CAD Training Part 1 D

This training will focus on making a simple assembly. This will be an accelerated version of the Lake Effect CAD Training. That document should also be read as it includes more practice including revolves.

This lesson will work on CADing the gearboxes we use on robots.

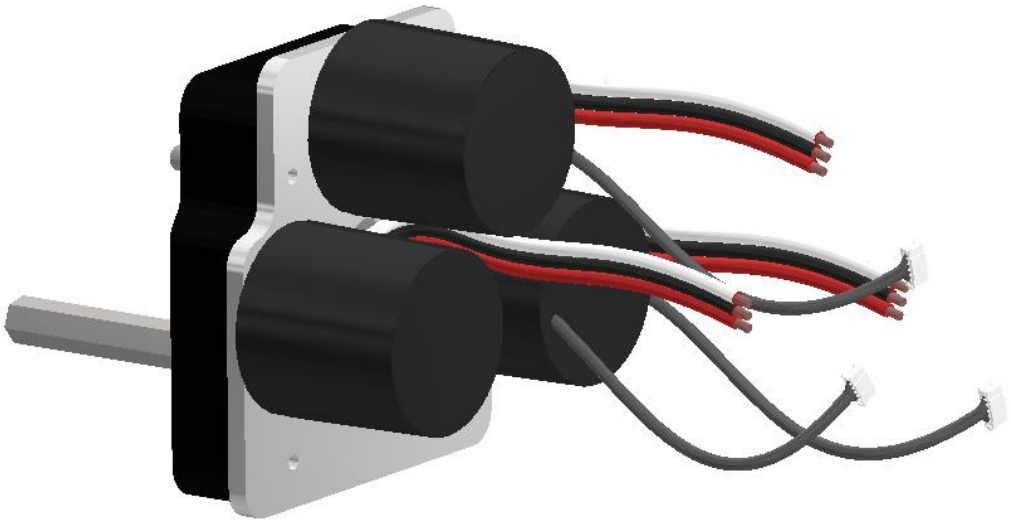


Figure 1: Gearbox assembly from turret bot CAD

D. Final Assembly

Now that all the parts have been made, we can start working on the final assembly. In addition to the parts we have already made, we will be making a few shafts and using supplier-provided models for gears, bearings, and mounting hardware. For this process, there is a .zip file with the supplier models and parts from previous steps if needed.

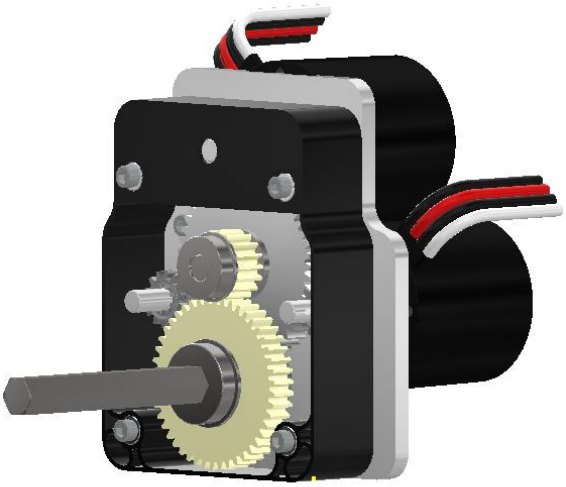


Figure 2

1. Create an Assembly

This is just like creating a new part; however, you want to choose assembly from the menu instead.

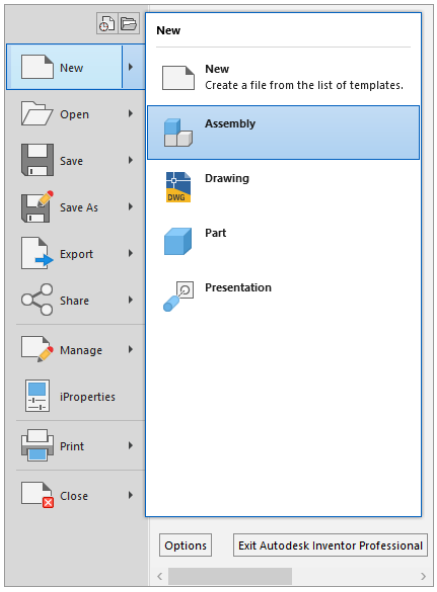
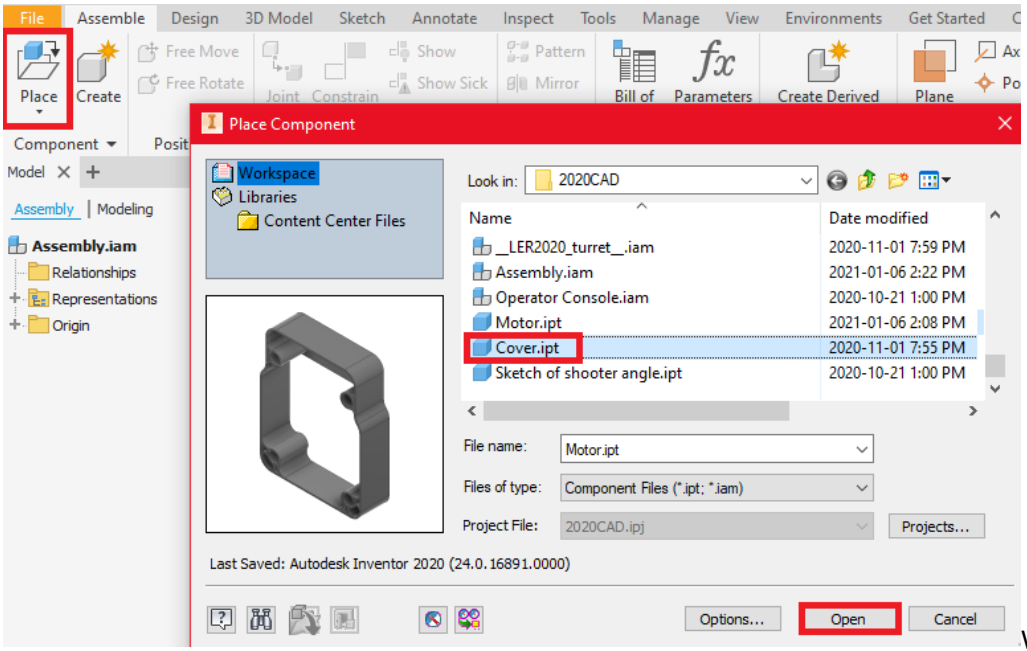


Figure 3

2. Housing Assembly

Place Parts

To add parts to an assembly, you add them from the place menu. To do this, select “Place” from the top-left, and in the menu that appears select the part(s) you wish to place. To prevent issues, make sure that parts you place are in roughly the same area as the project you are working on.



WW

Figure 4

Once you have selected a part, you can left-click to place the part, multiple clicks will place multiple times. The right-click menu has options for rotating about the X,Y, and Z axes. Press escape to stop placing.

For the first step, you will want to place the following:

- 1x Cover
- 1x Faceplate
- 4x Standoff
- 14x SHCS 10-32 x 0.625

Once you have placed the parts, you will want to set the faceplate as “grounded”. This means that is it immovable, so any interactions will take place with respect to its location. If no parts are grounded, attempting to test moving parts could just move the whole assembly instead. To ground the part, simply right click it and check “grounded”.

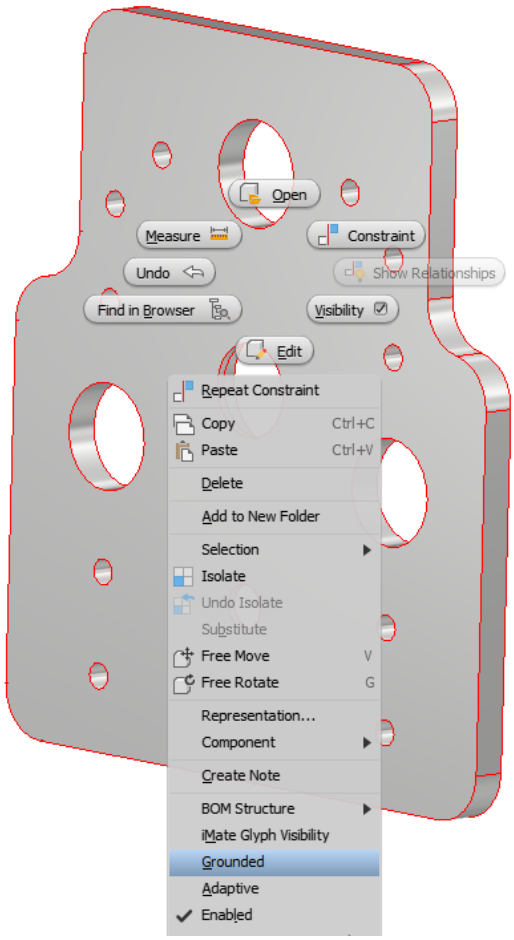


Figure 5

Constraints

In an assembly, constraints describe the physical relationship between parts. There are a variety of constraints, the most common being the mate, which describes various properties about adjacent faces or points. Another constraint that is often used is the insert constraint, as it allows for mounting relative to a hole and face.

The first things we will constrain are the bolts which will be used to mount the motors. To do this you will select the constrain tool and set it to Insert. Then the bolt shaft (a line with an arrow at the end should appear), then one of the walls of the respective hole (another line should appear, pointing away from the face). This constraint ensures that the bolt will always be aligned with the hole.

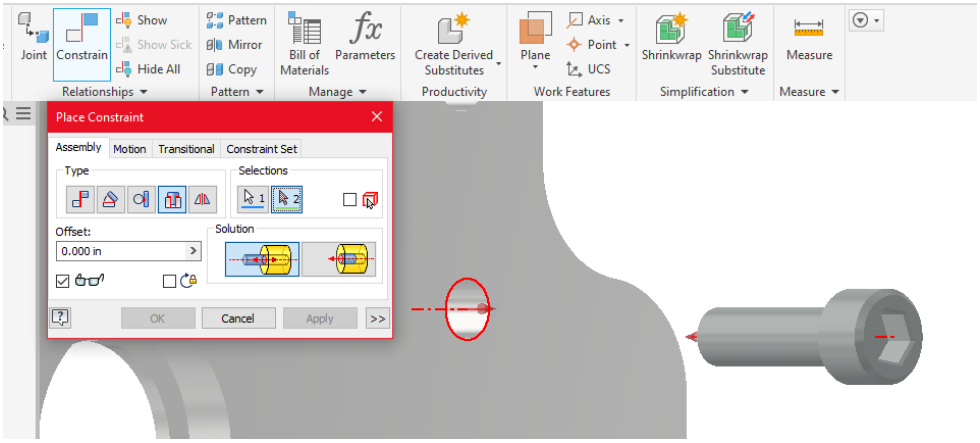


Figure 6

This process should be repeated for the remaining 5 bolts, followed by 4 bolts in the opposite direction.

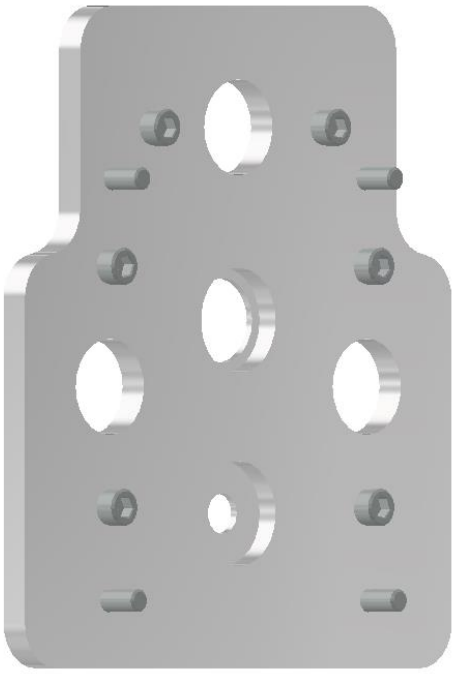


Figure 7

Once the bolts are mounted, standoffs should be attached to the 4 reversed bolts. Due to the way these are mounted, we will use 2 mates for each. The first mate will be similar to the inserts, first choosing the inner edge of the standoff followed by face of the bolt. While this constrains on 2 axes, the distance from the standoff to the faceplate is not fixed. This can be resolved with a second mate between the faceplate and the standoff's close face.

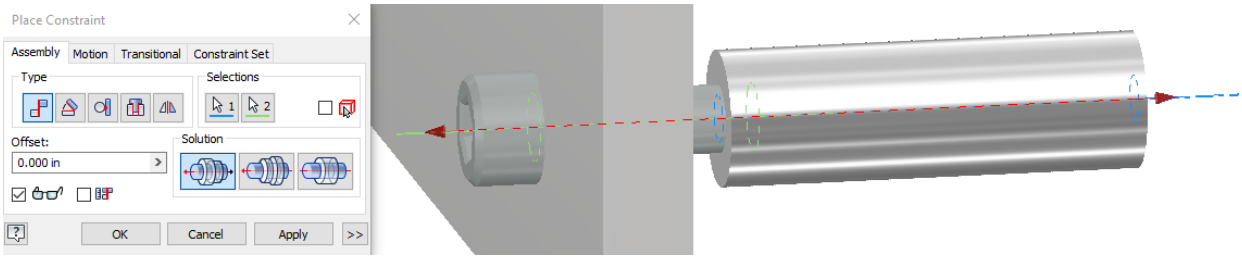


Figure 8

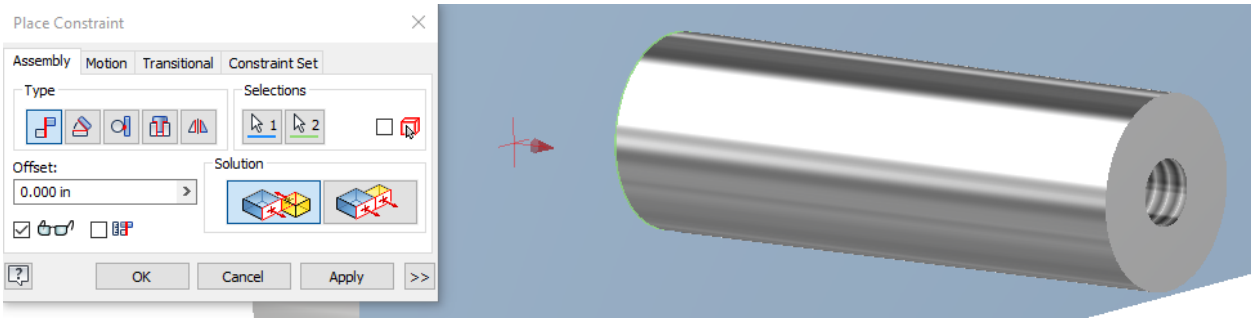


Figure 9

With the standoffs in place, the next step is to attach the cover to the standoffs by mating them with the 4 holes on the cover. The holes are slightly larger than the standoff as 3D printed parts shrink slightly as they cool. Once this is done, attach the final 4 screws to the exposed end of the standoff. Normally a washer would be used here to ensure the attachment was secure, but that is omitted from the model for simplicity. An additional mate will be required between the faceplate and the inner face of the cover to fix that distance.

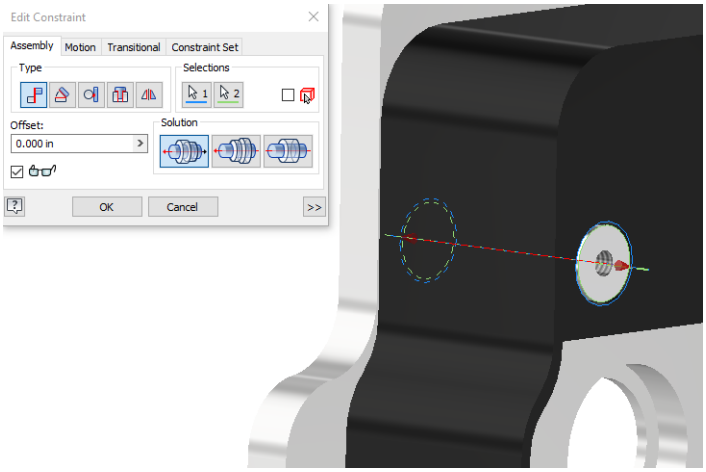


Figure 10

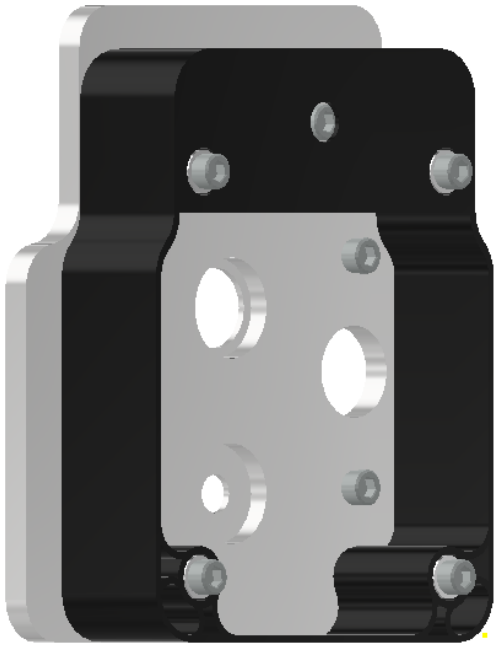


Figure 11

3. Motors

Now that the housing is built, the next step is to attach the motors and their respective gears.

You will need to place the following parts:

- 3x Motor
- 3x 5-16 Washer
- 3x Toughbox d09
- 3x 8mm Spring Clip

Constraining the Motors

Each motor requires 3 mate constraints: one for each of the corresponding bolts and a third for the motor face. Getting the bolts to mate properly may take a few tries, if the motor appears backwards, change the solution to the opposite direction. When mounting the motors, ensure that the wires don't collide.

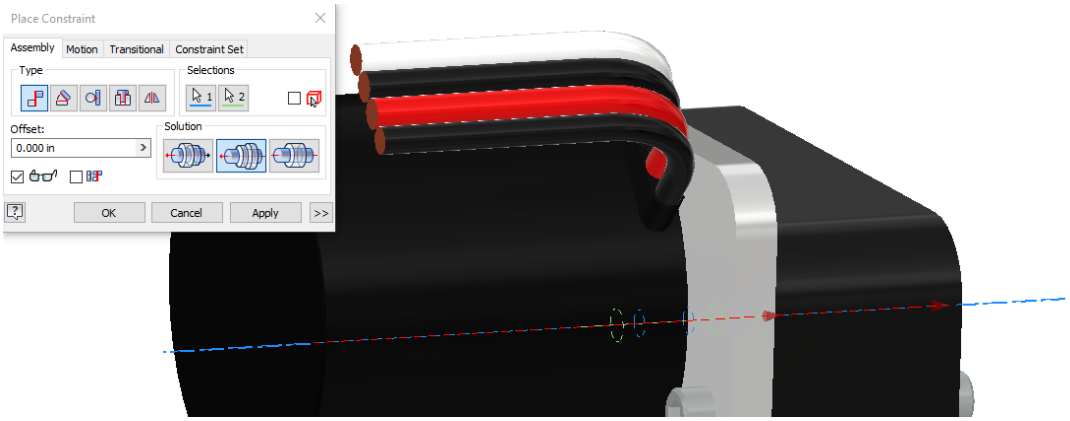


Figure 12

Constraining the Gears

Each motor shaft needs a stack consisting of a washer, gear and spring clip mated to the motor shaft and adjacent faces. The inner face of the washer should then be mated flush with the faceplate.

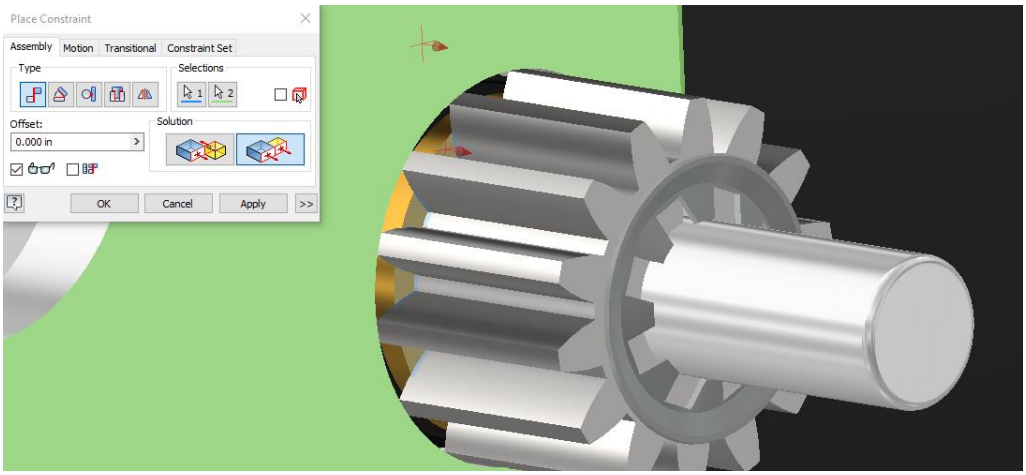


Figure 13

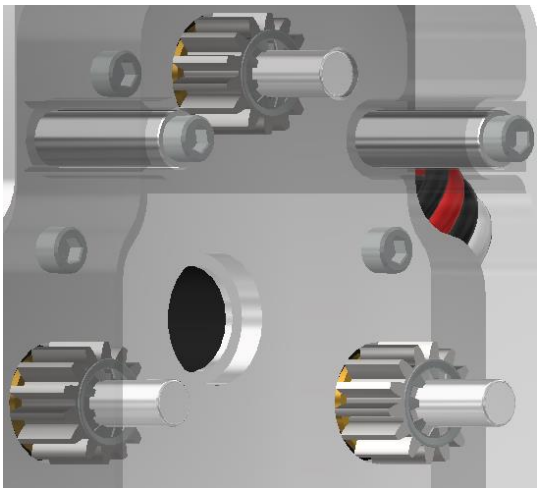


Figure 14

4. Output Shaft

For the lower gear assembly to be made, we need to create the output shaft. This will be done using the shaft generator. Click anywhere to place the default shaft.

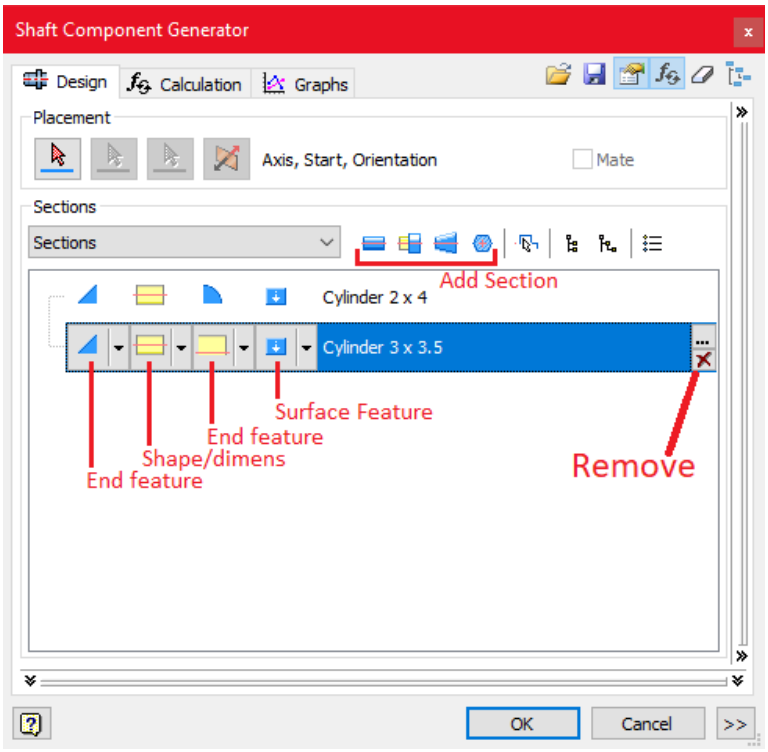


Figure 15

Upon placing the saft, remove all but one cylinder. Resize it to be 0.37” diameter by 0.28” length, with a fillet of 0.02” on the left. Add a hexagon (polygon) with D_{in} of 0.5” and length of 0.52”, a cylinder with 0.44” diameter by 0.06” length, and a final hexagon with D_{in} of 0.85”, a length of 0.24”, and an 0.1” fillet on the right end. Optionally, the material and appearance can be changed to aluminum for aesthetic reasons. A model of this shaft is included in the .zip for reference.

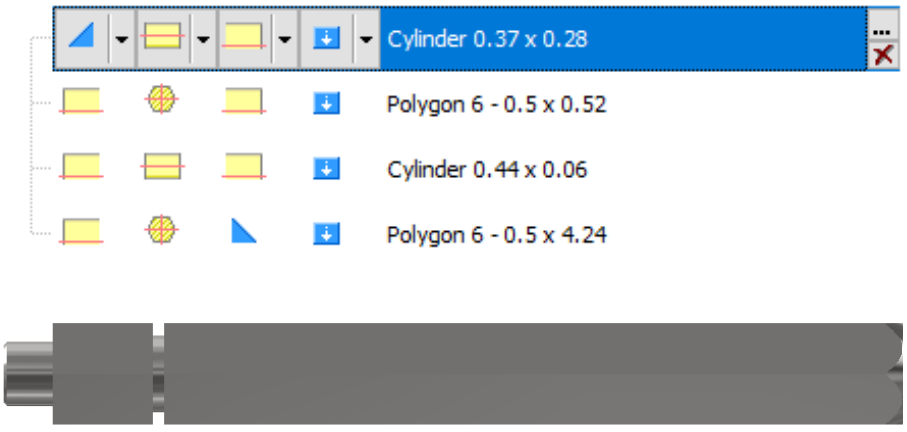


Figure 16

5. Lower Gears

For the lower gears, you'll need to place the following:

- 1x R6ZZ Bearing
- 1x FR8ZZ Hex Bearing
- 1x 46t Gear
- 1x 500 E-klip

The first step is to constrain the circular bearing into the lower faceplate space. This can be done with 2 mates or an insert.

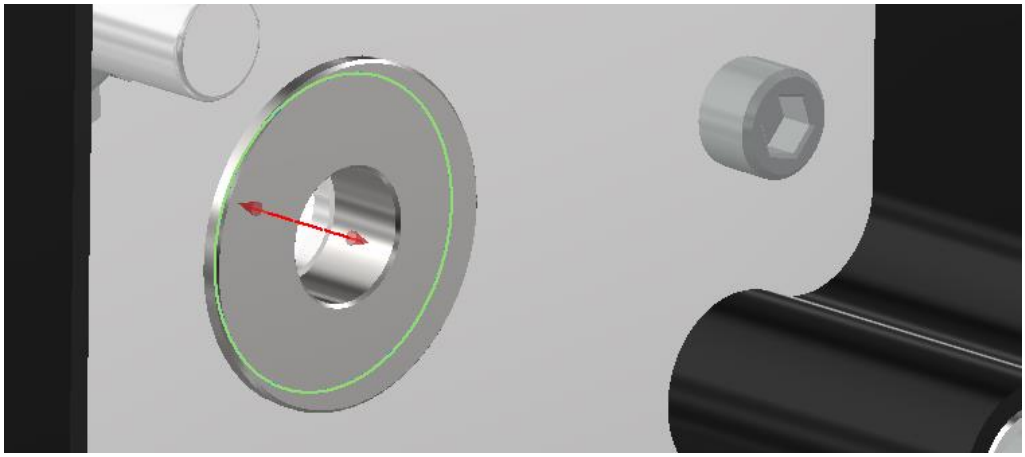


Figure 17

Once the bearing is in place, we will focus on the shaft itself. Constrain the E-Clip into the cut section and constrain it to the outer edge. Next constrain the gear and hex bearing onto the shaft, then adjacent to each other. For constraining onto hex shafts, choose two adjacent faces and use them for two mates.

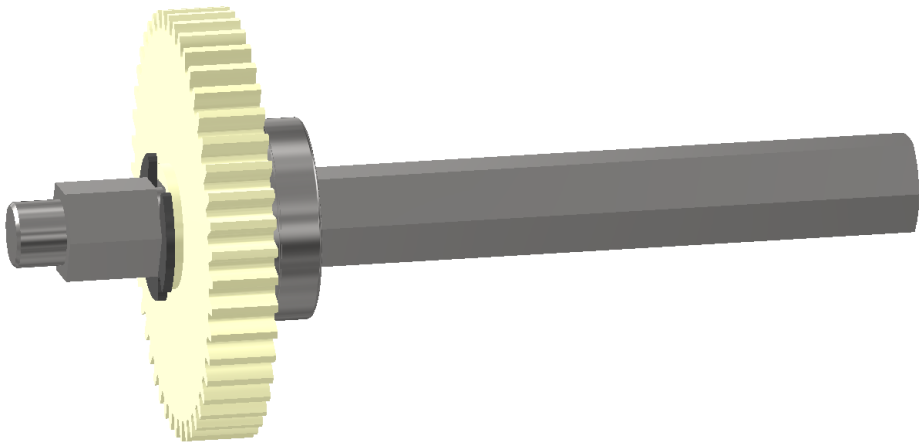
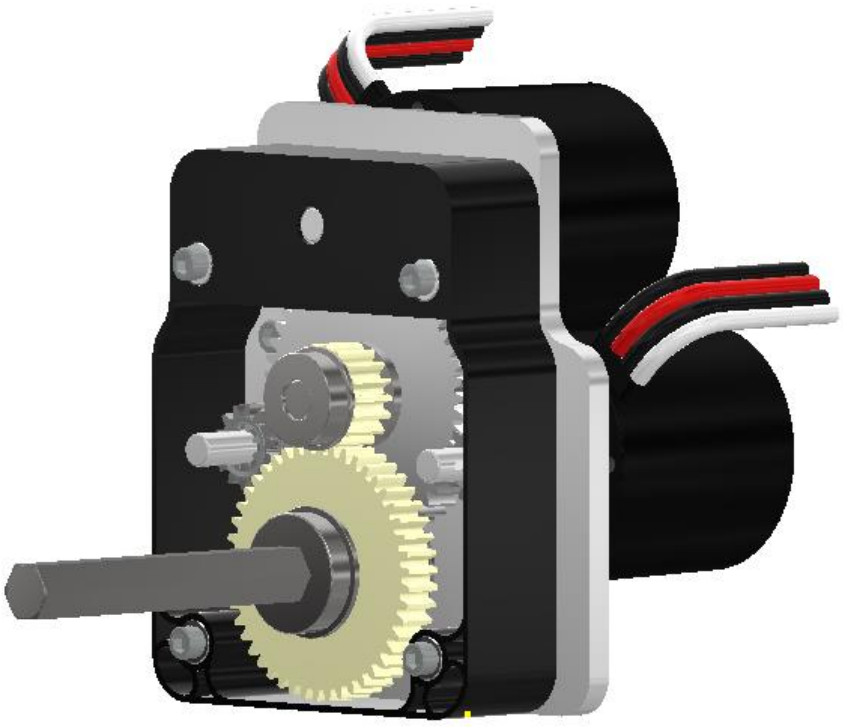


Figure 18

Once the shaft is complete, attach it to the bearing with a mate constraint.

6. Central Gears

The final step in completing the gearbox is adding the central gears. These will connect the motors to the output shaft. To save time, an assembly has been provided (named centralgear) which contains the requisite components. This can be placed like any individual part and should be constrained to the central hole. Once this is in place the gearbox is complete.



Appendix: Connecting Gears

While not critical to making the gearbox, we can use motion constraints to make the gears spin together. With these in place, rotating one gear will make the others rotate the correct amount.

To create a motion constraint, select the motion tab in the constraint window, select the faces of the gears you wish to connect, then enter the ratio/directions.

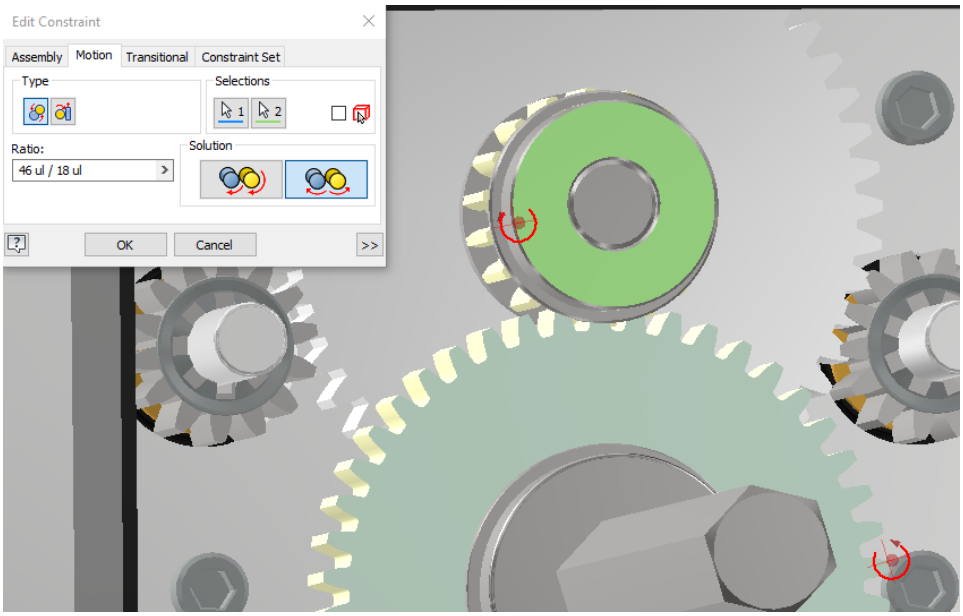


Figure 19

The gears in the gearbox have the following tooth counts:

- Motors: 14
- Large Centre: 50
- Small Centre: 18
- Lower: 46