

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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AUTOCAD®

We used the Joint Tool



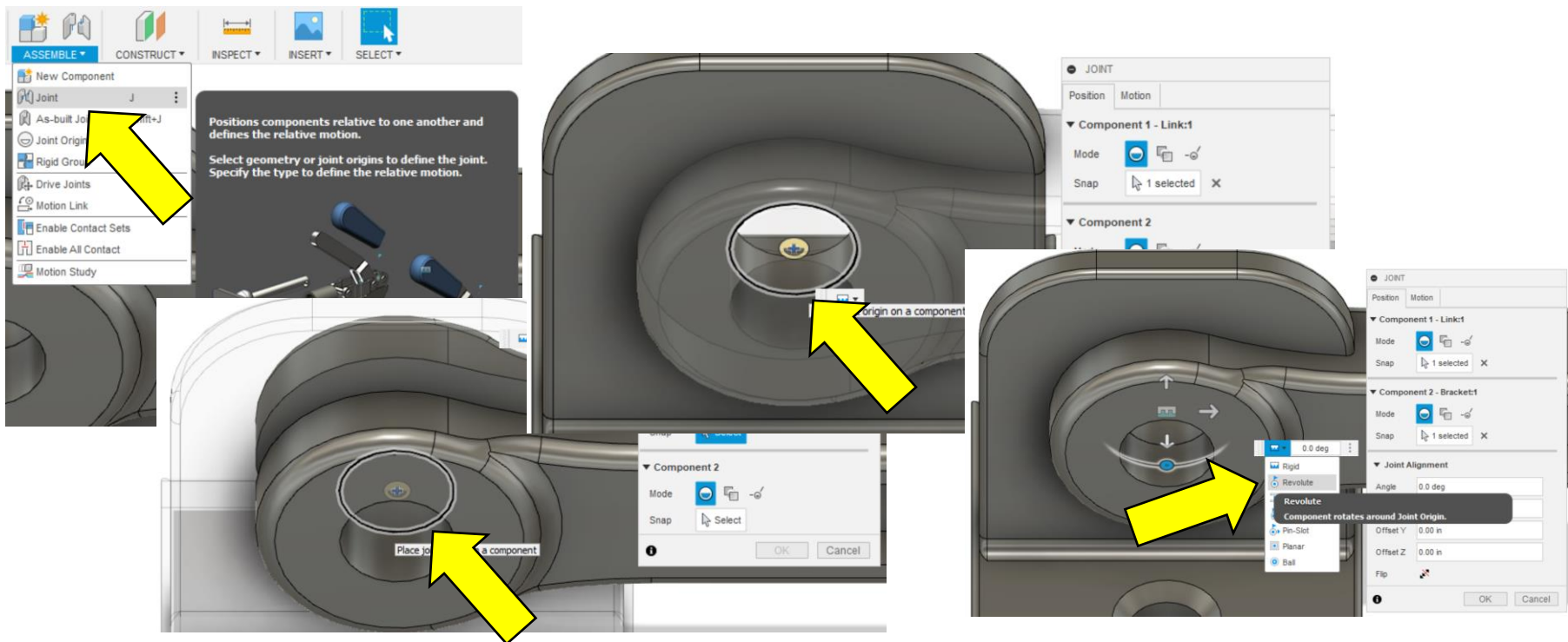
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34 – Next we need to create a Joint. Select the **Joint Tool** from the **Assemble Menu**.

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**.





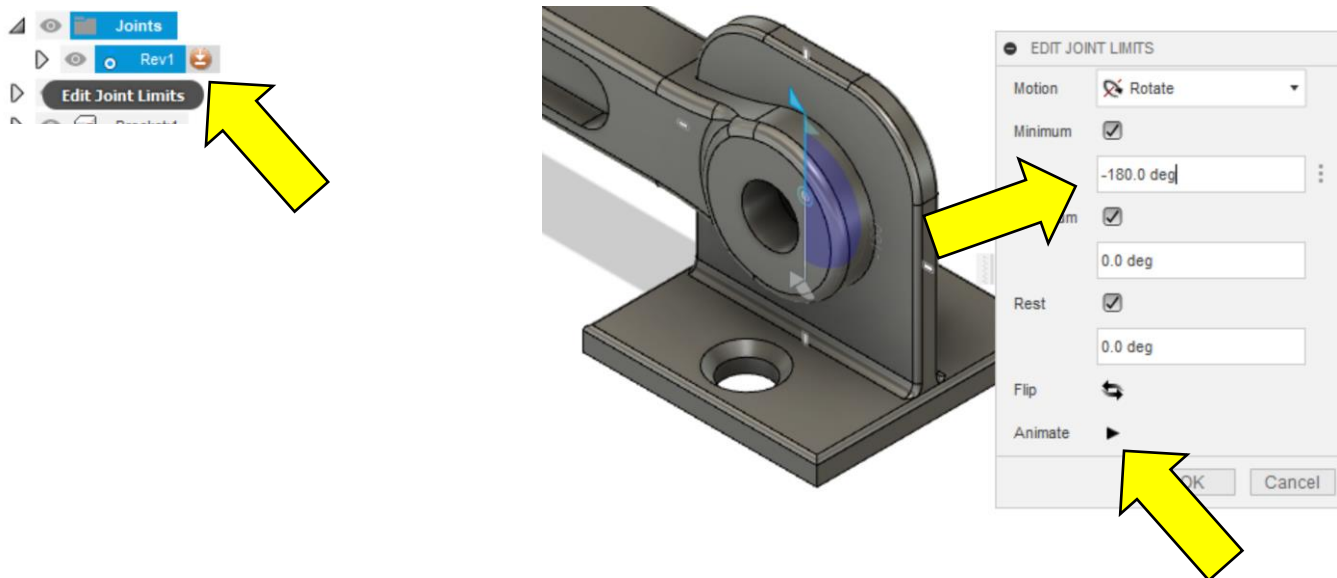
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We set Pivot Joint Limits for motion

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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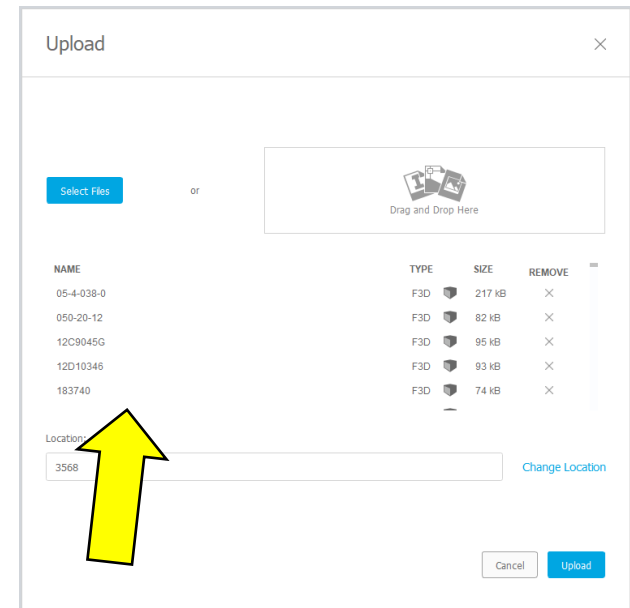
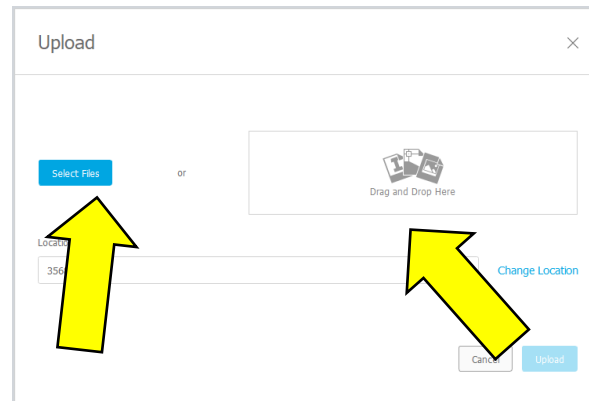
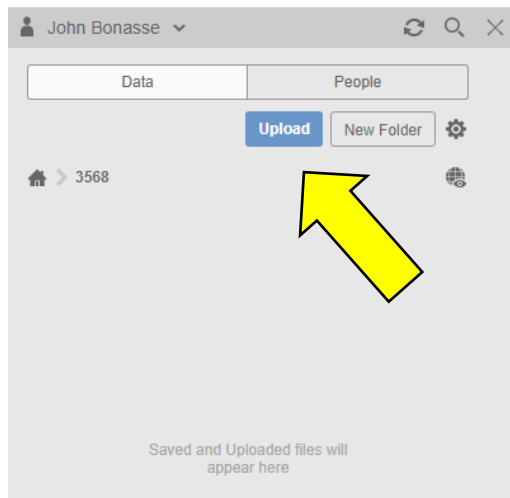
We Uploaded part files

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.)

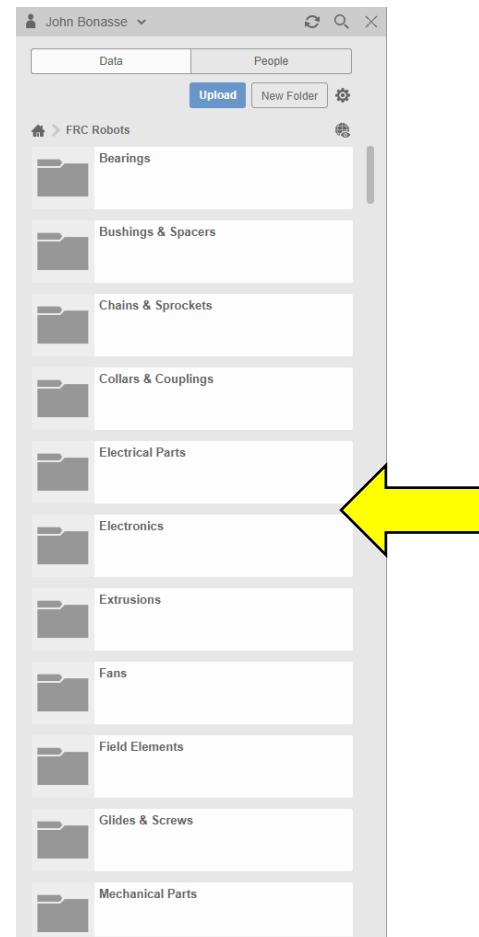
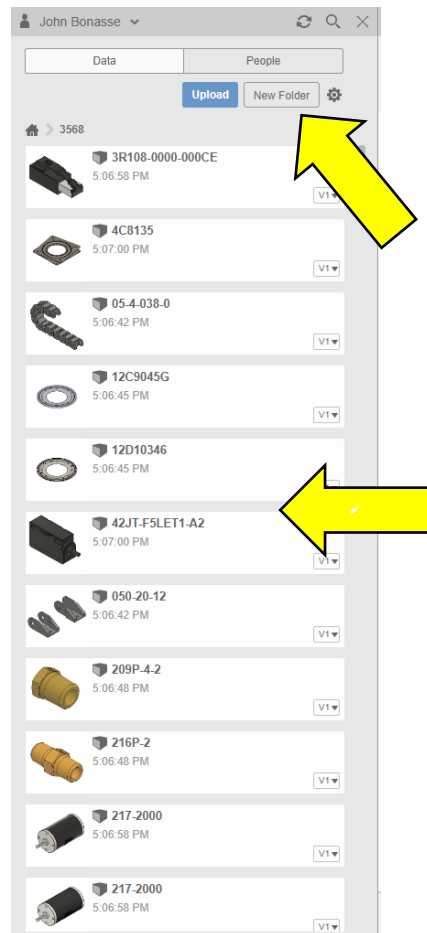




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Let's Build a Robot

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.



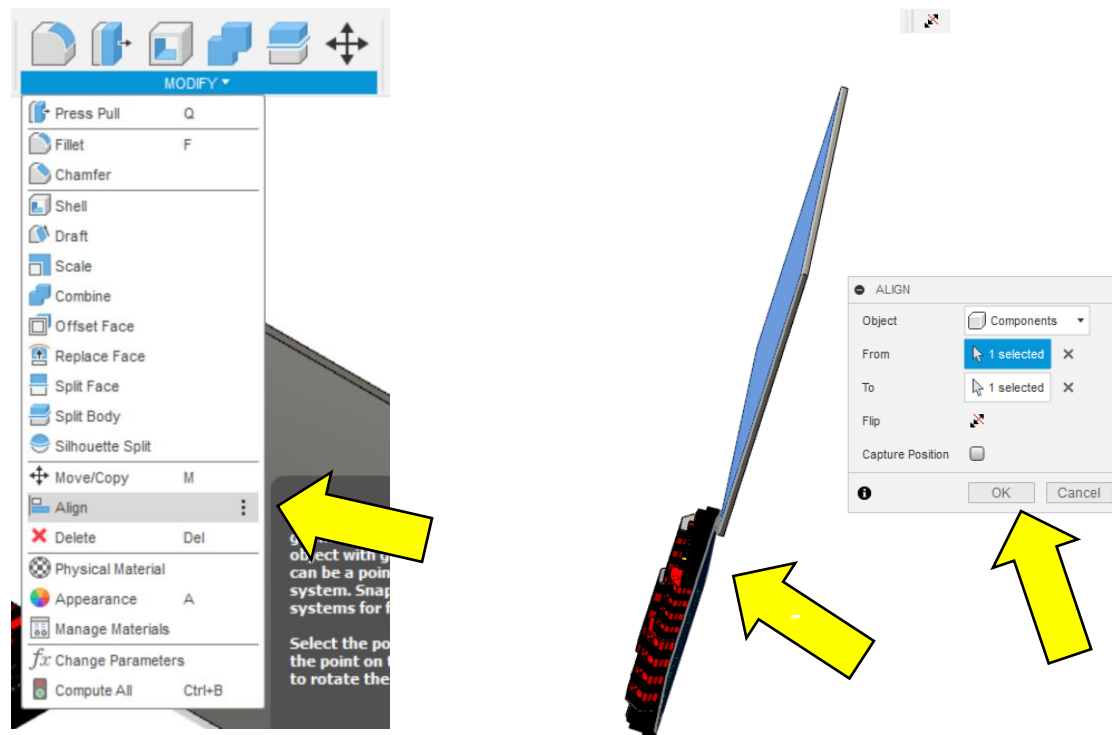


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We used the Align Tool

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**.

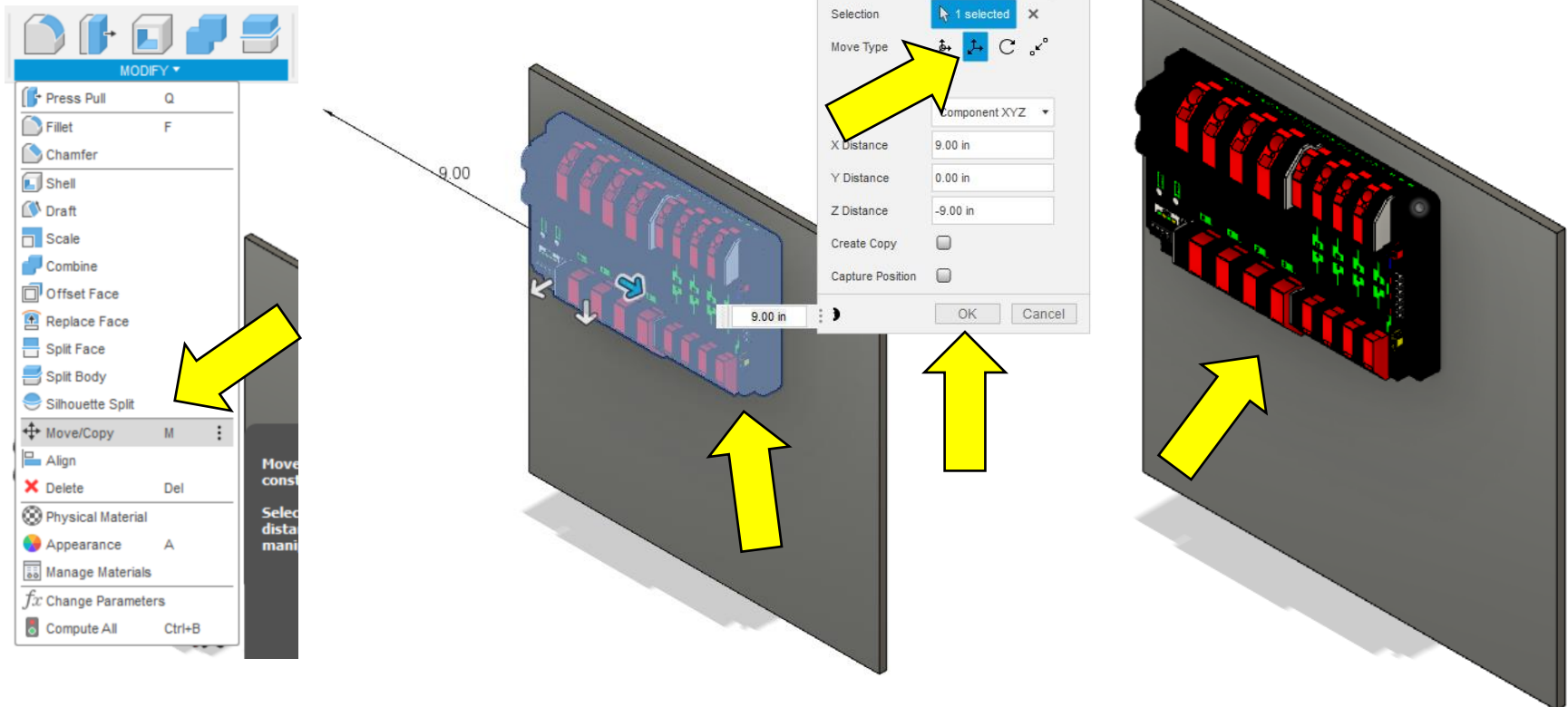




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We used the Move/Copy Tool

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**.



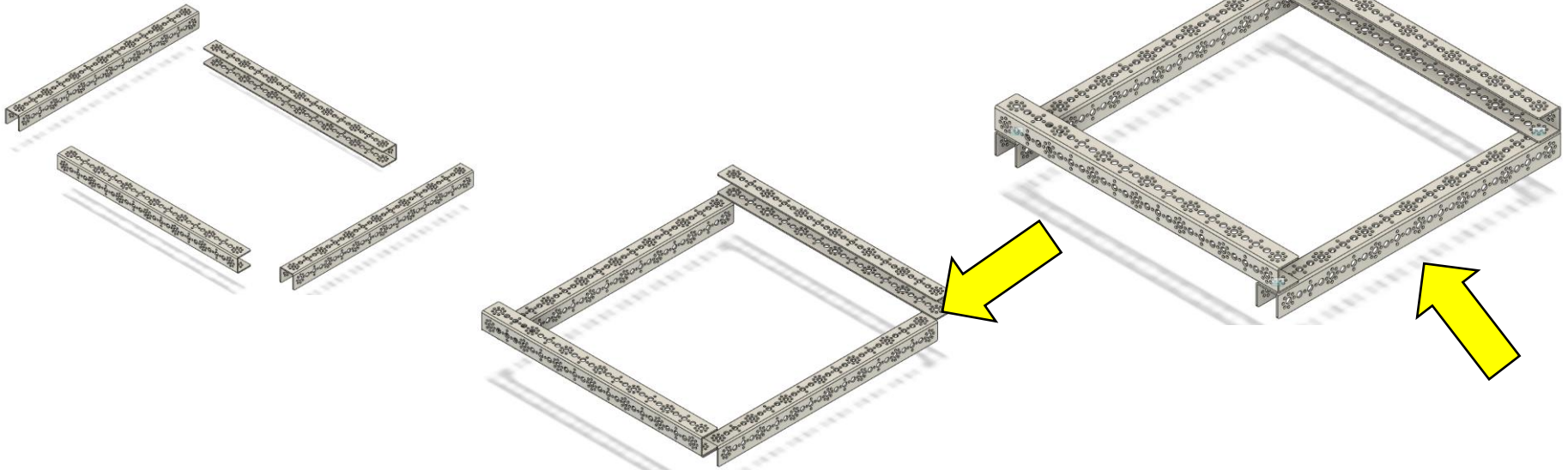


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We used the Align and Joint Tools

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.



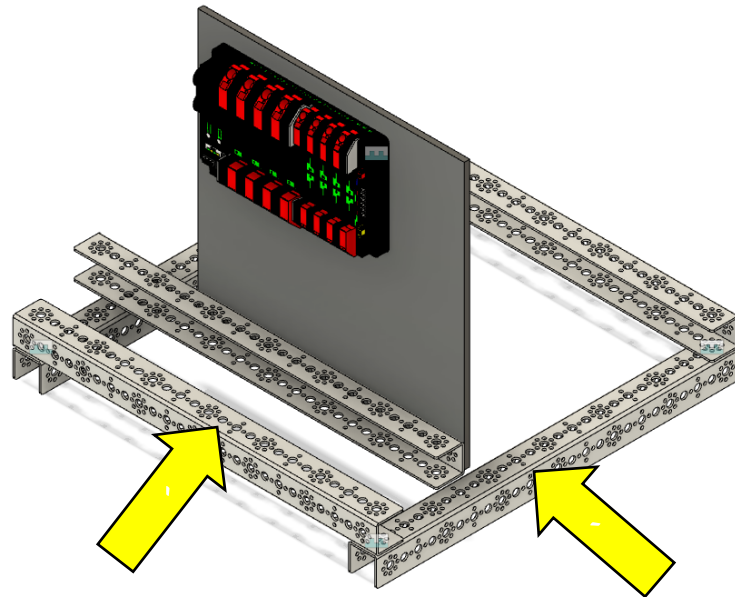
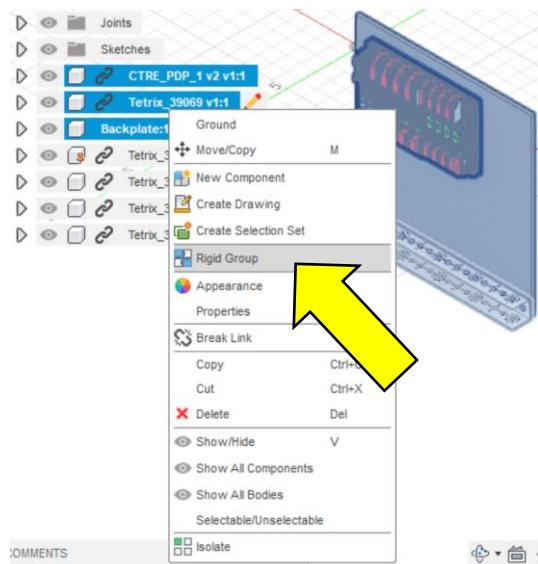


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We created a Rigid Group

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.





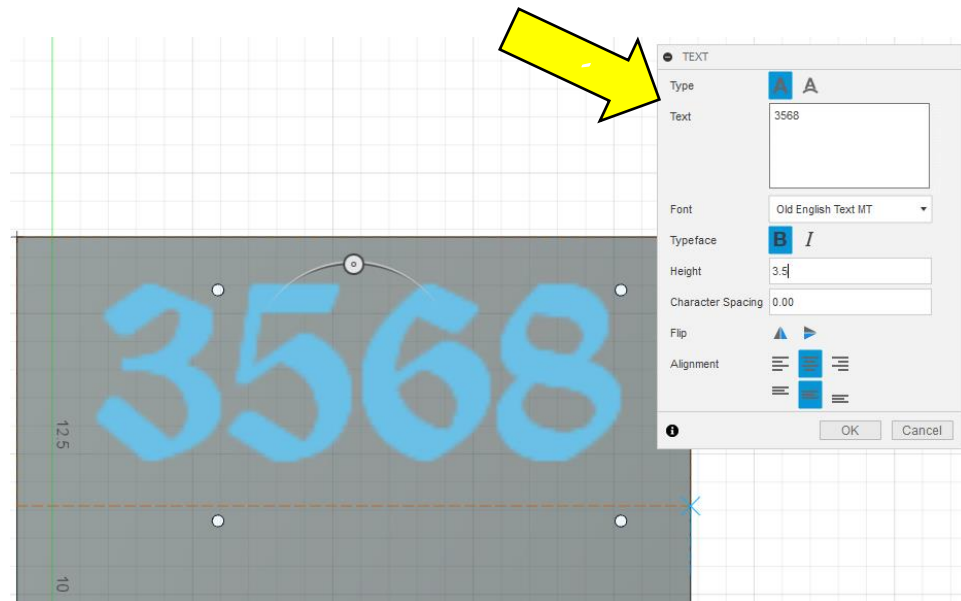
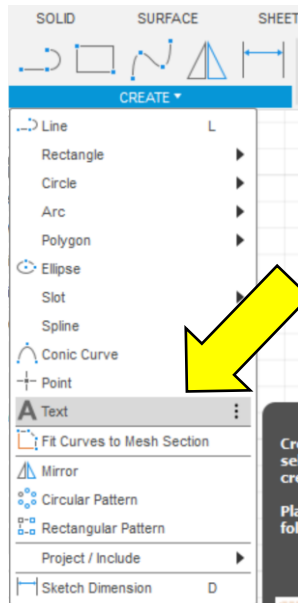
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We used the Text and Canvas Tools

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**.





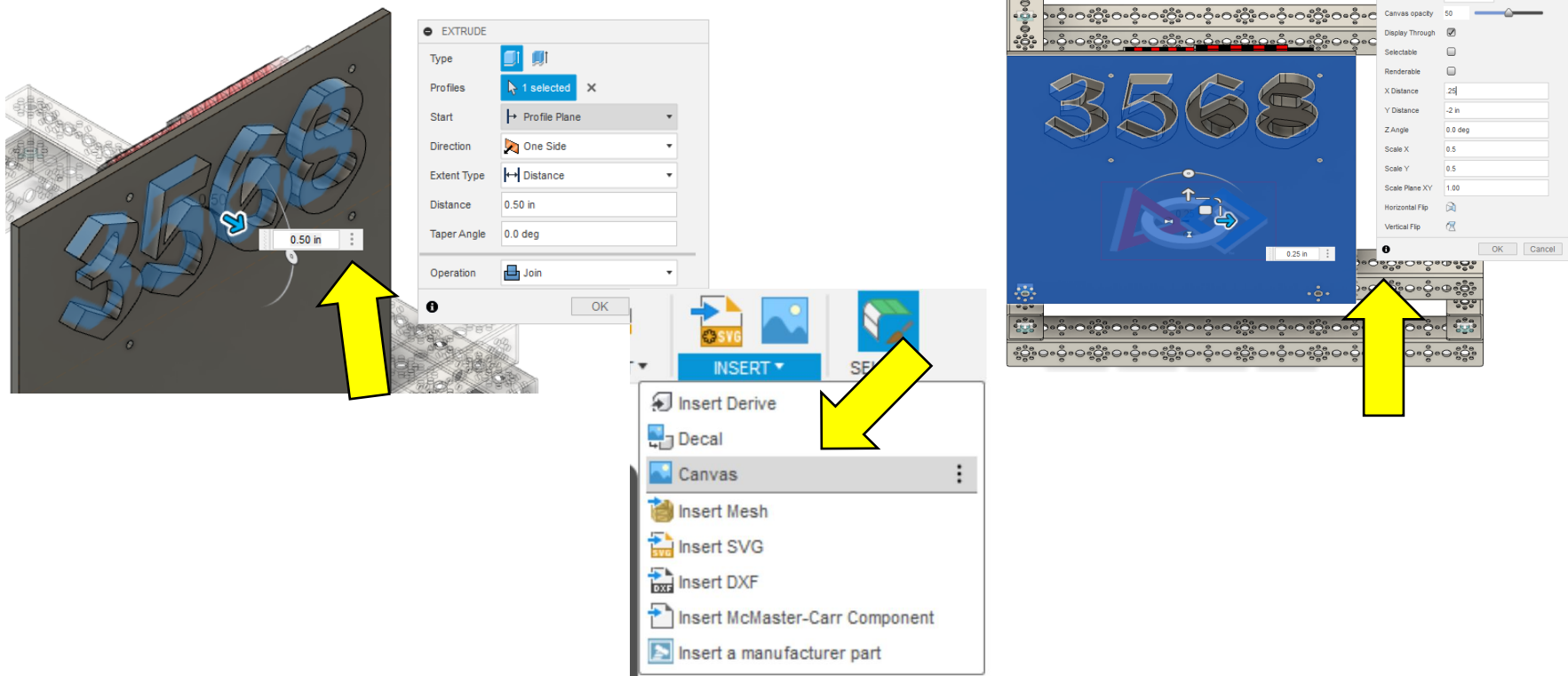
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Using the Text & Canvas Tools

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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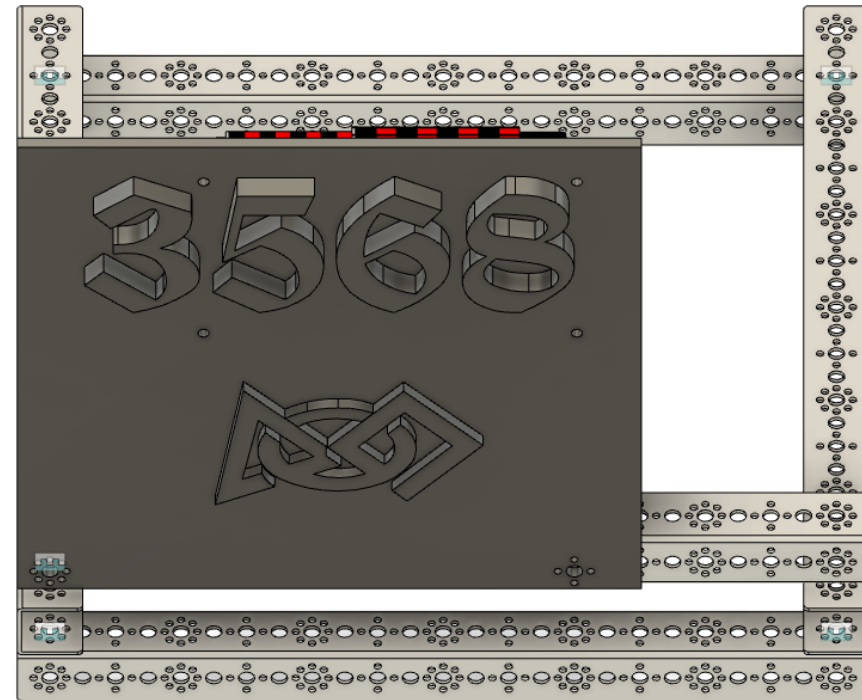
We used the Line and 3-Point Arc Tools

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**.

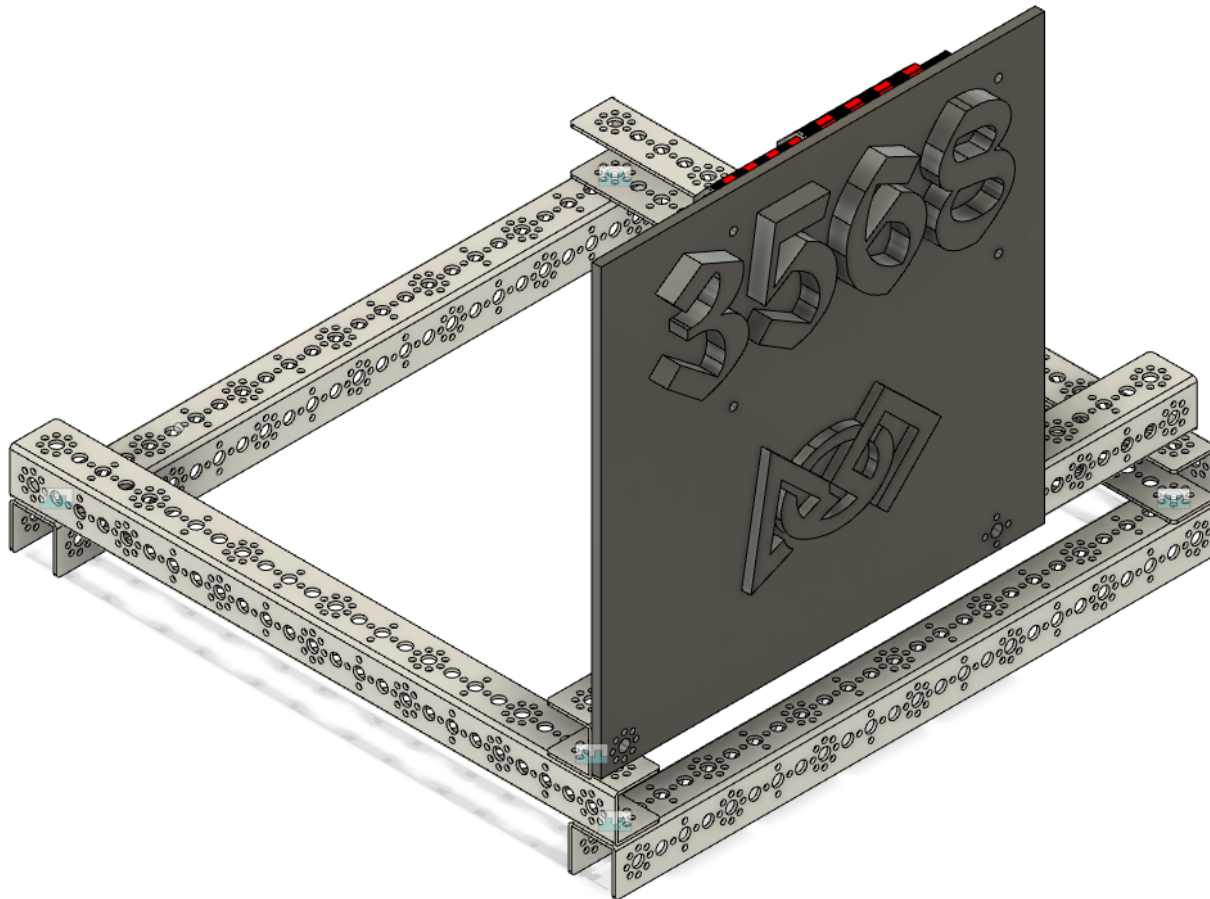
44 – Delete the **Canvas** in the **Timeline** by right clicking on the icon and selecting **Delete**.



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



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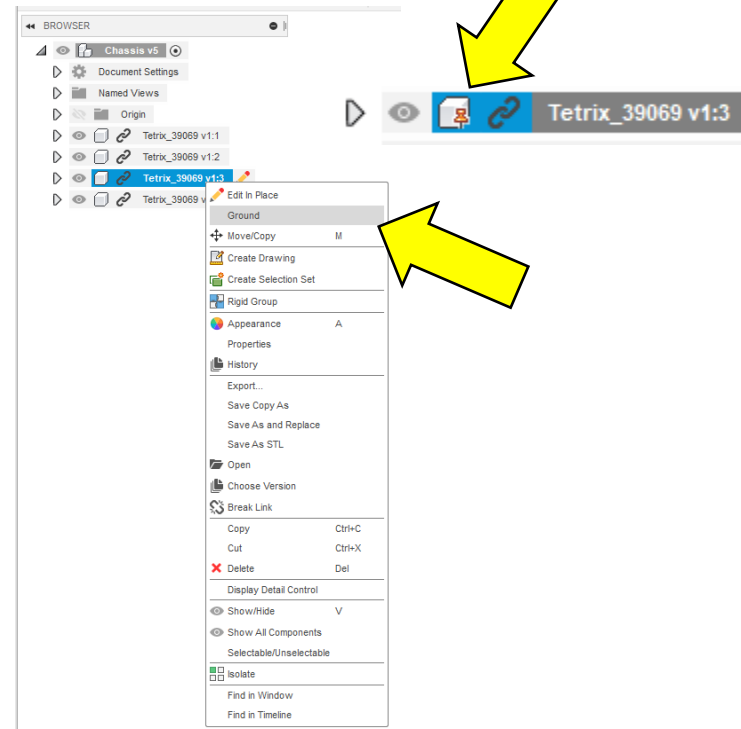
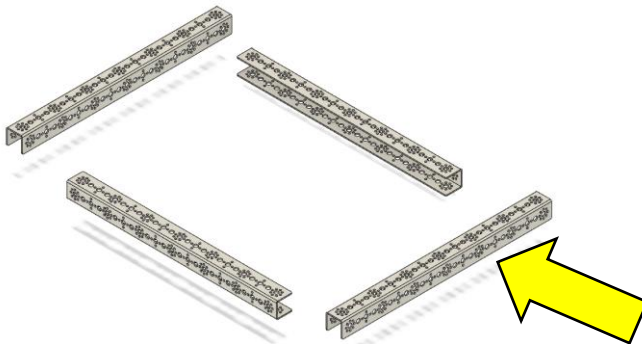


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Let's review the Align and Joint Tools

1 – Start a **New Design** and drag a **Tetrix_39069** into the drawing. Make three copies for a total of four using the **Move/Copy Tool**. Orient them roughly into position as shown below.

2 – To assemble the Chassis we can use the **Align Tool** under the **Modify Menu** and the **Joint Tool** under the **Assemble Menu**. Start by **Grounding** the right side rail and **Capture Positions** if prompted. To do this right click on the component in the **Browser** and choose **Ground**. A red push pin should appear on the Component Cube.



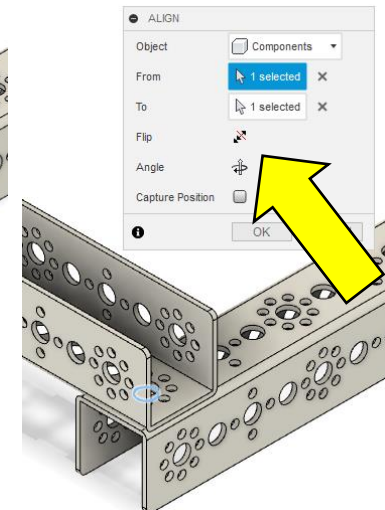
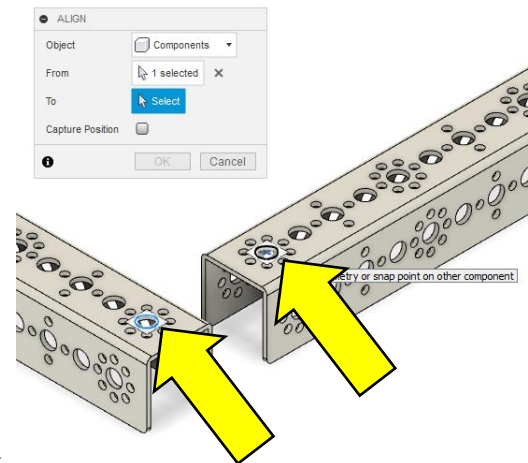
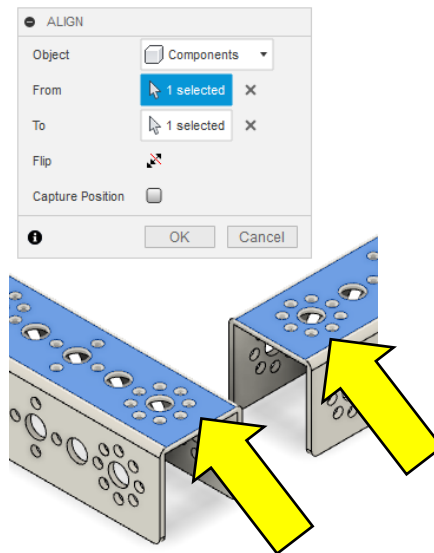
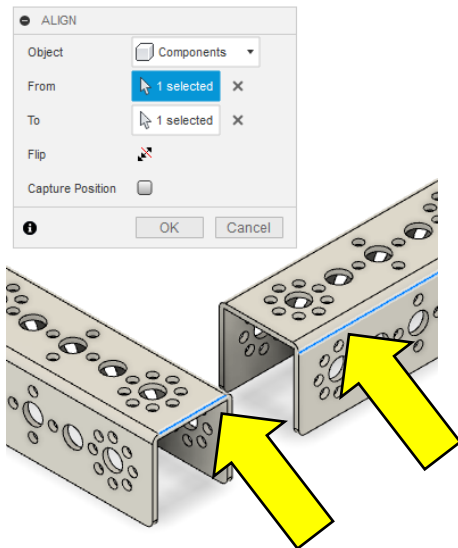


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Let's review the Align and Joint Tools

3 – Using the **Align Tool**, select the outside edge of the end of the C-Channel and the outside edge of the outside of the right side rail. Then Align the top surfaces of the C-Channels, followed by the top edges of the center holes on the end of the C-Channels. Use the **Flip** and **Angle** toggles to orient the part.

NOTE: The order you apply the constraints does matter, and the Align Tool will move the parts into position but it does NOT create any rigid constraints.

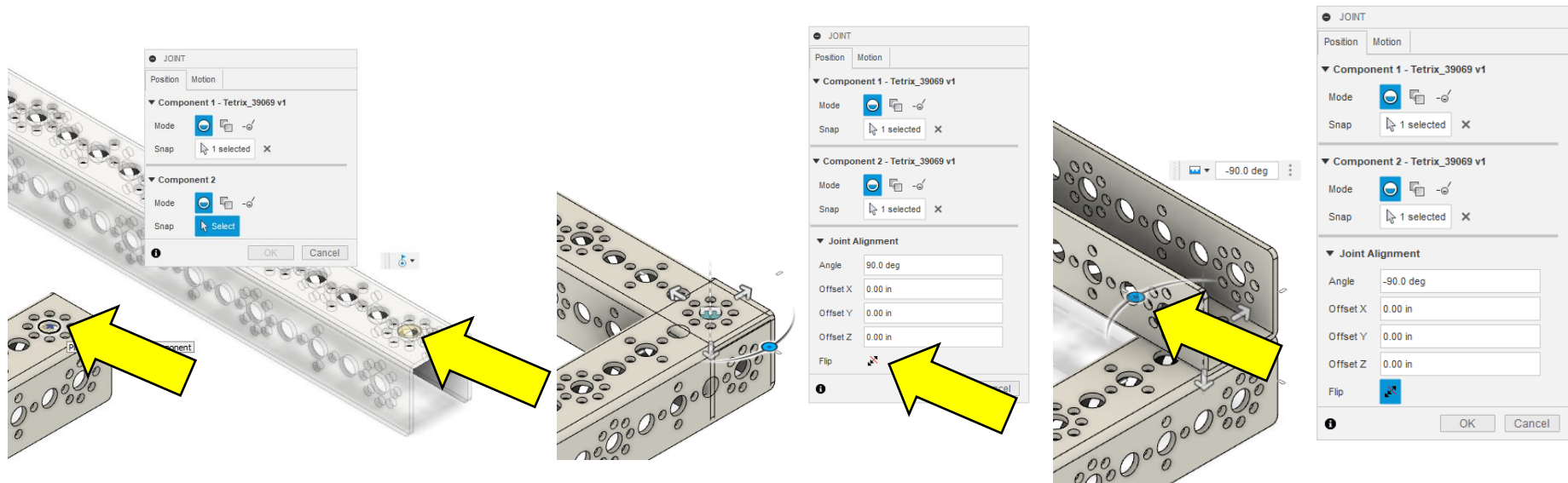




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Let's look at motion

4 – Using the **Joint Tool** to create a **Ridged Joint** between two components acts like a bolt and locks the two together. Select the top edges of the middle hole on the end of the two C-Channels, remember to choose the first hole on the part you want to move. Click **OK**. Repeat the process for the other (2) corners and add a **Rigid Joint** to the initial connection we made. Use the **Flip** option to orient the part if needed and use the rotate handle to rotate the part into position.





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5 – Import the **am-0150** and **am-0741 gear CAD files** from the **Andymark.com** website. To do this visit the site, from the **Mechanical – Motion** menu select **Gears**, click on each gear and from their pages scroll down to the **Documents** section and download the CAD file. **Upload** the files into your project like shown on slide 5.



Product Overview

Specifications

- Bore: 0.502 in. hex hole
- Diametral Pitch: 20
- Face Width: 0.375 in.
- Material: 4140 steel, cold formed into gear teeth
- Overall Width: 0.400 in.
- Pitch Diameter: 2.5 in.
- Pressure Angle: 14.5 degrees
- Teeth: 50
- Weight: 0.425 lbs

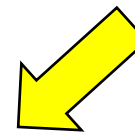
Documents

Layout Print(s)
[am-0150 50T 20dp 500h.pdf](#)

CAD File(s)
[am-0150 Toughbox Large Output Gear.STEP](#)

Don't see what you need?
[See_all_our_guides_drawings_and_CAD_files_here](#)

Returns



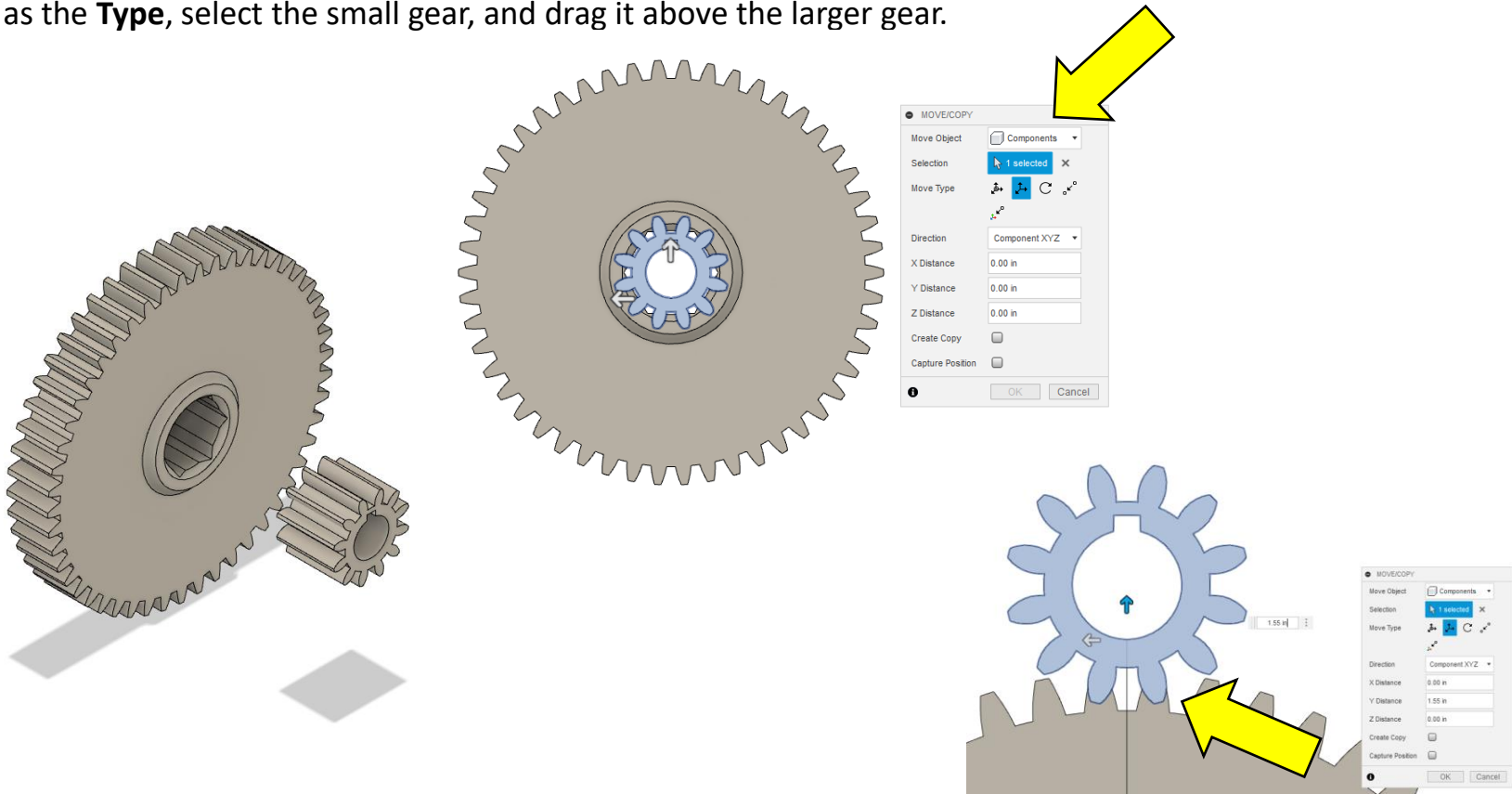


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6 – Drag one of each of the gears into your design.

7 – Orient the smaller gear above the larger gear using the Move/Copy Tool. Choose the **Move/Copy Tool**, select **Components** as the **Object**, choose **Translate** as the **Type**, select the small gear, and drag it above the larger gear.

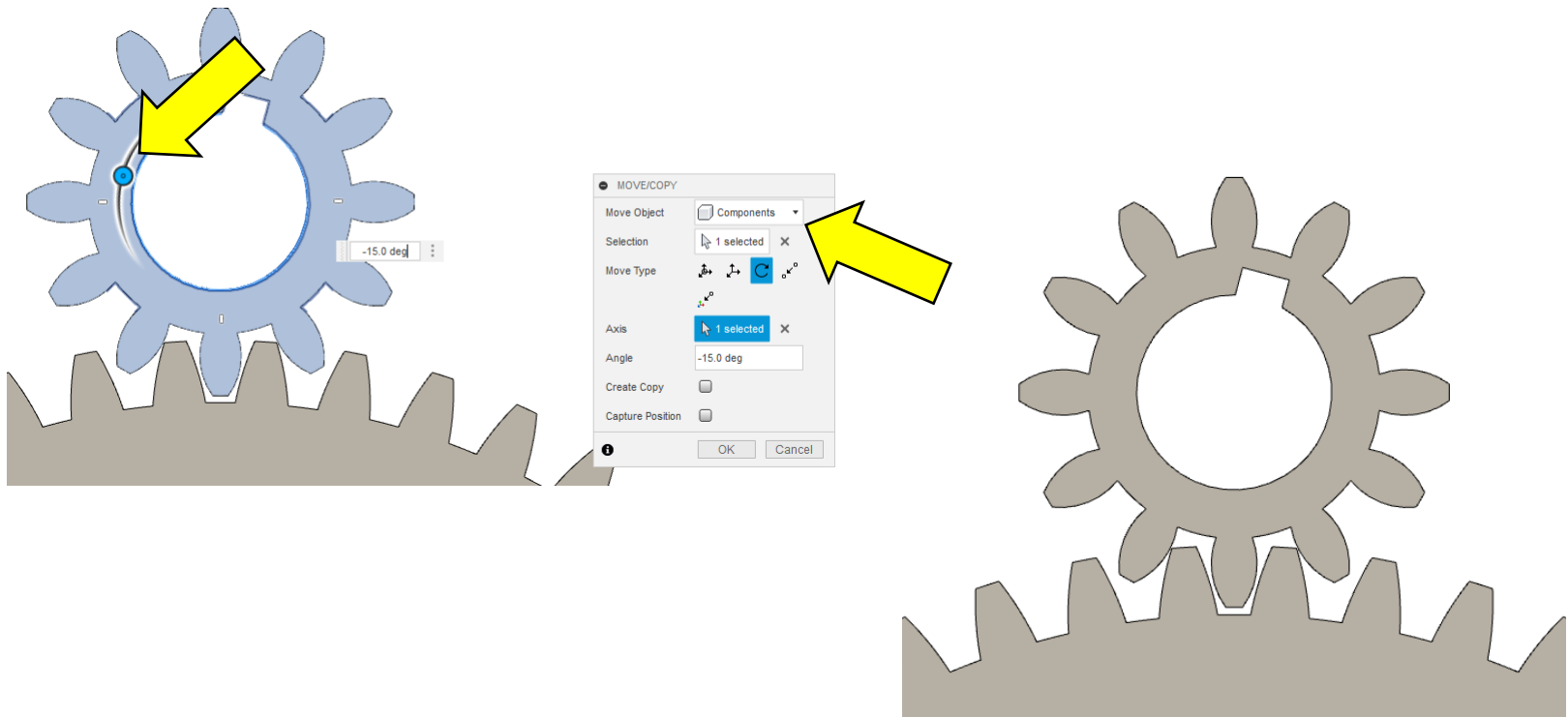




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8 – Orient the teeth of the smaller gear to mesh with the larger one by selecting the **Move/Copy Tool**, choose **Component** for the **Object**, **Rotate** for the **Type**, and select the circular center of the gear as the **Axis**. Use the rotate handle to rotate the gear into position. Click **OK**.

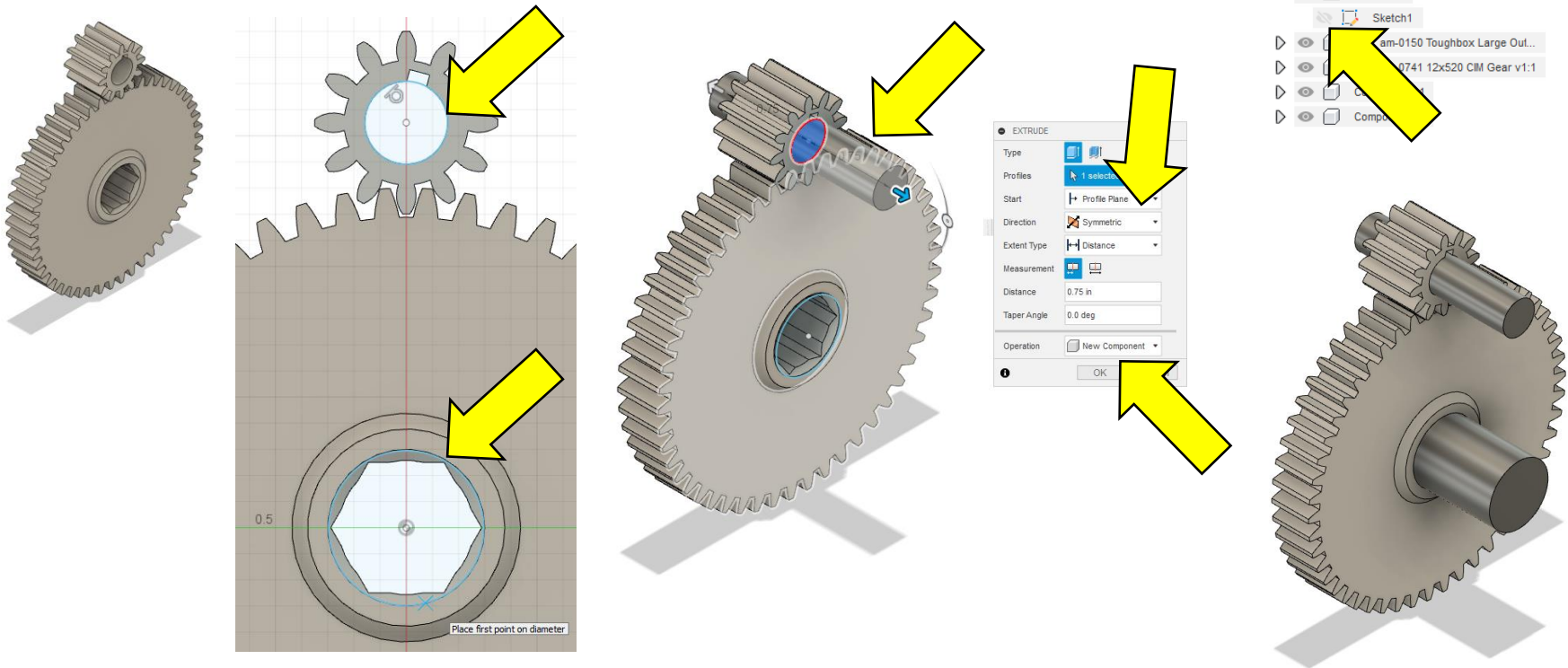




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9 – Create shafts for the gears to be mounted to. To do this **Create Sketch** on the surface of the small gear (**Capture Position** if prompted). Use the **2-Point Circle Tool** to draw circles at the center of the two gears. **Finish** the Sketch and use the **Symmetric Press Pull Tool** to create **.750"** shafts through the center of the gears one at a time. Start with the top, select **Symmetric** and **New Component**, enter **.750"** for the **Distance**. Click **OK**. To turn the Sketch back on for the second shaft, select the **Eye Icon** under **Sketches** in the **Browser** on the left side of the screen.



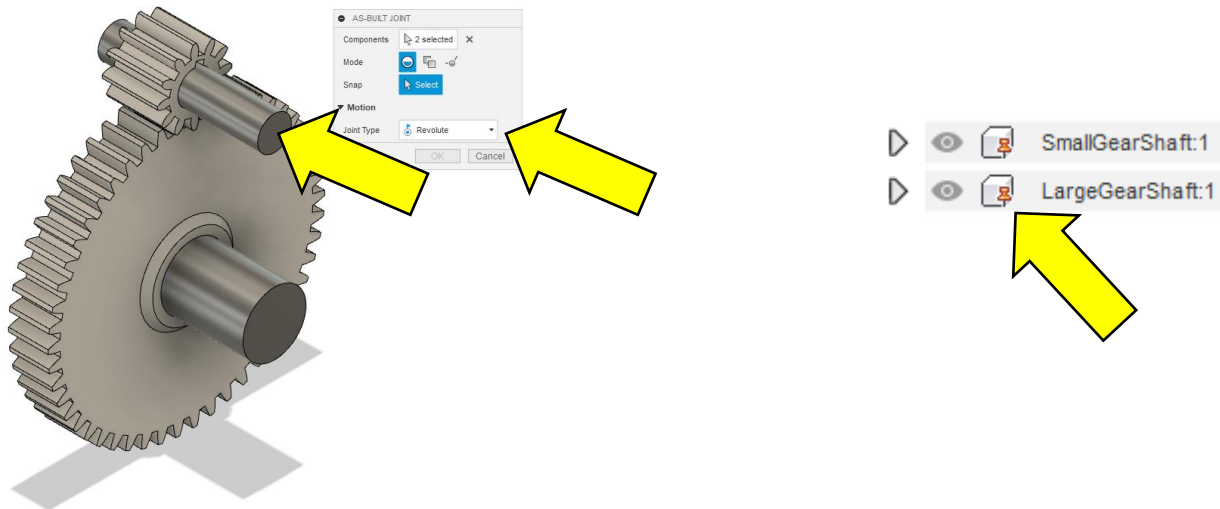


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10 – Create joints between the Gears and the Shafts. To do this select the **As Built Joint Tool**, change the **Type** to **Revolute**, select the Gear (what you want to move), select the Shaft, and set the center of the Shaft as the **Snap** point. The Gear should **Animate** and rotate around the Shaft. Repeat for the second Gear.

11 – Ground the Shafts to maintain their positions. To do this right click on each Shaft component in the **Browser** and choose **Ground**. A red push pin should appear on the Component Cube.



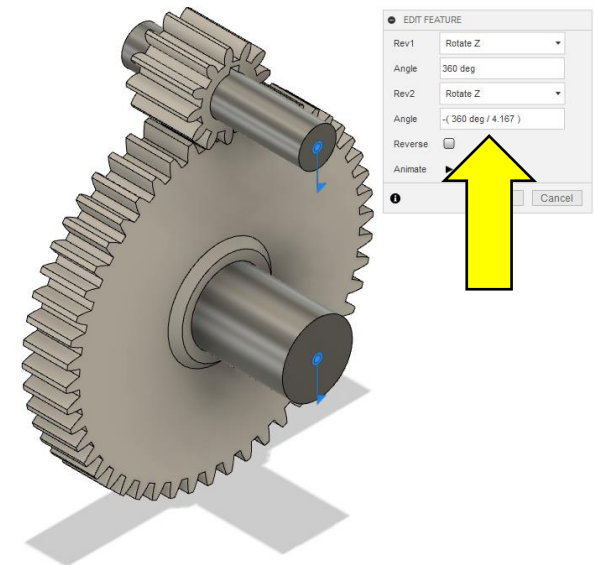
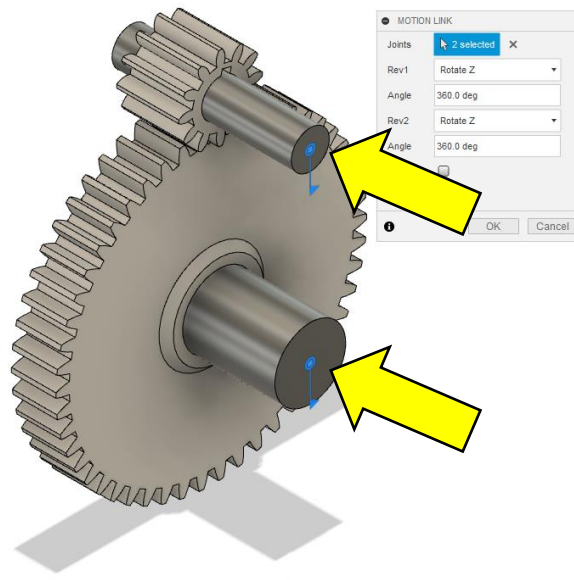
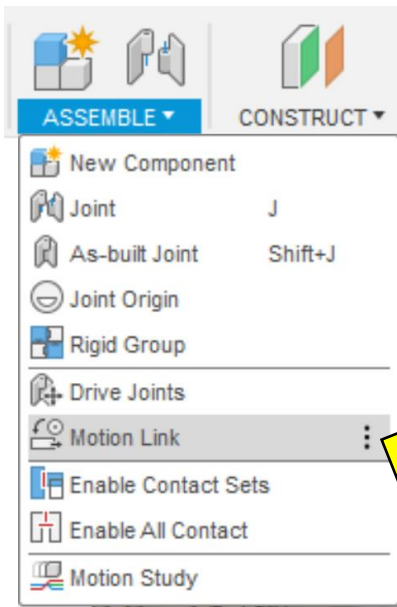


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12 – The gears can now rotate around the shafts but they are still independent of each other. To connect the Gears together we need to create a Motion Link between them. To do this select the **Motion Link Tool** under the **Assemble Menu**.

13 – Select the **Joint Markers** at the center of each Shaft, they should **Animate** and begin rotating. Notice that they rotate at the same speed and direction. To scale the rotation divide the number of teeth for each gear ($50 / 12 = 4.167$) and enter the following for the second Angle **-(360 / 4.167)**. The small gear will rotate 4.167 times when the larger gear has turned once, and the negative reverses the rotation of the larger gear.

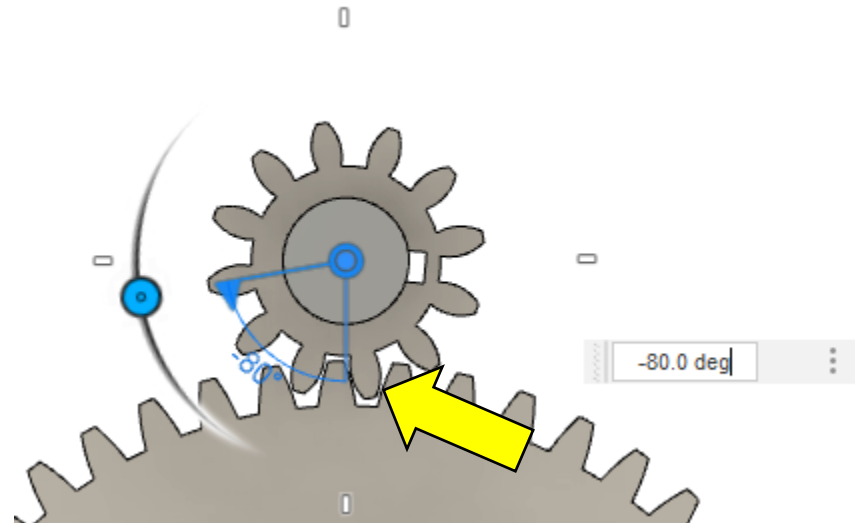
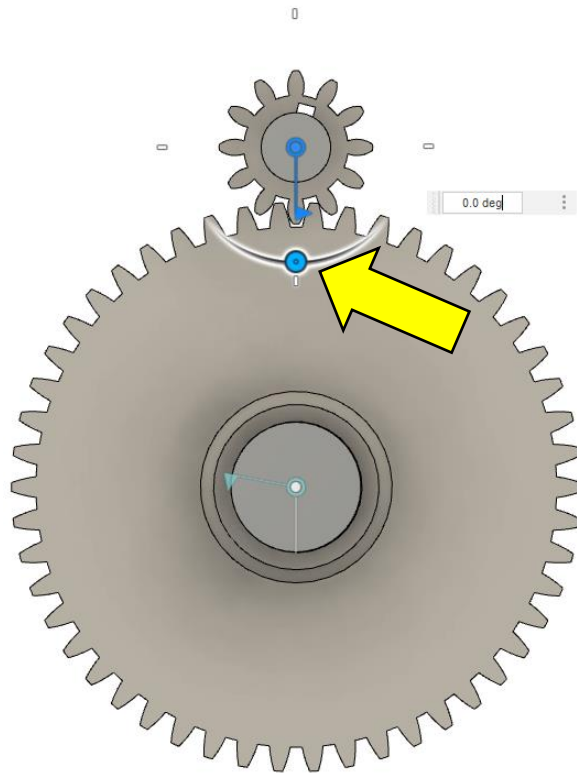




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14 – Use the rotate handle to spin the Gears and check their rotation.

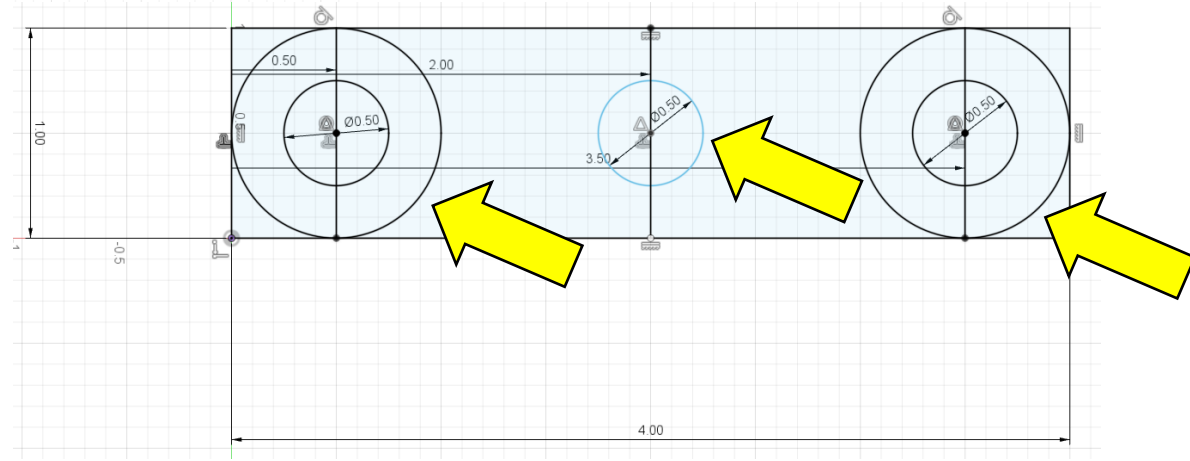
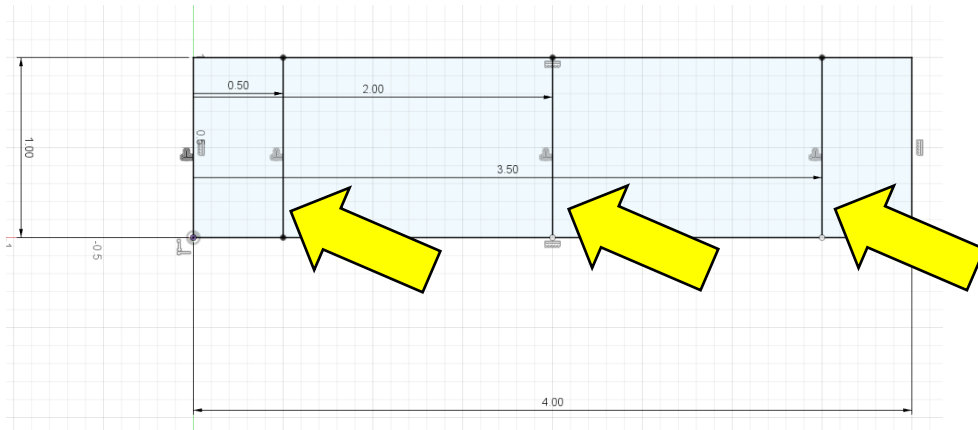




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15 – Create a Link and make three copies. Start by creating a sketch and drawing a **1" by 4" Rectangle** on the **XZ-Plane**. Select the left side of the rectangle and select the **Offset Tool**. Offset the side by **-0.5"**, **-2.0"**, and **-3.5"**. Use the **Center Diameter Circle Tool** to create circles at the **Mid-Point** of each of the **Offset Lines**. Draw two addition circles at each end from the **Mid-Point** out to the edge.





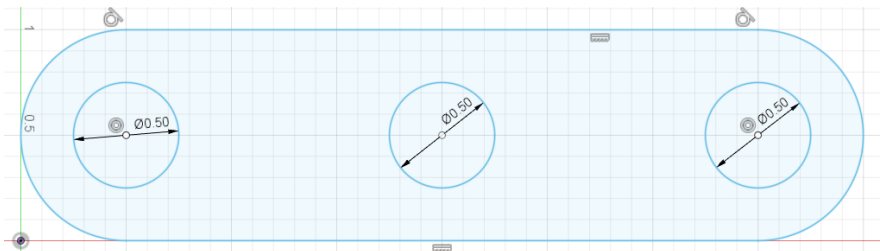
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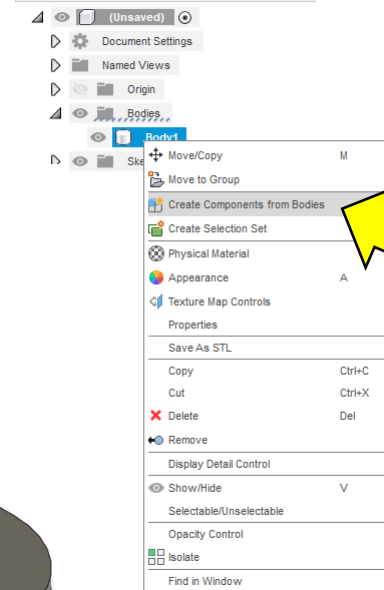
16 – Use the **Trim Tool** to remove unneeded lines and **Finish Sketch**.

17 – Extrude the shape to **0.125"** thick using the **Press Pull Tool**.

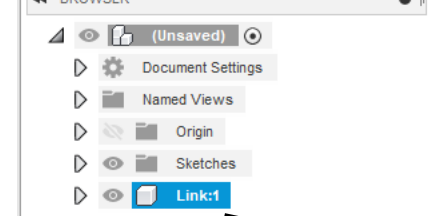
18 – Convert the **Body** into a **Component** by right clicking on it in the **Browser** and selecting **Create Components from Bodies**. Rename it **Link**.



BROWSER (Unsaved)



BROWSER (Unsaved)



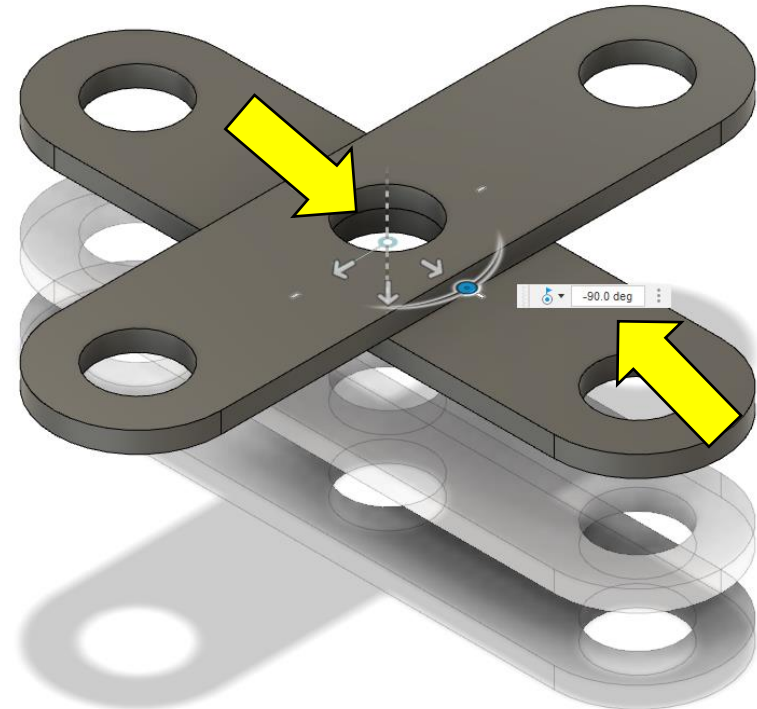


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14 – Create three copies using the **Move/Copy Tool** or **CTRL + C** and **CTRL + V** on a Windows PC.

15 – Use the **Joint Tool** to create a **Revolute Joint** between the two center holes on the top two links. Select the bottom edge of the circle in the top link and the top edge of the circle in the bottom link. Set them at **-90** degrees to each other. Click **OK**.

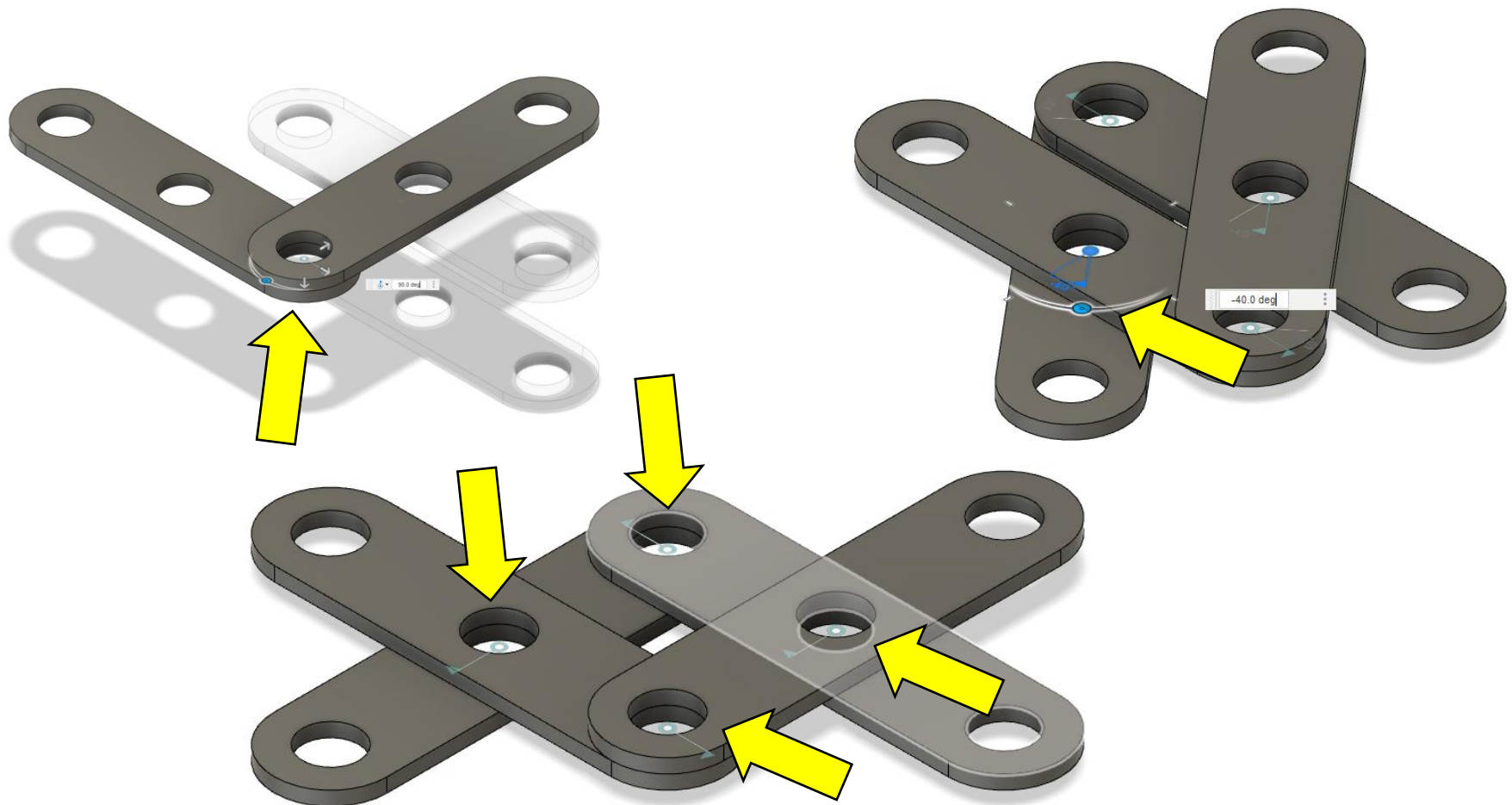




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16 – Create **Revolute Joints** at the ends and the center of the remaining Links.
Use the rotate handle to test the joint motion.



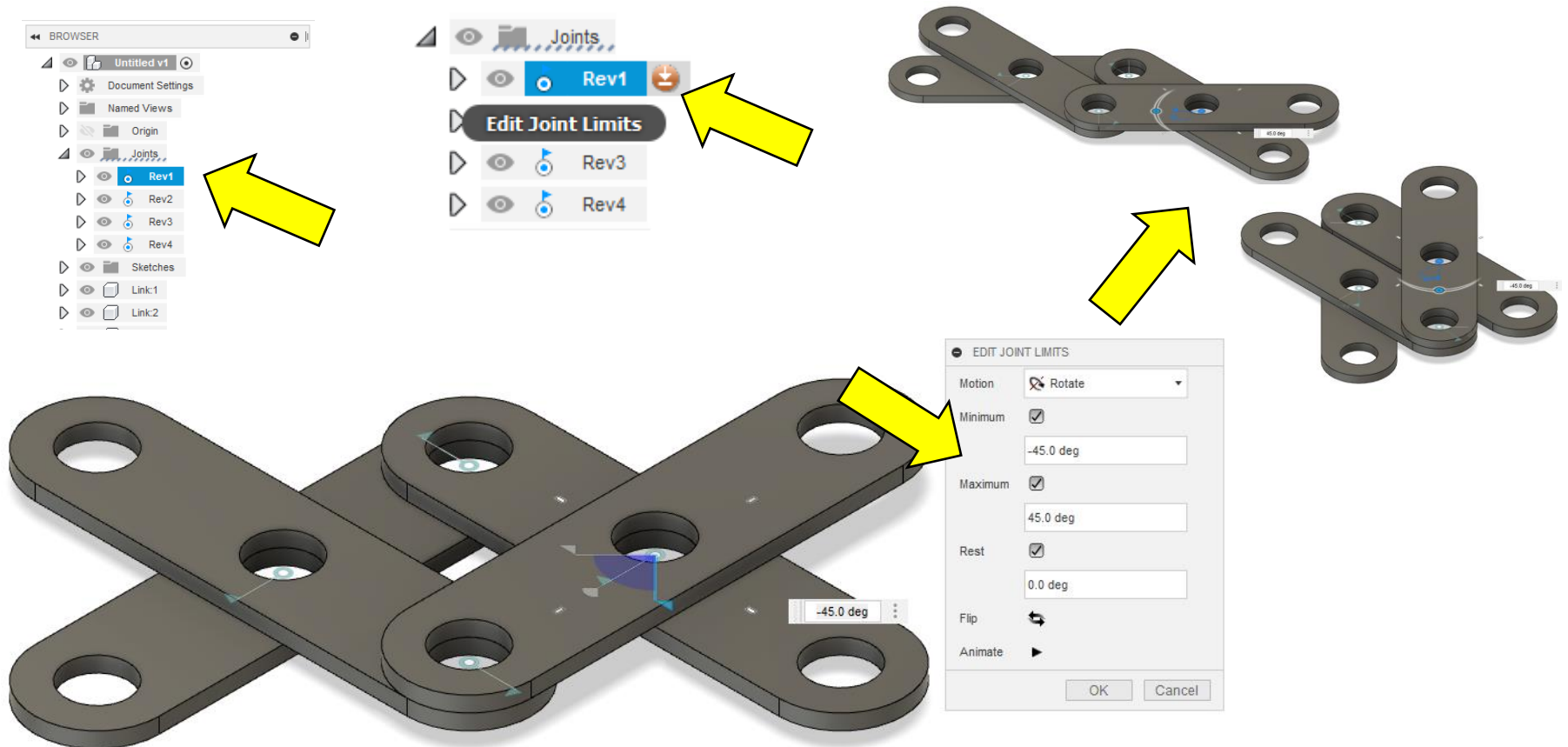


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17 – Set the Joint's Motion Limits by clicking on **Red Down Arrow** next to **Rev1** in the Joints category in the **Browser**. Set the **Minimum** at **-45 deg**, the **Maximum** at **45 deg**, and the **Rest** position at **0 deg**.

18 – Test the limits using the rotate handle.





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Next week... AutoCad

If you're interested in downloading and installing Synthesis from Autodesk you will need to use the following links. [LINK1](#) Synthesis, [LINK2](#) Video, [LINK3](#) GitHub (if Fusion 360 Tools don't appear)

Download and install AUTOCAD from the Autodesk website. [LINK](#)

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