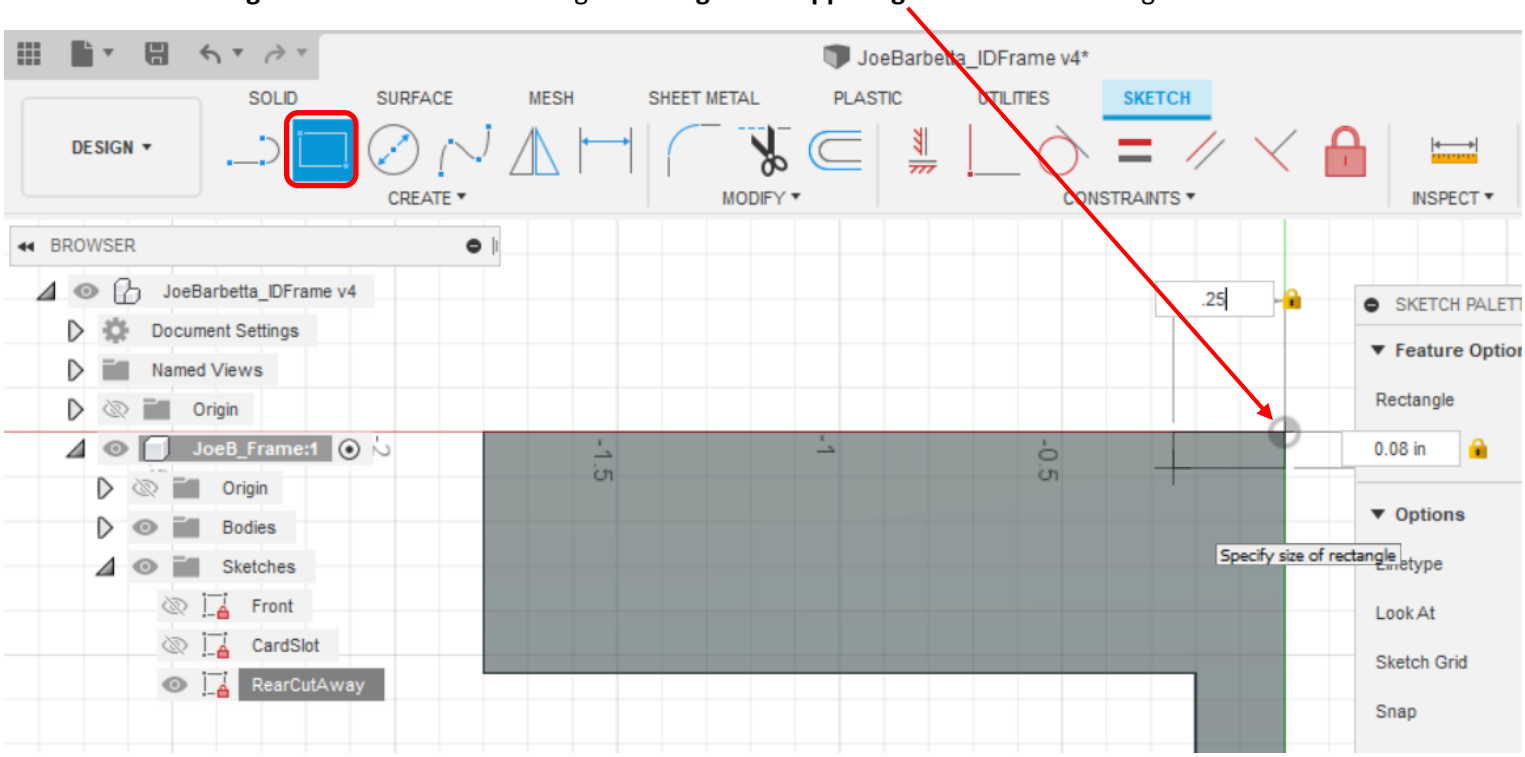
These chamfers will make it easier to slide an ID card into the slot.



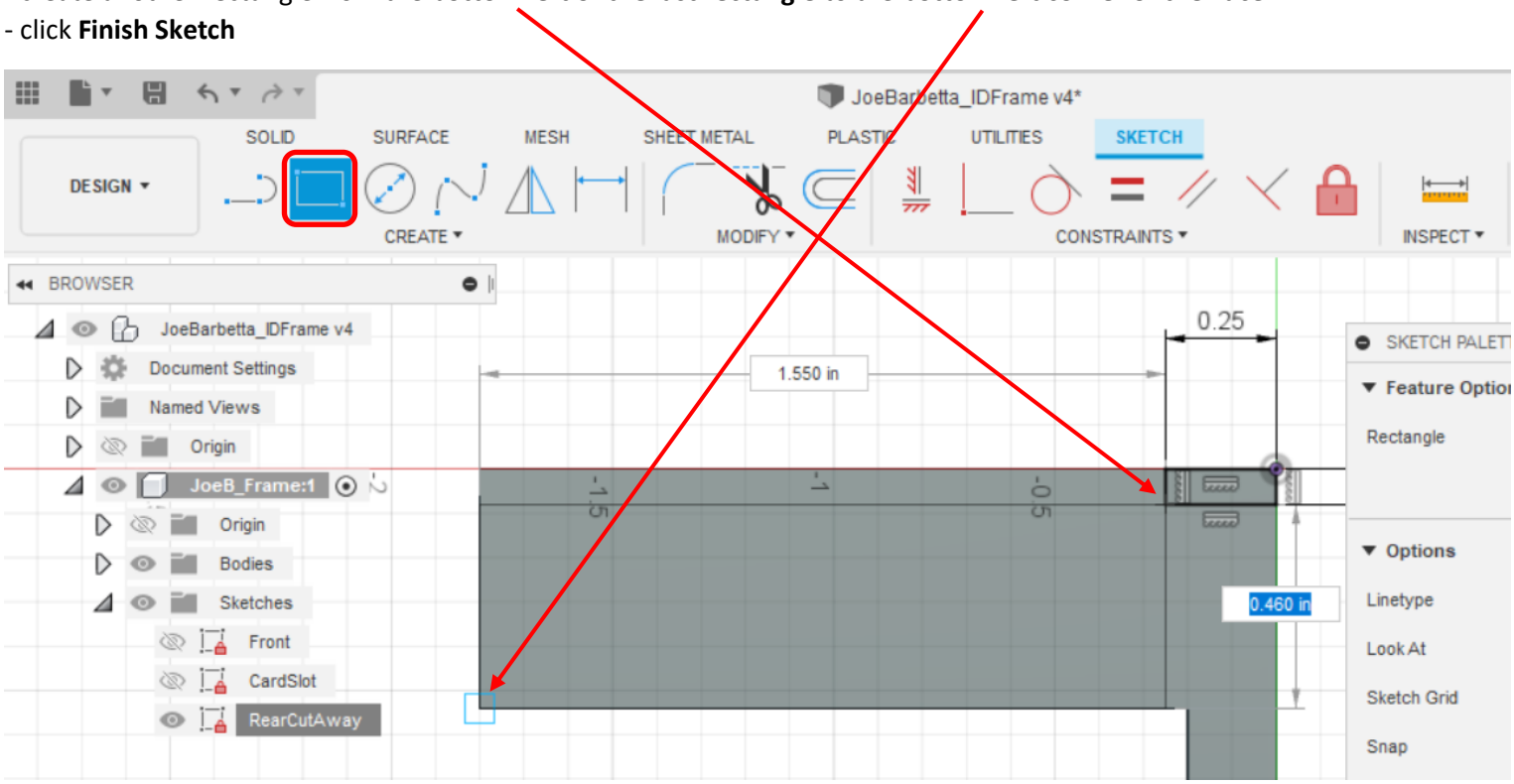

- adjust the **View** to access the back area as shown.
- click on the **Create Sketch** tool and click on the back **Face**.



- rename the new Sketch to **RearCutAway**
- zoom in and, if needed, use the **curved arrows** at the **View Cube** to attain this view
- click on the **Rectangle** tool and create a rectangle **starting at the upper right corner** with a height of **0.08** and width of **0.25**

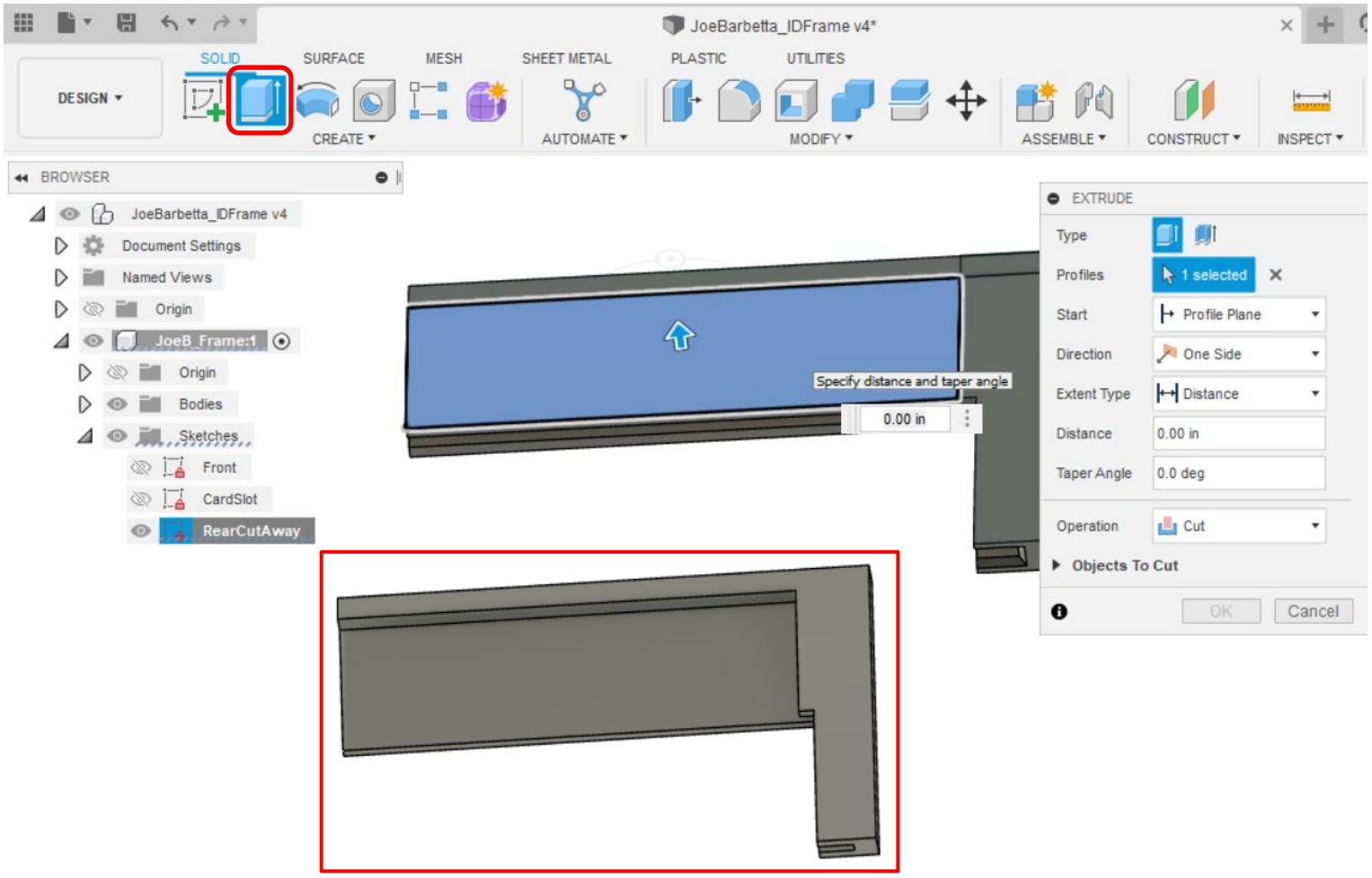



- create another rectangle from the **bottom left of the last rectangle** to the **bottom left corner of the Face**.
- click **Finish Sketch**

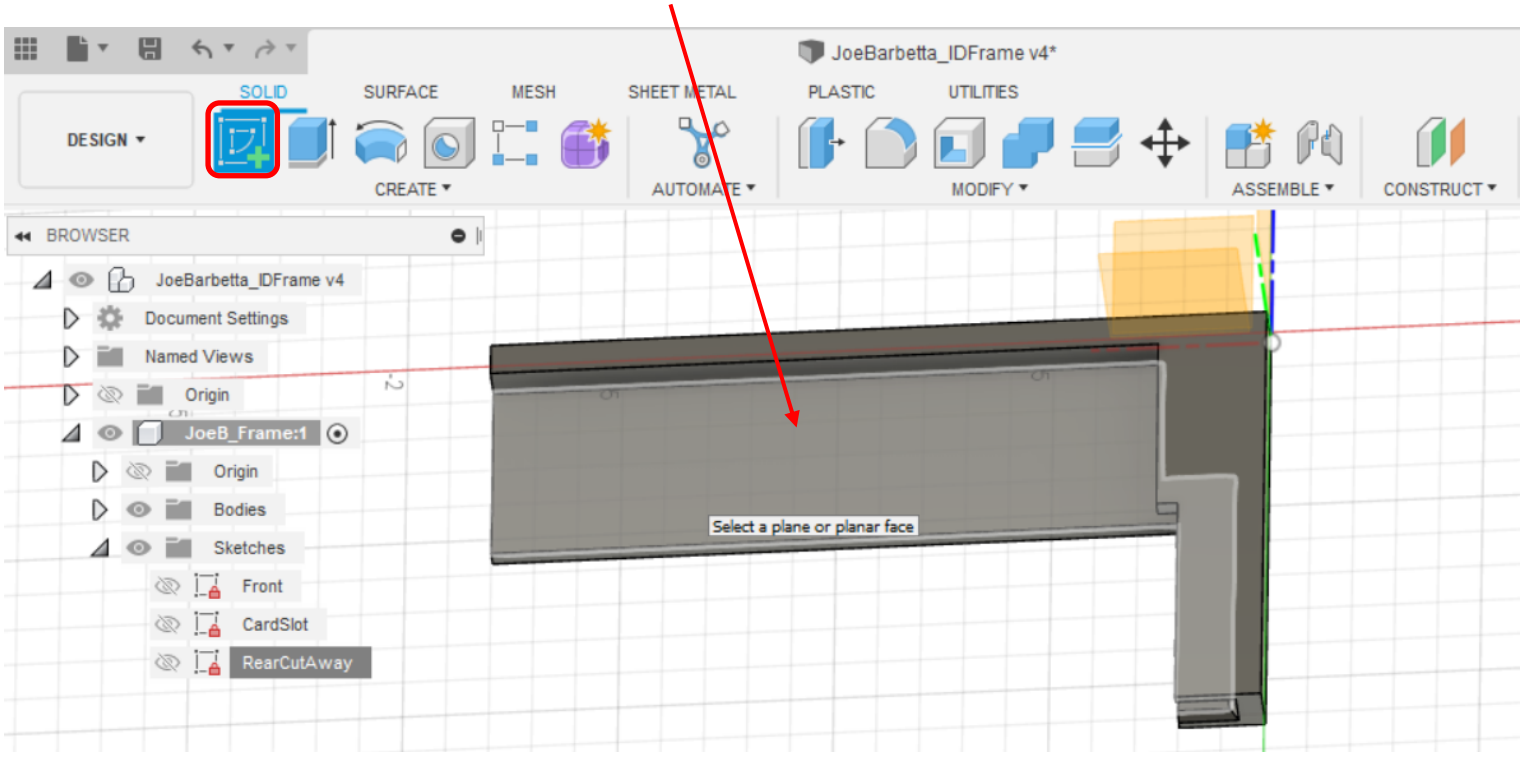


- click on the **Extrude** tool and click on the rectangular profile just created and type **-0.08** (note the minus sign)
- ensure the **Operation** is set to **Cut** and click **OK**.

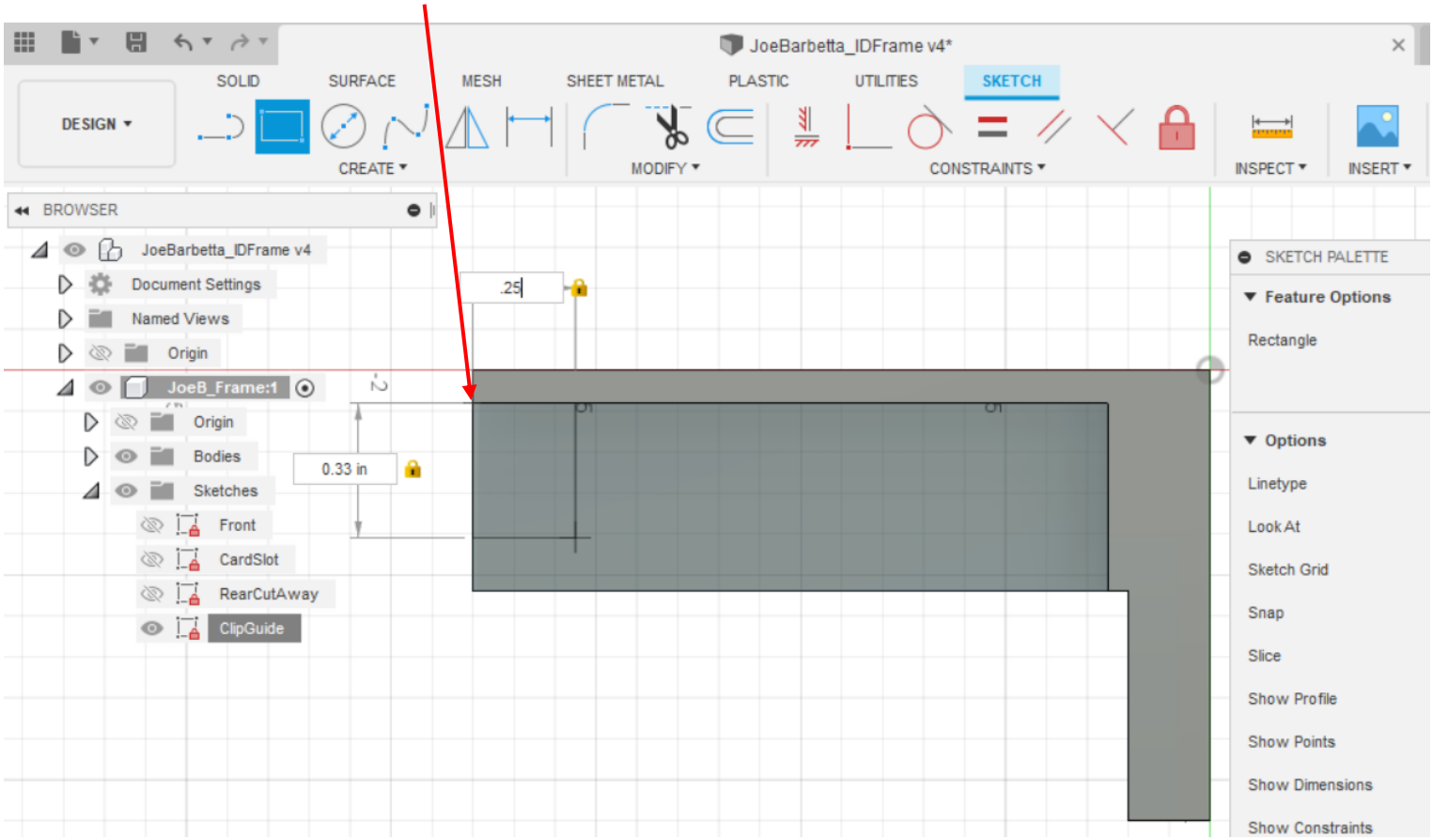
The result should look like the inset picture.  This cut operation was to remove plastic to reduce printing time.



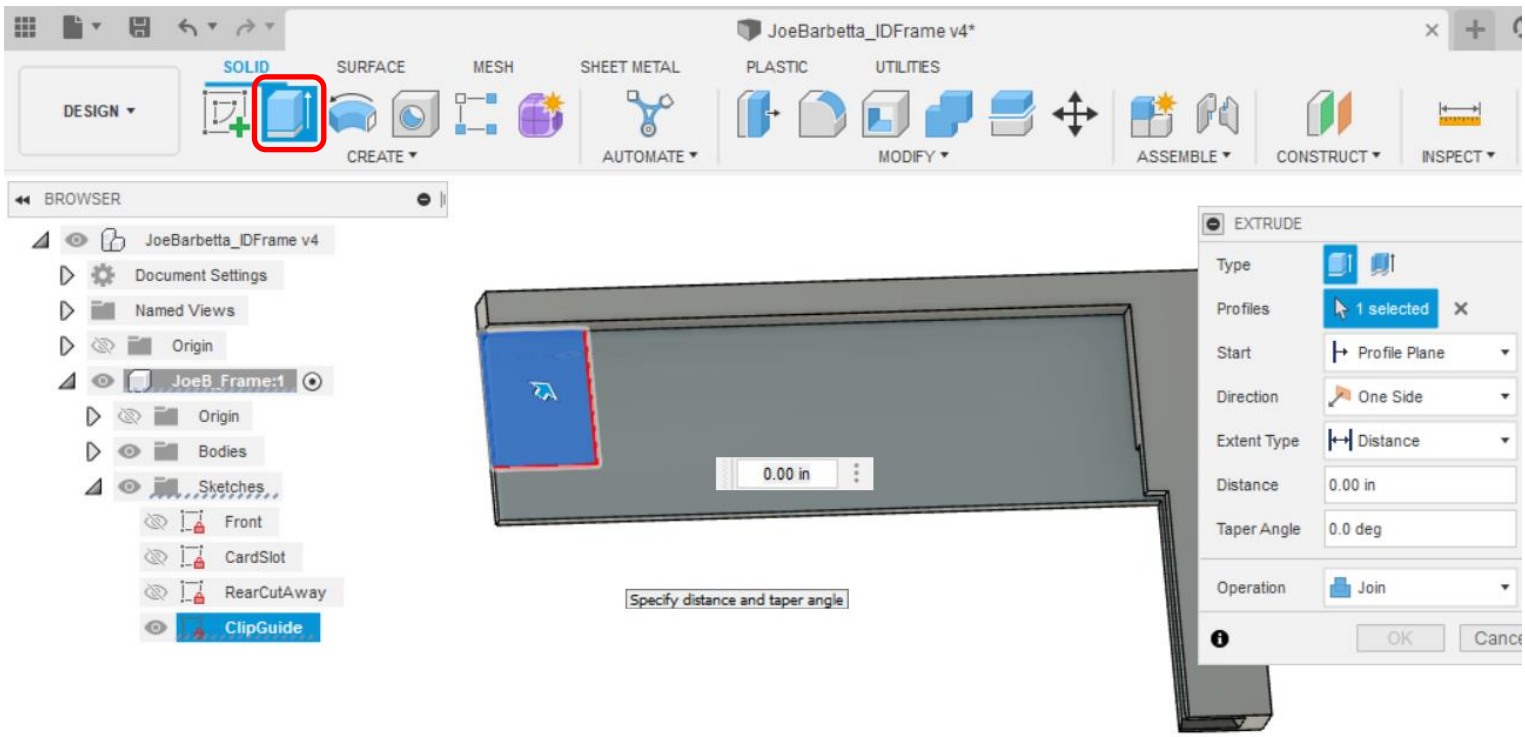

- click on the **Create Sketch** tool and click on the **recessed area**.



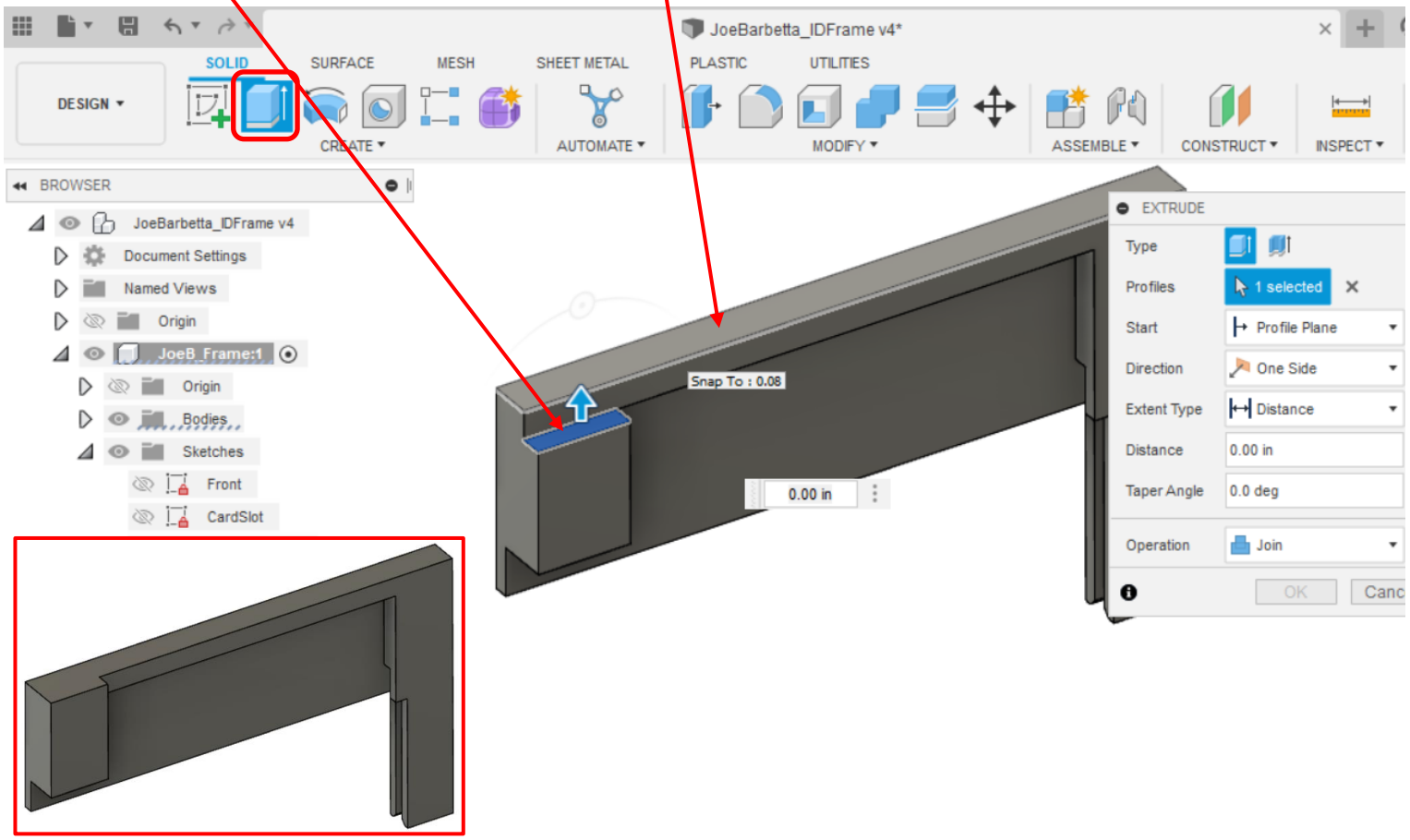
- rename the Sketch to **ClipGuide**
- create a **Rectangle** starting at the **upper left** of the Sketch area with a height of **0.33** and a width of **0.25**. Click **Finish Sketch**.




**Extrude** the profile by **0.14**

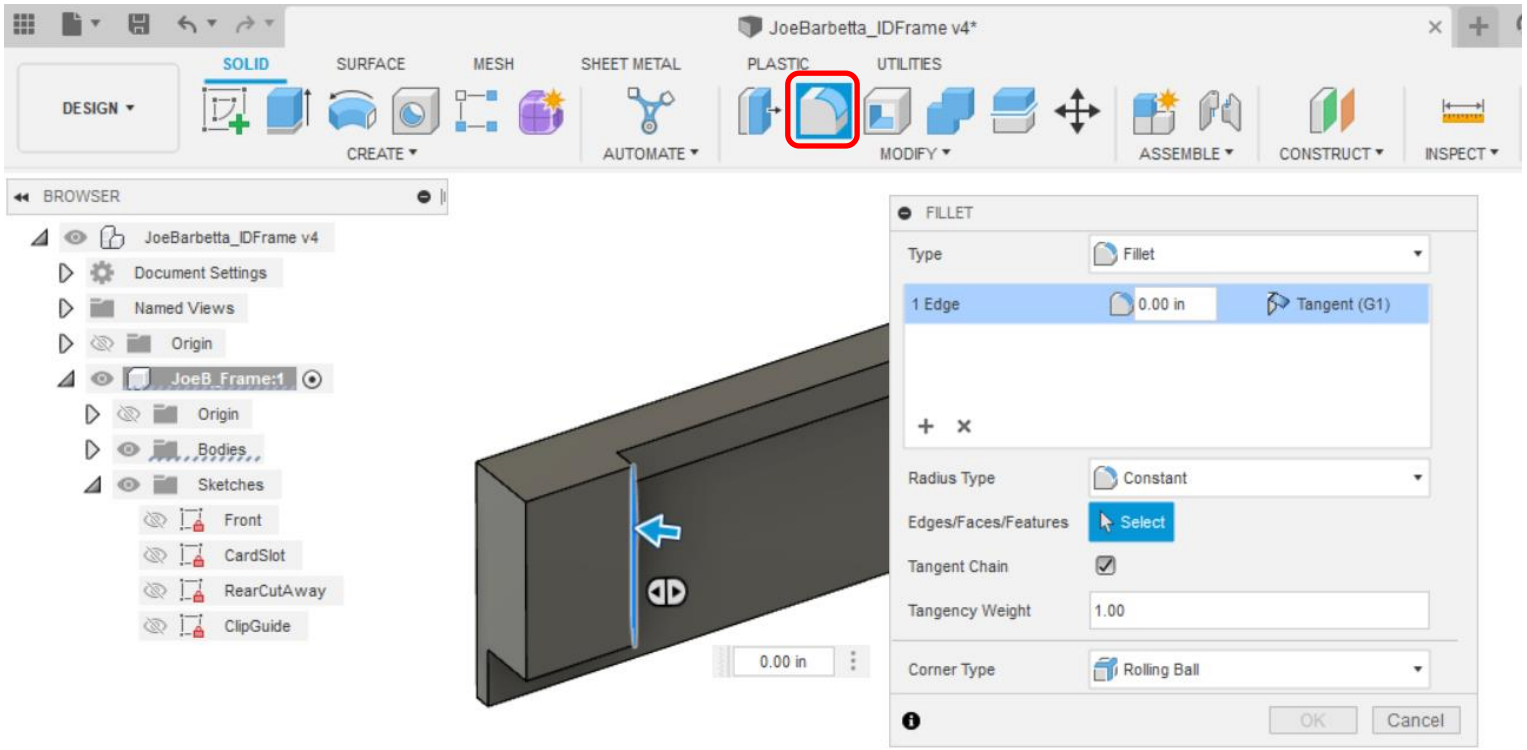


- adjust the **View** to access the top of the frame
- click on the **Extrude** tool
- click on the **small Face** as shown and then click on the **top Face of the frame**. The small Face should move up so that it is level with the top as shown in the inset picture.

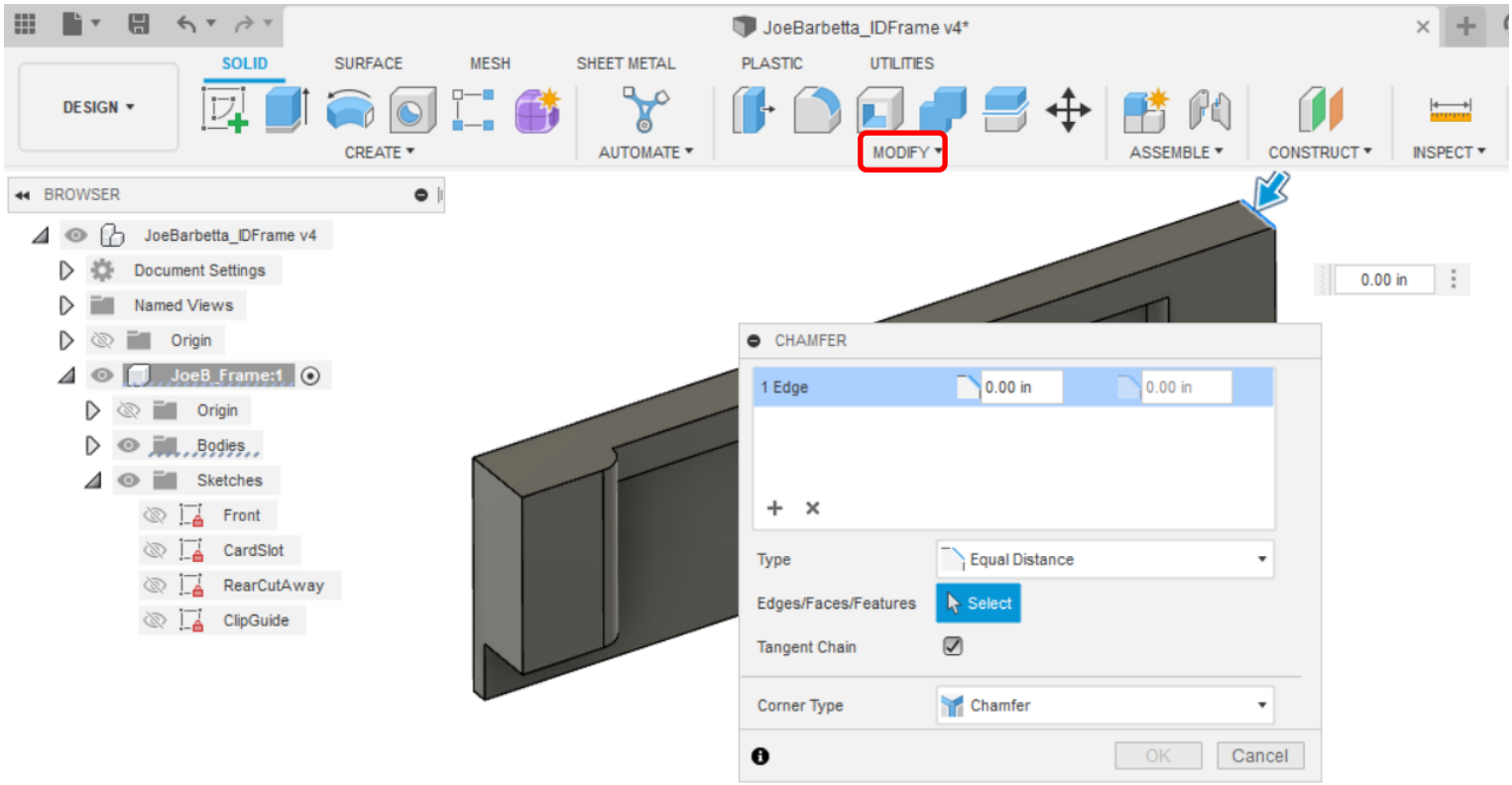




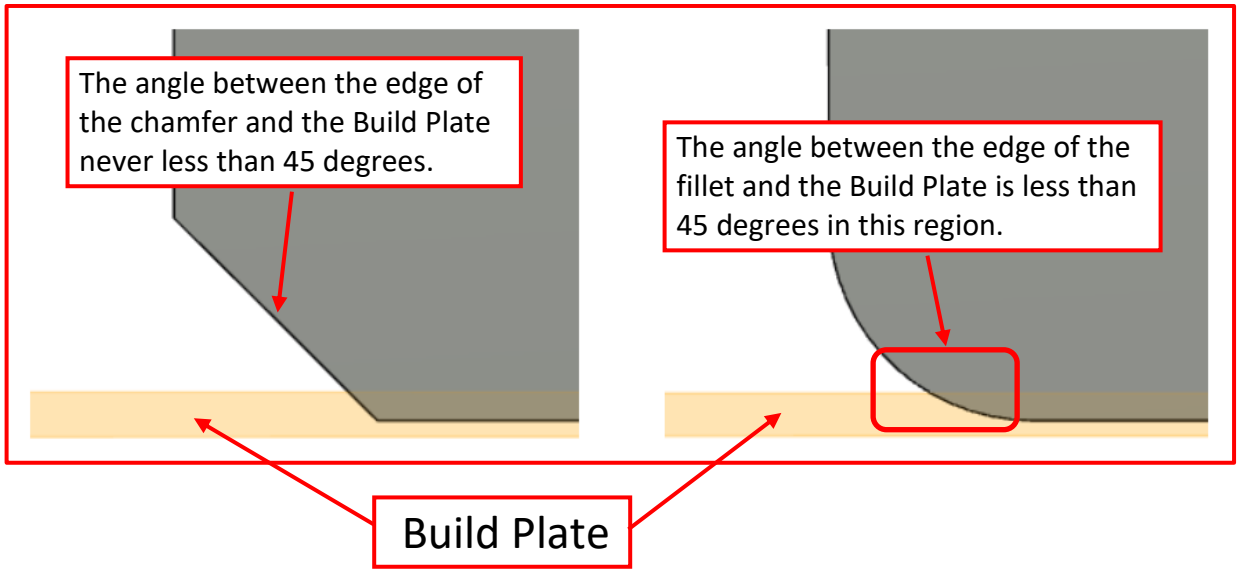

- click on the **Fillet** tool (pronounced with a hard T and not like the piece of fish)
- click on the **Edge** as shown, type **0.06**, and click **OK**. This rounding is mostly for aesthetics.



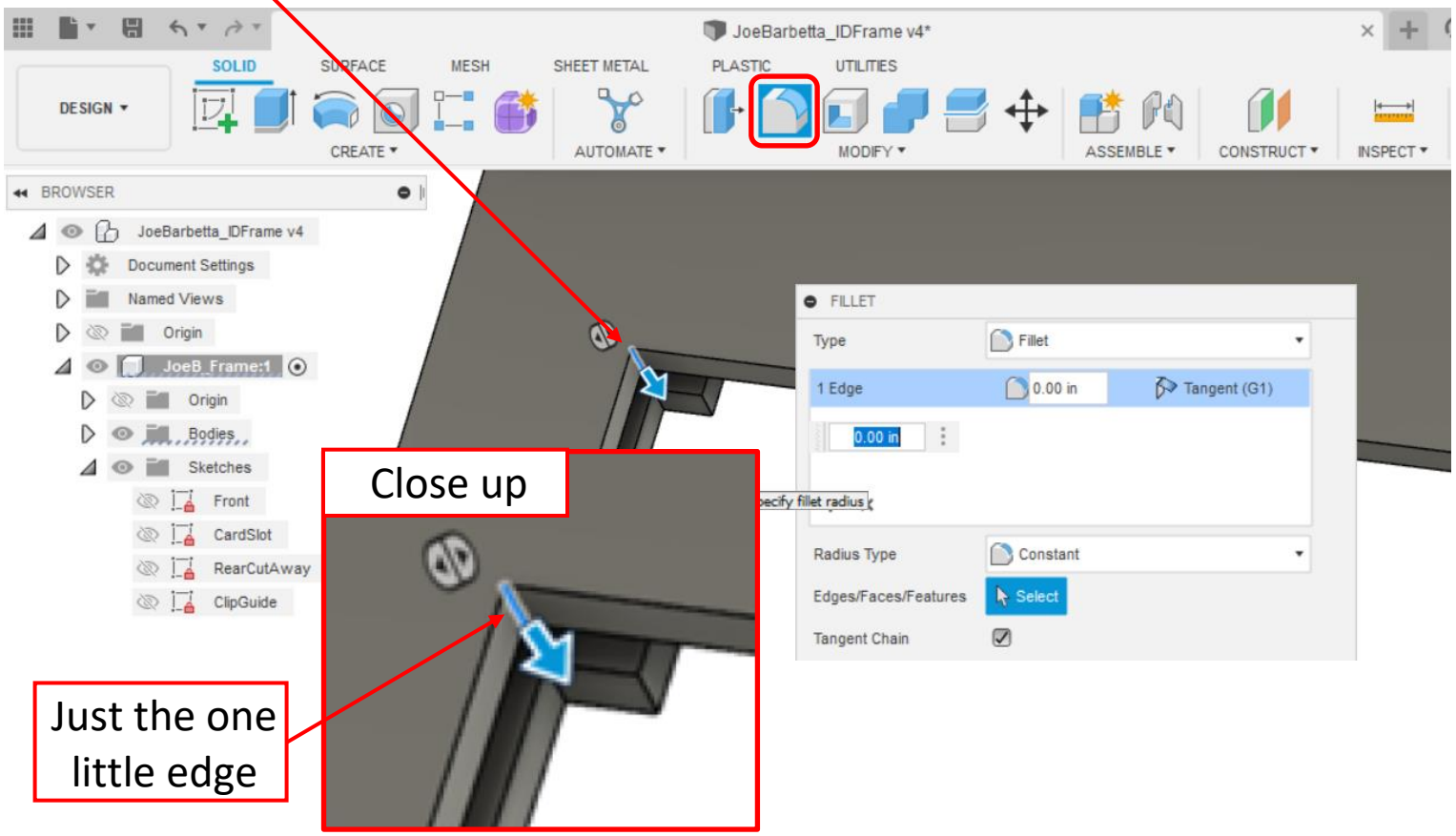
- in the **MODIFY** pull-down menu select **Chamfer**. Click on the **Edge** as shown, type **0.1**, and click **OK**.
This chamfering is also added for aesthetics.




For the Edge we just Chamfered, a Chamfer is a better choice compared to a Fillet because the frame will be printed upside down and the Fillet would violate the 45 Degree Rule.

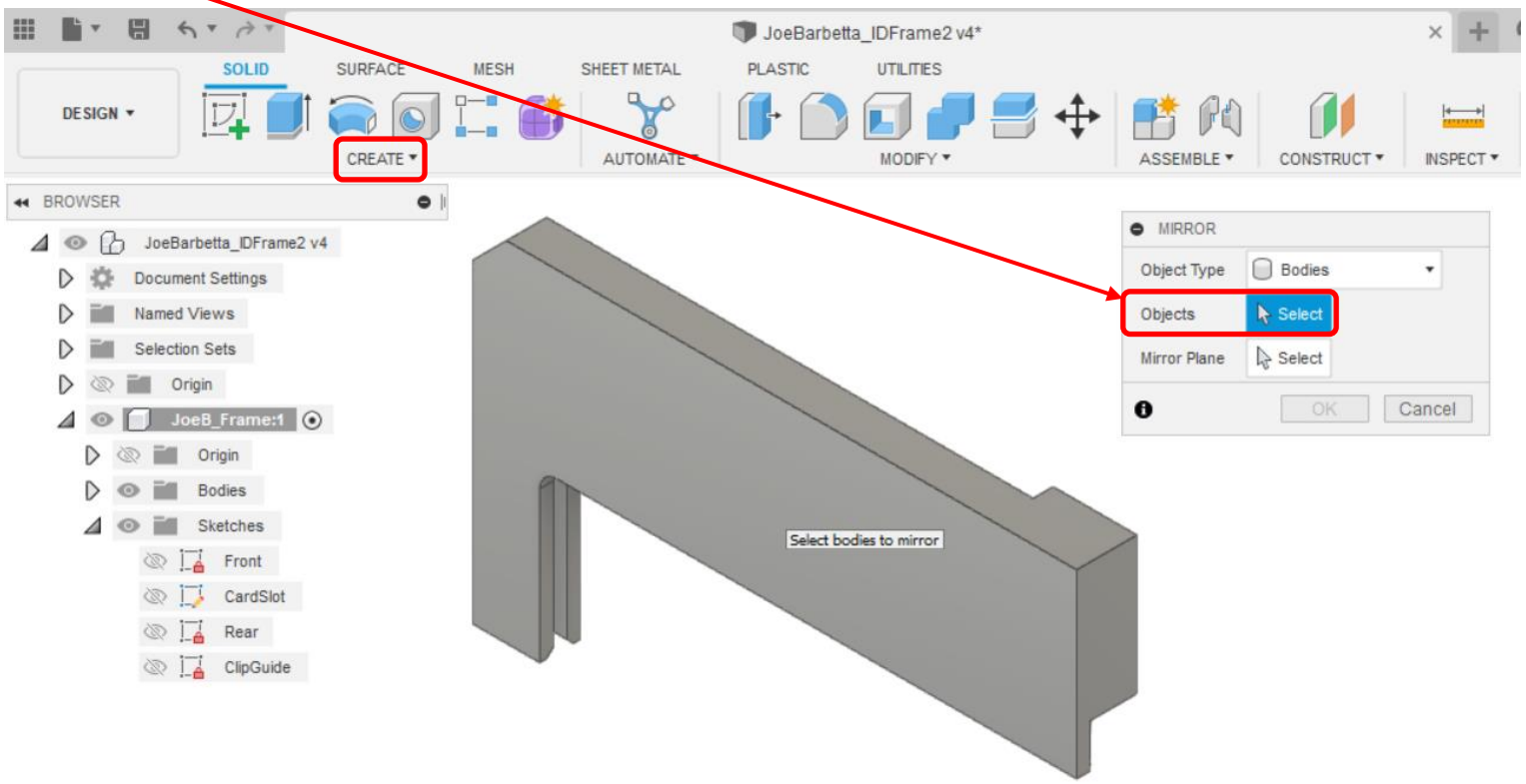


- click on the **Fillet** tool
- click on the **Inner Edge** as shown, type **0.05**, and click **OK**. This rounding is mostly for aesthetics, but the fillet also provides some strength. A sharp inner corner is vulnerable to stress concentrations that can lead to a crack forming.

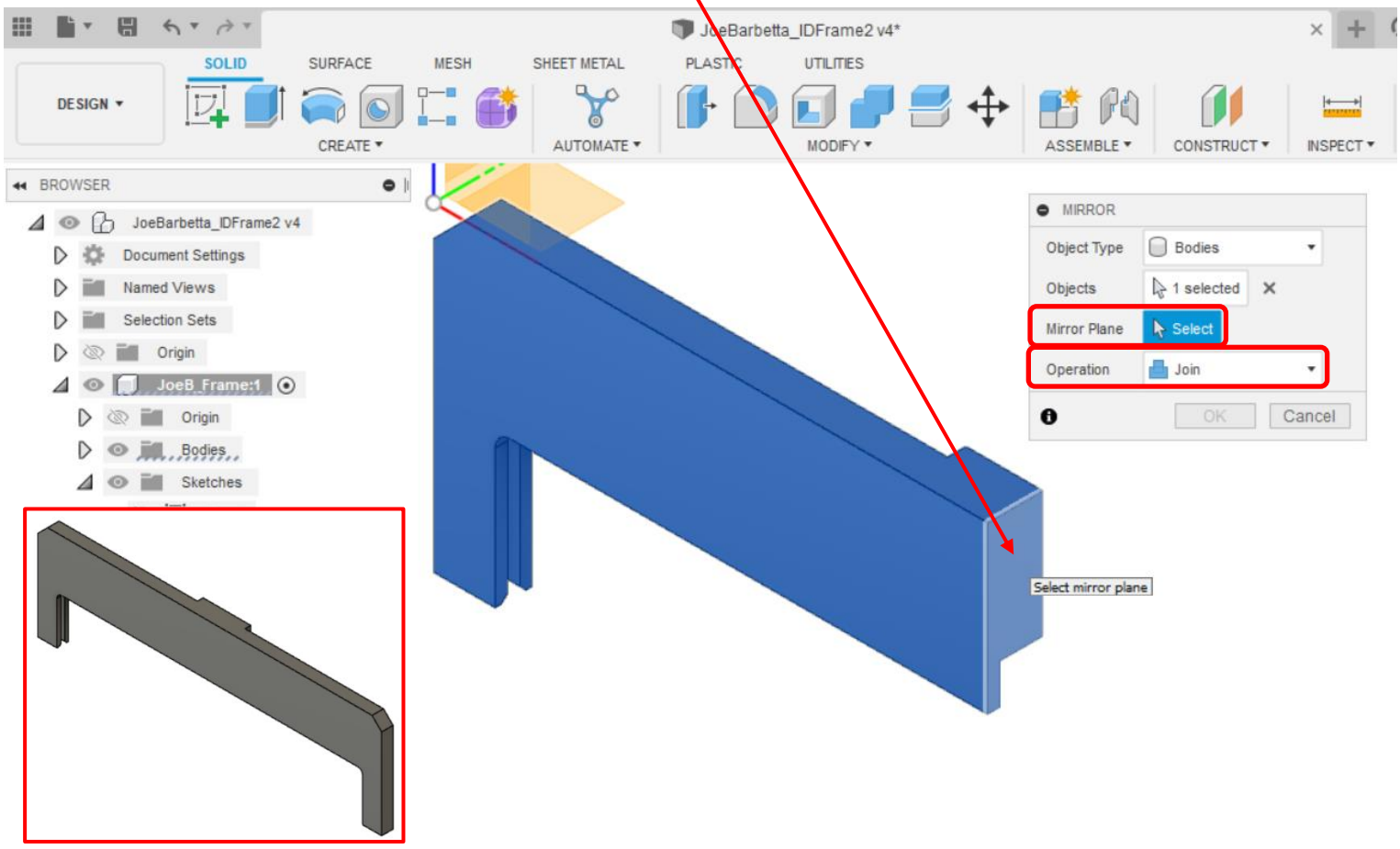



**Now for a really neat step!**

- from the **CREATE** pull-down menu select **Mirror**
- click on **Select** next to **Objects** and then click on the frame **Body**

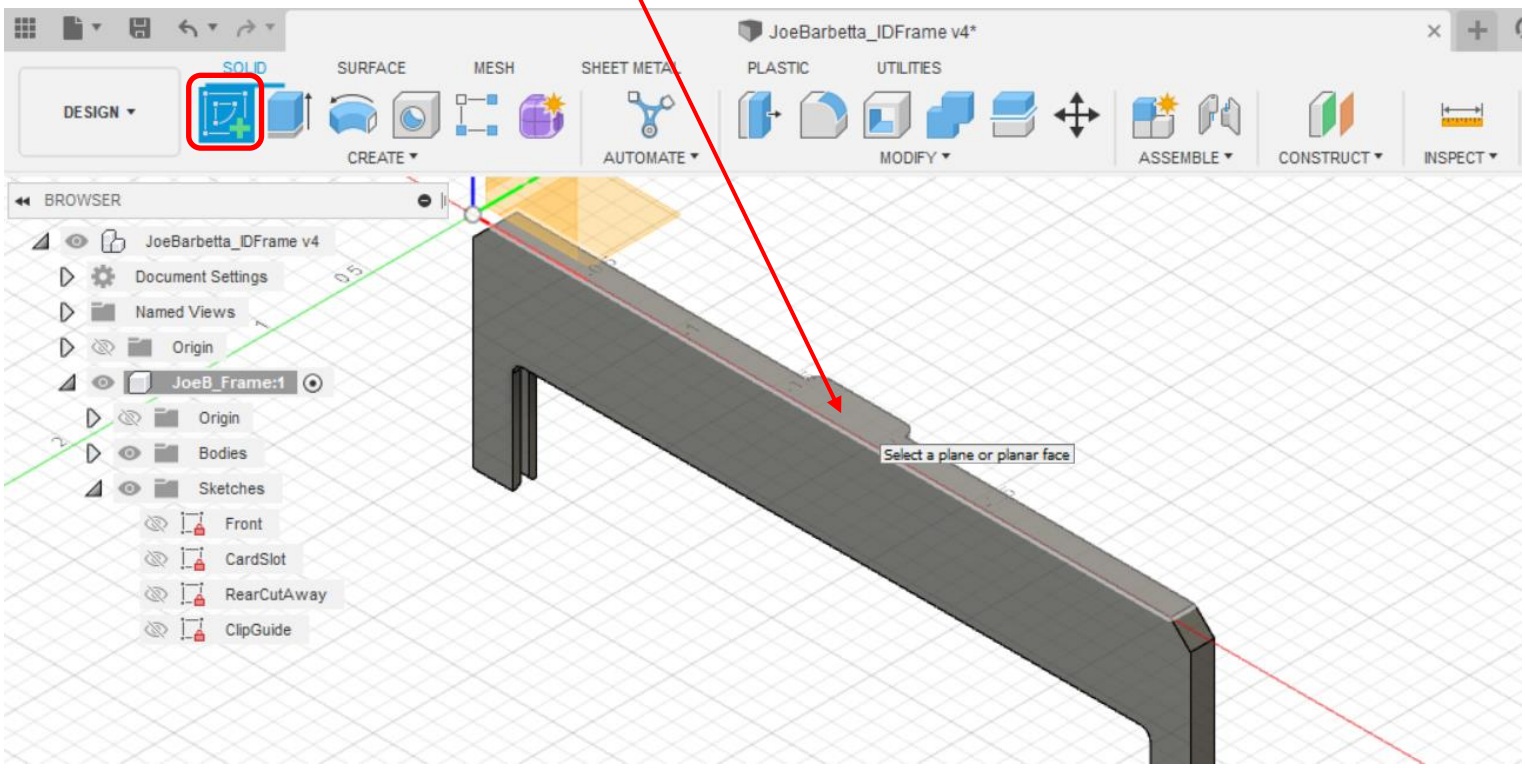


- click on **Select** next to **Mirror Plane** and then click on the **Face** of the frame
- ensure that **Operation** is set to **Join** and click **OK**. The inset picture shows the result.

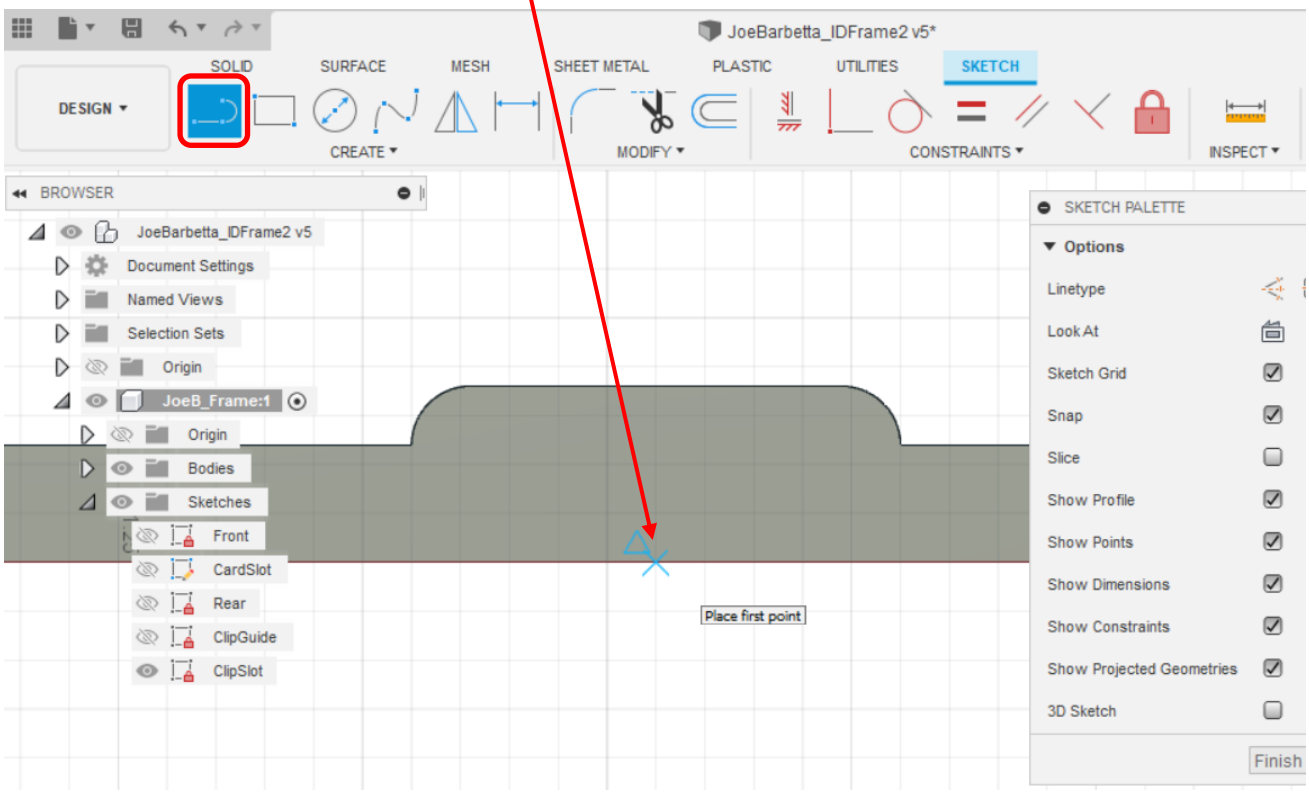



**- Yell out. “That was neat!”**

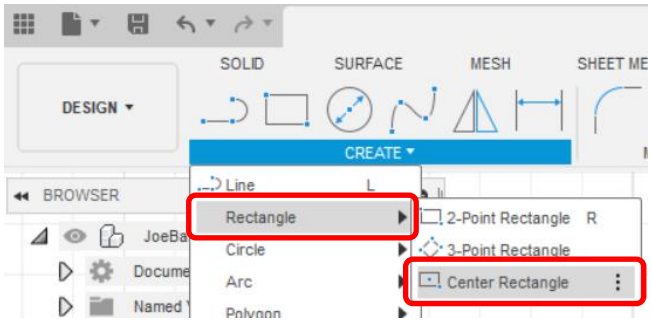
- click on the **Create Sketch** tool and click on the **top Face** of the frame



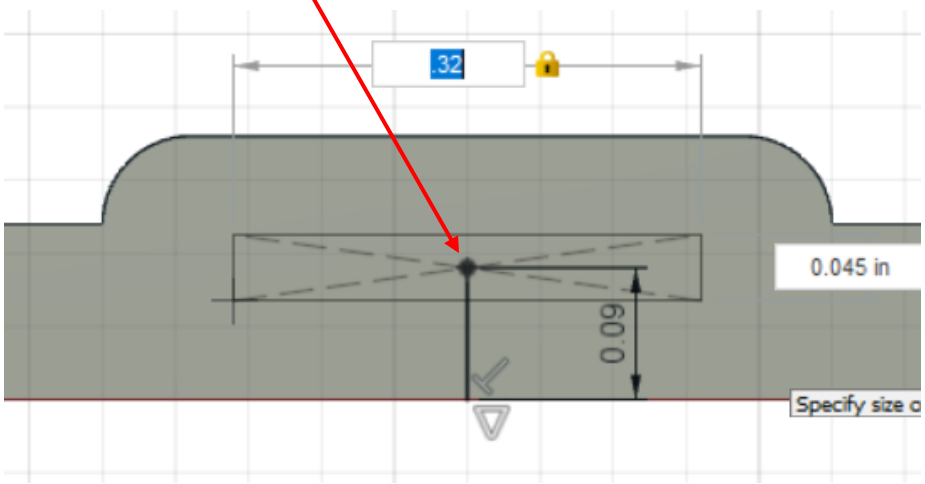
- zoom into the top of the frame as shown and rename the Sketch to **ClipSlot**
- click on the **Line** tool and click on the **center of the bottom edge**. When the mouse is over the center point a **blue triangle** will appear.
- type **0.09**, **click**, and press the **Esc key**



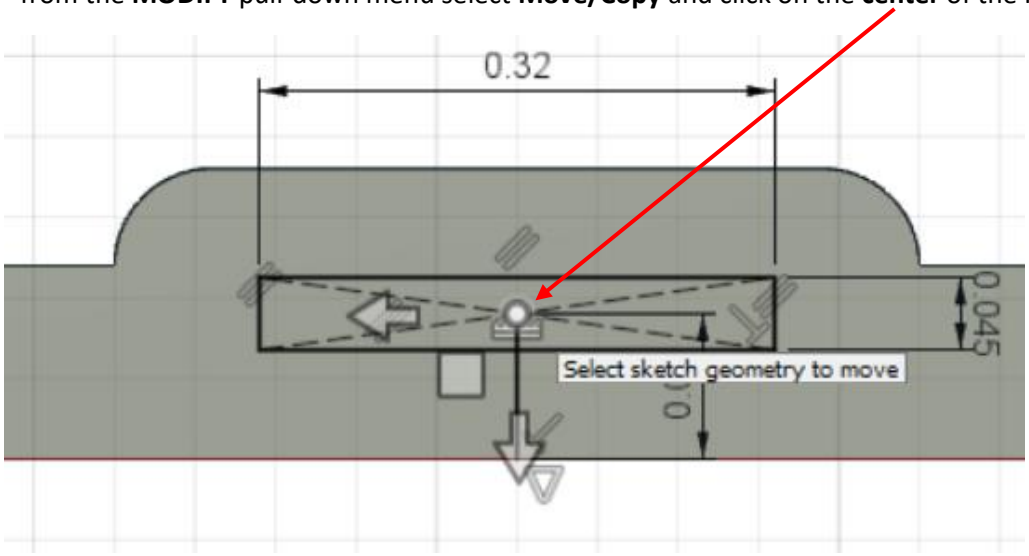

- from the **CREATE** pull-down menu select **Rectangle** and **Center Rectangle**



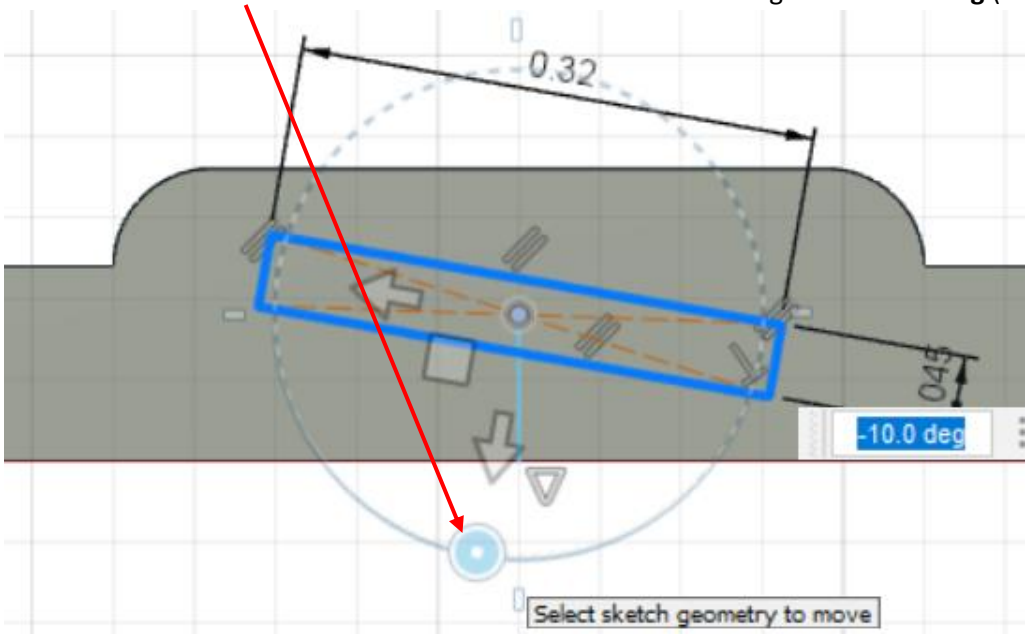

- click on the **top of the Line** just created and expand the **Center Rectangle**.
- type **0.32** for the width, press the **Tab key**, type **0.045** for the height, and **click**



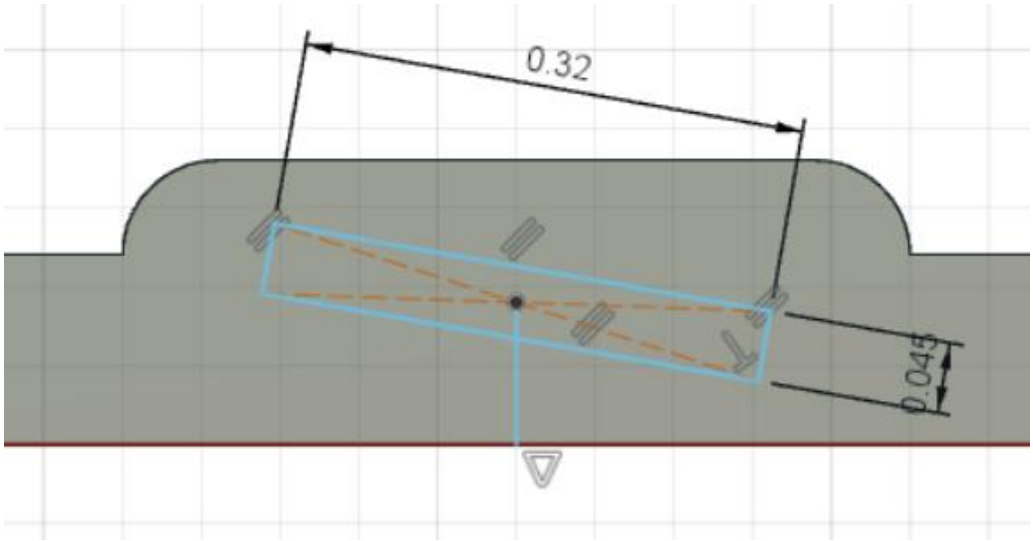
- from the **MODIFY** pull-down menu select **Move/Copy** and click on the **center** of the Rectangle



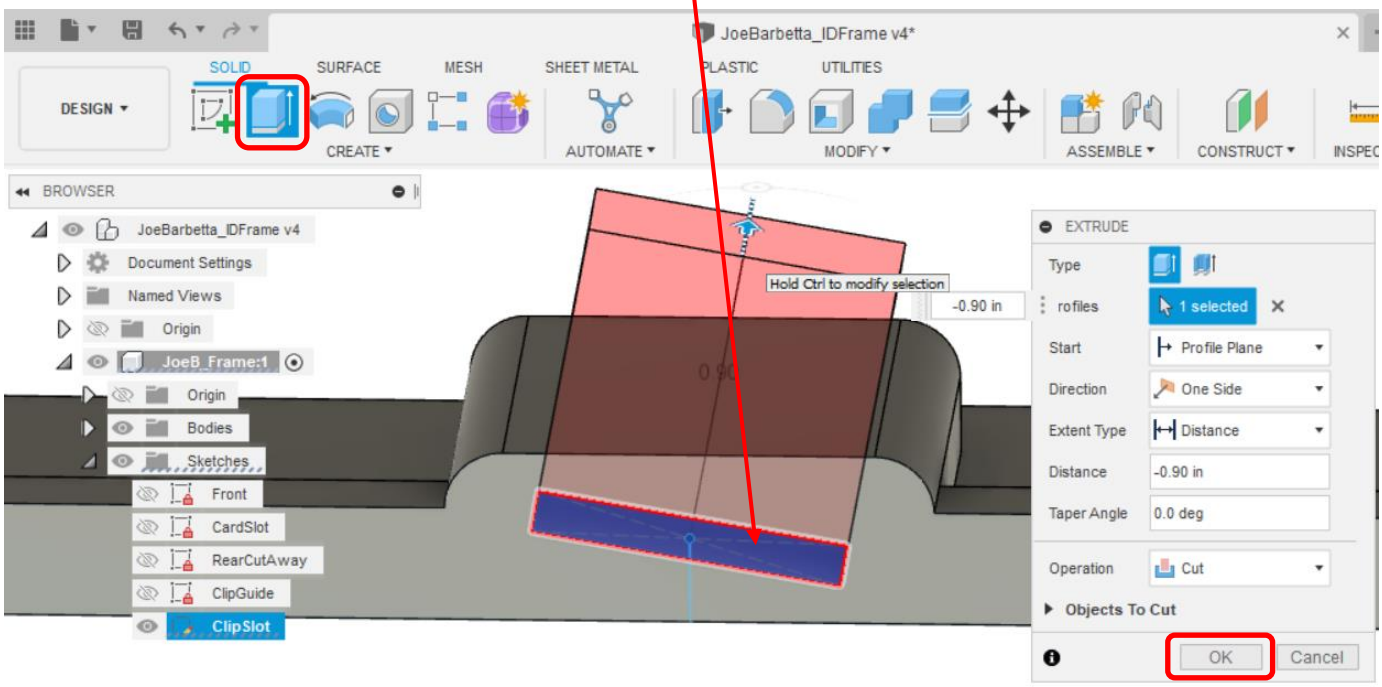

- move the **rotation handle** towards the left to rotate the rectangle until **-10.0 deg** (note the minus sign) is achieved



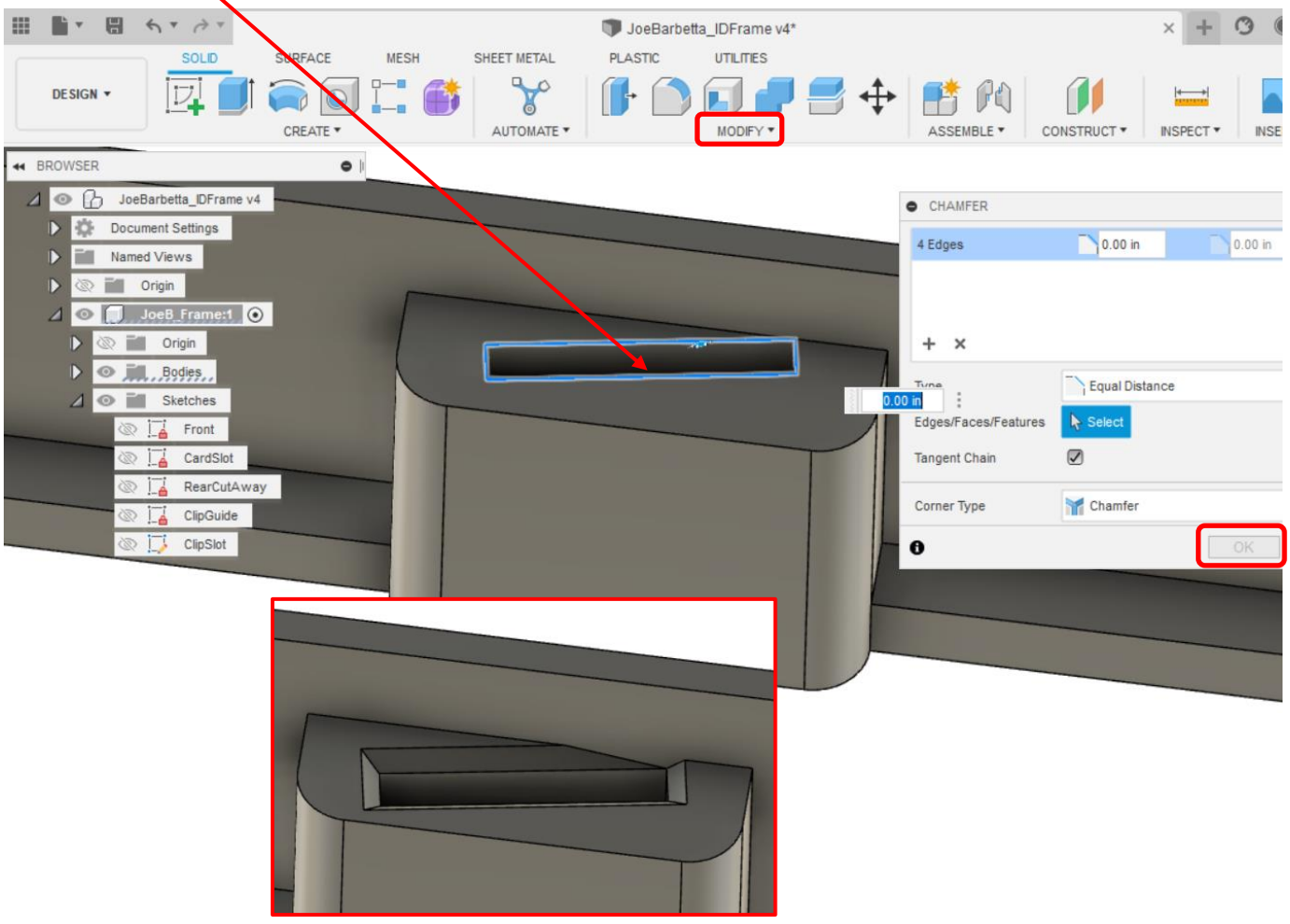

- click **OK** and then **Finish Sketch**



- adjust the View slightly as shown below
- click on the **Extrude** tool and then click on the **interior of the angled rectangular area**
- type **-1 (note the minus sign)** and the light red section indicates that the rectangle is being cut through the frame.
- click **OK**

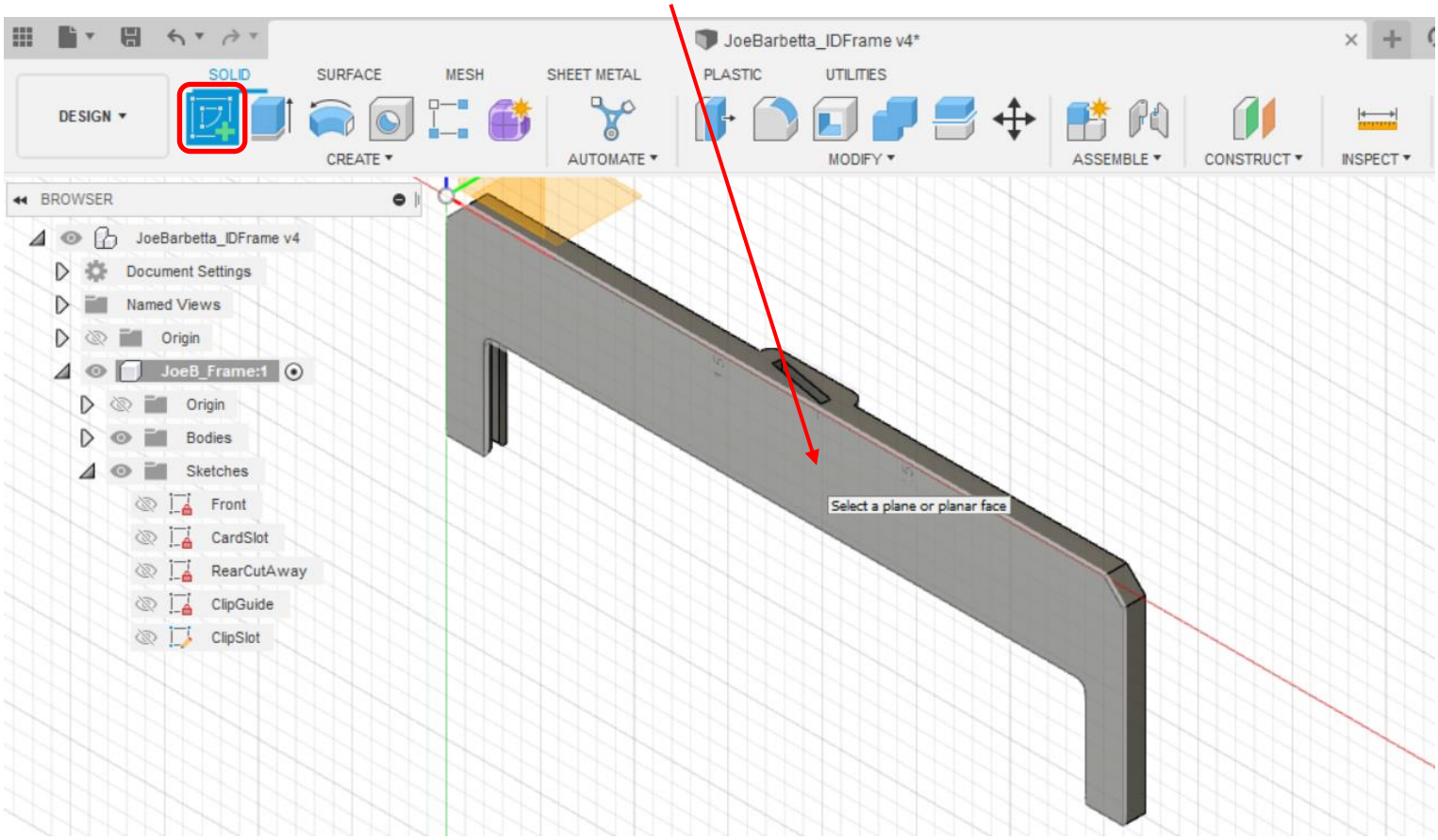



- adjust the View to access the other side of the rectangular slot just created
- from the **MODIFY** pull-down menu select **Chamfer**
- click on the **4 Edges** of the slot, type **0.02**, and click **OK**. These chamfers will make it easier to push the paperclip through.



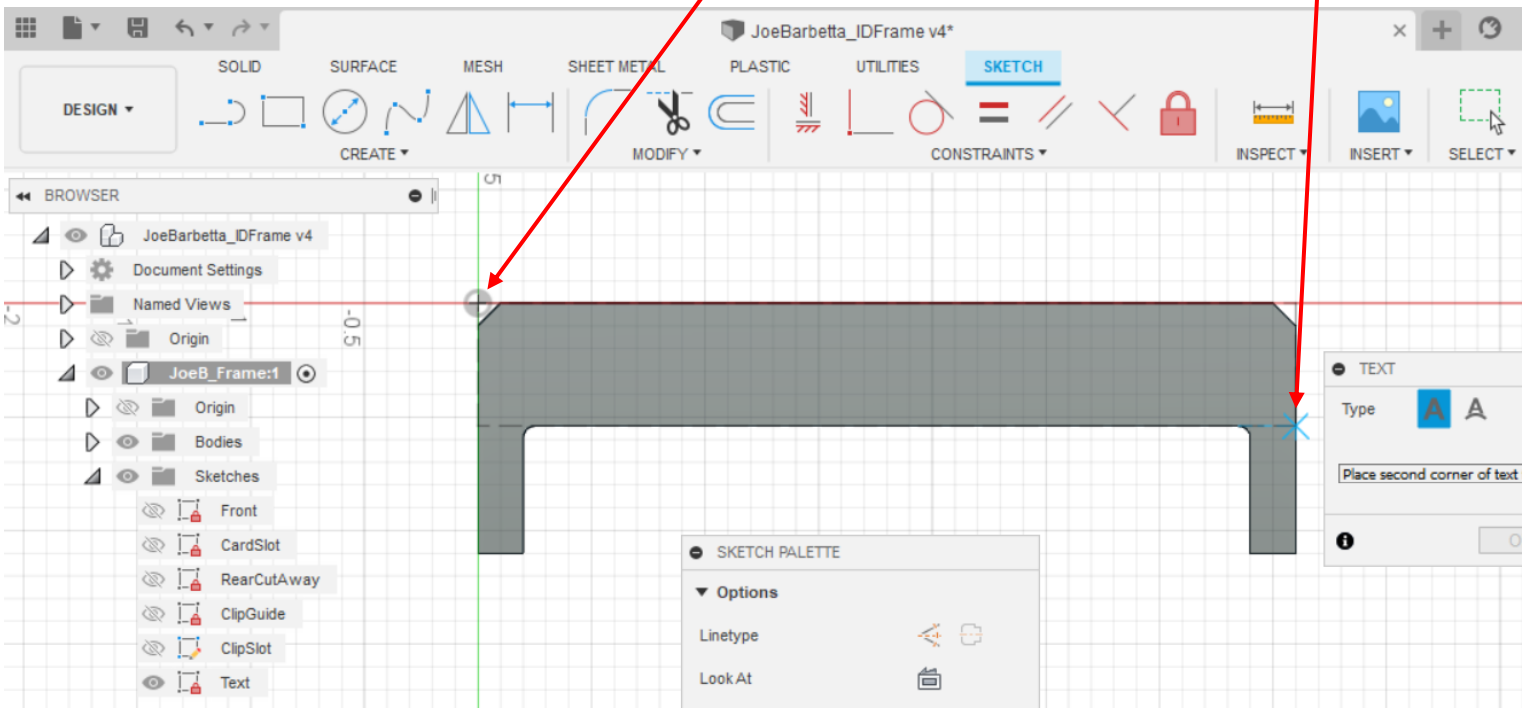
# Adding the Front Text

- return to the **Home** view
- click on the **Create Sketch** tool and then click on the **front Face**

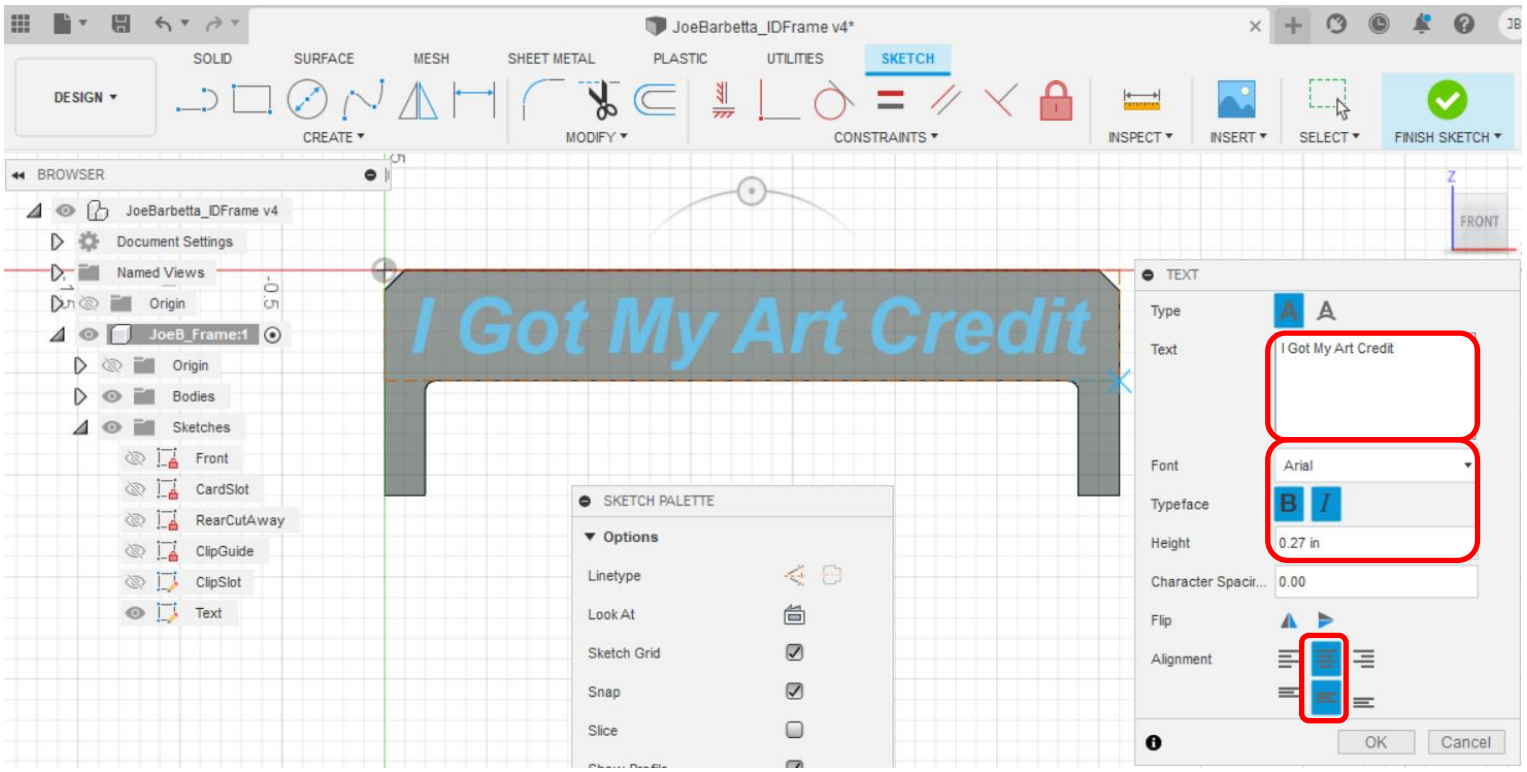



- zoom in similar to that below and rename the **Sketch** to **Text**
- from the **CREATE** pull-down menu select **Text**
- define a rectangle for the Text Extents by clicking on the **origin at the top left corner** and then on the **right edge** as shown

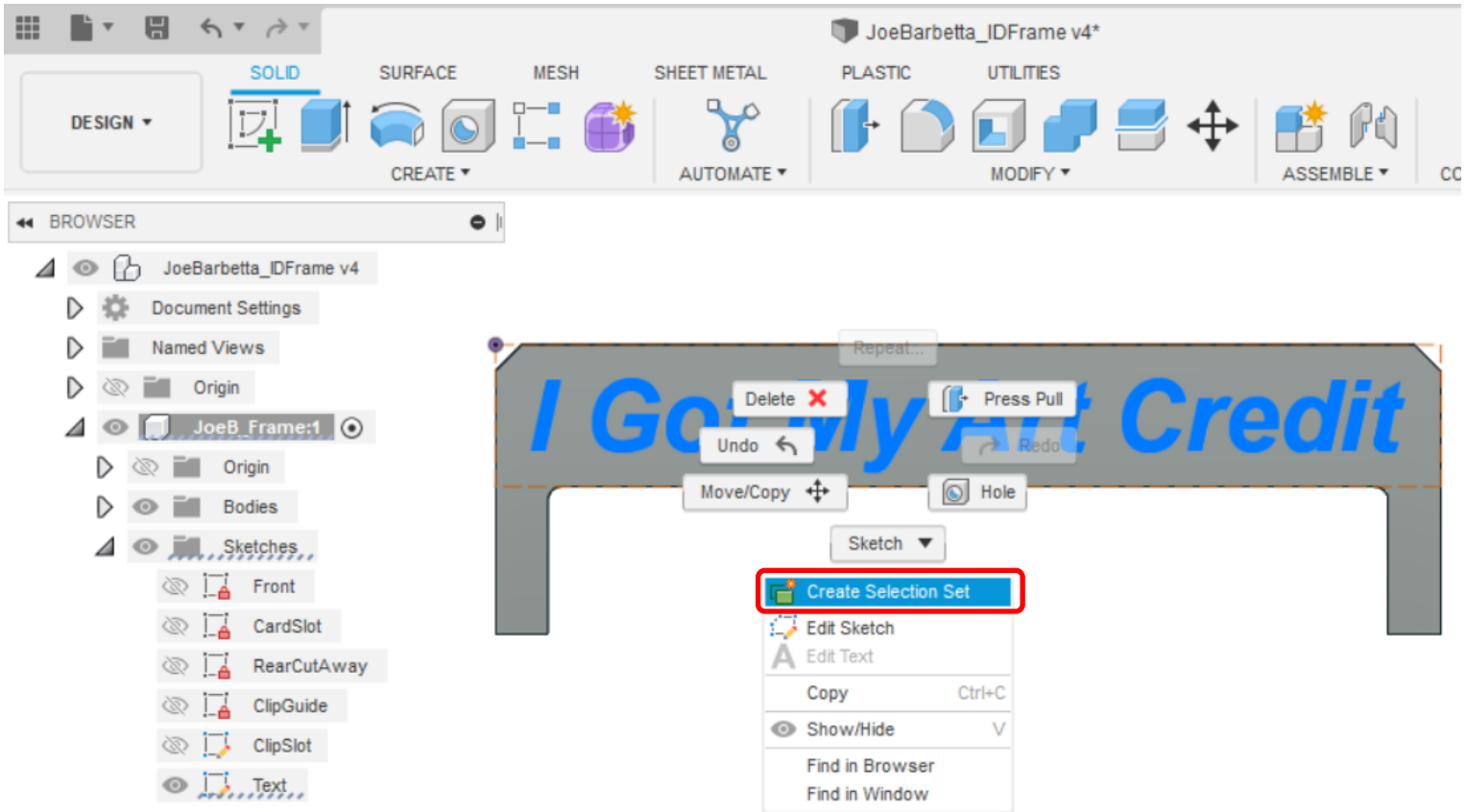
If you can't click at the Origin move the frame to the right further from the BROWSER area.



- in the **TEXT** window enter your text for **Text** and click on the **Center** and **Middle** icons for **Alignment**.
- try different values in the **Height** box to set the desired height. Here **0.27** is used. If the text doesn't fit try a smaller height.
- as per personal preference **Bold** and/or **Italics** can be selected for the **Typeface** and the **Font** can be changed from the default of **Arial**. Note that not all fonts can be extruded and if the later Extrude step fails, a new font must be selected.
- click **OK** when done and then **Finish Sketch**

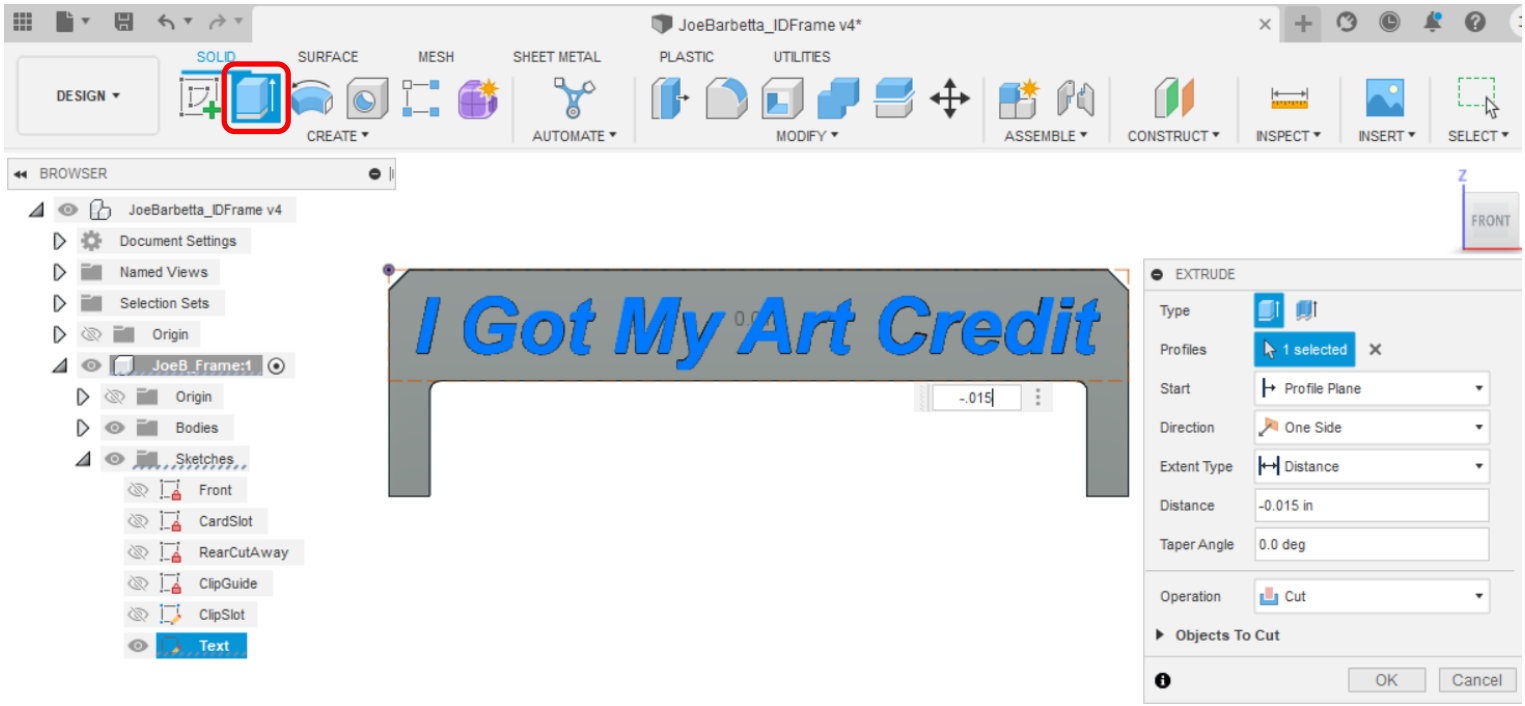



- right-click on the **text** and select **Create Selection Set**. Nothing will seem to happen, but this is needed for the next Extrude operation.

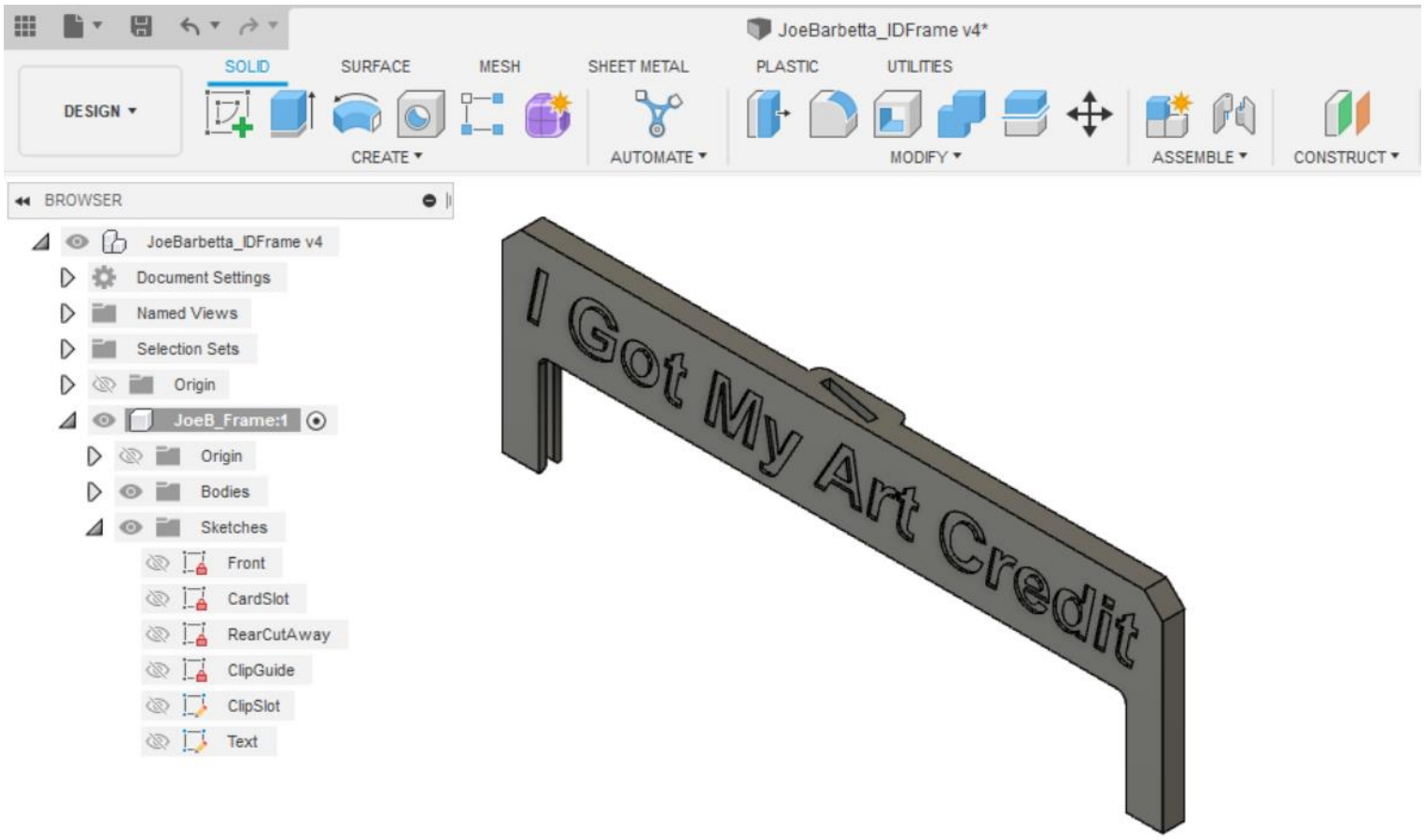


- select the **Extrude** tool, type **-0.015** (note the minus sign), and click **OK**

If you want the text to extend out use 0.015 (no minus sign). This is a personal preference and you can ask to see a sample to decide. If you wish to color in your letters a negative extrude should be used.

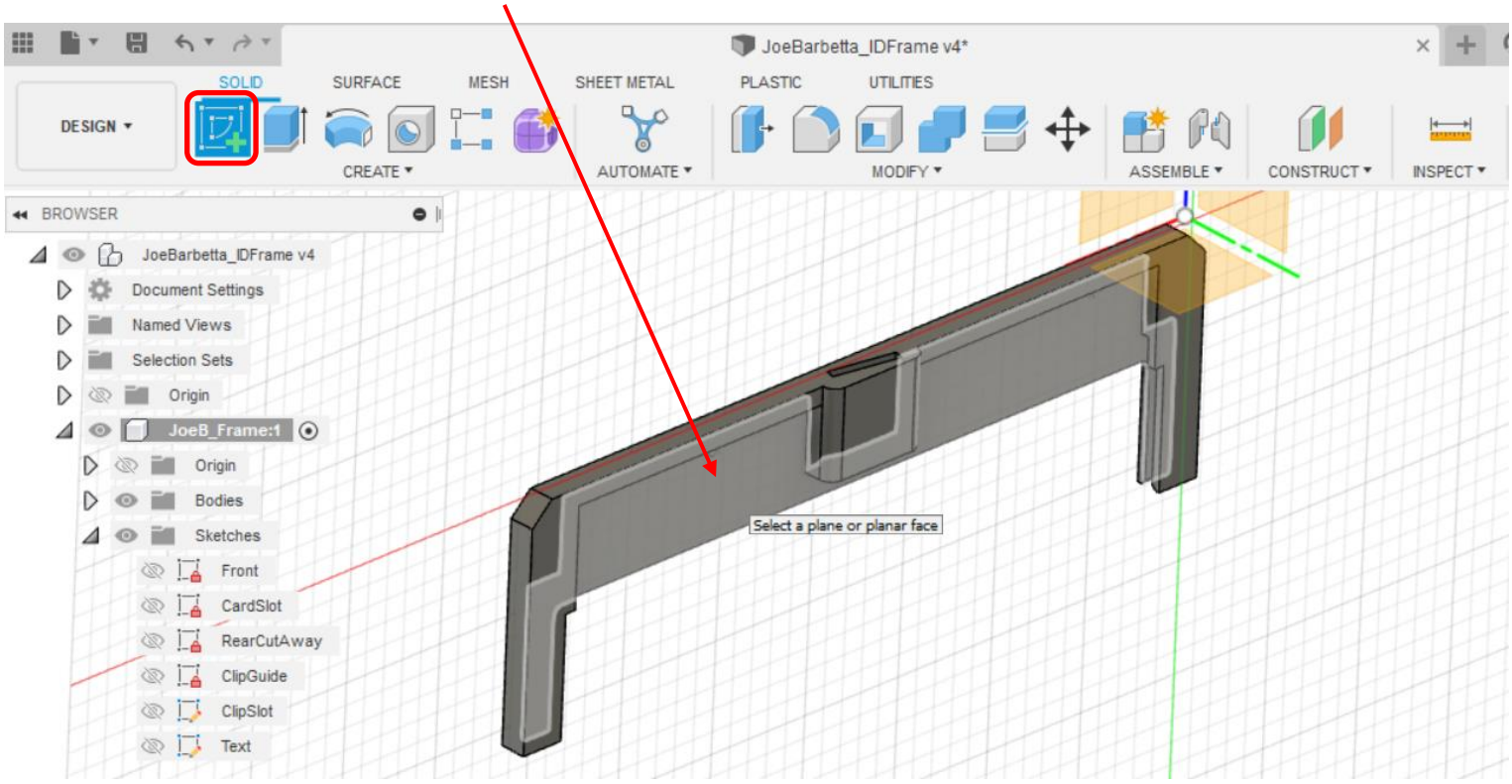



- return to the **Home** view to admire your masterpiece



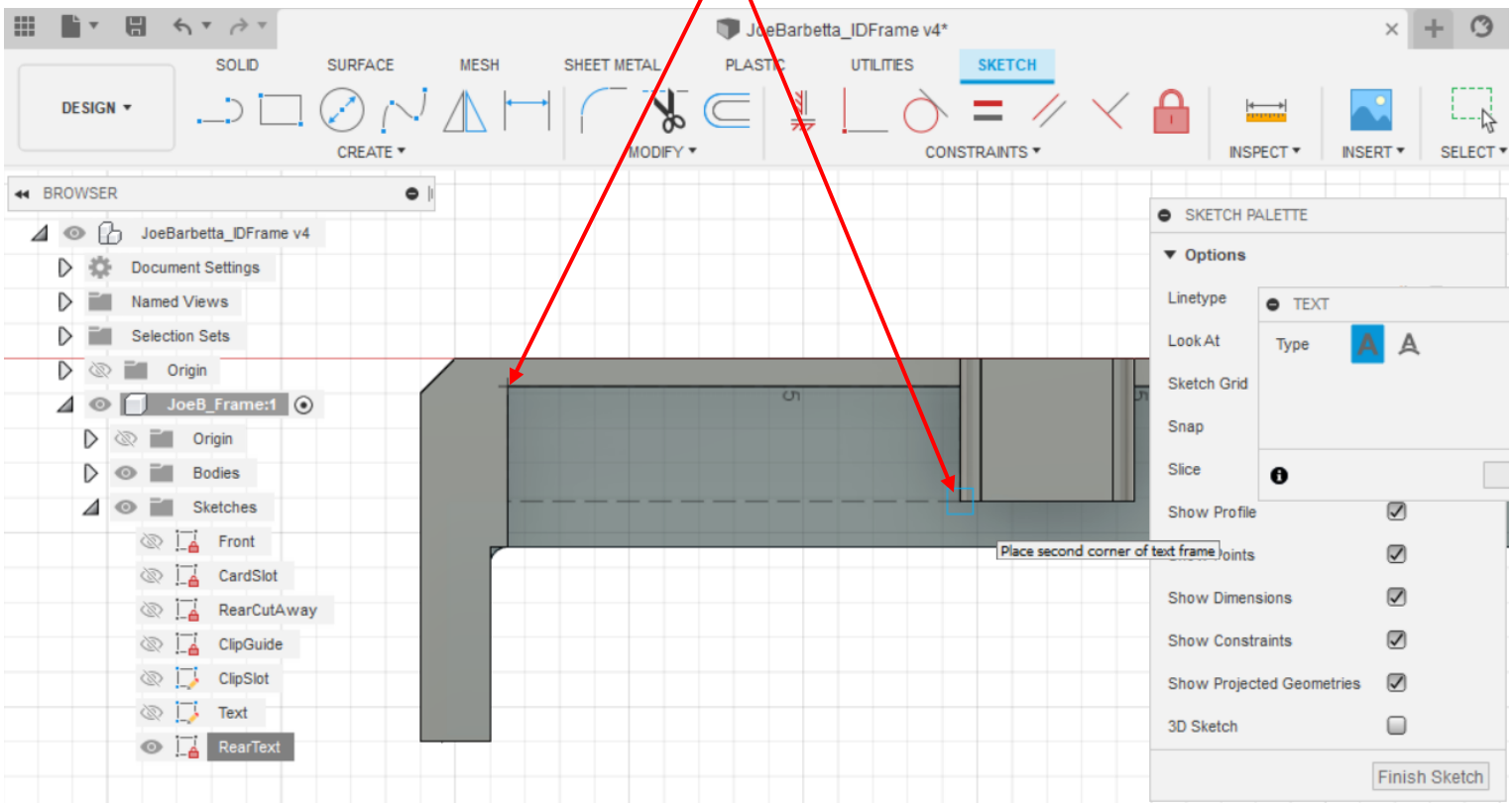
Add your initials to the back of the frame.

- rotate the **View** to access the back of the frame
- click on **Create Sketch** and click on the **rear Face**

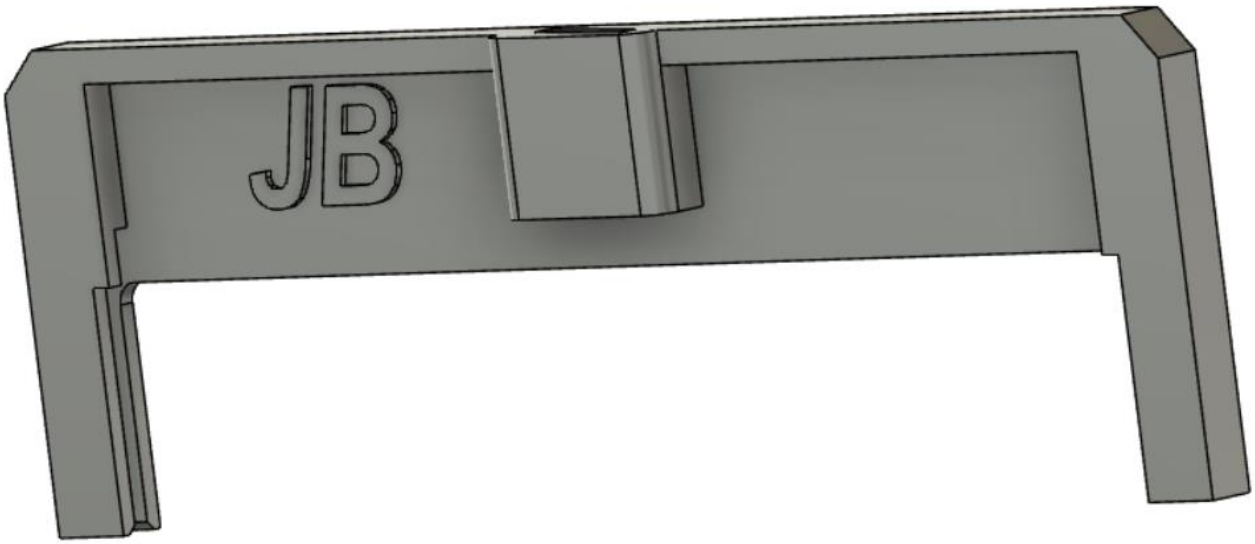



- from the **CREATE** pull-down menu select **Text**
- define a rectangle for the Text Extents by clicking at the **points** shown

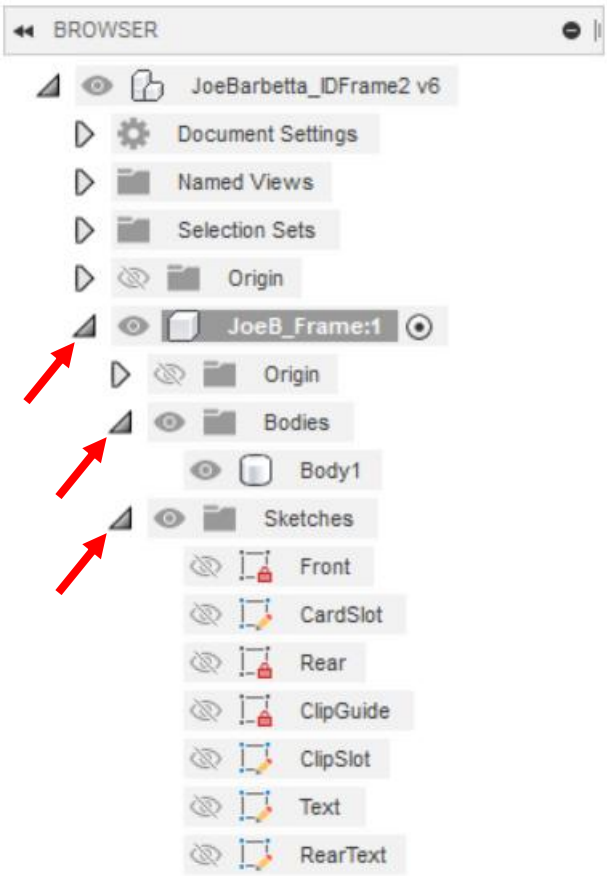
If you can't click on a point move the frame to the right further from the BROWSER area.



- perform the same steps as done with the text on the front. **This text must be extruded out so that it doesn't interfere with text extruded in on the front of the frame.**




At this point the BROWSER section should look like that below after using the **Expand Arrows** to open the folders under the Component. A common error is reopening a project to work on it and not **Activating the Component** being worked on. If Bodies or Sketches are outside of the Component, one may be able to drag them onto the Component Name, but if the final object is complete it can be kept as is. Note that some Sketches have a tiny lock icon. This does not mean they are locked, but fully Constrained. A Fusion 360 expert may say that they should all have a lock to be complete and you will answer, **"Dude, I'm just trying to get my art credit."**

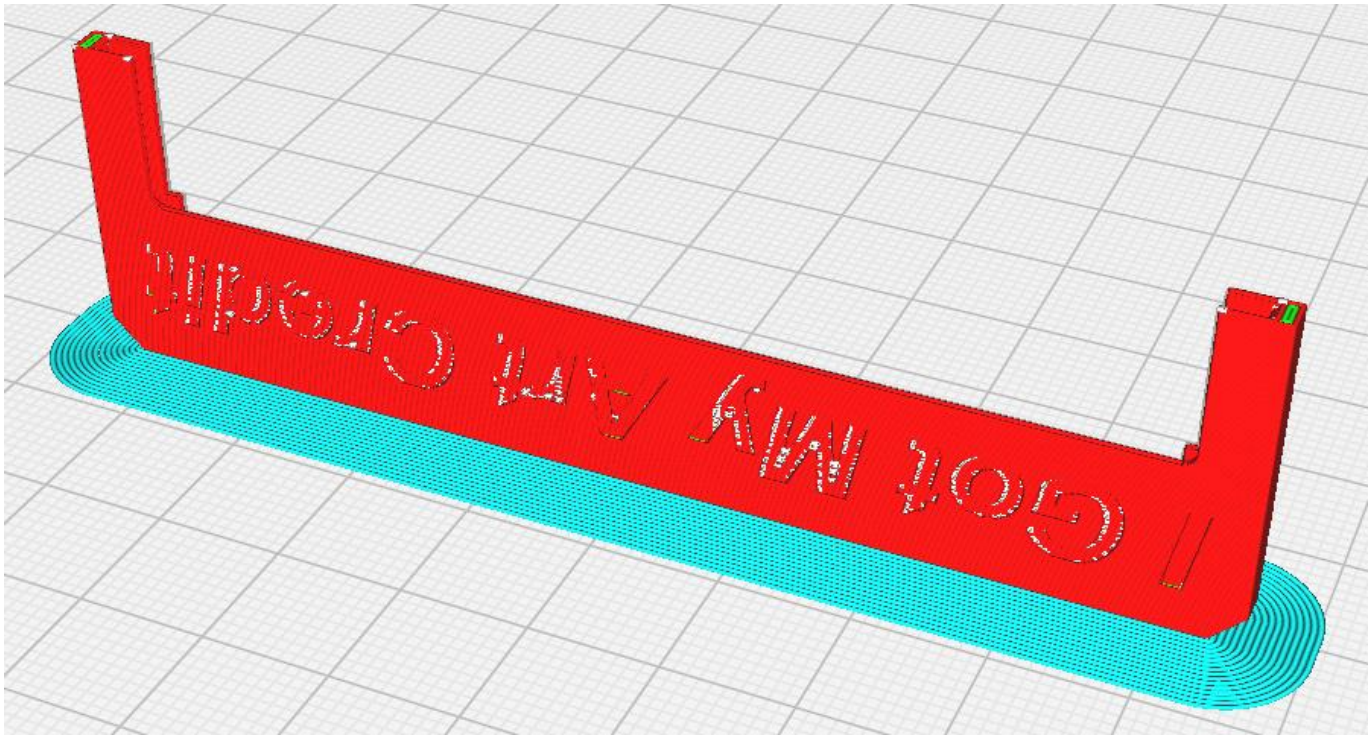


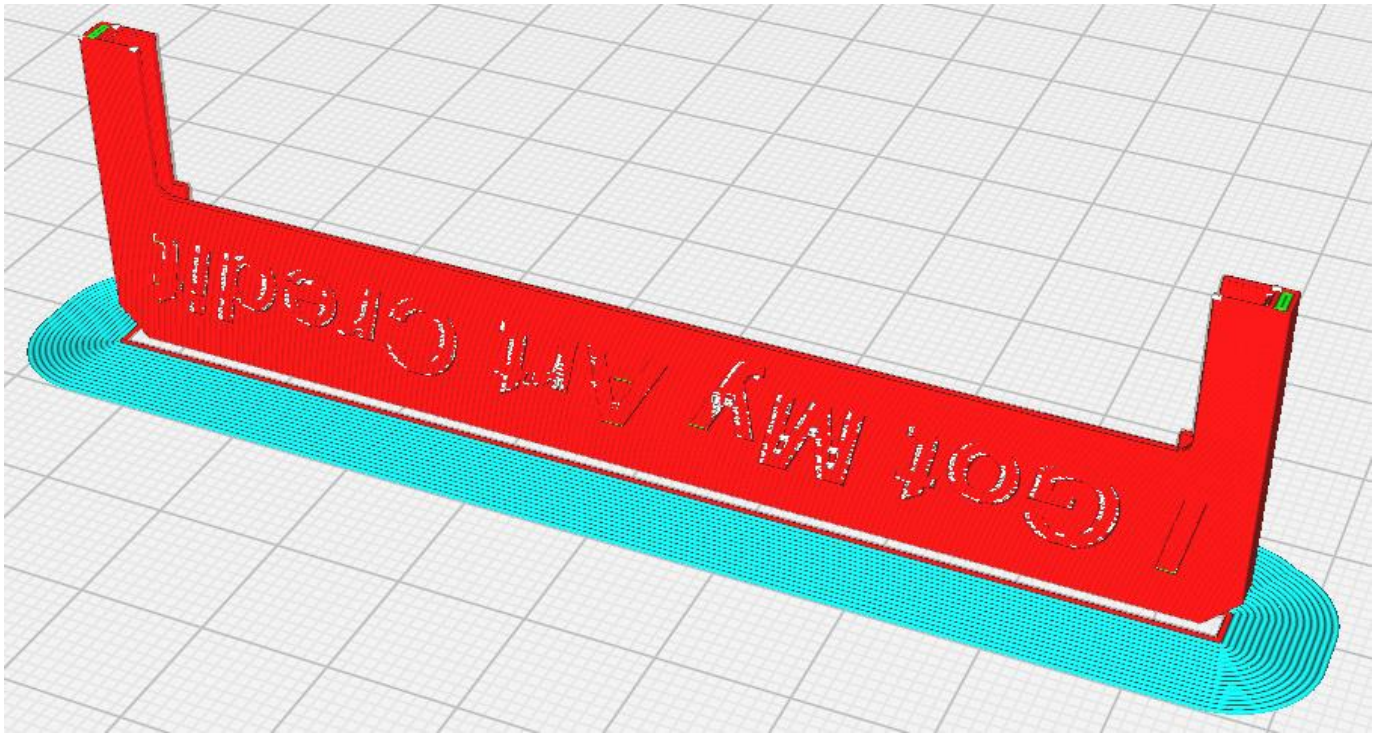
# Managing Cura Brim Generation

**This page if for information.  Instructions continue on the next following page.**

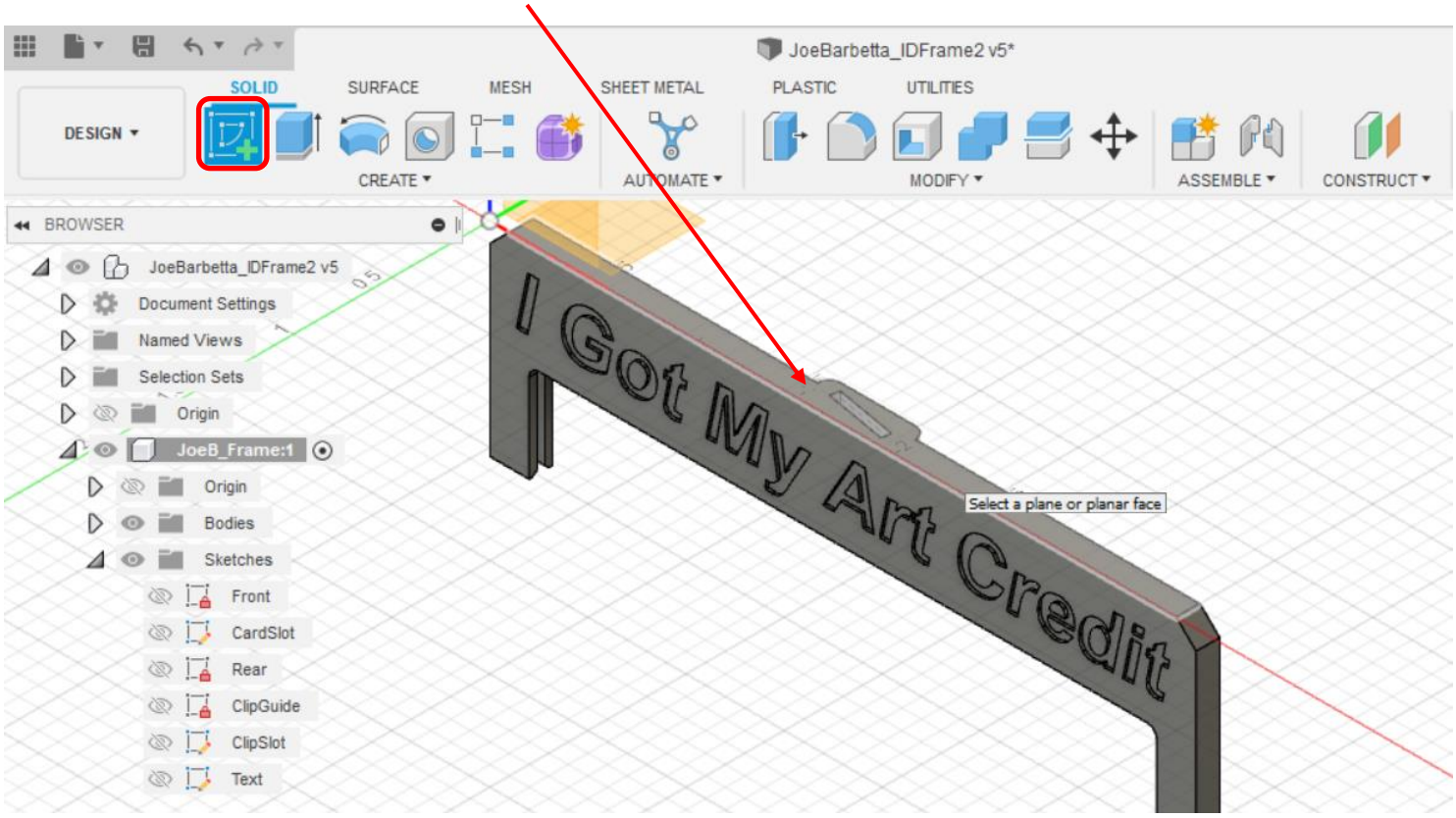
By default the Cura Slicer software will generate an extension of the first layer around the bottom of parts.  This aids "**bed adhesion**" by preventing sections of the first layer from separating from the build plate.  After printing is finished, the brim is removed by hand.

When the Brim is removed the edges around the part will not be "clean".  We can ensure a clean edge at the front of the frame by adding a small "blocking" member.

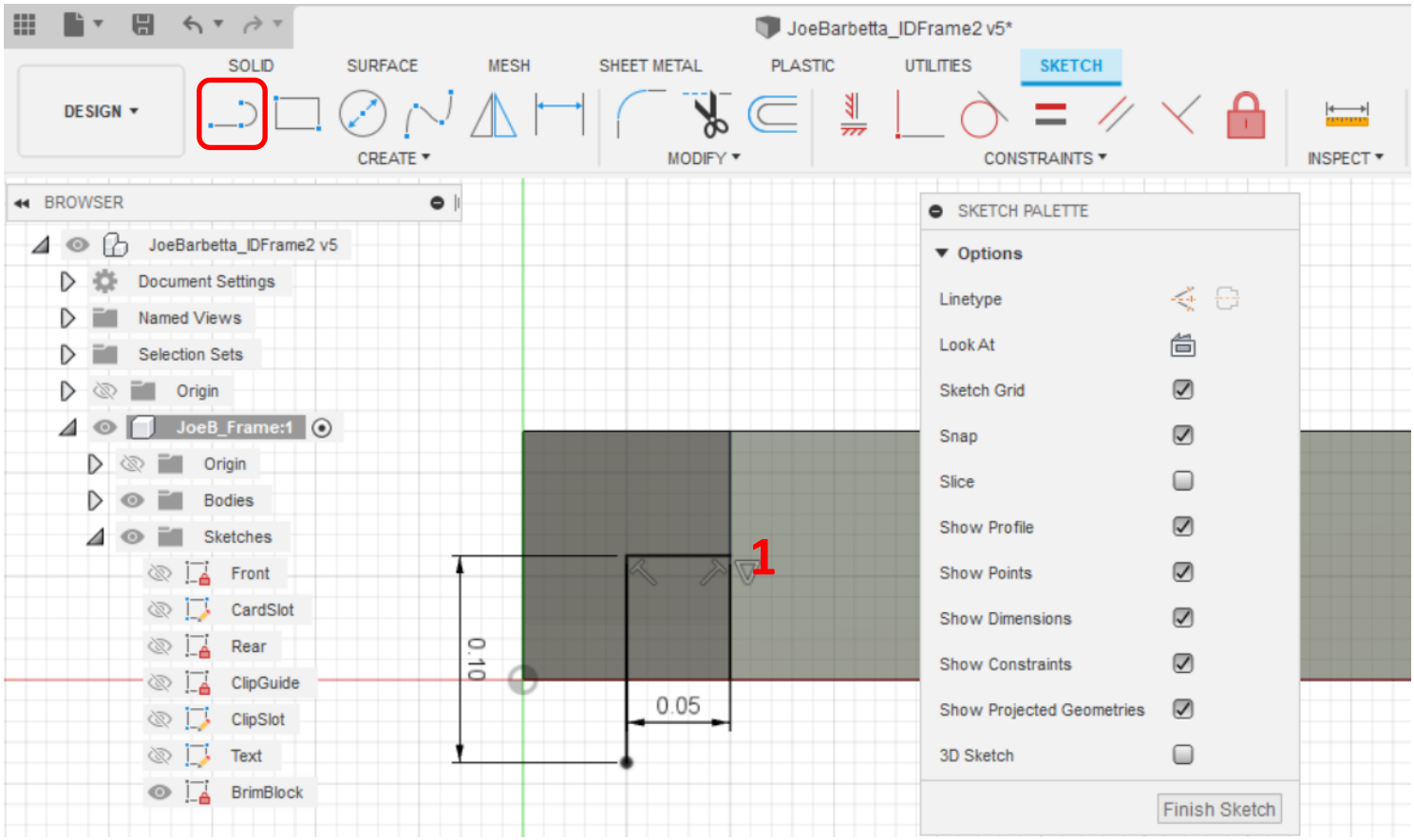




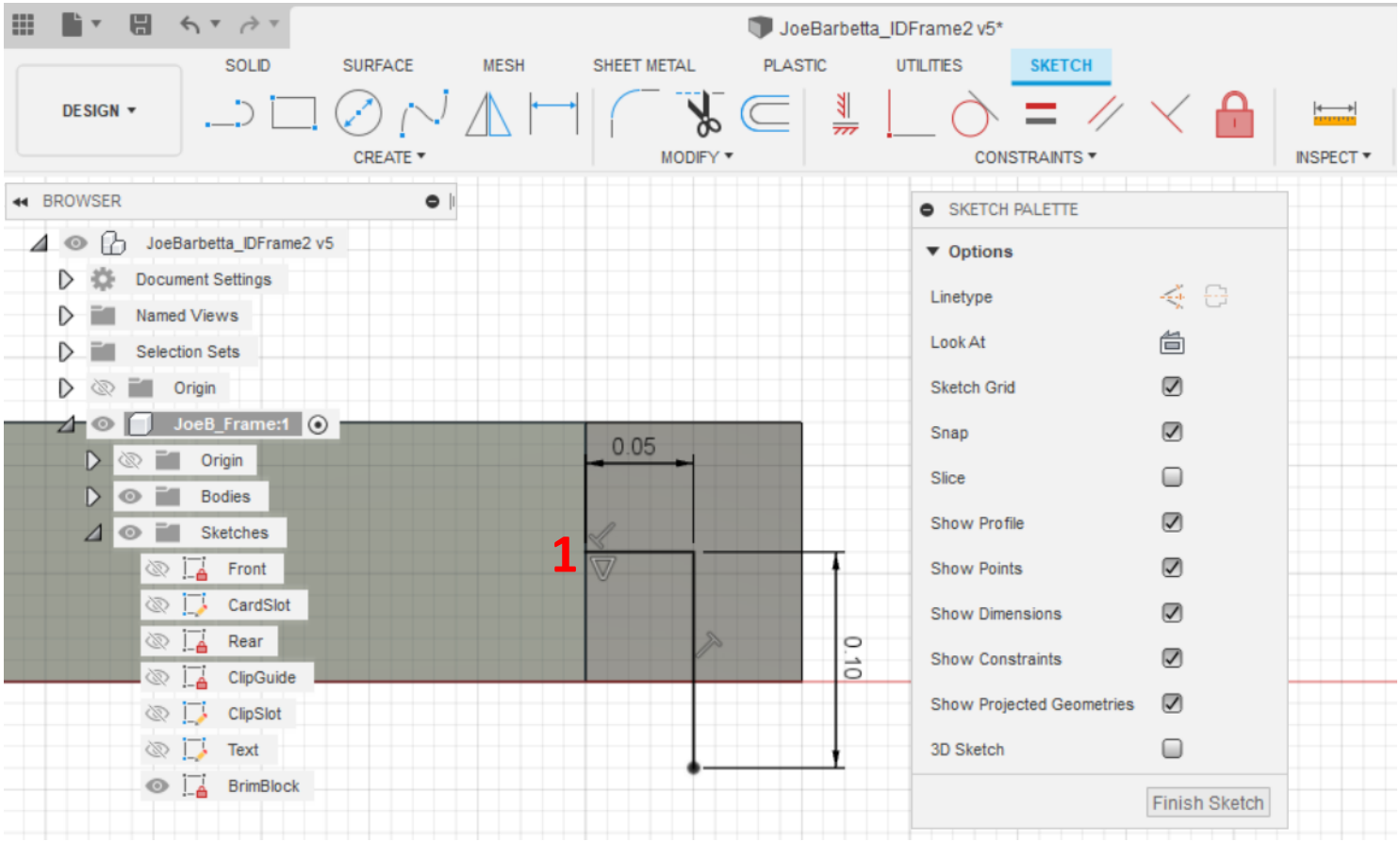
- click on **Create Sketch** and click on the **top Face** as done earlier



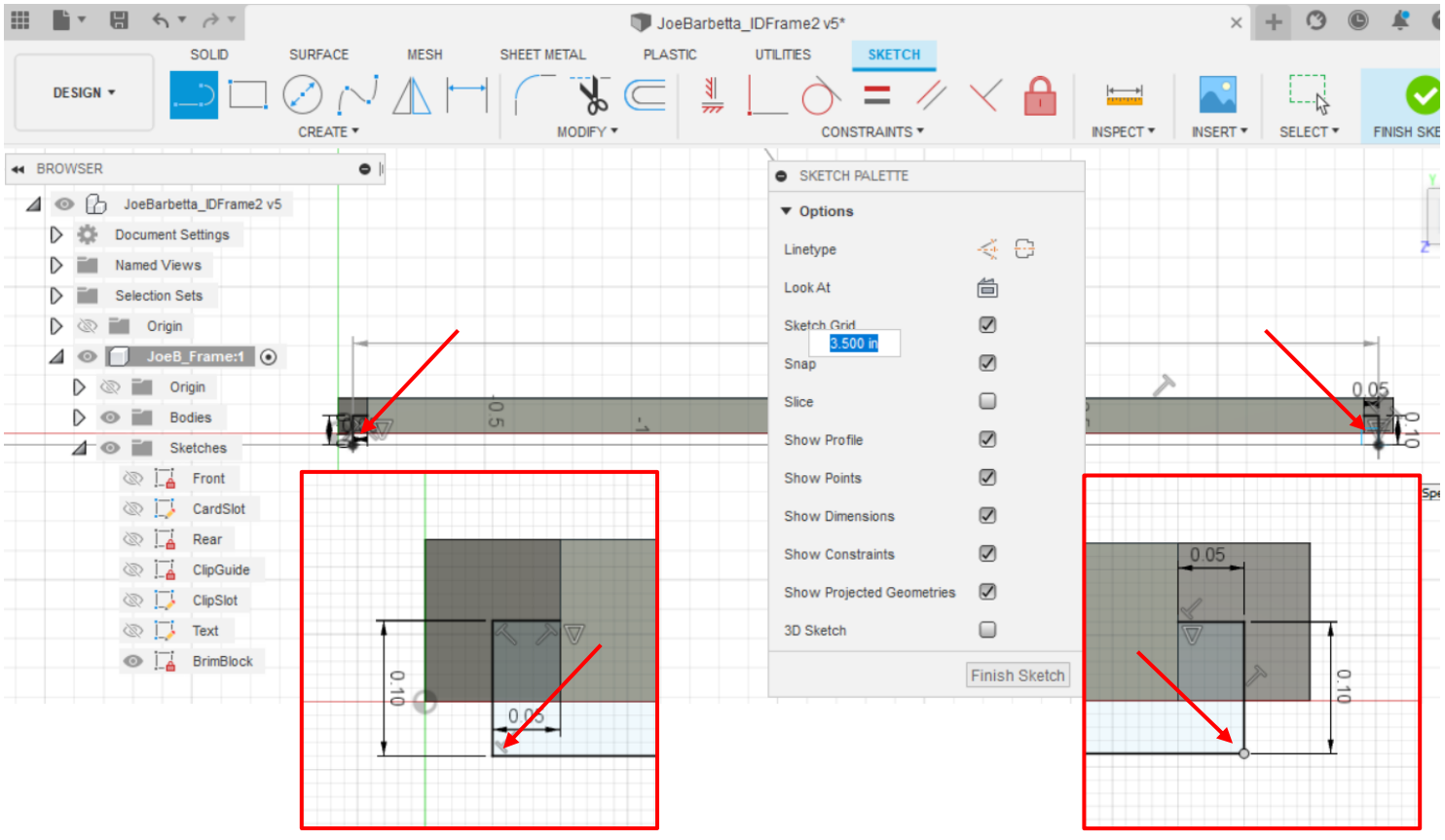

- rename the Sketch to **BrimBlock**
- click on the **Line** tool and start a line at point **1**. The mouse cursor should snap to the center of the edge.
- extend the line **0.05** to the left and then down **0.1**



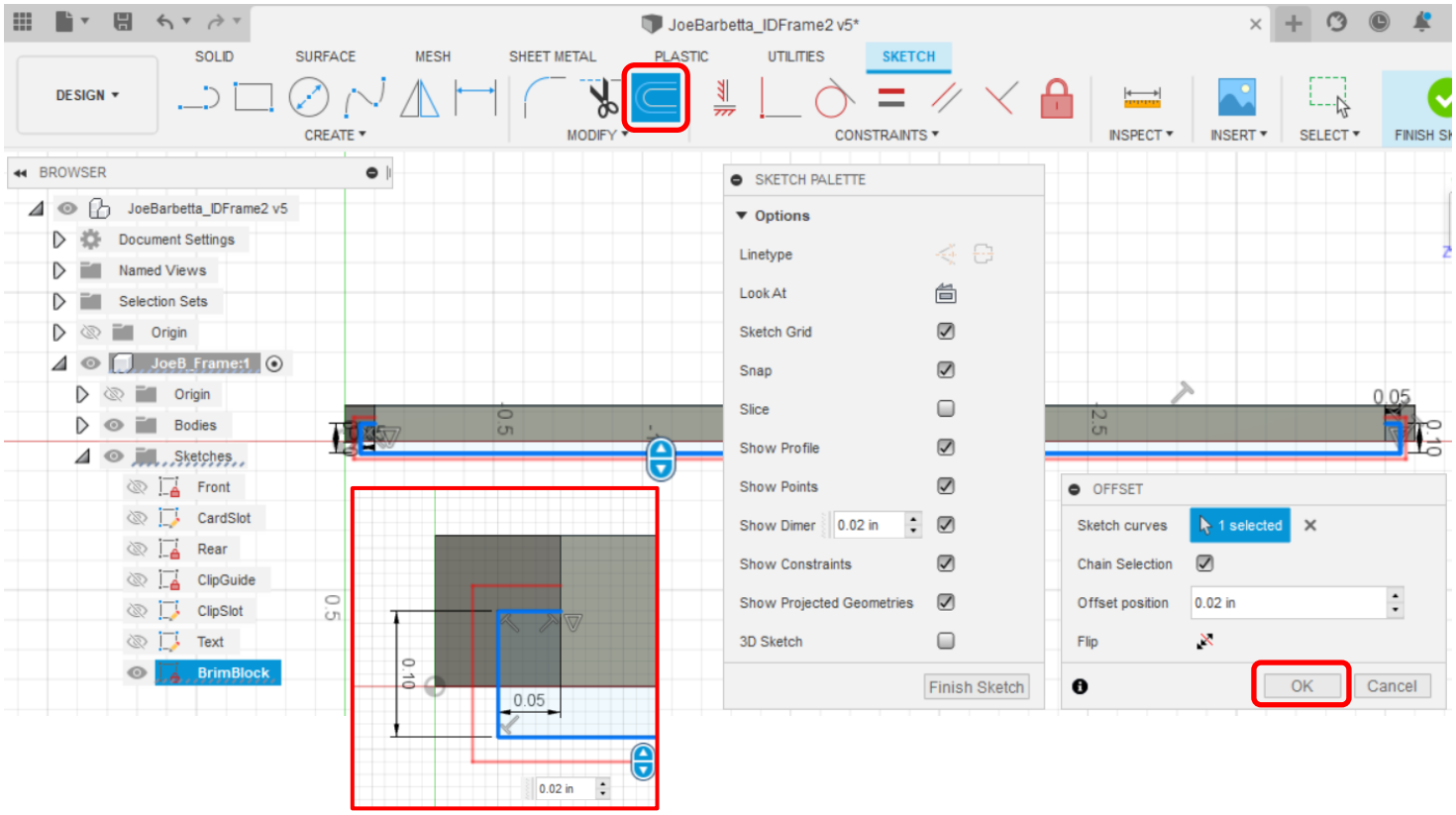
- zoom into the other end of the top and do similarly



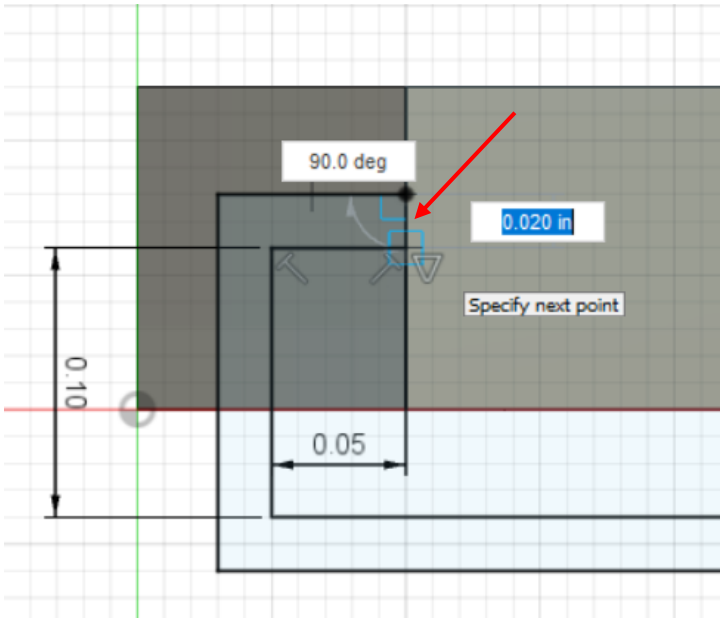

- create a **line** between the **lower endpoints** of the lines just created, as shown in the close-up pictures. Zooming in on each end will help.

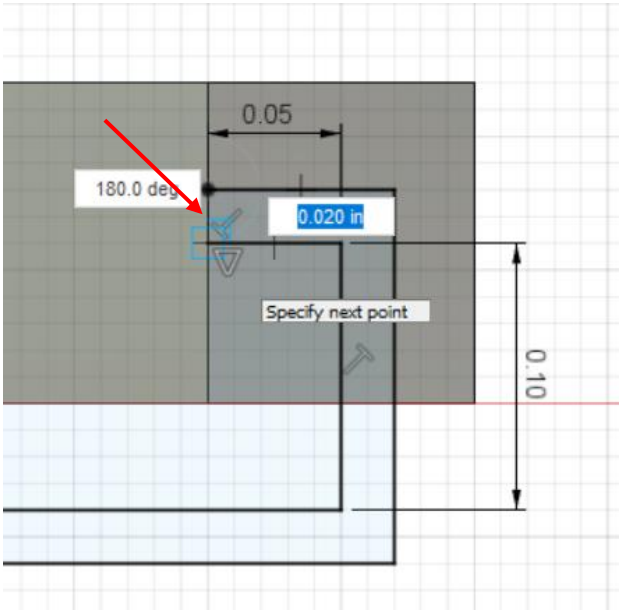


- click on the **Offset** tool and then on one of the lines just created, which should turn them blue and cause red lines to appear.
- type **0.02** and click **OK**.  The close-up picture shows the lines before OK is clicked.

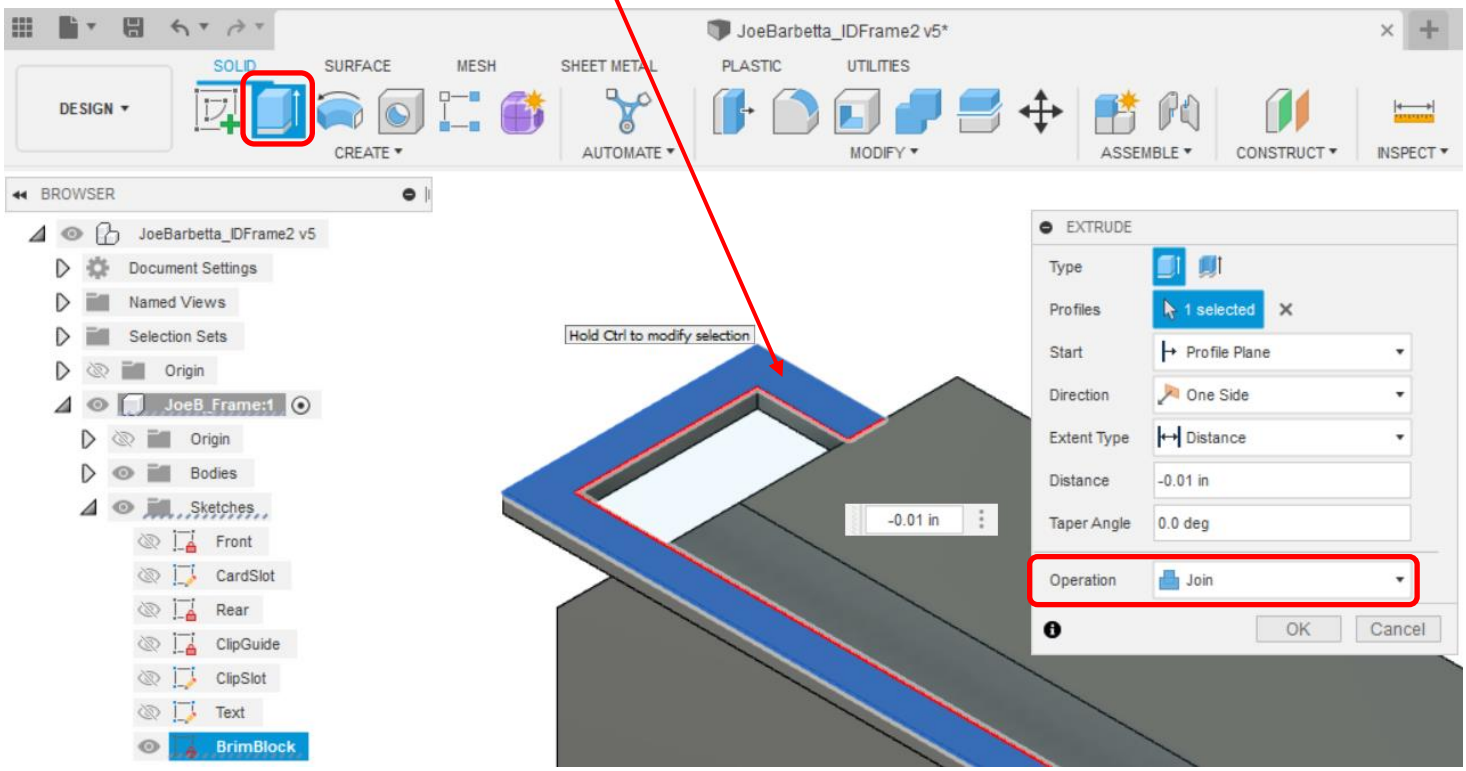



- zoom into each end and create a **line between line segment ends** to close the profile.  Click **Finish Sketch**.



- return to the Home view and zoom into one end of the top
- click on the **Extrude** tool and then on the **Profile** just created and type **-0.01** (note the minus sign)
- ensure that Operation is set to Join and click **OK**

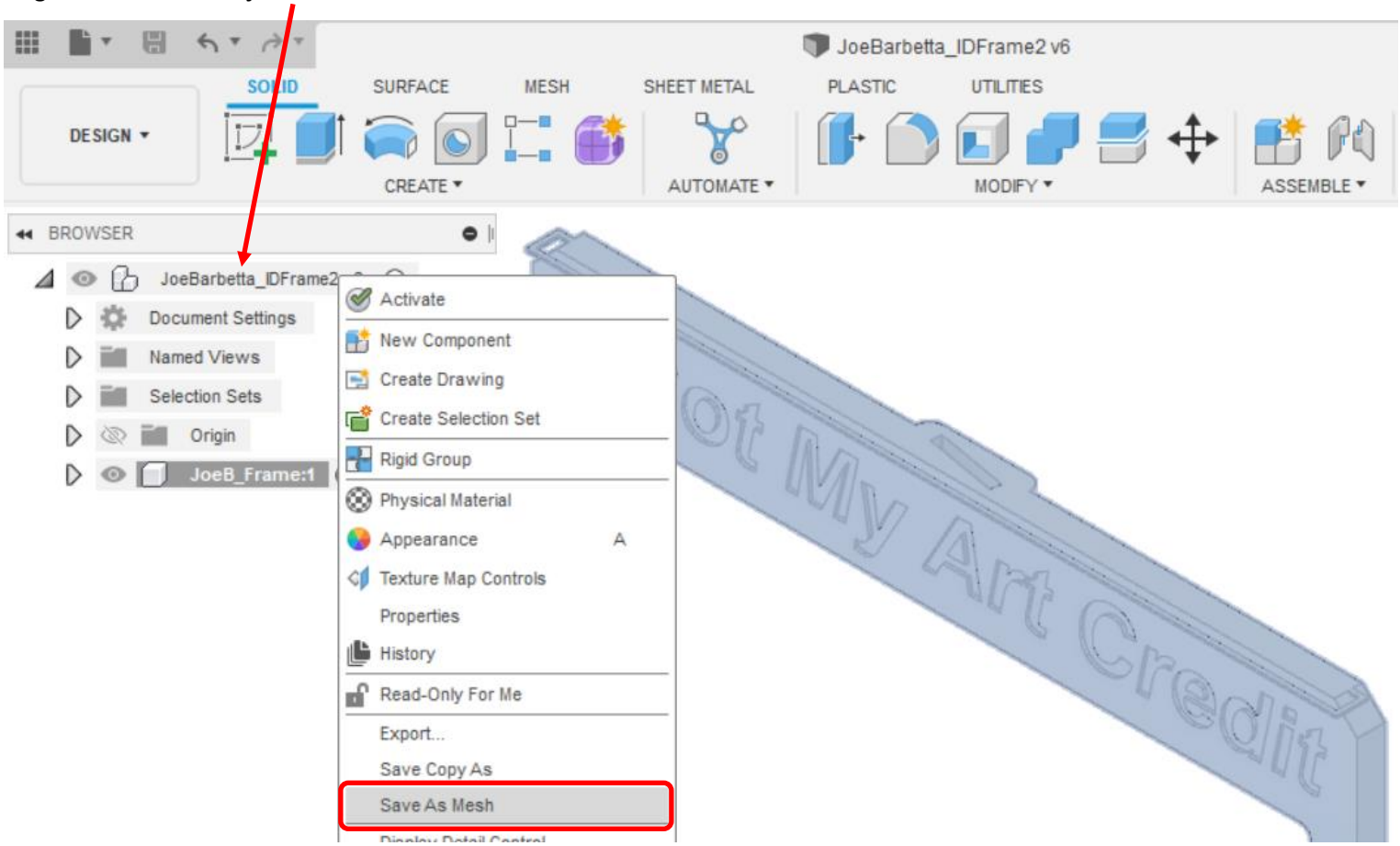



Here is the final design with the Brim Block.

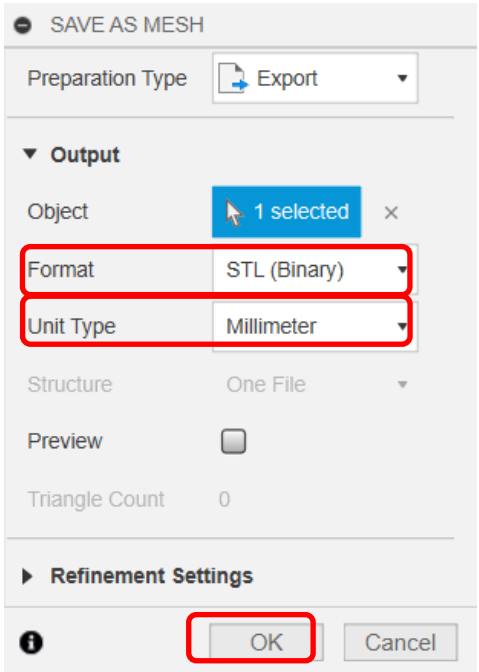
# Exporting STL Files

There are various methods for creating STL files. One is using Export from the File menu, however, this can be slow because it sends the job to the cloud. This alternative method is faster.

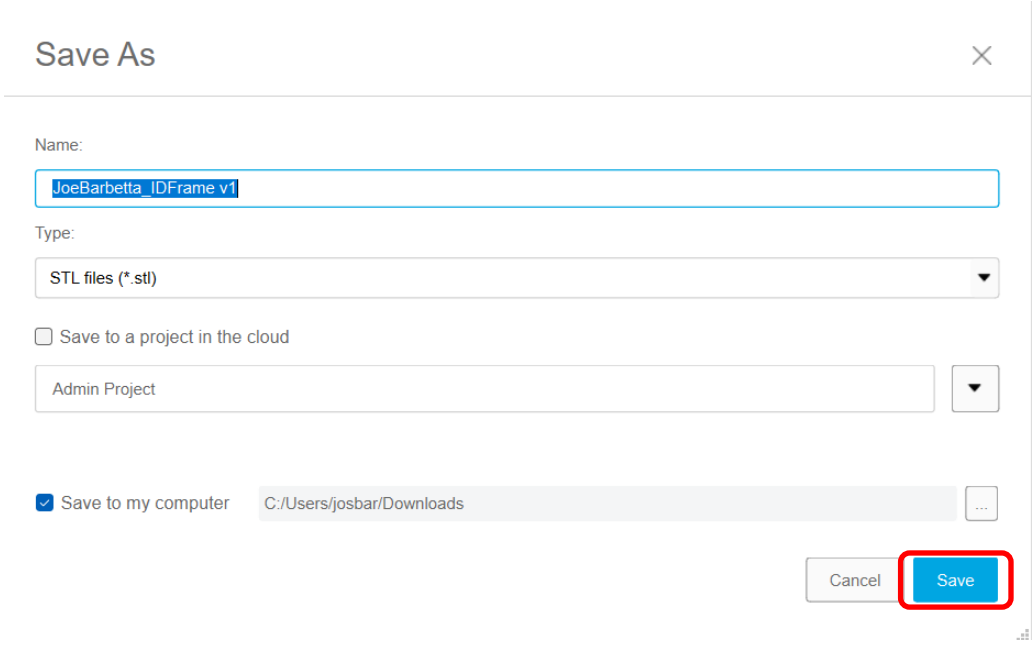
- right-click on the **Project Name** and select **Save As Mesh**




This window will show each time Save As Mesh is used. Ensure that **Format is set to STL (Binary)** and **Unit Type is set to Millimeter** and then click **OK**. You will then be prompted to save the file. The default location is the **Downloads** folder.



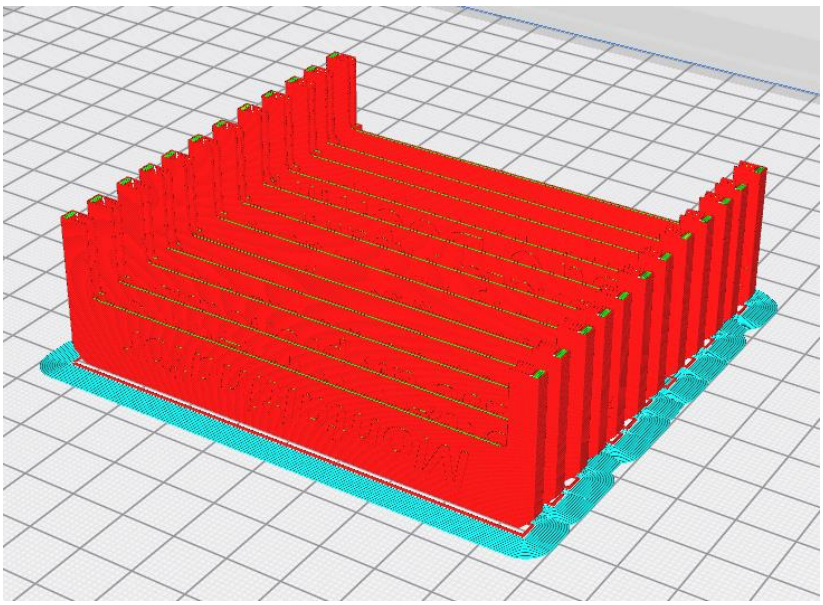
- click **Save**.  By default, Fusion 360 will save the STL file to the **Downloads** folder.



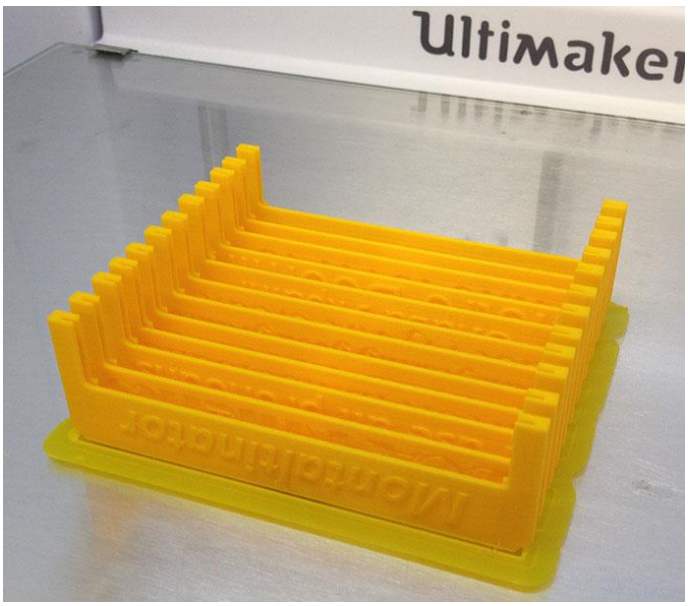

Once you submit your STL file, it and those of your colleagues, are opened in the Cura slicer program.  In Cura they are rotated 180 degrees so their tops are on the build plate.  The program then "slices" them using 0.15mm layers and adds a brim.  Cura outputs a single .ufp file that is loaded into an Ultimaker 3D printer.

They are then printed overnight because the printing takes several hours.  A single ID Frame can be printed in 40 minutes.

A group of ID Frames in the Cura slicer program.



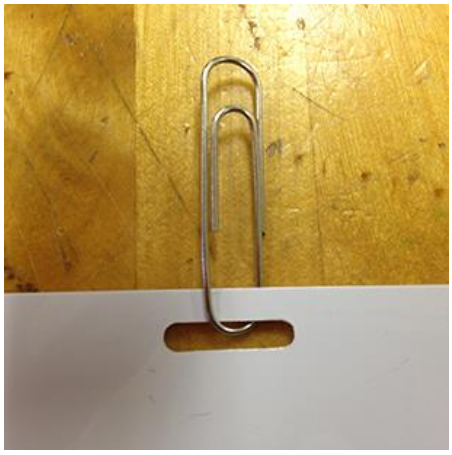
The same group after printing is finished.



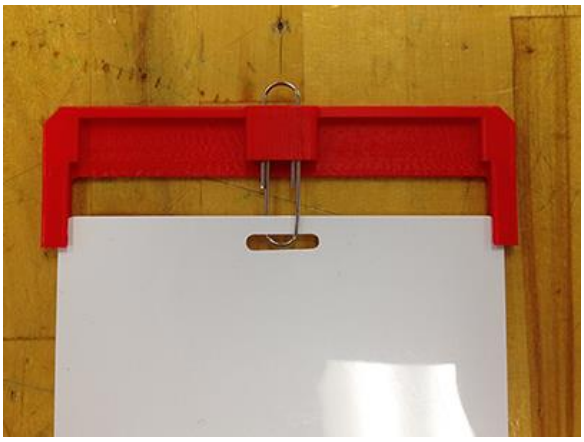
# Assembling Your ID Frame

**1** Bend a small (about 1  1/4" long) paperclip and pass the smaller section through the ID slot.

**2** Pass one half through the ID slot and bend the paperclip straight again.



**3** Pass the paperclip (large end first) through the frame's **center slot** and slide the side edges of the ID into the **side channels**.



**4** Slide the ID fully into the frame and connect the lanyard hook in the paperclip.



## Coloring your letters

The instructions guide one to use a negative extrude to allow letters to be colored in.

If one colors the letters in directly, the ink will be absorbed into the plastic and give the letters a smeared look, as shown on the left.

One trick is to brush clear nail polish over the letters and then quickly wipe it away and then pat the letters with a lint free cloth.  Paper toweling can tend to leave some fibers behind.

Let it dry for about 10 minutes.  This will allow the nail polish to migrate into the plastic and form a seal.

Then use a ultra fine point marker to carefully fill in the letters.  Don't press hard with the marker so the tip doesn't get damaged by the rough surface in the letters.