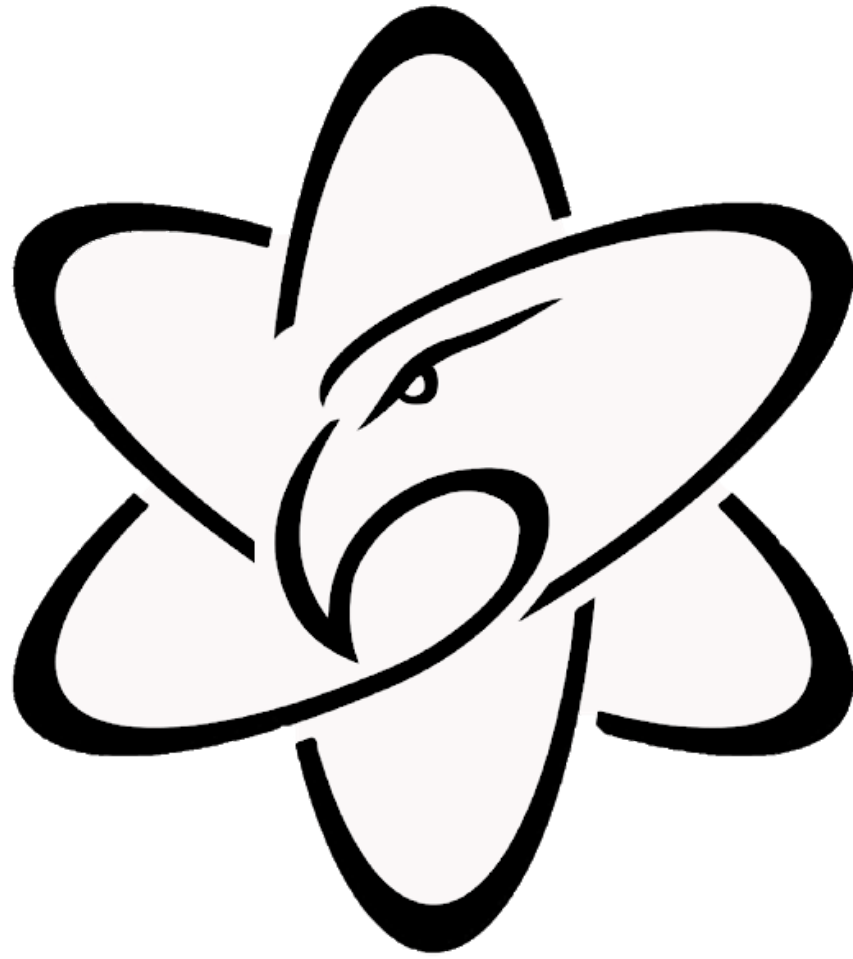


# 6672 Manufacturing and Assembly Training Project Outline



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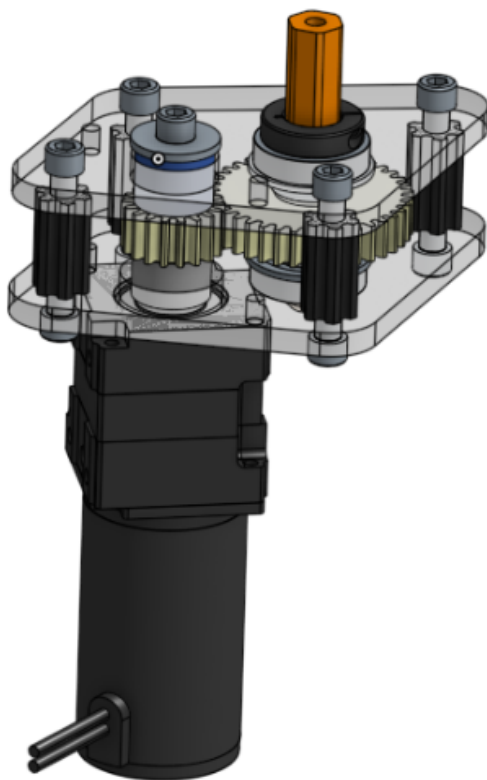
## Abstract

6672 Fusion Corps is going into our fifth season during the 2020-2021 school year. With the uncertainty of how the pandemic will affect the competition season, we have decided to make a strong effort to build the foundations for our team to rise to the next level of competition robotics. One main area that we have decided to focus on is training curriculum. We will pivot away from lecture based learning towards project based learning which we think will help retain new members and help them get up to speed faster. This project will be the first experience with competition robotics for most of our students, meaning that they will be a clean but blank slate. Therefore, the goal is to introduce them to as many robotics-related skills as possible in a single project, while also familiarizing them with our team's construction methods and tools.

With the uncertainty of whether we will be able to hold team meetings or not, we will also develop this curriculum so that new team members can take a kit of parts and tools home and assemble the project off campus, if needed. This is described as "Level 1" of the project. When we are able to hold team meetings, new students will start with both Level 1 and Level 2 of the project simultaneously - full manufacturing and assembly of the project with assistance from student leaders and mentors. After they have completed Level 1 and Level 2, they will graduate to Level 3 where they will learn design principles that went into the project, learn to CAD/CAM/CNC an equivalent project, and will operate the CNC and Lathe without assistance (while still maintaining close supervision).

## So what is the project?

The goal of the project is to produce a dual Versaplanetary and 20dp gearbox, shown below:



Throughout the project, students will learn all of the basic skills needed to construct robot mechanisms. They will assemble a versaplanetary gearbox, learn to crimp motor wires, learn about the polycarbonate and churro construction method, learn about bearings, shaft spacers, hex shaft, three shaft retention methods and different bolt sizes. They will also get their first experiences producing parts with both the CNC router and the lathe, while also using other tools like the bandsaw, arbor press, files, allen keys, wrenches etc.

## Skills learned during the project

<b>Level 1</b> - (full at home)	<b>Level 2</b> - full manufacture and assembly with assistance	<b>Level 3</b> - learn design principles, be able to CAD/CAM/CNC/lathe without assistance
Assemble VP Gearbox	Cut churros to proper length with bandsaw or metal chop saw	Understand all of the features needed on a gearbox plate
Assemble 20 dp gear combination with spacers	Debur and tap churros for ¼-20 bolt	Understand pros/cons of VP vs 20dp gear systems
Use e-clip to retain shaft	Press bearings with arbor press	Design an equivalent gearbox plate
Use screw in shaft to retain gear	With help, learn to run the CNC and cut gearbox plates	Import into F360 and create CAM
Use clamping shaft collar to retain shaft	Cut shaft and hex spacers on the lathe with assistance	Export CAM, setup CNC and run.
Assemble gearbox using pre cut and tapped churros	Connect power pole connectors to the motor.	Cut lathe parts with no assistance
Basic hand tool skills.	3d print ½ hex spacers	

## Parts list

- 01- 18t ½ hex 20 dp aluminum gear
- 02 - 42t ½ hex 20 dp aluminum gear
- 03 - 775pro or Bag motor
- 04 - ½ thunderhex bearing
- 05 - 13.75 mm round TTB bushing
- 06 - 9\* ¼-20 ½" or ⅝" screws
- 07 - ½ hex shaft collar
- 08 - 4\* churros cut to 1"
- 09 - ½ thunderhex shaft, will be cut on the lathe
- 10 - 4 3d printed ½ hex spacers
- 11 - pt01 cut from ¼" polycarbonate
- 12 - pt02 cut from ¼" polycarbonate
- 13 - Versaplanetary Gearbox ½" hex output
- 14 - Ring gear kit
- 15 - 4:1 gear

Parts cost breakdown: [BOM for M&A](#)

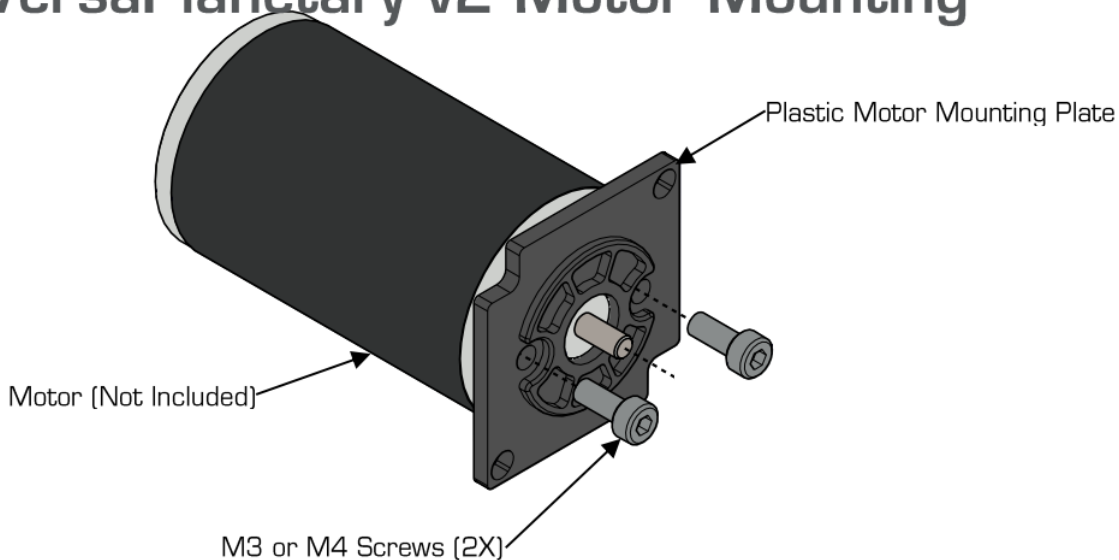
- Do note that roughly that a majority of this cost is a one-time thing, as most parts can be reused for the next time someone undertakes the project. Only recurring costs are the manufactured parts - churro/hex shaft/polycarbonate/shaft spacers and it is expected to cost less than \$40/kit per year.

## Assembly instructions

Versaplanetary Gearbox:

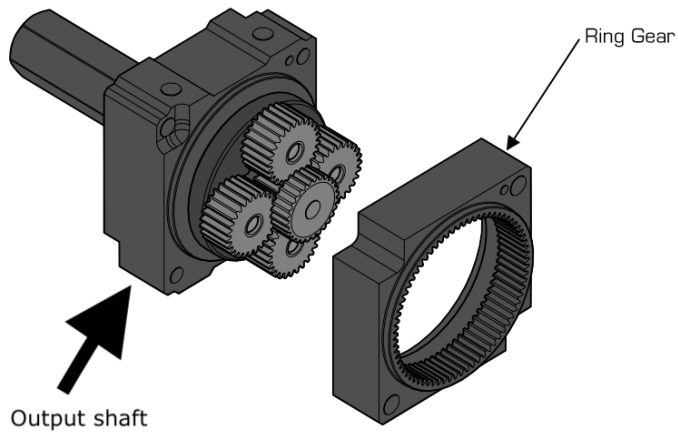
**Step 1:** First begin by putting the correct Plastic Motor Mounting Plate on the front of the motor. This acts as an adapter from the motor to the gearbox. There are several in the versaplanetary box but only one is correct. Then get the smallest silver screws and screw them in securing the Plastic motor mounting plate to the motor.

## VersaPlanetary v2 Motor Mounting

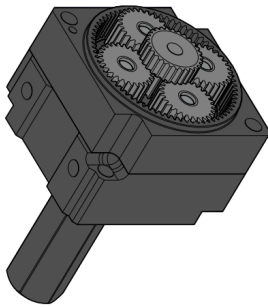


**Step 2:** Next you will find the Ring Gear and the 4:1 gear. This part of the assembly gets messy so be sure to have an ample amount of paper towels on hand. Now that you have paper towels,

the ring gear and the 4:1 gear you need to find the output shaft.

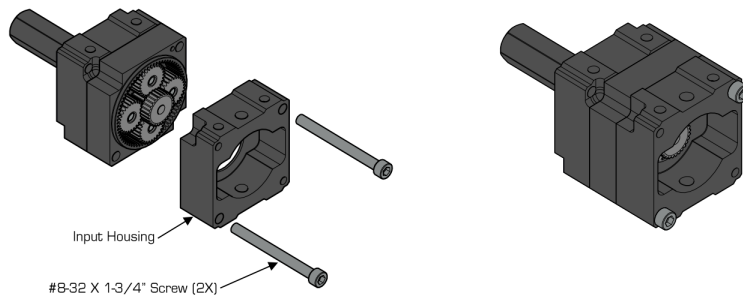


Put the gear onto the output shaft and then slide the ring gear over it. You will now want to hold the gearbox with the Output shaft facing down.

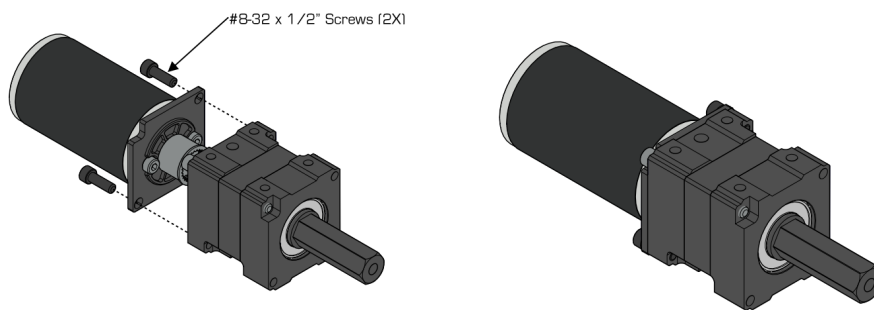


**Step 3:** Next you will take the bag of white lithium grease and cut a corner off to make a sort of icing bag. Then you will add four dots of the grease in between the gears. You will then proceed to spin the Output Shaft until the grease is evenly distributed. **BEWARE** that grease will fly in every direction if you go too fast! Once this is done you will take the Input Housing and screw it into the gearbox. There are several long screws in the versaplanetary box so make sure to find

the one with the correct length.



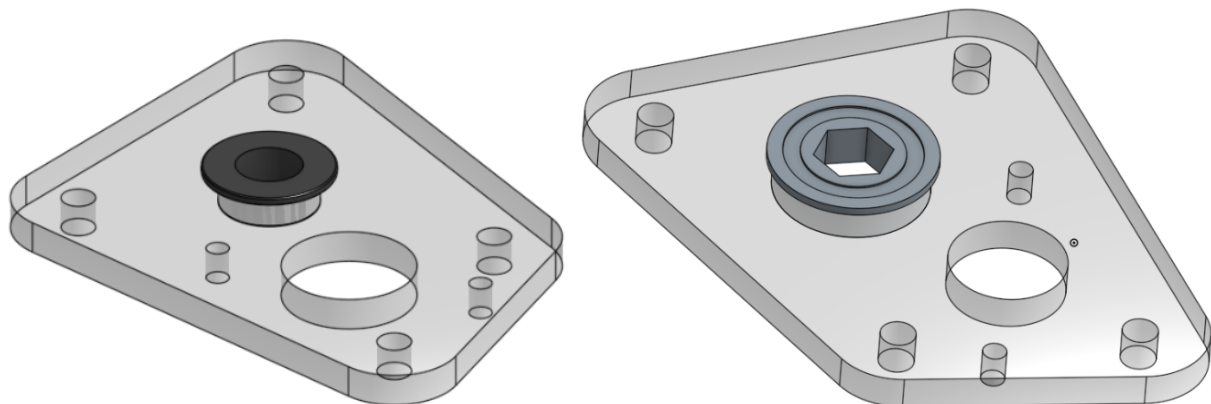
**Step 4:** Once this is done you will take the gearbox and place it on the motor. It should fit tightly into the Plastic Motor Mounting Plate on the motor.



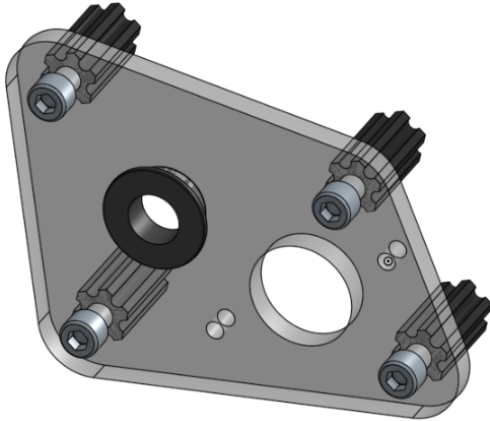
Be sure to hold the gearbox with the output shaft down. If you do not the gears may fall out of place. When you are trying to mesh the gearbox and the motor it may take some turning of the output shaft to get the motor and the gears aligned. Once it is aligned it will fall into place and is ready for you to safely secure the gearbox onto the motor. You have finished putting the Versaplanetary gearbox together.

20dp gearbox:

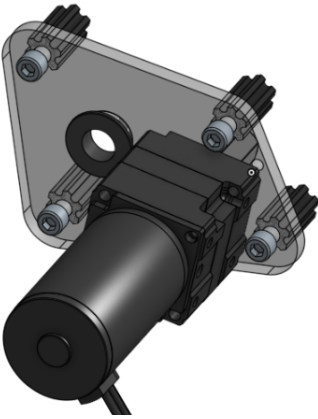
**Step 1:** press the  $\frac{1}{2}$  thunderhex bearing into pt02 and the  $\frac{1}{2}$  round TTB bushing into pt01 with the flanges facing the outside of the gearbox.



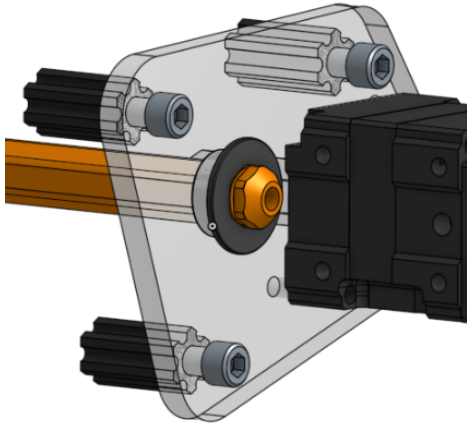
**Step 2:** attach the four churros (07) to pt02 on the opposite side of the bushing flange with four ¼-20 screws.



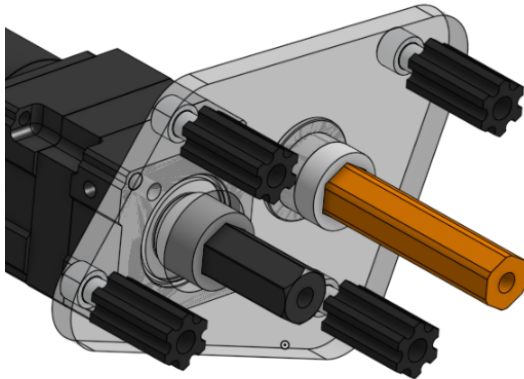
**Step 3:** attach the versaplanetary gearbox onto pt02.



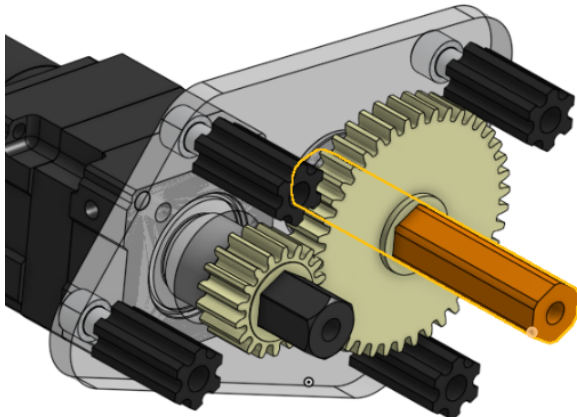
**Step 4:** attach the e clip onto the thunderhex shaft (04) and slide the shaft into the thunderhex bearing, until the e-clip contacts the bushing.



**Step 5:** place spacers onto the shaft of the VP gearbox (0.481") and the thunderhex shaft(0.25").

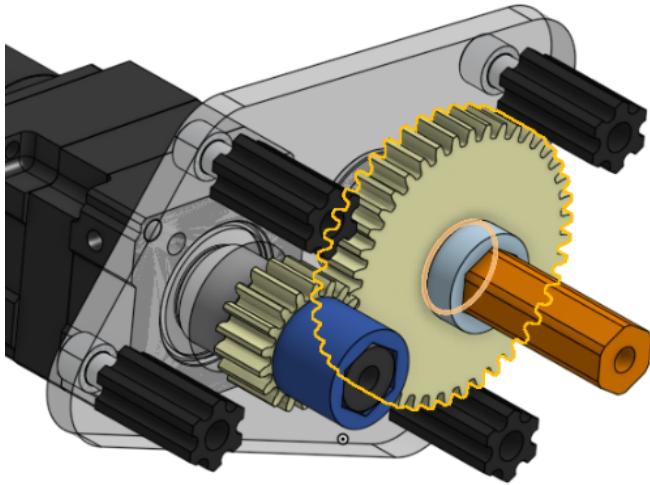


**Step 6:** place the gears onto the shaft with the 18t gear on the shaft of the VP gearbox and the 42t gear on the thunderhex shaft.

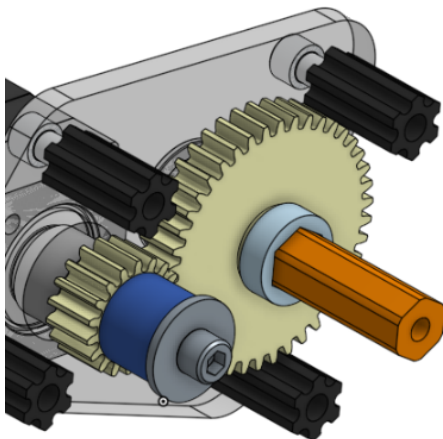




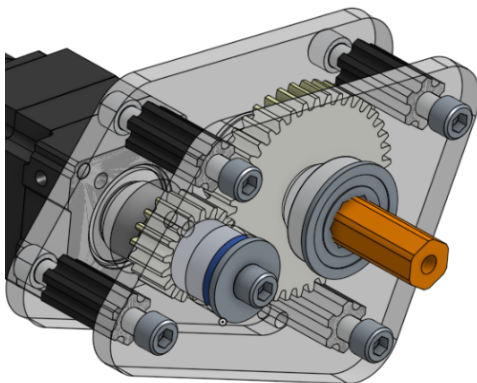
**Step 7:** place the final spacers onto the shafts



**Step 8:** attach the washer and a  $\frac{1}{4}$ -20 screw onto the end of the already tapped VP gearbox shaft.



**Step 9:** attach pt01 onto the gearbox and secure using four  $\frac{1}{4}$ -20 screws screwed into the churros



**Step 10:** place the thunderhex clamping shaft collar onto the end of the thunderhex shaft and tighten until snug.

