

# LINDEN ROBOTICS

FRC-3568 Linden RoboEagles

FTC-7031 Linden Battle Blazers

# Autodesk Fusion 360 Training



**We need to thank our FIRST sponsor -**



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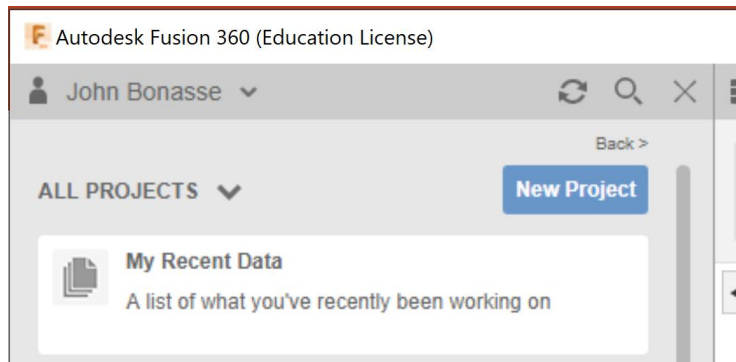
You should have already downloaded and installed Fusion 360. If you haven't please see the email previously sent with details.

Open the software. You may be prompted to sign into Autodesk.

Click on New Project and name it RoboEagles.



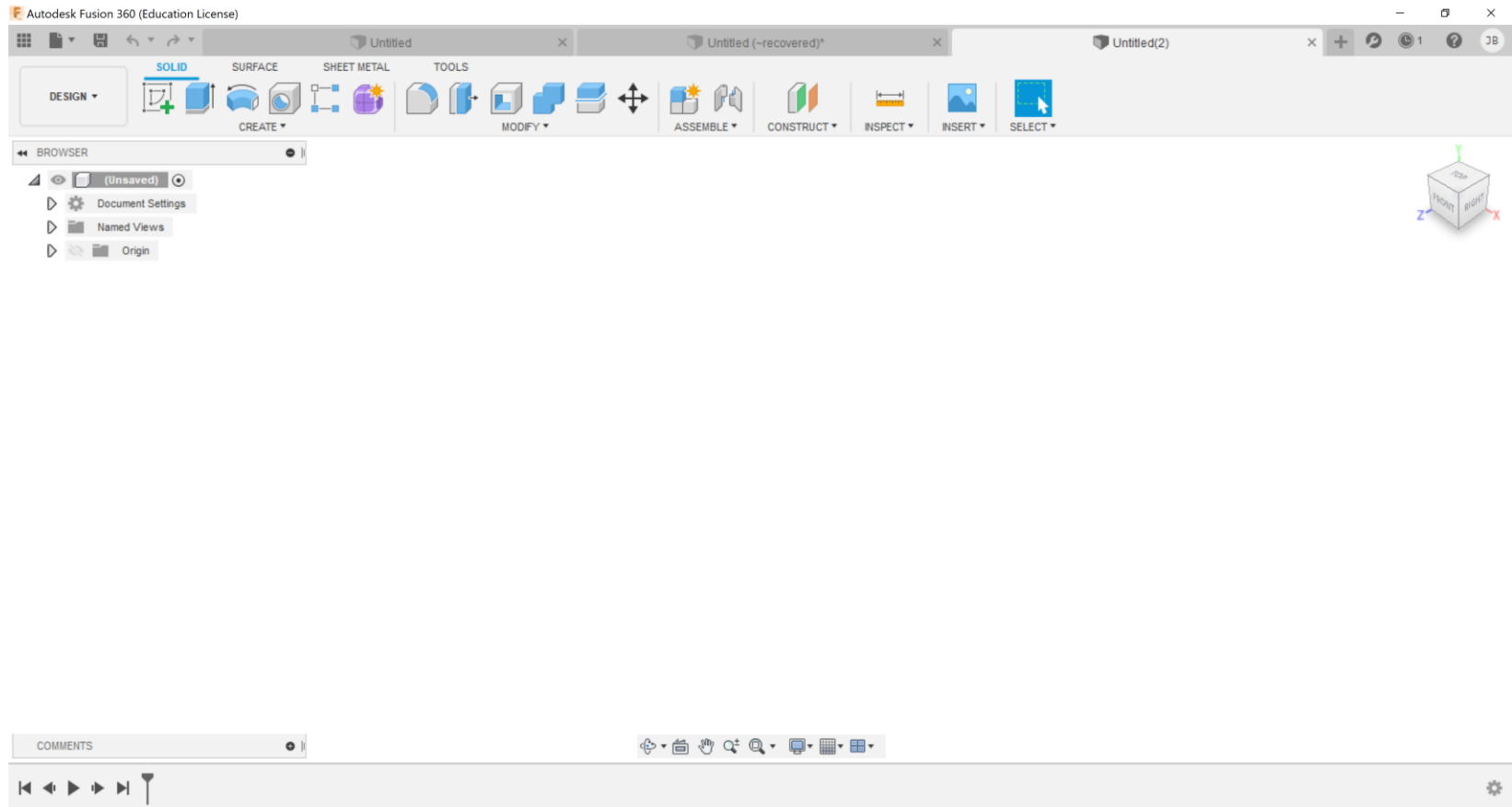
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Your screen should look similar to the one shown below.





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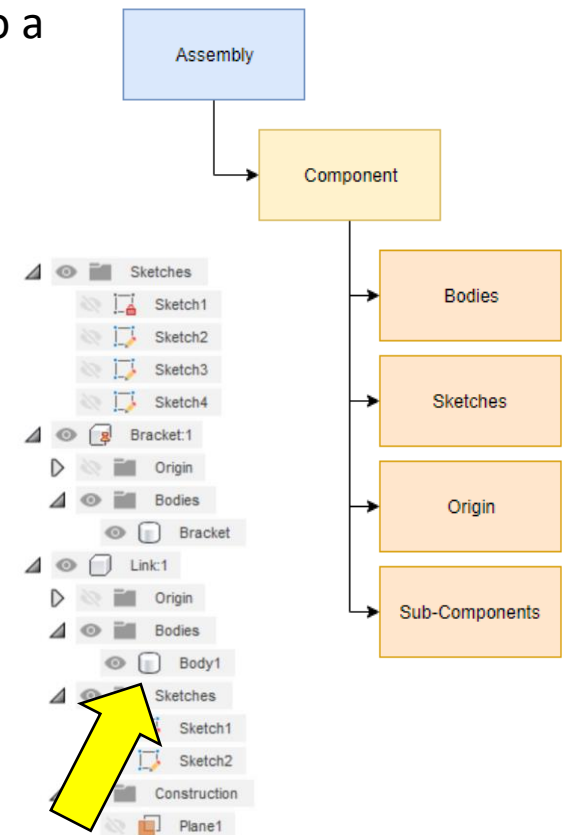
## Assemblies, Bodies, & Components

In Fusion 360, a **Body is any continuous 3D shape**. Whenever you create a 2D sketch in Fusion 360 and then extrude it into a 3D shape, you automatically create a Body.

So therefore, **the Bracket we made is considered a Body**.

There are **four types of Bodies**; Solid, Surface, Mesh, and TSpline (Polygon).

Bodies are shown as a **solid cylinder** in the project tree.





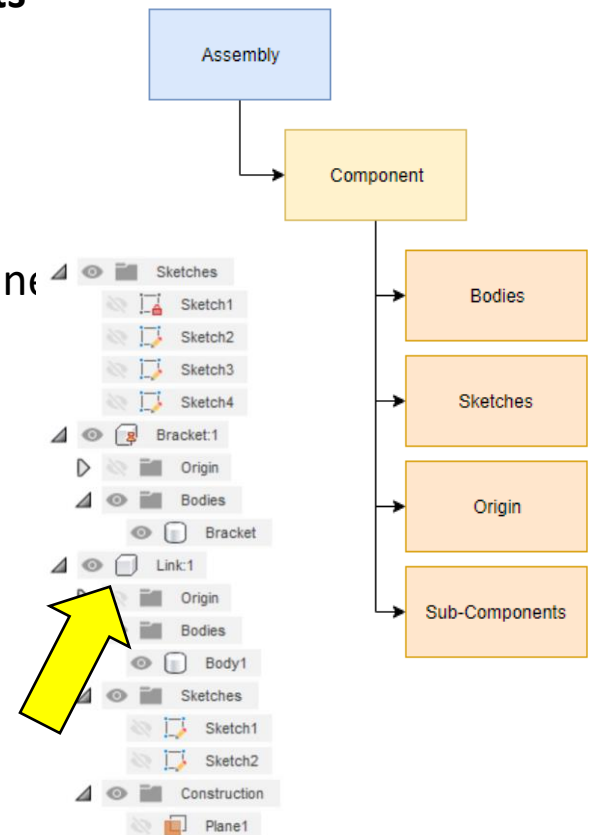
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## Assemblies, Bodies, & Components

A **Component** is a part that is capable of motion and has its own unique origin.

Components are “containers” that can contain Bodies, and **Bodies can be converted into Components**. They can also contain Construction Planes, Sketches, Canvases, Origin Planes and other Components.

Components are shown as a **solid cube** in the project tree.





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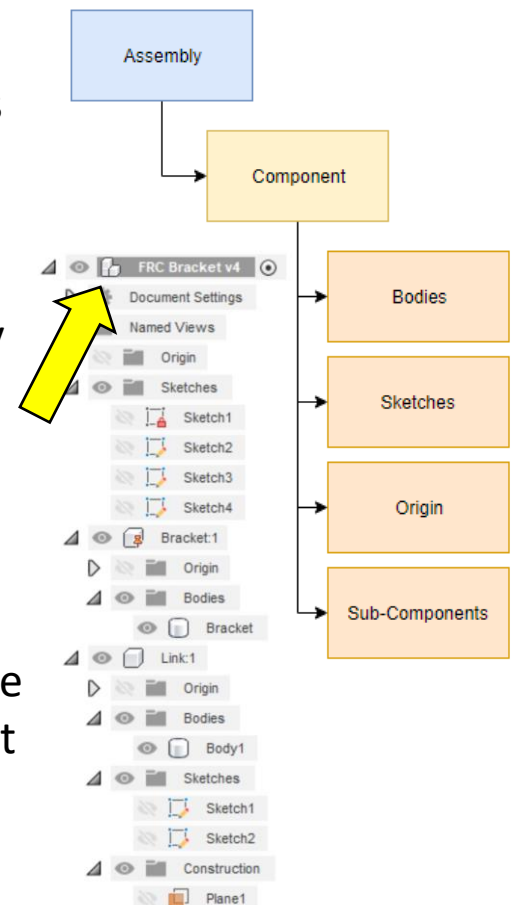
## Assemblies, Bodies, & Components

An **Assembly** can contain **one or more Components**.

**Bottom-Up Assemblies** are when each piece of the assembly is a separate file and imported into the assembly. **Top-Down Assemblies** are where each piece is a component within the assembly. This is important because of the relationships between each piece. Top-Down creates links that automatically adjust based on the changes made.

Assemblies are shown as a **three stacked component cubes** in the project tree.

Components can be combined within a main assembly to create **Subassemblies**. This helps to organize your project and makes it easier to work within it.





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## Assemblies, Bodies, & Components

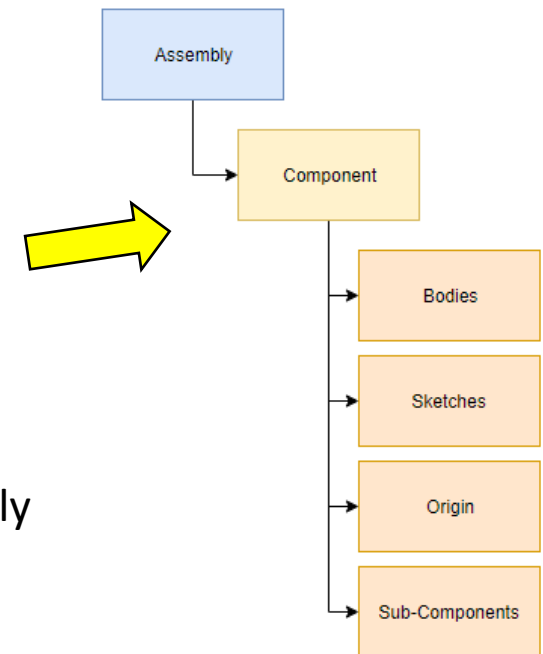
The Unofficial Rules –

#1 Always start your design with a new component.

This ensures that you always start out with the right file structure.

#2 Always rename assets right after creation.

This enables you to easily navigate through your assembly and its components.



We didn't follow these rules...

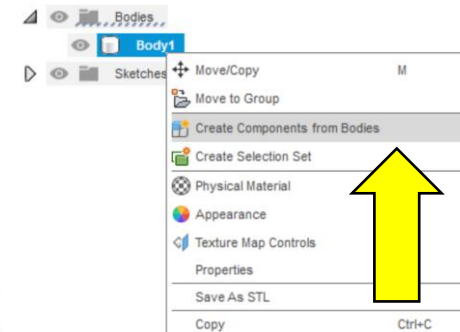
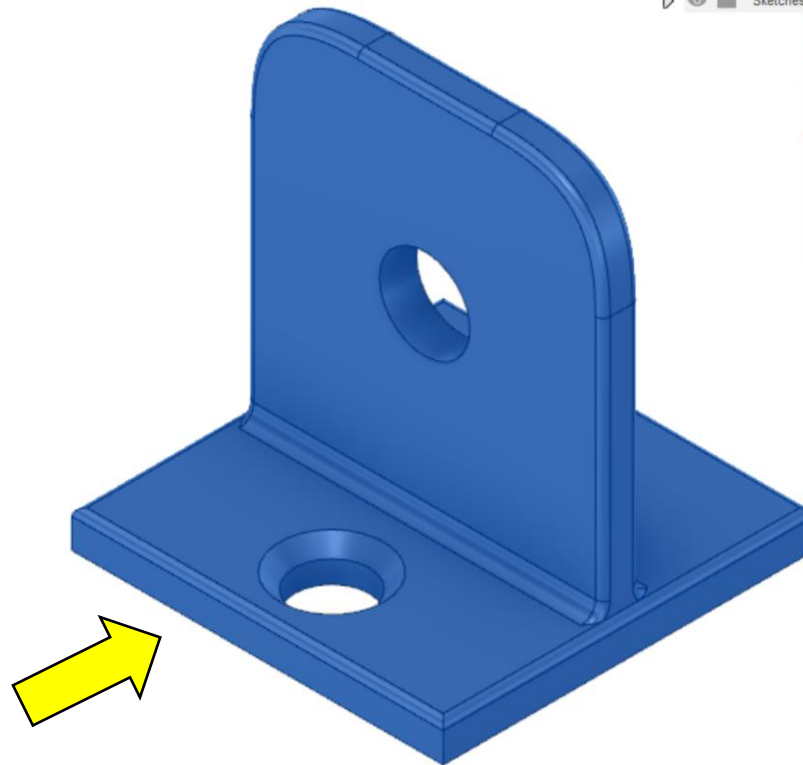
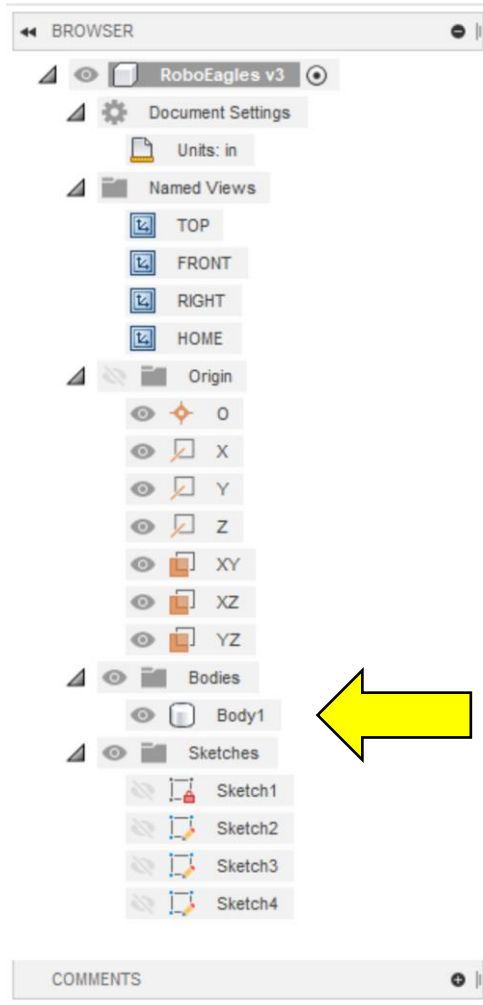




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## We Converted a Body Into a Component

- 1 - Select **Body1** in the Project Browser.
- 2 - The bracket will become highlighted.
- 3 - Right-Click and select **Create Components from Bodies**.



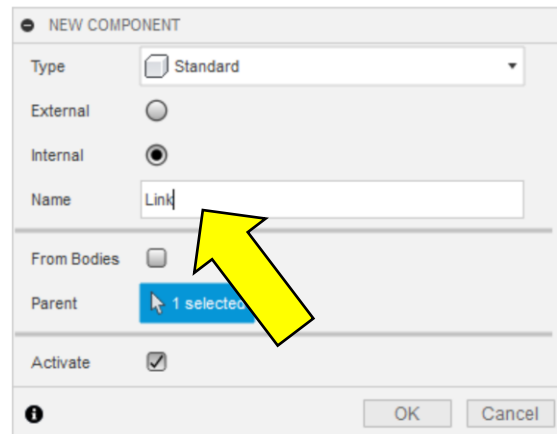
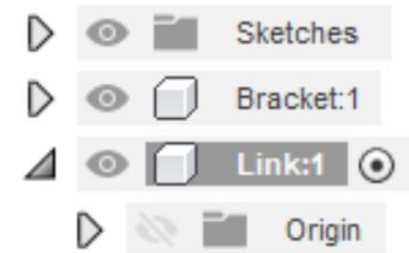
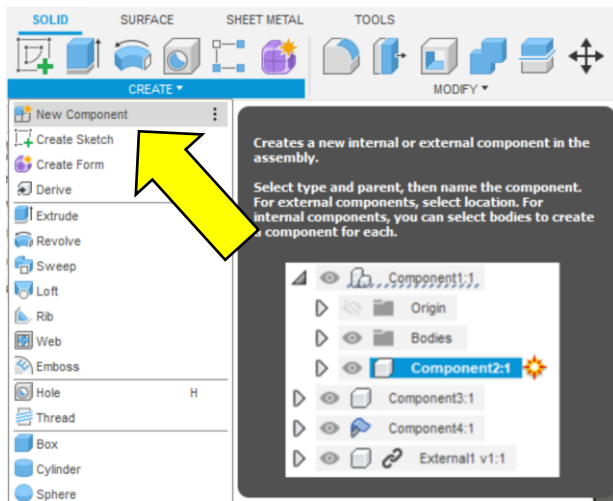


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## We Created a New Component

6 – Under **Create** choose **New Component**.

7 – Rename the component to “**Link**”. Note that the component named “Link” appears in the **Project Browser** but it is empty and only has Origin information.



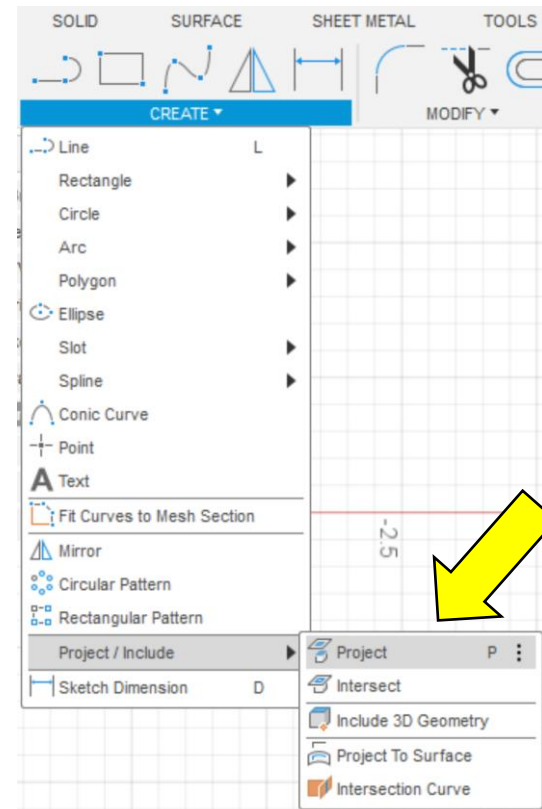
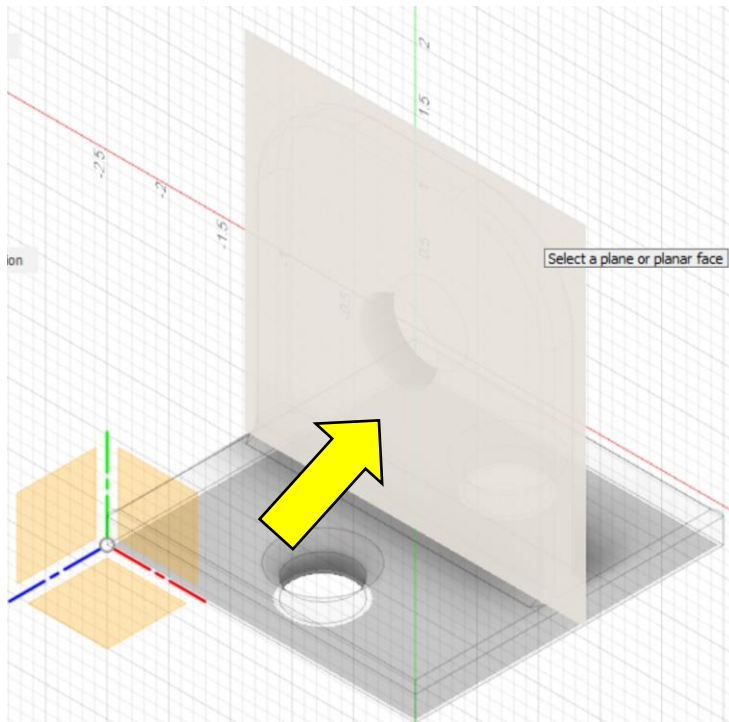


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## We Created a Construction Plane

10 – **Create a Sketch** on the **Construction Plane**.

11 – We need to Project the hole to enable us to create that relationship with the Link Component. To do this select **Project** from the **Create Menu**.



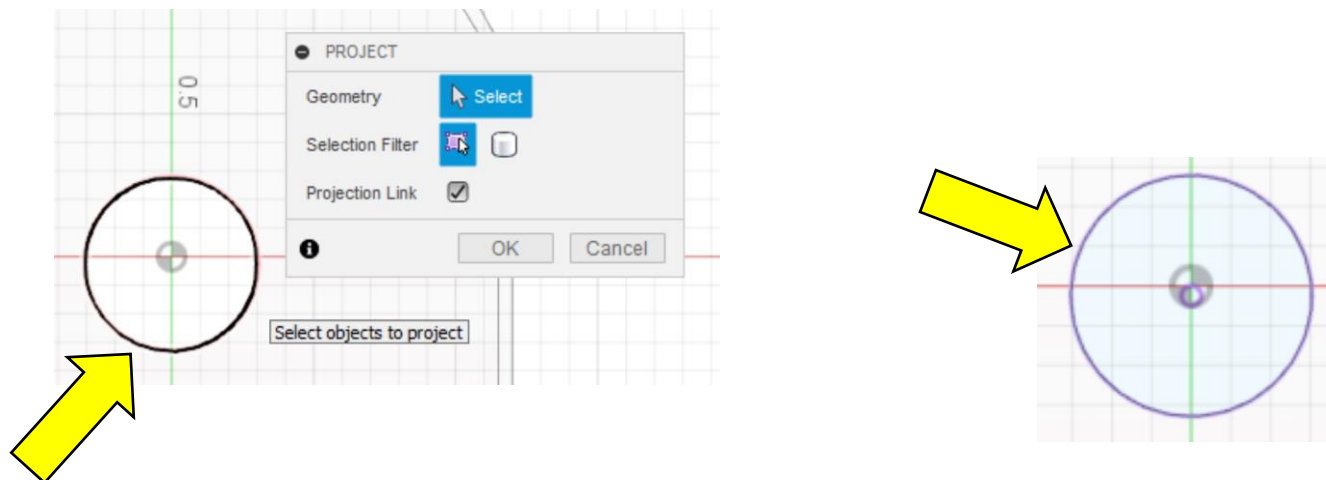


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## We Talked About Parametric Relationships

12 – Select the hole and click OK. It will now be highlighted on the sketch plane. This will create a **Parametric Relationship** between the two Components. So for example, if the bolt size changes and we modify the Bracket hole size the Link's hole will change as well.

Note: This is a good reason for **Top-Down Assemblies**.



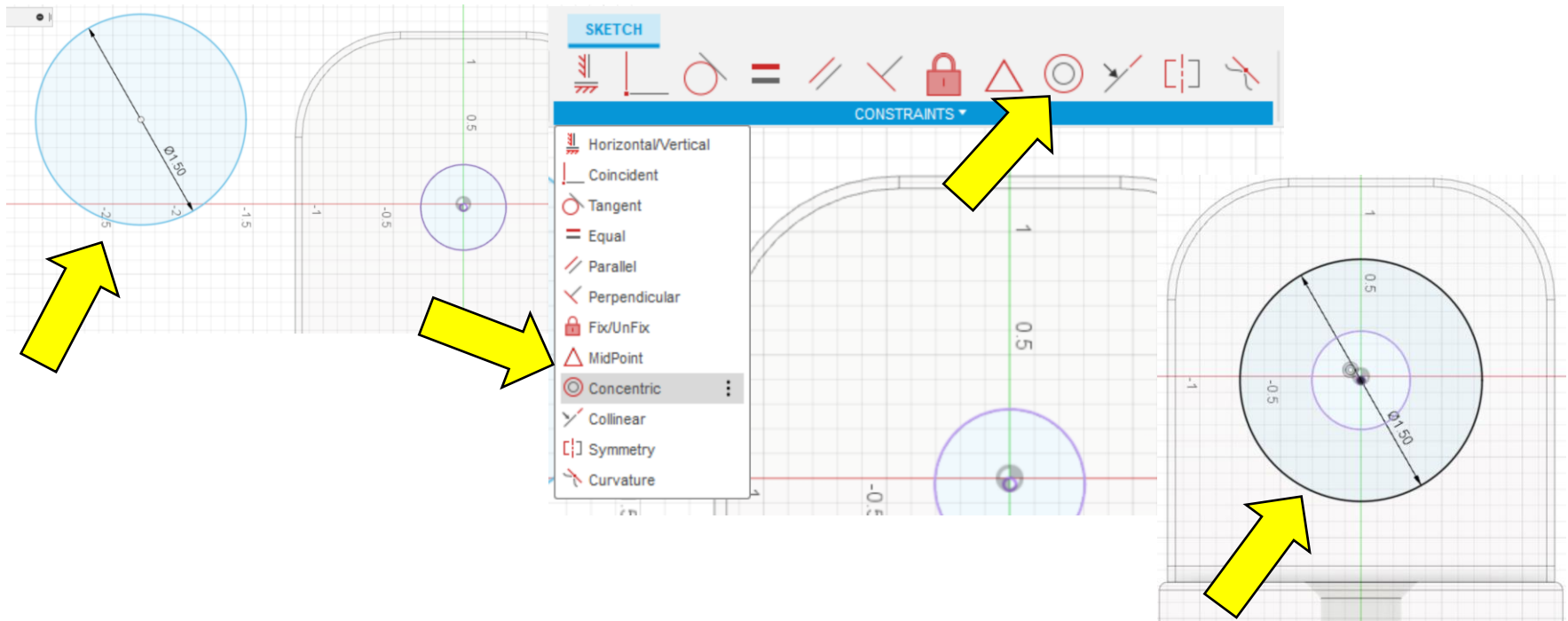


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## Parametric Relationship Through Constraints

13 – Draw a circle using the **Center Diameter Circle Tool** any place on the sketch. Set the diameter to be **1.50"**.

14 – Now we need to set **Constraints** to anchor the Circle to the Bracket. To do this select the **Concentric Tool** from the **Constraints Menu** either by clicking on the icon or selecting it from the menu. Choose both circles and click OK. The circle should **Snap** to the **Center Point** of the **Projected Circle**.



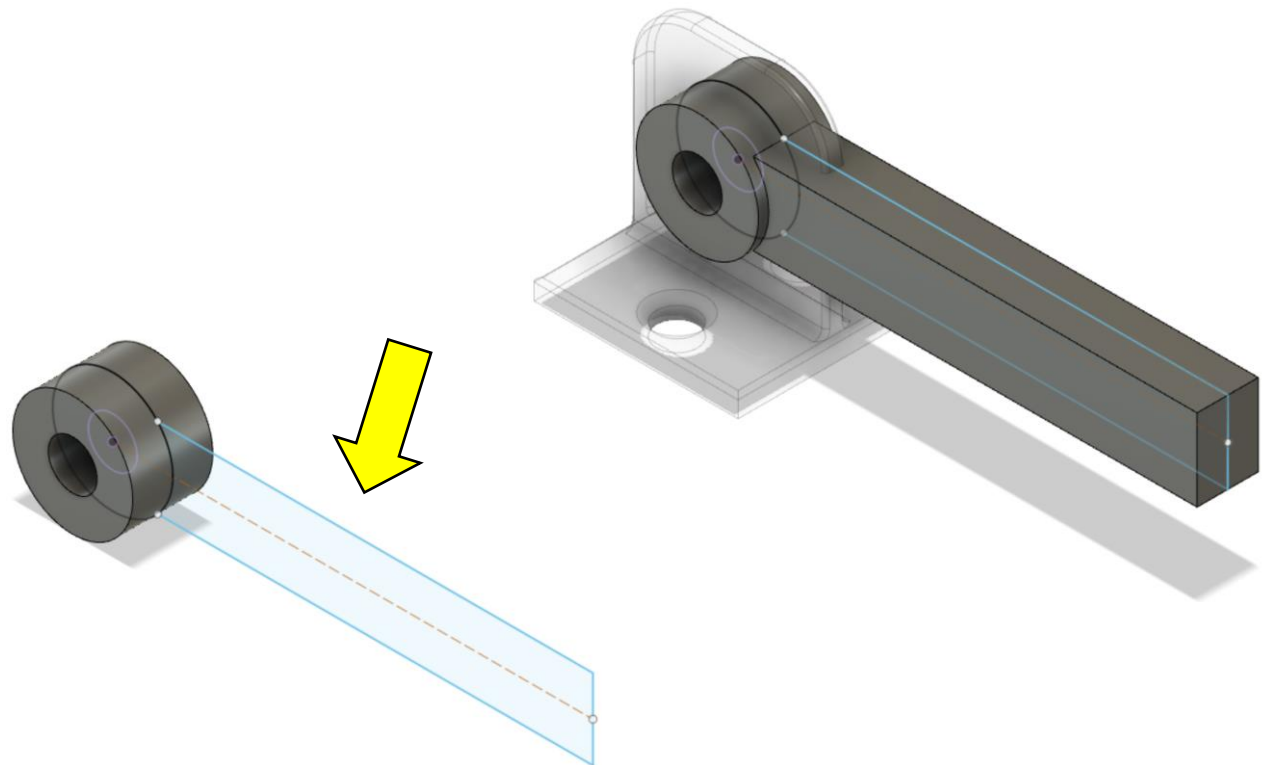
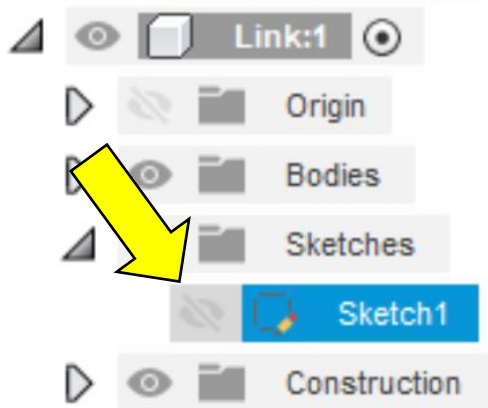


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## We Used Symmetric Press Pull Tool

22 – The Sketch has disappeared and will need to be turned back on. To do this click on the **Eye Icon** for **Sketch1** under the **Link Component** and **Sketches** Folder.

23 – Press Pull the Link Arm the same way as Step 21 to a **Symmetric Distance** of **.375"**.



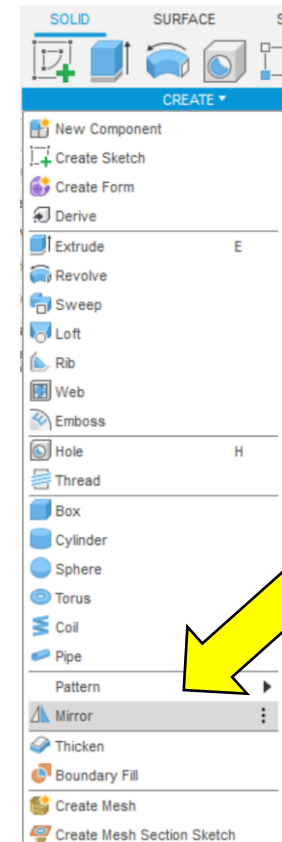
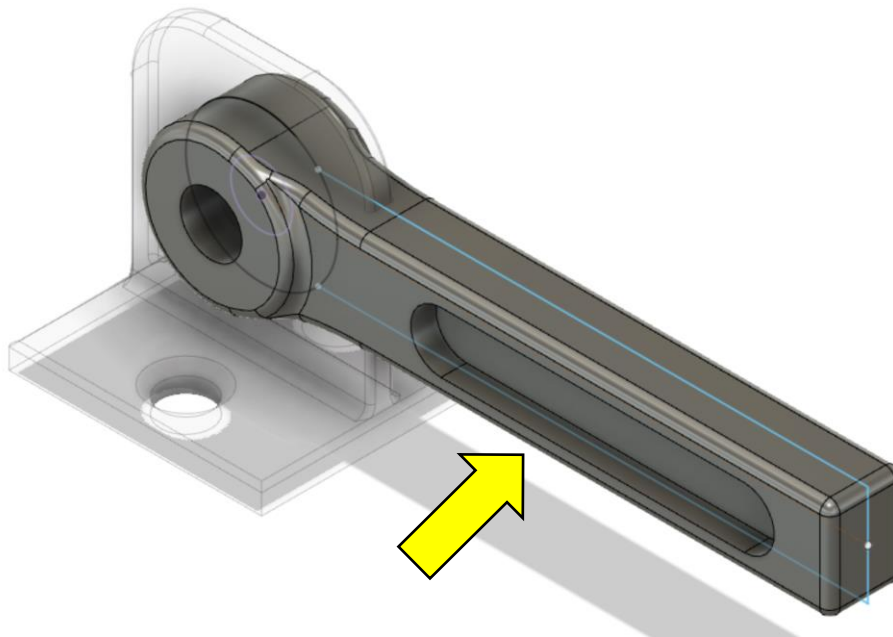


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## We Used the Mirror Tool

29 – Use the Press Pull Tool to recess the form .25” in.

30 – Use the **Mirror Tool** to duplicate the shape on the other side. To do this select **Mirror** from the **Create Menu**.



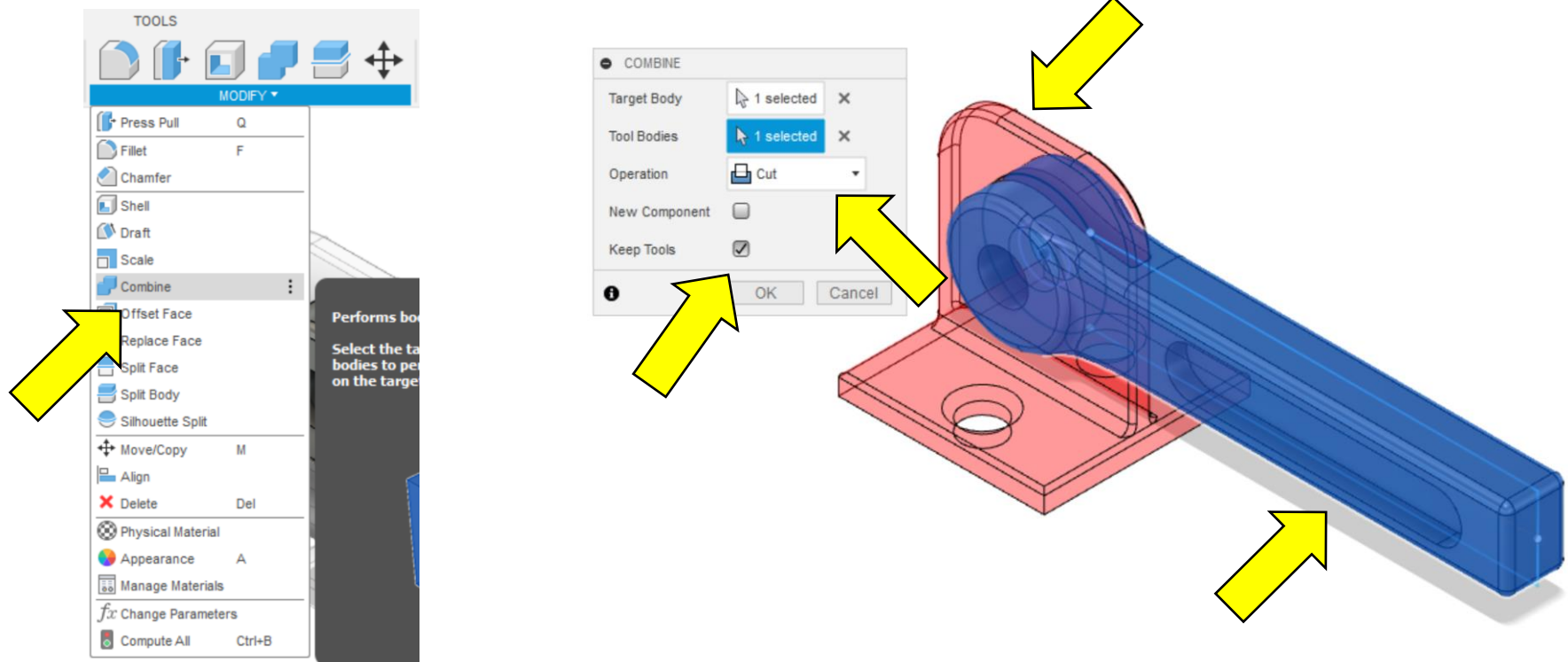




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## We Used the Combine Tool

32 – Now we need to remove the material where the two components overlap. To do this we will use the **Combine Tool**. Select it under the **Modify Menu**. The **Target Body** is the **Link** and the **Bracket** is the **Tool Bodies**. Make sure to change the **Operation** to **Cut** and check the **Keep Tools** box. Click **OK** to remove the overlap.



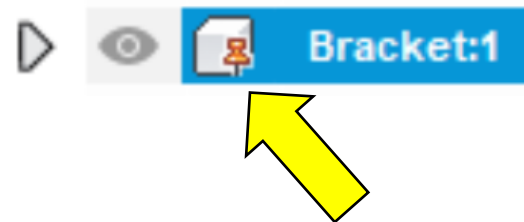
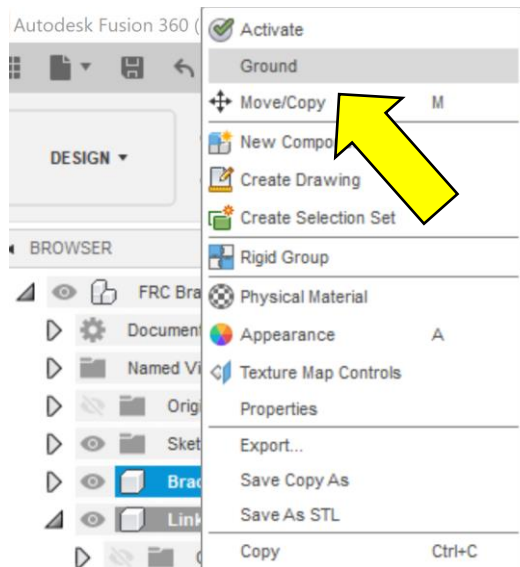




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## We Grounded the Bracket

33 – To begin we need to **Ground** our **Bracket** to keep it from moving. To do this right click on the Bracket and choose **Ground** from the menu. You will see a push pin appear in the Component cube.



## We Added a Pivot Joint With Motion



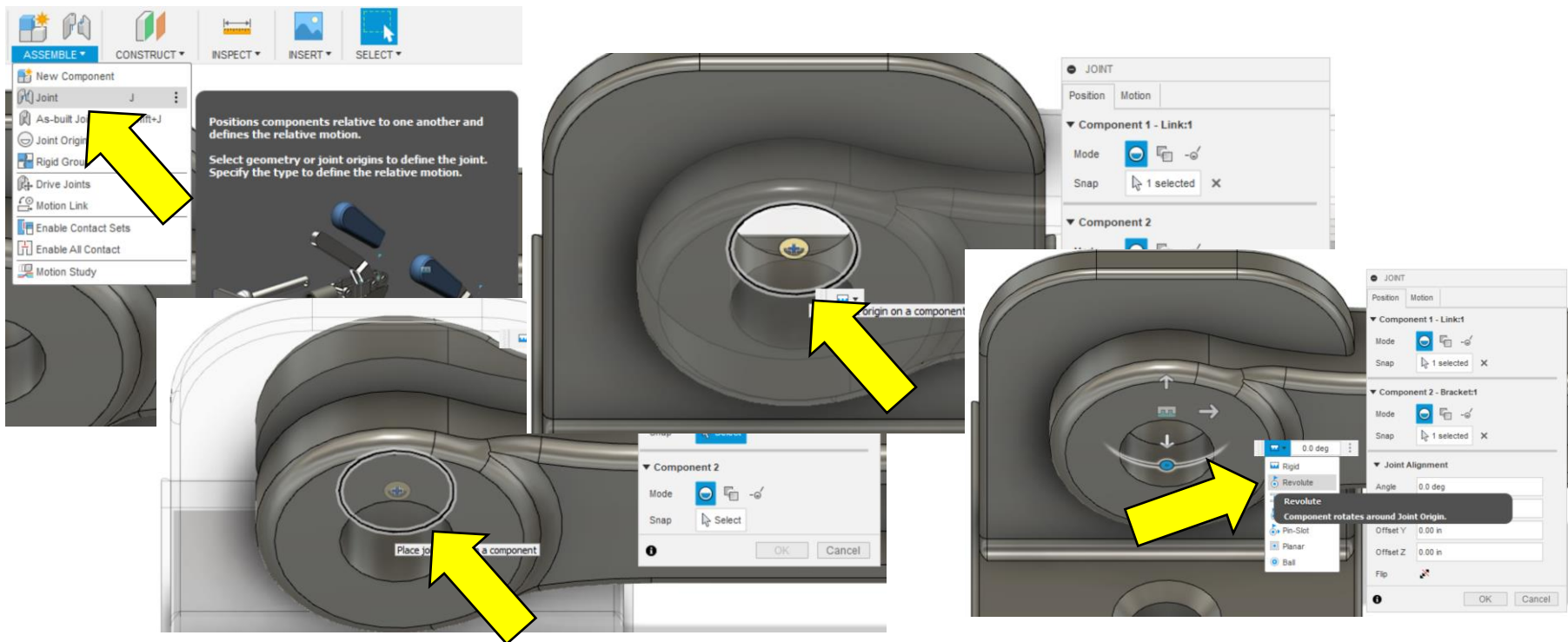
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34 – Next we need to create a Joint. Select the **Joint Tool** from the **Assemble Menu**.

35 – The **Joint Tool Window** will appear and the **Bracket** will turn transparent. Choose the inside edge of the **Link**.

36 – The **Link** will turn transparent and **Bracket** will turn solid. Choose the outside edge of the **Bracket**.

37 – Select the **Motion Type** as **Revolute** by clicking on the drop down or using the **Motion Tab** in the **Joint Tool Window**. The **Link** will animate and rotate around the joint. Click **OK**.





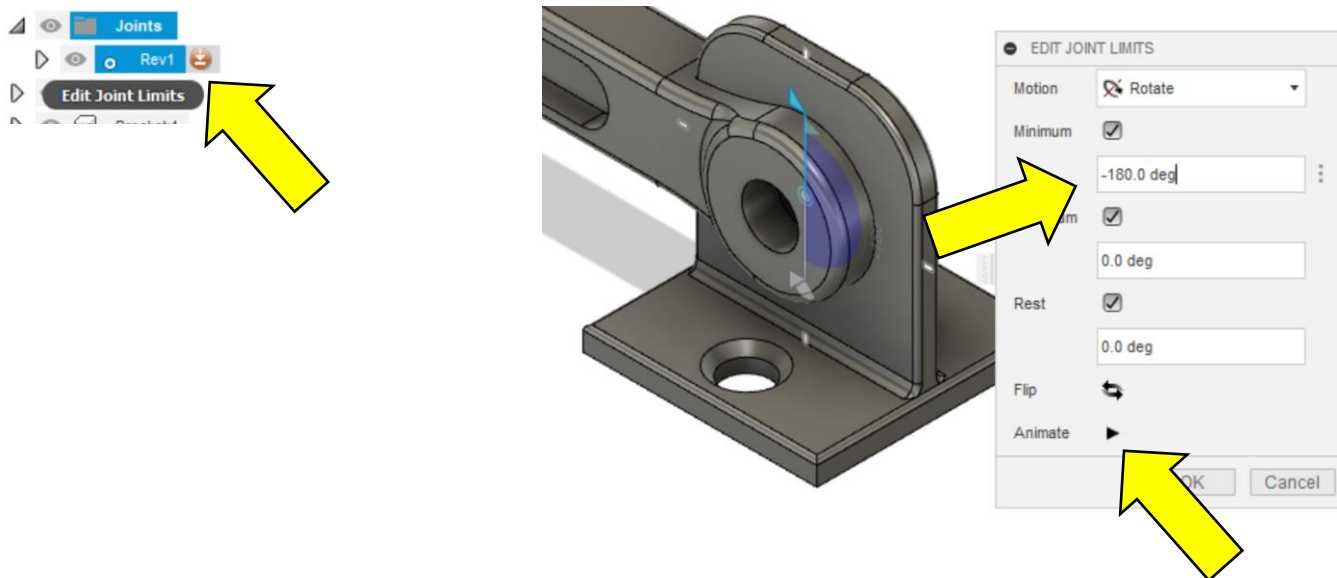
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## We Set Pivot Joint Limits For Motion

38 – Click on the Red Down Arrow to edit the Joint Limits. The Edit Joint Limits Window will appear.

39 – Click the 3 check boxes to enable the limits and enter **-180 deg** as a **Min**, **0 deg** as **Max**, and **0 deg** as the **Rest** position.

40 – Click **Animate** to verify limits are set and if good click **OK**.





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## Let's Build a Robot

- 1 – Click on the **Show Data Panel** symbol.
- 2 – Click the **New Projects Button** and create a new Project called **3568**.
- 3 – Double click on the 3568 project button.

The image shows a sequence of four screenshots from the Autodesk Fusion 360 interface, illustrating the steps to create a new project named '3568'.

- Screenshot 1:** Shows the top toolbar with the **Show Data Panel** icon (a grid of squares) highlighted by a yellow arrow.
- Screenshot 2:** Shows the **ALL PROJECTS** panel with the **New Project** button highlighted by a yellow arrow.
- Screenshot 3:** Shows the **ALL PROJECTS** panel with the newly created project **3568** highlighted by a yellow arrow.
- Screenshot 4:** Shows the **3568** project selected, with the **Upload** button and **New Folder** button visible. A yellow arrow points to the **3568** project name, indicating a double-click action.



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## Let's Build a Robot

4 – Download the **KoP Files** from

<https://www.autodesk.com/education/competitions-and-events/first/recommended-software>

5 – Scroll down the page and select the **Fusion 360 Kit of Parts** and the **FTC Skystone STEP Kit of Parts**. Download and unzip the files (remember where the files are located).

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### Additional resources

To support FIRST students in their design process, we have developed a kit of parts and field models in CAD.

<p><b>FRC 2020 kit of parts</b></p> <ul style="list-style-type: none"><li><a href="#">Fusion 360 kit of parts</a></li><li><a href="#">Inventor kit of parts</a></li><li><a href="#">STEP kit of parts</a></li></ul>	<p><b>FRC 2020 field model</b></p> <ul style="list-style-type: none"><li><a href="#">Fusion 360 field model</a></li><li><a href="#">Inventor field model</a></li><li><a href="#">STEP field model</a></li></ul>	<p><b>FTC Skystone kit of parts</b></p> <ul style="list-style-type: none"><li><a href="#">Inventor kit of parts</a></li><li><a href="#">STEP kit of parts</a></li></ul>
<p><b>FTC Skystone field model</b></p> <ul style="list-style-type: none"><li><a href="#">Inventor field model</a></li><li><a href="#">STEP field model</a></li></ul>		

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<p><b>FRC previous releases</b></p> <ul style="list-style-type: none"><li><a href="#">Fusion 360 kit of parts (2019)</a></li><li><a href="#">Inventor kit of parts (2019)</a></li><li><a href="#">STEP kit of parts (2019)</a></li><li><a href="#">All (2018)</a></li></ul>	<p><b>FTC previous releases</b></p> <ul style="list-style-type: none"><li><a href="#">Inventor kit of parts (Rover Ruckus)</a></li><li><a href="#">STEP kit of parts (Rover Ruckus)</a></li></ul>
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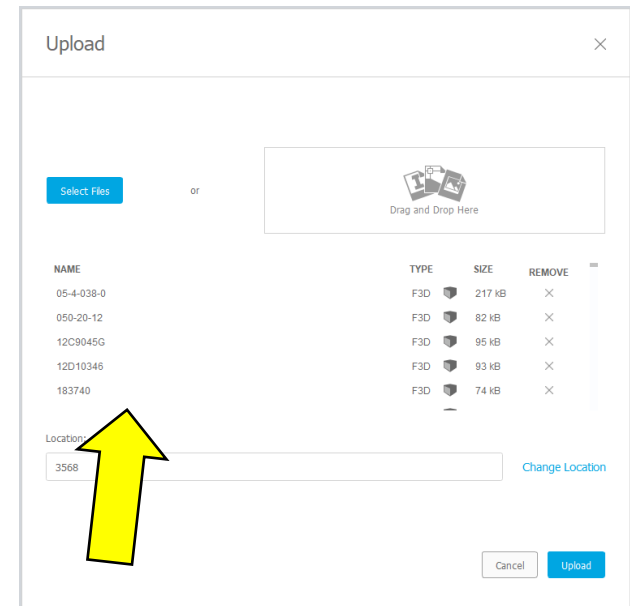
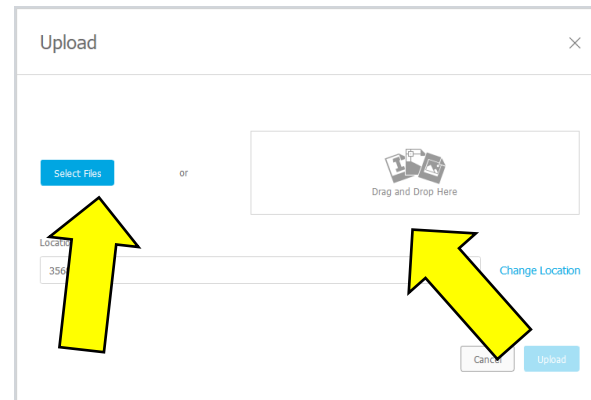
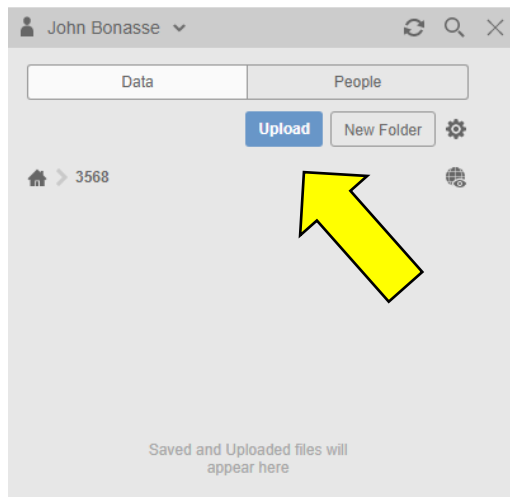
## Let's Build a Robot

6 – Click on the **Upload Button**.

7 – Click on **Select Files** or drag and drop the unzipped files into the Project.

8 – You should see the files listed in the window. Click on the **Upload Button** and the parts will be loaded into your Project.

(you may want to create folders first, see next slide for details.)

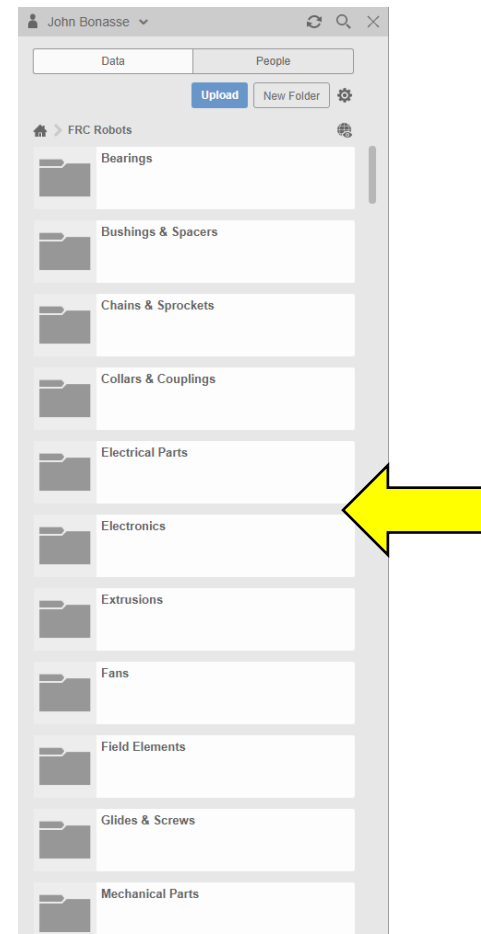
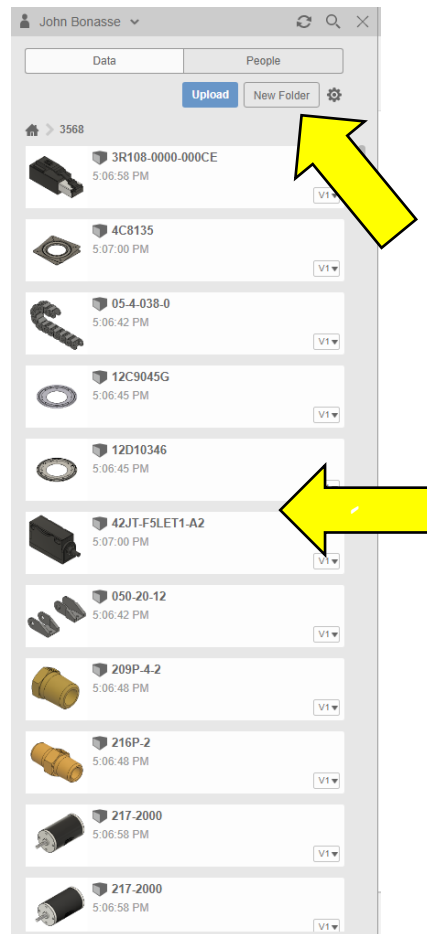




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## Let's Build a Robot

9 – You should see the parts get loaded into your **Project Data Panel**. I would recommend creating **New Folders** and sorting out the parts. This will make it easier to find the parts and to add new ones down the road.





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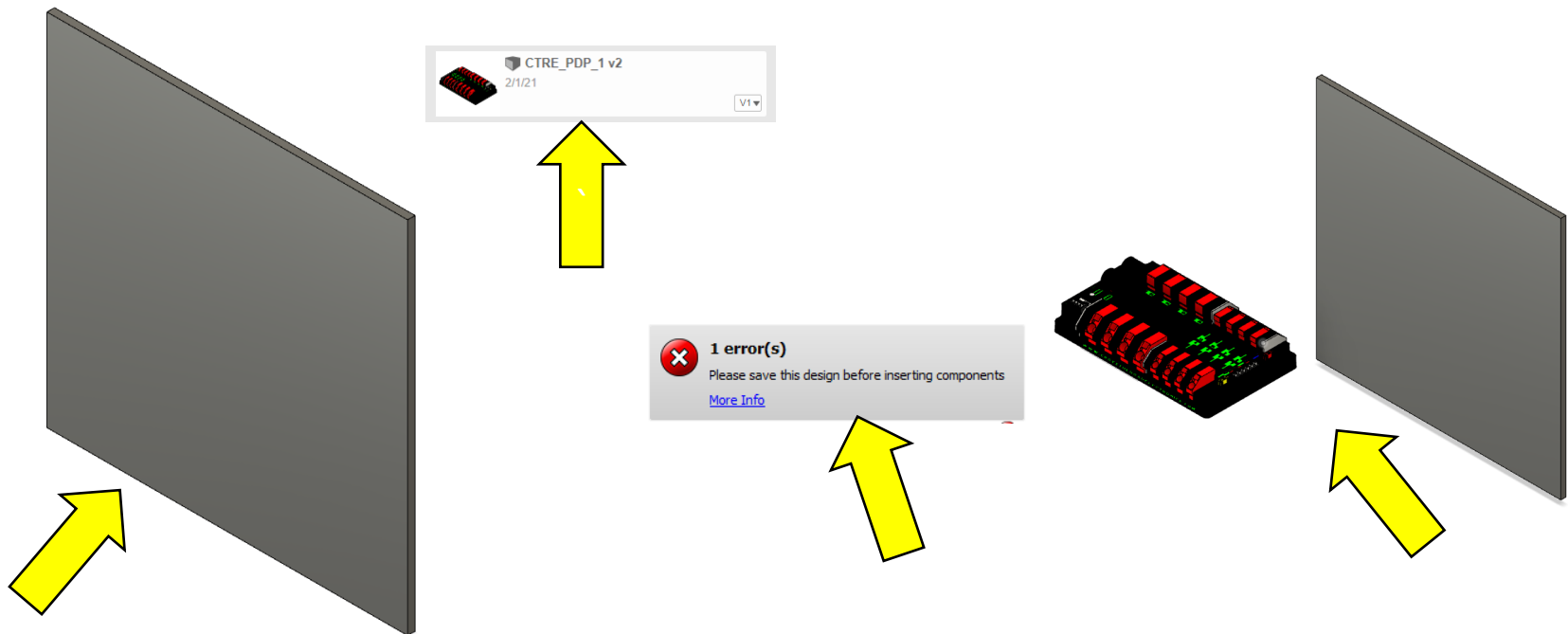
## Let's Build a Robot

10 – First let's look at the **Align Function**. Start by creating a **New Sketch** on the **XY-Plane**.

11 – Draw a **12" X 12" Rectangle** and **Press Pull** it to a **.25" thickness**.

12 – Find, grab, and drag the **CTRE\_PDP\_1 v2** part from the **Project Data Panel** into the design. You can position the part and when ready click **OK**.

(You may get an error if you haven't saved the design, if so save and add the part after.)





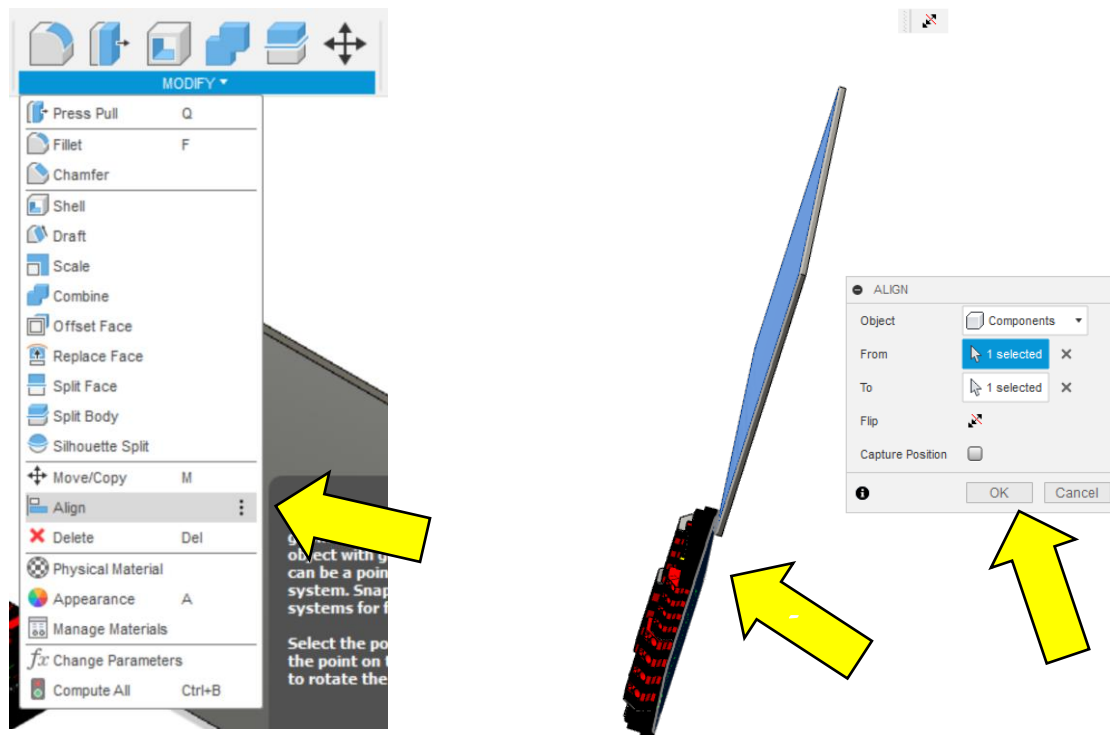


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## Let's Build a Robot

13 – To locate the PDP on the Backplate, select the **Align Tool** from the **Modify Menu**.

14 – Select the bottom surface of the PDP and the front surface of the Backplate. The PDP should align itself to the Backplate. Click **OK**.

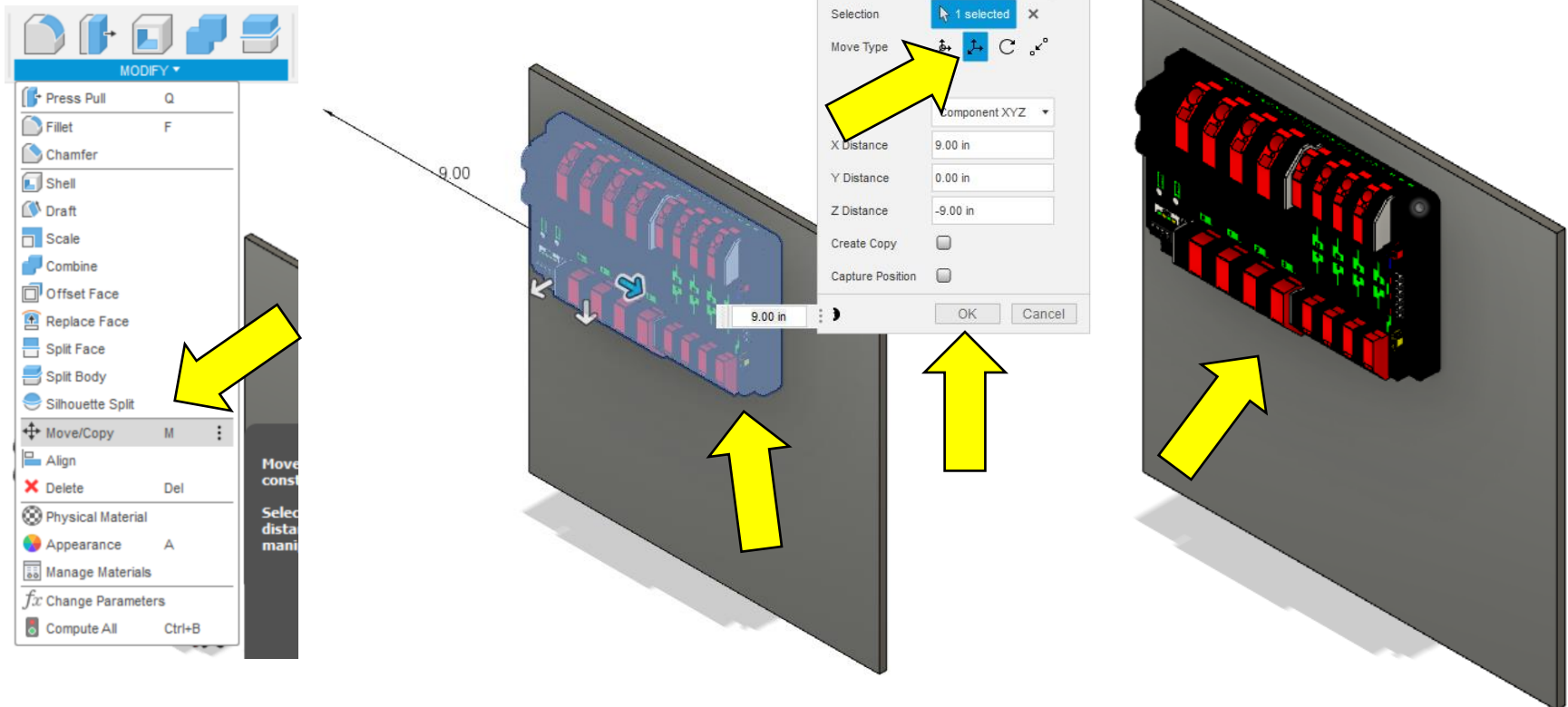




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## Let's Build a Robot

15 – Select the **Move/Copy Tool** and drag the PDP into position on the Backplate. Change the **Move Object to Components** and select the **Translate Move Type**. When finished placing the PDP click **OK**.



## Let's Build a Robot

16 – Switch the view to the Front View and zoom in on the PDP.

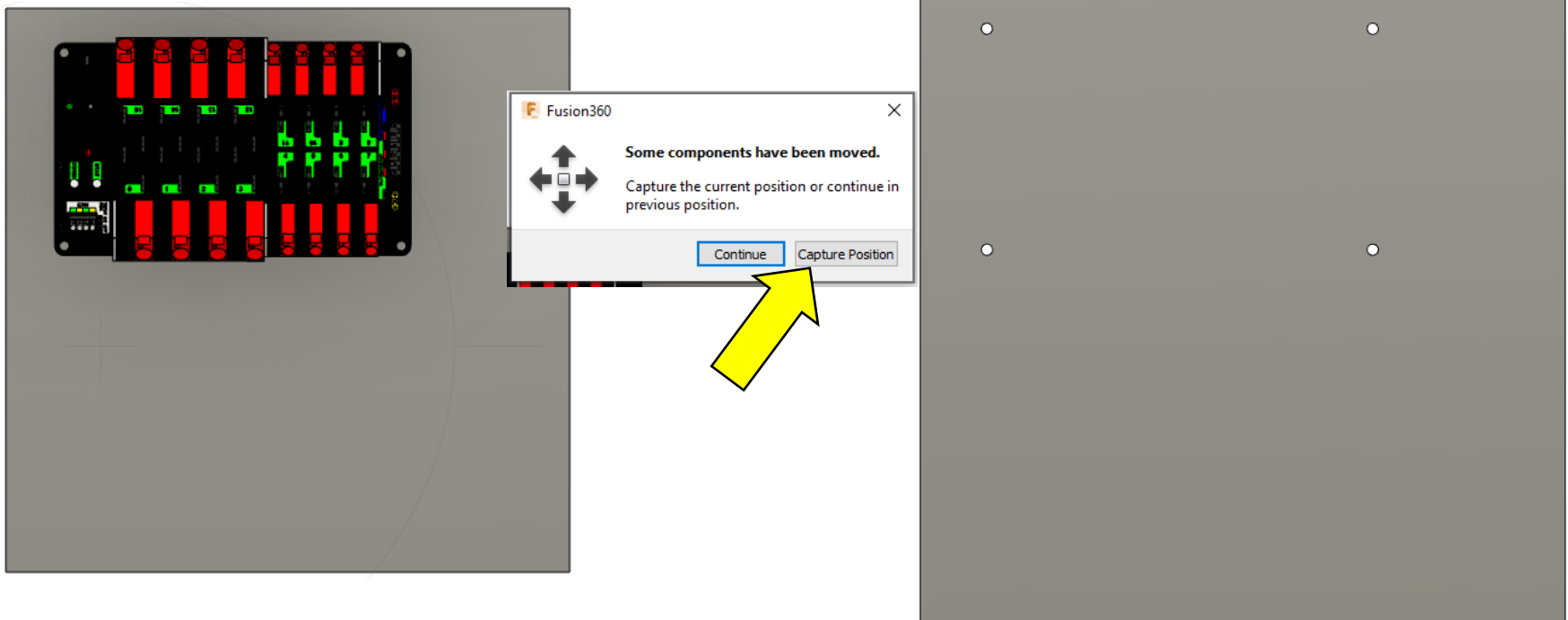
17 – Transfer the mounting holes to the back plate by creating a **Sketch** on the surface of the Backplate. You will be prompted to capture the change in position for the PDP. Click the **Capture Position Button**.

18 – Using the **2-Point Circle Tool**, zoom in on each of the four mounting holes and select the top and bottom points of each circle.

19 – Finish the **Sketch**, turn off the PDP image using the **Eye Icon**, and extrude the holes through the Backplate using the **Press Pull Tool**. (You can repeat the steps for all components you place on the Backplate and print the pattern to scale for a template.)



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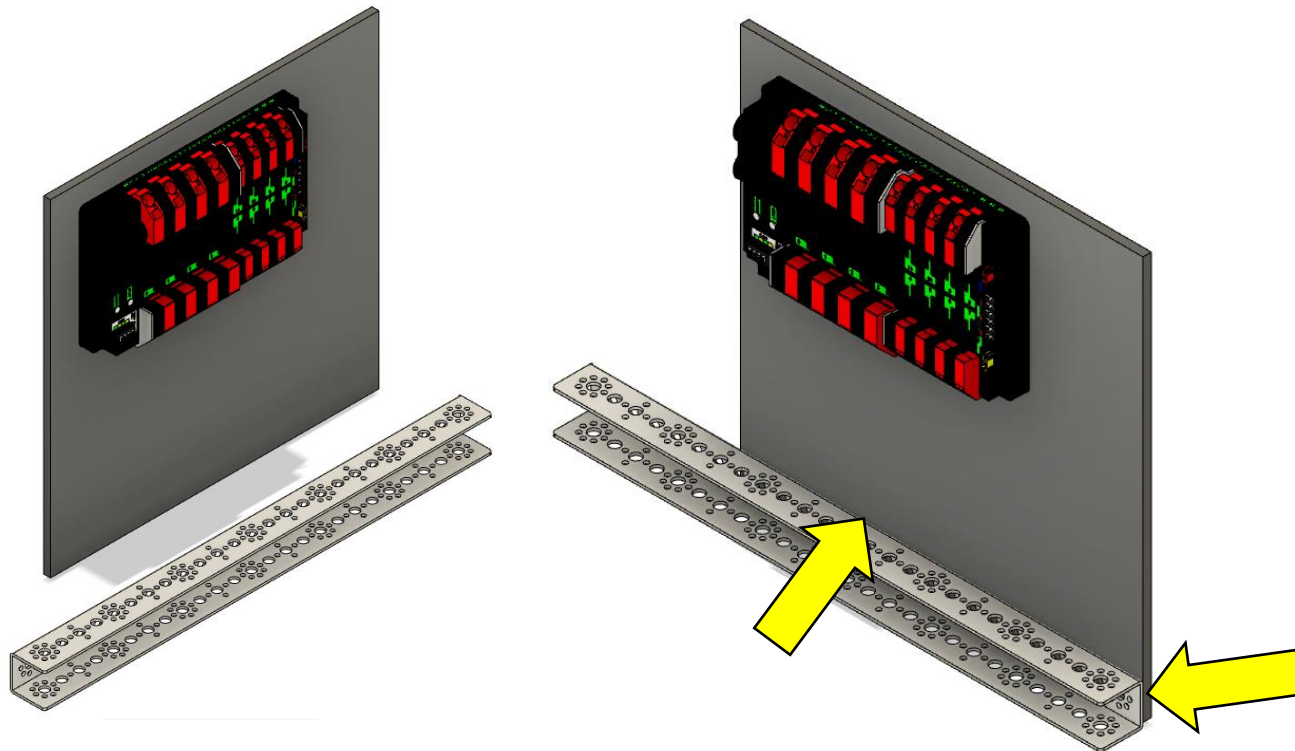


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## Let's Build a Robot

20 – Let's add mounting holes for Tetrix C-Channel to the Backplate. Start by adding a **Tetrix\_39069** to your design. Rotate and translate the C-Channel into a position close to the Backplate.

21 – Use the **Align Tool** to align the back surface of the C-Channel to the Backplate, and repeat with the outside edge of the C-Channel and the Backplate.



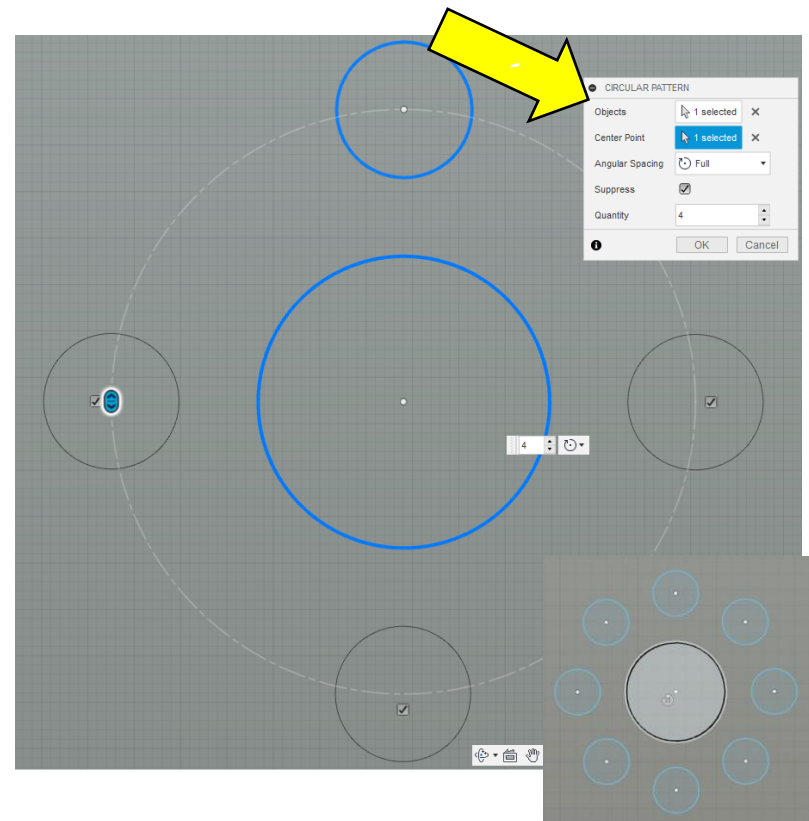
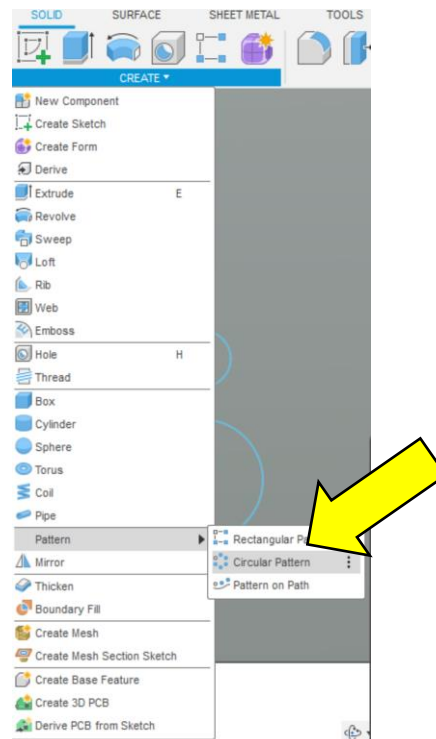
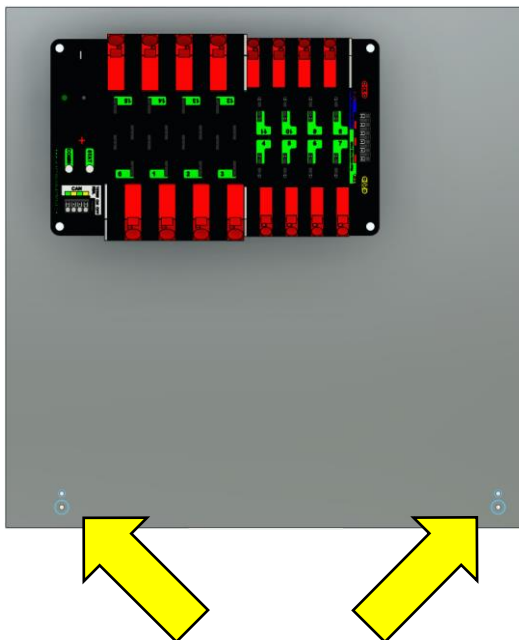


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## Let's Build a Robot

22 – Use the **2-Point Circle Tool** to transfer the top and middle holes to the Backplate at both ends of the C-Channel. Turn off the C-Channel but do **NOT** Finish Sketch.

23 – Use the **Circular Pattern Tool** in the **Create Menu** to make a Pattern of holes around the outside of the middle hole. Select the outside edge of the top hole as the **Object**, click on the **Select Center Point** and pick the outside edge of the middle hole, enter either **4** or **8** for a **Quantity**, and click **OK**.

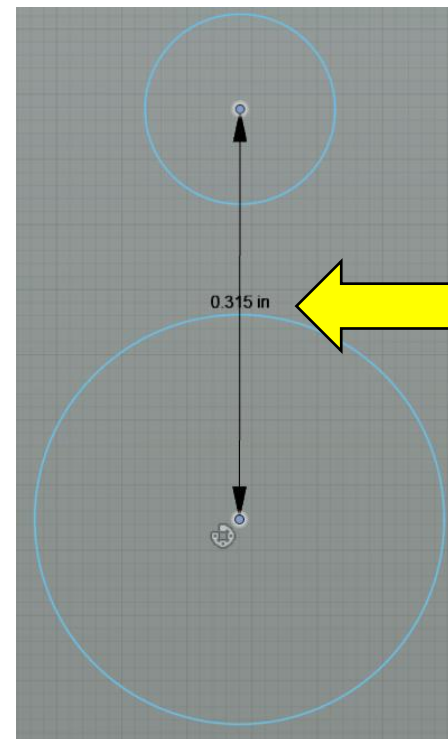
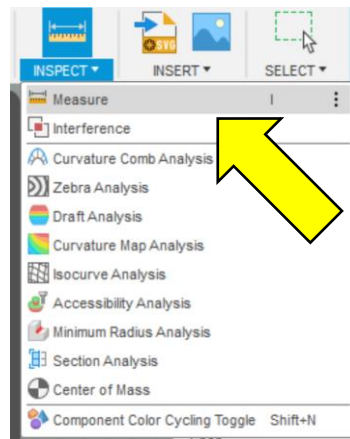




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## Let's Build a Robot

24 – To verify the hole patterns you can turn the C-Channel back on and zoom in to make sure they line up, or you can also check the distance between the center points of the top and middle holes. They holes should be **8mm (.315 in)** apart center-to-center. To do this select the **Measure Tool** from the **Inspect Menu**. Select the center points of the top and bottom circle and confirm the distance.



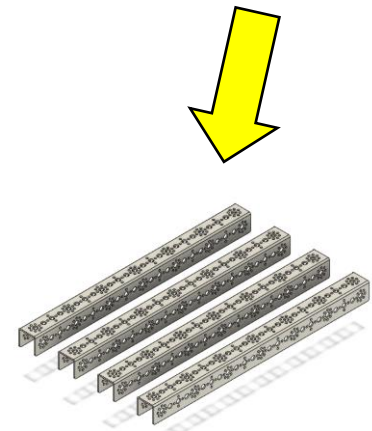
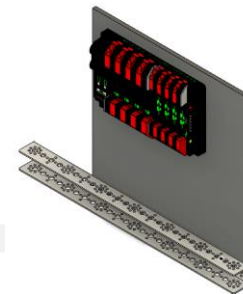
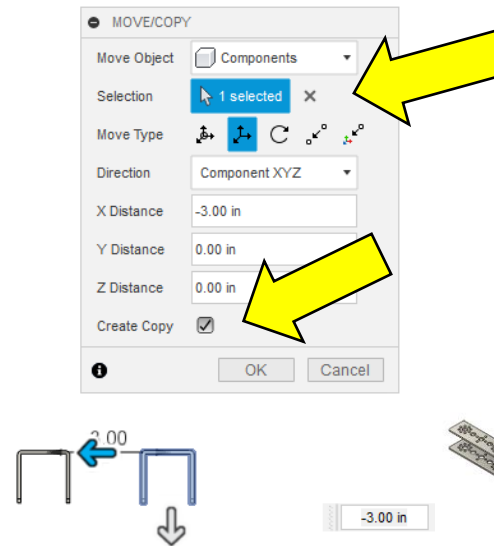
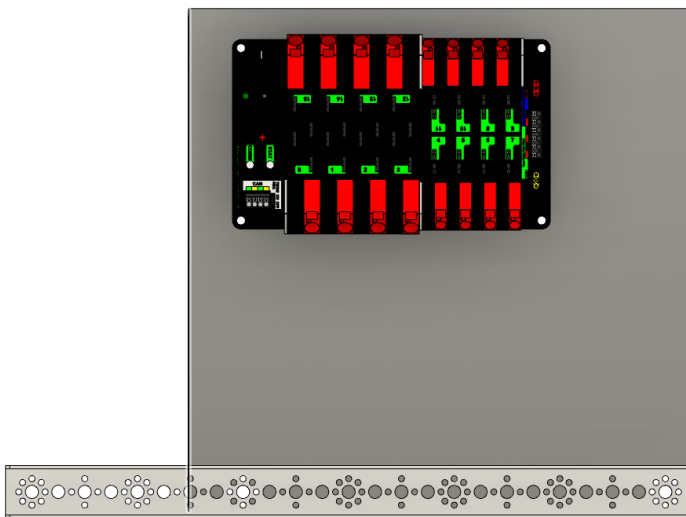


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## Let's Build a Robot

25 – If the holes measure or look correct, **Finish Sketch** and use the **Press Pull Tool** to punch the circles through the Backplate. Turn the C-Channel back on.

26 – To build a Chassis import another **Tetrix\_39069** into the design. Position it in the design using the translate arrows and click **OK**. Make (3) more copies using the **Move/Copy Tool** from the **Modify Menu**. Select the C-Channel, choose **Translate Move Type**, check the **Create Copy Box**, drag the copied C-Channel to either side of the original, and click **OK**. Repeat until (4) C-Channels are present.



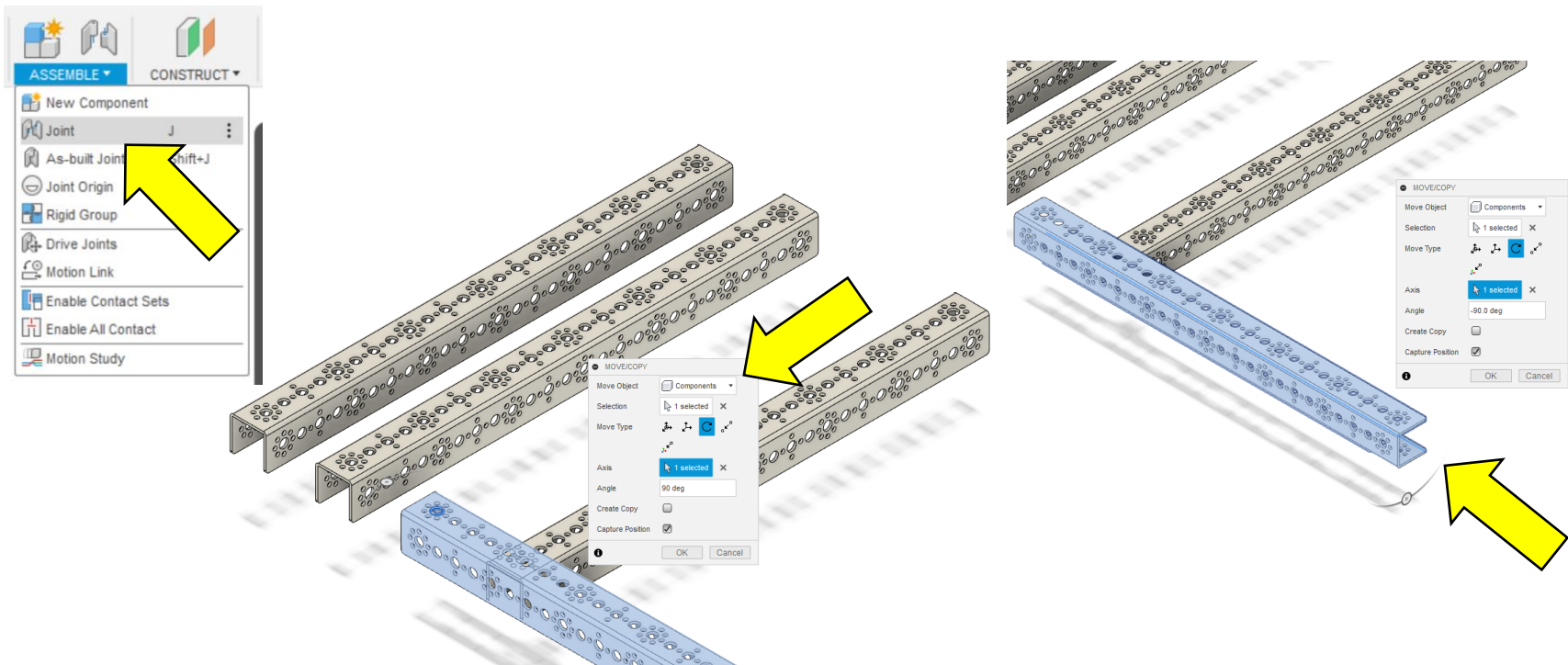




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27 – Using the **Move/Copy Tool**, rotate two C-Channels 90 degrees. To do this select the C-Channel, choose the **Rotate Move Type**, select the top center hole as the rotate **Axis**, enter +- **90** for the **Angles**, check the **Capture Position Box**, and click **OK**. Repeat the process for both and then rotate the C-Channel along to front bottom edge. Arrange as needed to form the four sides of the Chassis.





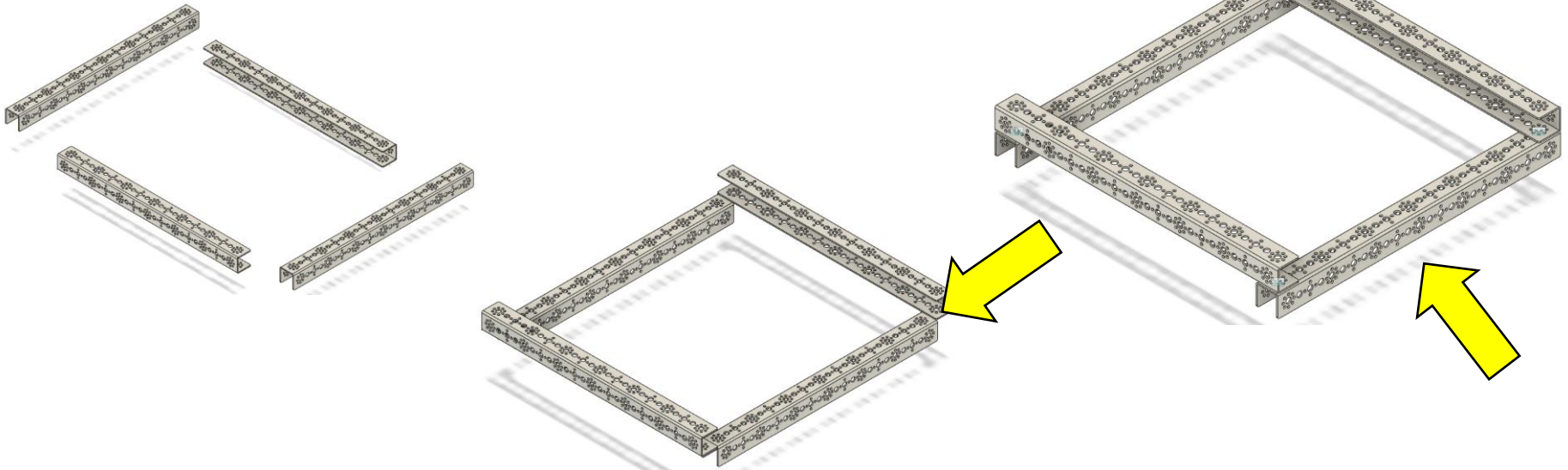


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28 – To assemble the Chassis we need to use the **Align Tool** under the **Modify Menu** and the **Joint Tool** under the **Assemble Menu**. Start by aligning the bottom surfaces of the front and rear C-Channel to the top surfaces of the left and right side rails. **Align** the outside edges of the C-Channels.

29 – Use the **Joint Tool** to create a **Ridged Joint** between the outside middle holes at each corner. **Ground** the right side rail, **Capture Positions** if prompted, select the end middle hole bottom edge on the part you want to move, select the middle hole top edge on the grounded rail, the rail will slide into place, and click **OK**. Repeat the process for the other (3) corners.



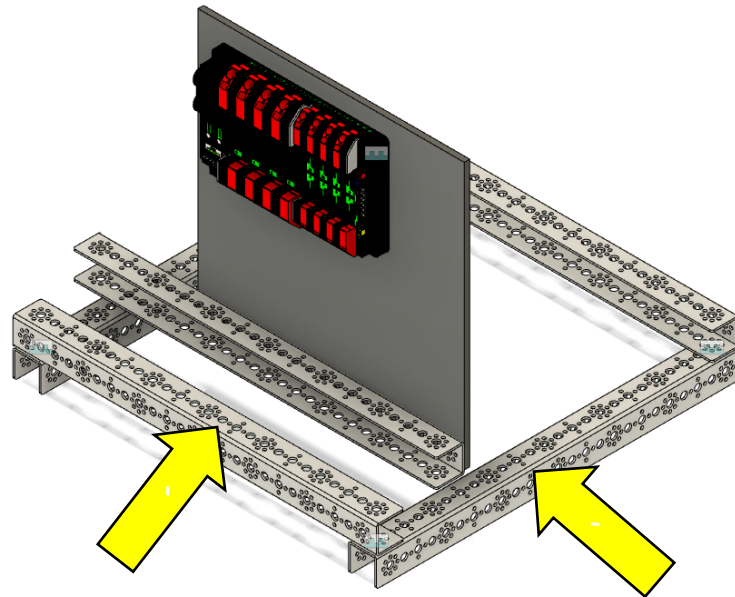
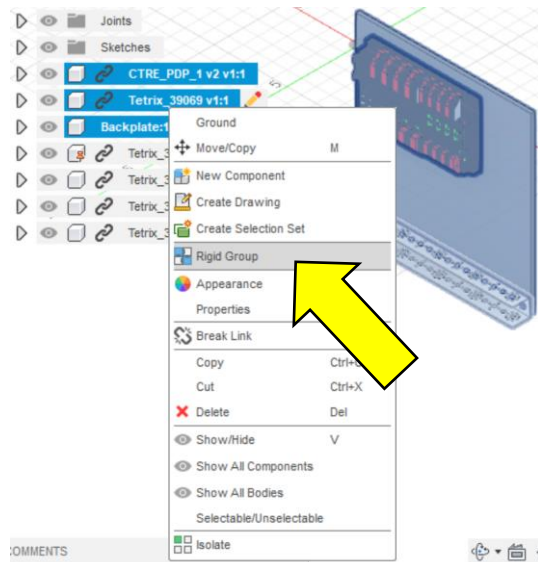


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## Let's Build a Robot

30 – Select the PDP, Backplate, and C-Channel from the previous Assembly, right click on the PDP, and select **Rigid Group**. This will allow us to move all three pieces together without losing their relationship to each other.

31 – Attach the Backplate to the Chassis using the **Align Tool** and **Joint Tool**. Align the bottom edge of the C-Channel attached to the Backplate to the top surface of the upper cross member. Also align the two outside edges of the pieces.



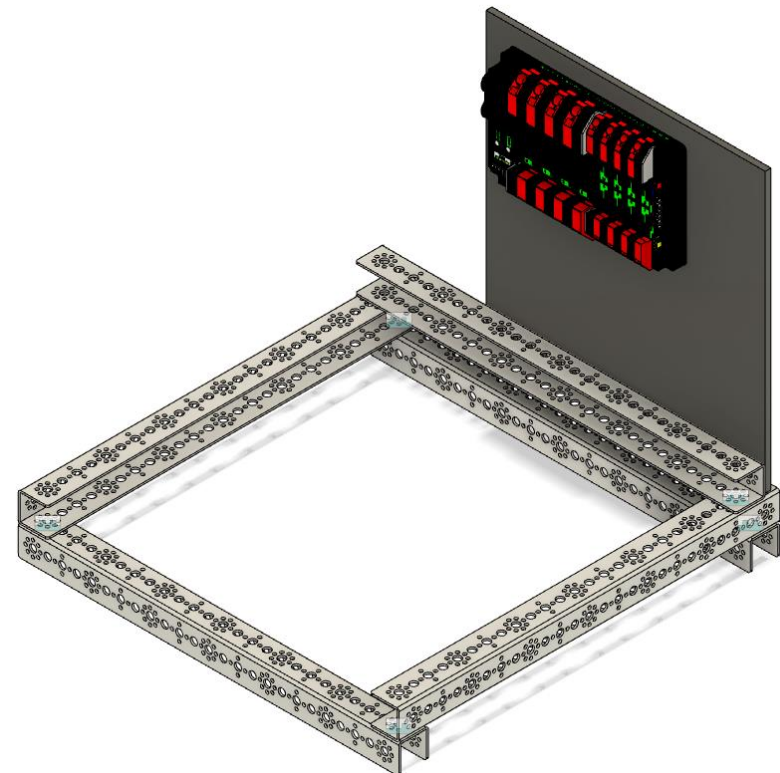
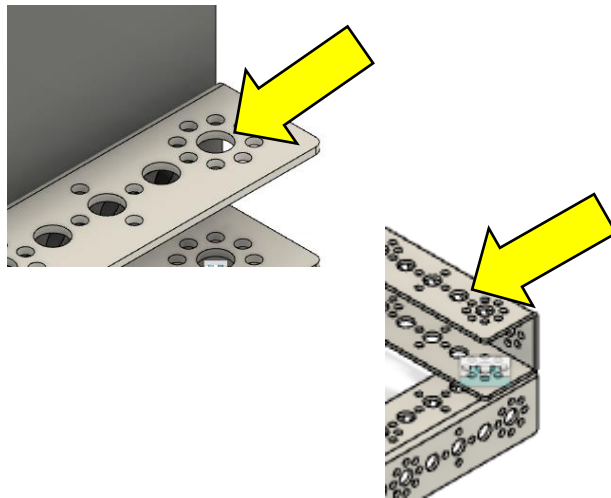


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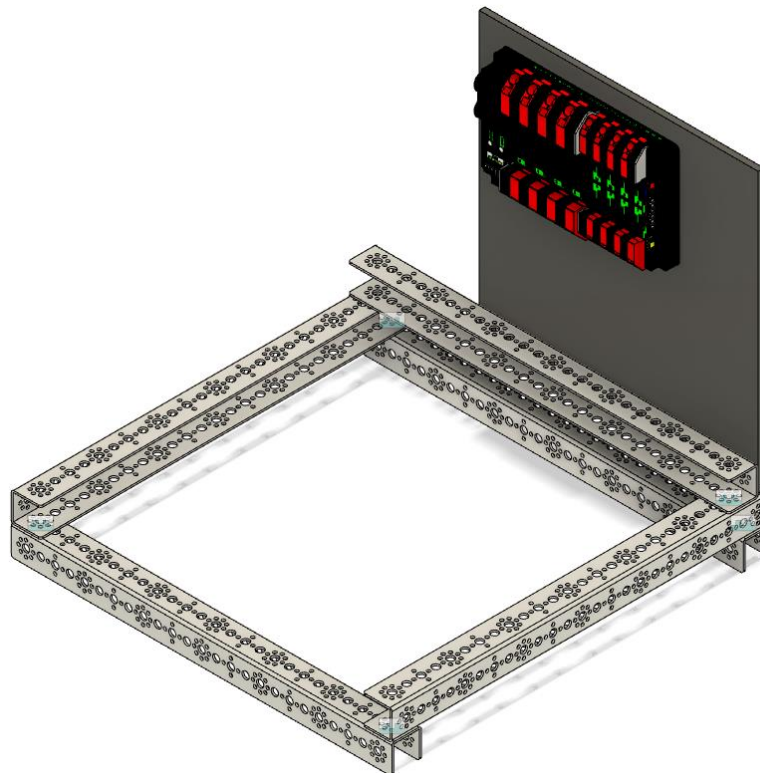
33 – Rotate the 3-Piece Assembly around the outside middle hole using the **Move/Copy Tool**.

34 – Using the **Joint Tool**, create a **Rigid Joint** by selecting the top edge of the middle hole of the second floret in from the edge of the outside rail and the bottom edge of the middle hole of the last floret on the C-Channel attached to the backplate. Click **OK**.



## Let's Build a Robot

You can continue to Assemble the pieces until the robot is complete. There are even bolts, washers, and nuts if you want to go into that much detail. For now we'll move on to the **Canvas Tool**.



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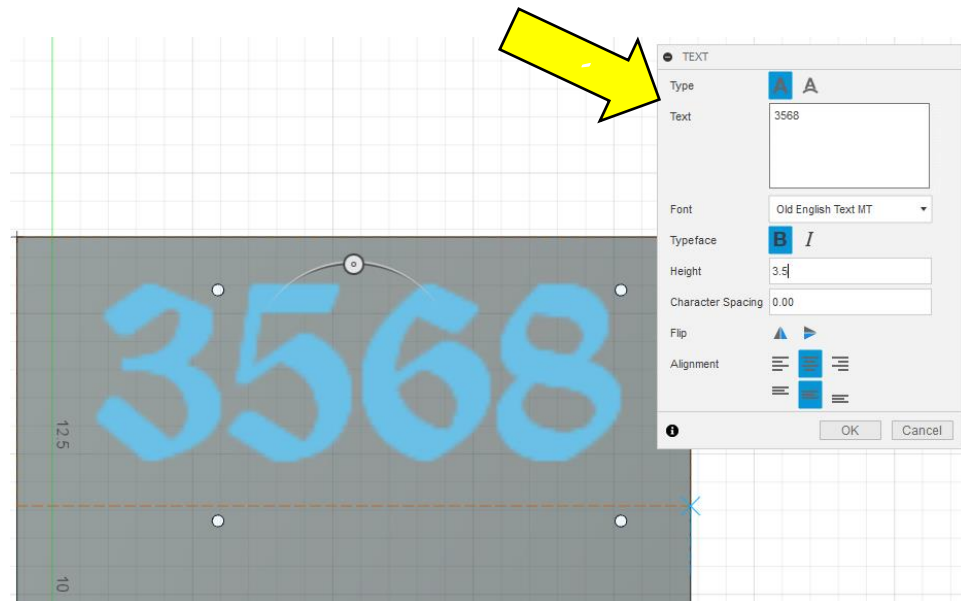
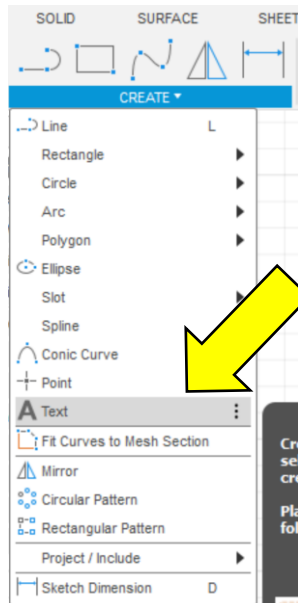
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## Using the Text & Canvas Tools

35 – Rotate the design so the outside edge of the Backplate is shown.

36 – Select the **Text Tool** from the **Create Menu** and drag a text box from the top left corner about a third of the way down the Backplate to the other edge.

37 – Select **Text**, enter **3568**, choose a font, enter **3.5"** for the height, center the horizontal and vertical spacings, click **OK** if everything looks good, and **Finish Sketch**.





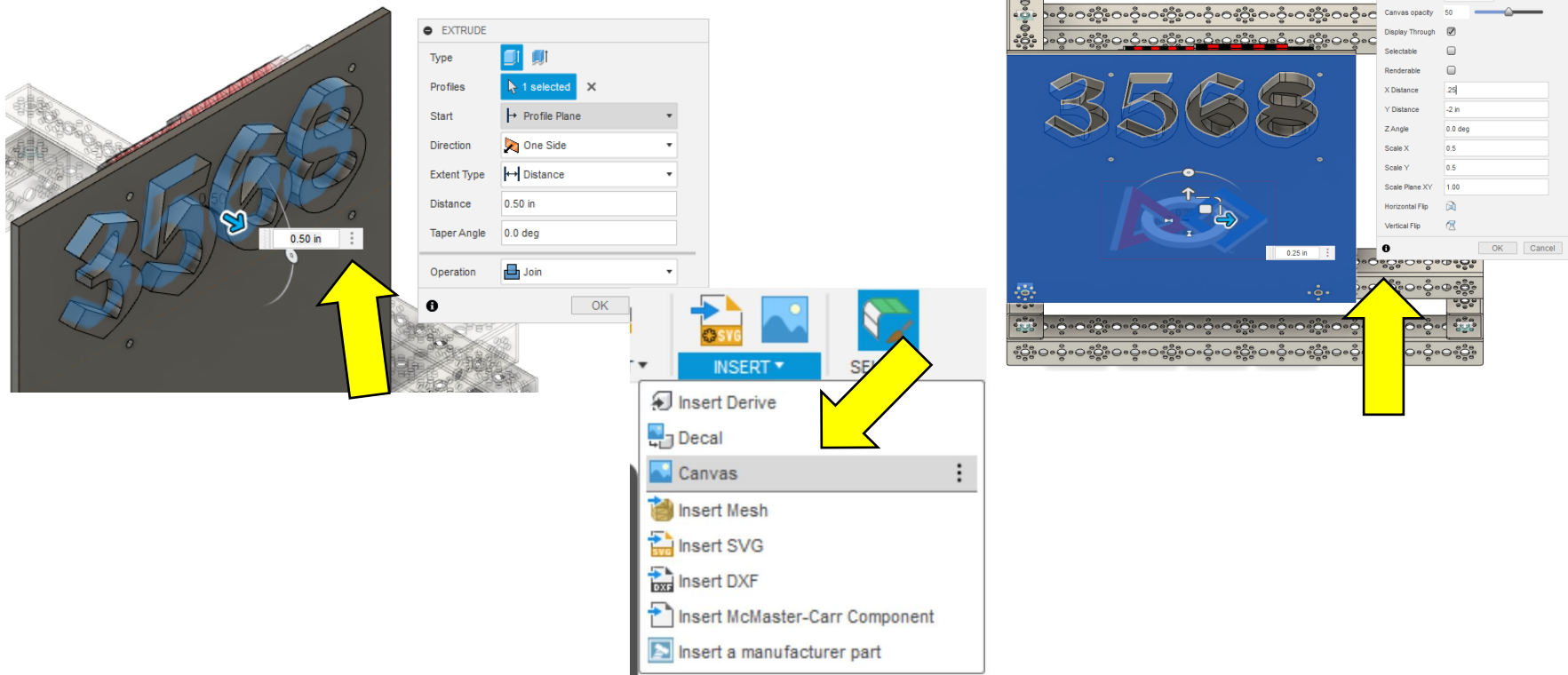
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## Using the Text & Canvas Tools

38 – Use the **Press Pull Tool** to **Join** the text out **.50"** and click **OK**.

39 – Use the **Canvas Tool** in the **Insert Menu** to insert the **FIRST Logo** on the outside surface of the Backplate.

40 – Adjust the size of the **FIRST Logo** using the **Scale-X** and **Scale-Y** and the position by the **X-Distance** and **Y-Distance**. When you're satisfied click **OK**.







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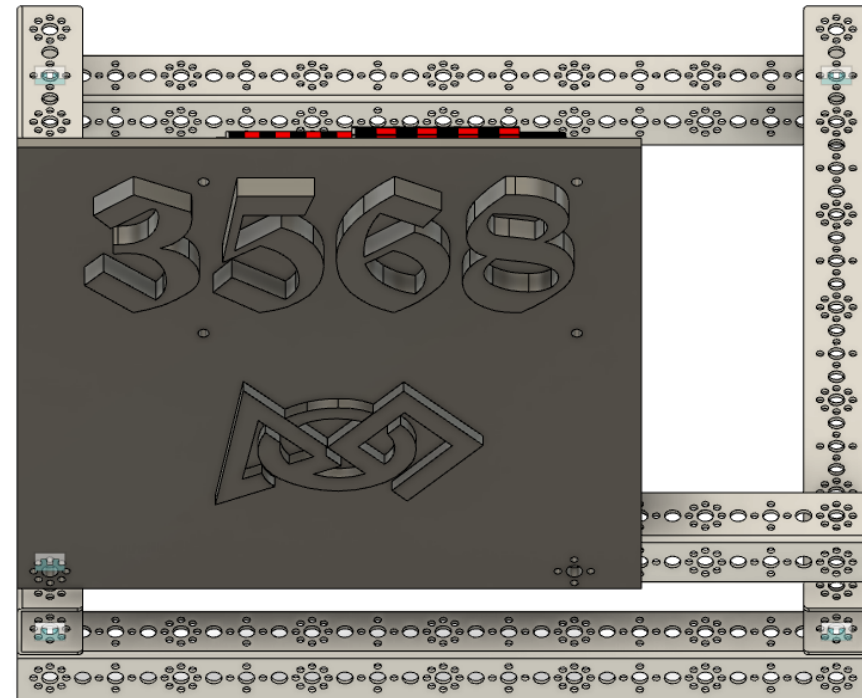
## Let's Build a Robot

41 – Create a **Sketch** on the surface of the Backplate.

42 – Using the **Line Tool** and **3-Point Arc Tool**, trace the **FIRST Logo**.

43 – **Finish Sketch**, use the **Press Pull Tool** to **Join** it **.25"** out, and click **OK**.

44 – Delete the **Canvas** in the **Timeline** by right clicking on the icon and selecting **Delete**.



That's it for now... next is Robot Motion and Synthesis



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