



90 Degree Adapter for VexPro VersaPlanetary Gearbox for FIRST Robotics

by [frc33killerbees](#) on April 5, 2016

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Intro: 90 Degree Adapter for VexPro VersaPlanetary Gearbox for FIRST Robotics

The Killer Bees Robotics team developed this solution in 2015 and now we would like to share it with all of the FIRST Robotics Community.

The VexPro VersaPlanetary Gearbox System is one of the most versatile and flexible components ever created for use in FIRST Robotics. This tutorial shows you how to make it even better. For all of its strengths, sometimes the VersaPlanetary gearbox and motor assemblies are hard to fit into tight spaces. With a simple adaptation using a commonly available drill adapter, now you can literally make your VersaPlanetary gearboxes reach around corners!

This solution uses the Dewalt Right Angle Attachment - P/N DWARA100. This is a great little component, featuring a lightweight magnesium housing, ball bearings, and hardened impact rated bevel gears. Our tests show it to be over 90% efficient even under heavy loads. Selling for under \$20, it is a great part at a bargain price!

Our particular application in this example is a 90 degree gearbox driving an internal chain drive inside of a 1" x 2" box tube. This exact solution was used in our ball collector design on Buzz21 for 2016, however you can use this method for all sorts of other right angle power transmission robotics applications. We have two of these Dewalt 90 degree devices on our current robot, with different speeds and output configurations.

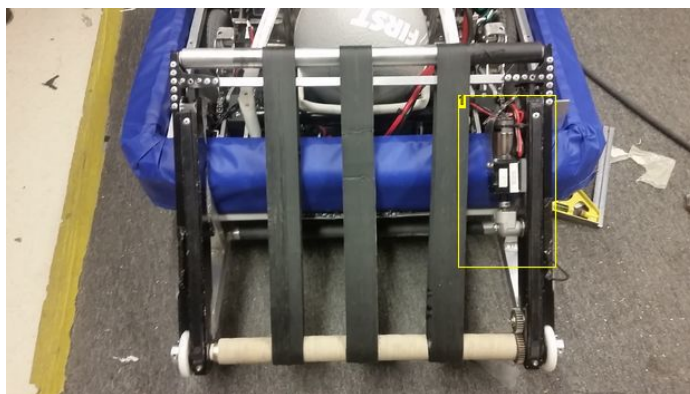
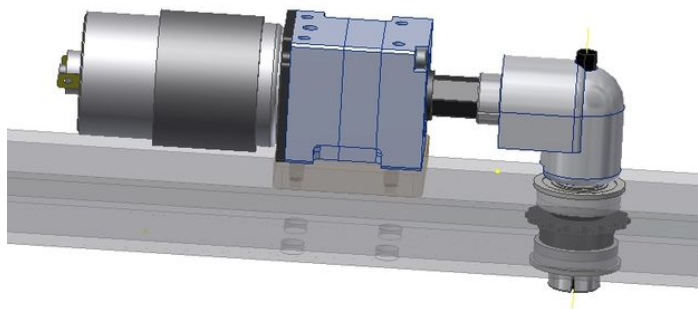


Image Notes

1. 90 Degree Adapter



Step 1: Gather Tools and Materials

Materials Needed (Right Angle Assembly)

- Dewalt Right Angle Attachment - P/N DWARA100 <http://www.amazon.com/DEWALT-DWARA100-Right-Angle-...>
- VersaPlanetary Gearbox <http://www.vexrobotics.com/versaplanetary.html>
- 12VDC 775 Pro Motor <http://www.vexrobotics.com/vexpro/motors-electroni...>
- 1/4" hex steel stock <http://www.mcmaster.com/#6512k121/=11vg2w2>
- Three 1/4" shaft collars <http://www.mcmaster.com/#6157k12/=11vg3c8>

Optional Materials Needed (Additional parts for full collector drive assembly as shown)

- Three 1/2" hex bearings 217-3875 <http://www.vexrobotics.com/bearings.html>
- Three 1/2" FR8ZZ round bearings PN 217-2731 <http://www.vexrobotics.com/bearings.html>
- Two 16 tooth sprockets PN 217-2642 <http://www.vexrobotics.com/25-sprockets.html>
- 1 x 2 x 1/8" box aluminum <http://www.mcmaster.com/#6546k39/=11xap1x>
- 1/2" Hex Aluminum stock PN 217-3309 <http://www.vexrobotics.com/vexpro/hardware/shaft-s...>
- 10-32 x 3/4" Allen Head Cap Screws <http://www.mcmaster.com/#91251a345/=11xaqvb>
- 1/16" Thick VexPro Hex Spacers PN 217-3257 <http://www.vexrobotics.com/vexpro/hardware/acetals...>
- 30T VexPro Gear PN 217-2705 <http://www.vexrobotics.com/vexpro/motion/vexpro-ge...>
- 40T VexPro Gear PN 217-2708 <http://www.vexrobotics.com/vexpro/motion/vexpro-ge...>
- 1/4-20 x .50" button head screws
- 1/4" washers

Tools Needed:

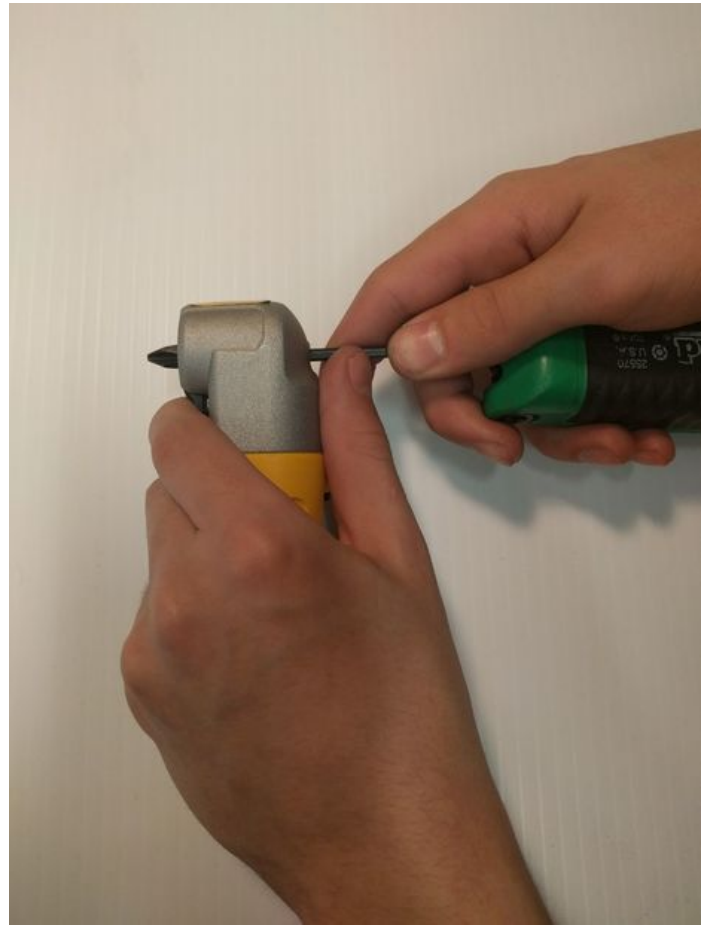
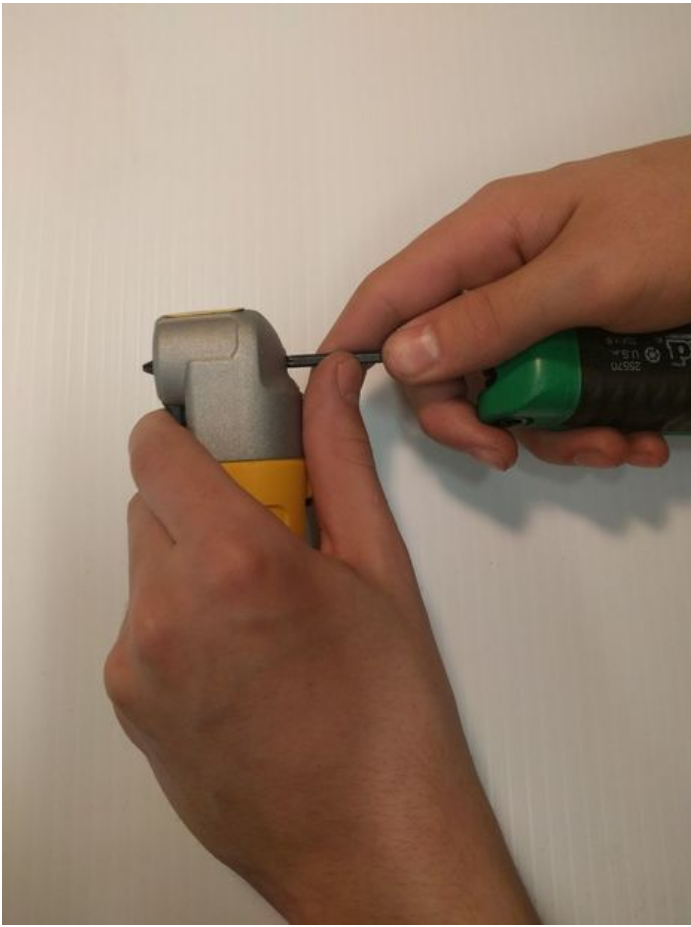
- Torx Key set
- SAE Allen Key set
- Metric Allen Key Set
- Snap Ring Pliers <http://www.mcmaster.com/#5415a61/=11vg6w7>
- 1/4" hex broach <http://www.mcmaster.com/#2875a15/=11vg6d9>
- Drill Press and Vice
- 7/32", 1/4", 5/16" Drill bit
- Arbor Press
- Lathe (optional but recommended)
- 1/4"-20 Tap and Tap Wrench



Step 2: Remove Dewalt Right Angle Drill Attachment from packaging



Step 3: Pop the phillips head bit out of adapter
Use a small tool on opposite side to push bit out.



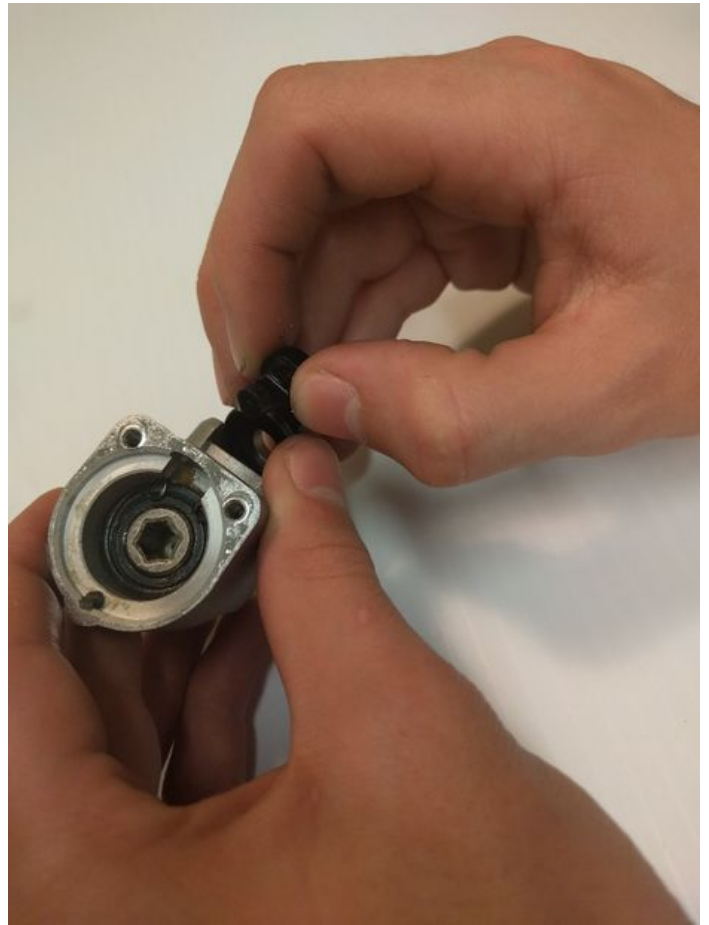
Step 4: Use T15 Torx key to remove screws on adapter

Remove 3 Torx screws to separate plastic handle and input shaft from the magnesium headpiece.



Step 5: Remove magnet from head of attachment

Remove the magnetic retainer clip from headpiece



Step 6: Use a 0.25" drill bit to drill hole through headpiece

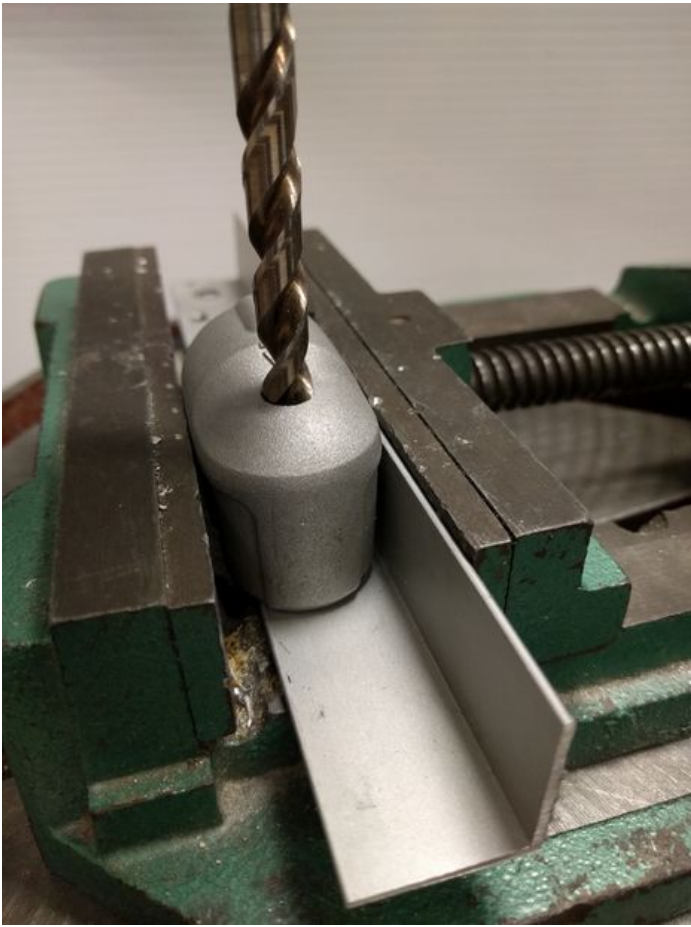
Note: This drill-through operation may be optional depending on your final application. This hole allows a 1/4" hex shaft to pass completely through the headpiece, allowing for bearing support or retention on both sides if needed.

Using a drill press and vise, carefully drill through the back of the headpiece with a 1/4" drill bit. Remove and discard internal magnet.



Step 7: Open hole using 5/16" drill bit

Using the drill press, re-drill the through hole to 5/16". Be careful when drilling and make sure you don't drill all the way through and hit the internal gearing. Just drill through the magnesium housing.



Step 8: Put RS-775 Motor coupling on the 775Pro Motor

Assemble the motor coupling per the standard VexPro assembly instructions:

<http://content.vexrobotics.com/vexpro/pdf/VersaPla...>



Step 9: Put the VP input coupler on motor

You may need to press or tap this part on.



Step 10: Tighten shaft collar on sun adapter

Use SAE Allen Key set



Step 11: Attach metal motor attachment plate

Use two M4 Screws included in VersaPlanetary Mounting Kit using Metric Allen Key



Step 12: Install VersaPlanetary reducer stage.

This device will accept a fairly wide speed/torque range so use any speed you choose. Single reduction stages from 3:1 to 10:1 are available, or use multiple stages.

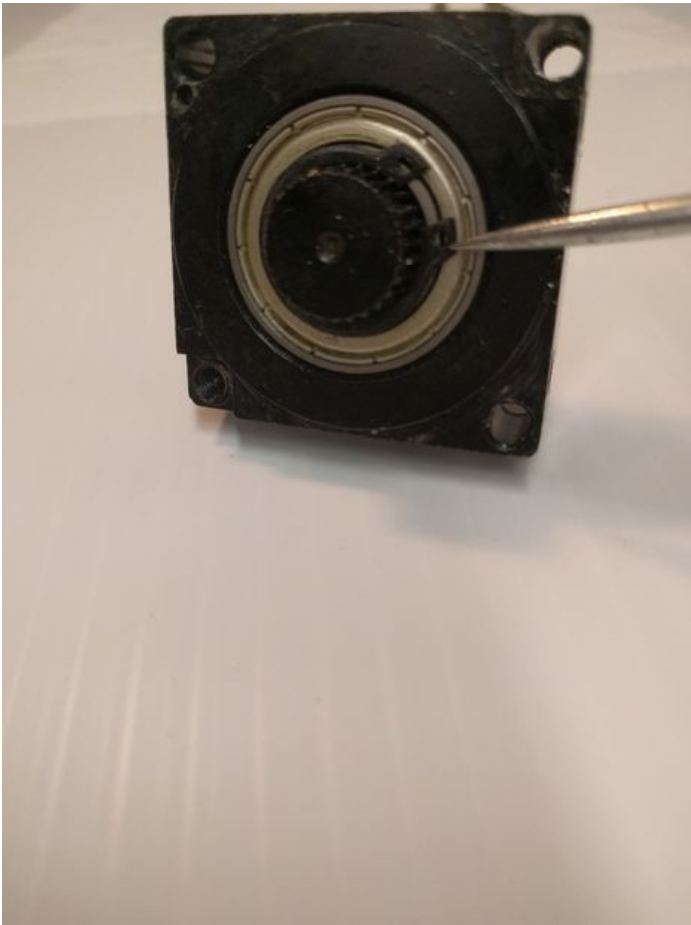
NOTE: the DWARA100 adapter is rated to approx 200 in.lbs of torque; check the total stall torque according to the VexPro VersaPlanetary users guide if you plan to use multiple stages of reduction. We have not ever used this 90 degree adapter method with ratios above 25:1. We have used these at speeds of 3000 RPM with no issue.





Step 13: Remove the ring clip from output shaft using a ring clip tool

Next you must remove the hex output shaft from the VersaPlanetary output stage. A single ring clip holds this shaft in place.



Step 14: Take apart output shaft

Remove output shaft, be careful not to drop the bearings or internal wave washers.



Step 15: Use a 1/4" drill bit on lathe to drill shaft all the way through

Using the existing tapped pilot hole as a guide, axially drill the output shaft all the way through with a 1/4" drill bit. It is easiest to do this on a lathe, but it can also be carefully done on a drill press if a lathe is not available.



Step 16: Cut down output shaft

Cut down the output shaft, leaving approx. 1/2" of hex output remaining. This step is optional, but it will make the subsequent broaching step easier if the shaft is shortened. Exact final length is non-critical in most applications. Cutting can be done on a bandsaw, or with a parting tool on a lathe.





Step 17: Reassembly Output Shaft into Versaplanetary bearing block

Reinstall output shaft. Make sure you put it in the right way.



Step 18: Reinstall snap ring clip back onto output shaft
Replace snap ring. Be sure snap ring is securely in the groove in the output shaft.



Step 19: Broach Output Shaft to 1/4" Hex

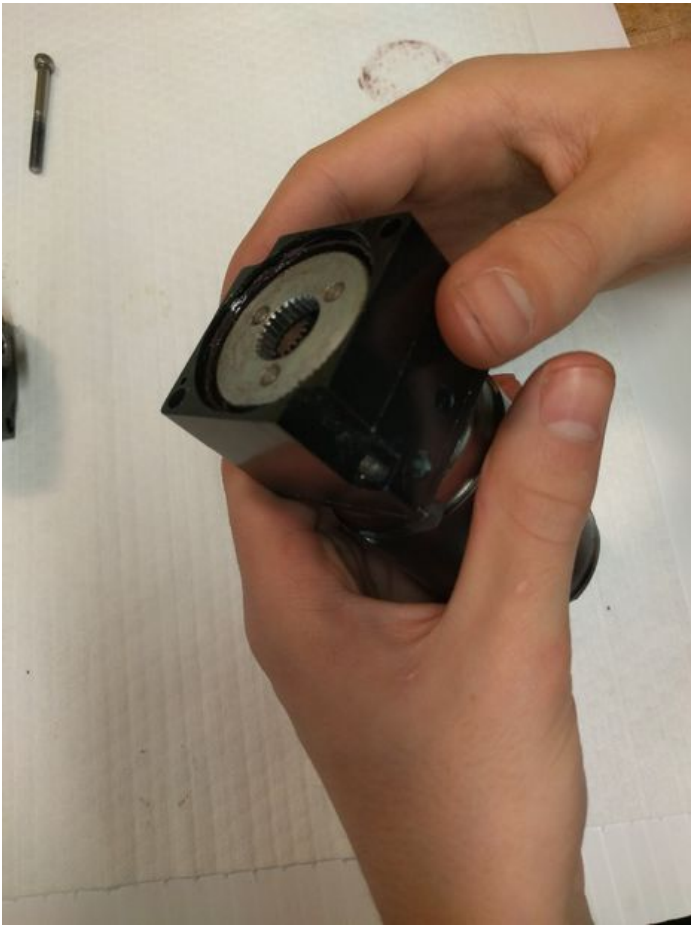
Using an arbor press, carefully broach the output shaft completely through with the 1/4" hex broach. **Be careful on this step, it is easy to snap a broach tool.** This is a long broaching action with a small tool. Lubricate broach with tapping fluid or WD-40 before starting. If efforts get too high, flip part over, back the broach out, remove chips and start again.

We find that it is easiest to perform this step properly and hold the shaft vertical if the output shaft is mounted in the bearing block, which is why we reinstall it before broaching.





Step 20: Attach selected gearing set for 775pro, we used a 7:1 ratio
Assemble complete gearbox according to standard VexPro VersaPlanetary assembly instructions.



Step 21: Attach output shaft block to the 775pro motor block

Assemble complete gearbox according to standard VexPro VersaPlanetary assembly instructions.



Step 22: Install 8-32 gearbox screws

Assemble complete gearbox according to standard VexPro VersaPlanetary assembly instructions.



Step 23: Make chain and gear drive shafts

Our application is an internal chain drive in a 1"x 2" box tube, driving a set of spur gears.

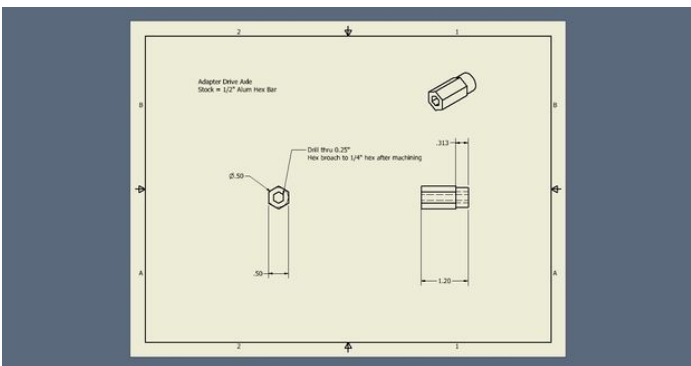
These parts are optional, You do not need to make these parts if your application is different, they are specific to our collector design.

There are 3 short aluminum hex shafts in our mockup example.



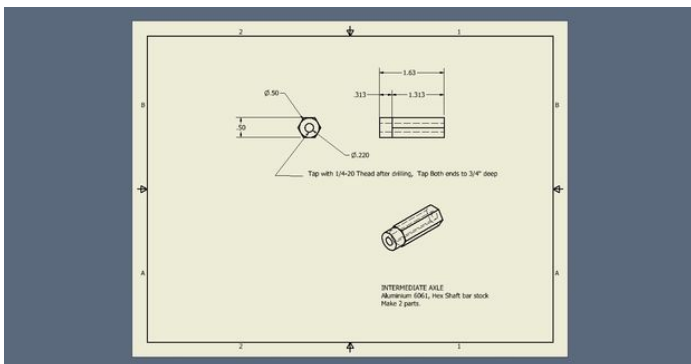
Step 24: Make Drive Adapter shaft

- Use 1/2" hex stock and lathe a shaft to 1.20" long
- Make 5/16" long 1/2" diameter bearing seat with lathe (see picture)
- Drill through shaft with 1/4" drill on lathe.
- Use 1/4" hex broach on arbor press to make hexagonal bore through center of shaft.



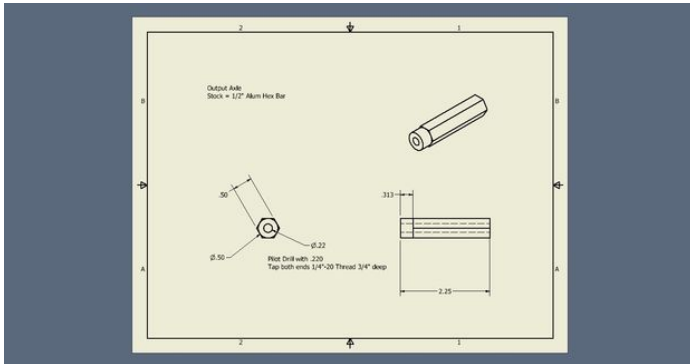
Step 25: Intermediate Shaft

- This shaft is driven by the internal chain stage and drives the 30T external spur gear.
- Use 1/2" hex stock and lathe a shaft to 1.625"
- Make 5/16" long 1/2" diameter bearing seat with lathe (see picture)
- Through drill shaft with 7/32" drill
- Tap both ends with 1/4-20 tap approx 3/4" deep.



Step 26: Output Shaft

- This is the output shaft which is driven by the external 40T spur gear. This part is actually 22" long in our robot, but we made a short version for our mockup for this tutorial.
- This shaft drives the front collector roller tube.
- Use 1/2" hex stock and lathe a shaft to 2.25".
- Make 5/16 deep 1/2" diameter bearing seat on one end (see picture) with lathe.
- Center Drill to 1" deep with 7/32" drill bit on both ends
- Tap both ends 3/4" deep with 1/4-20 Tap

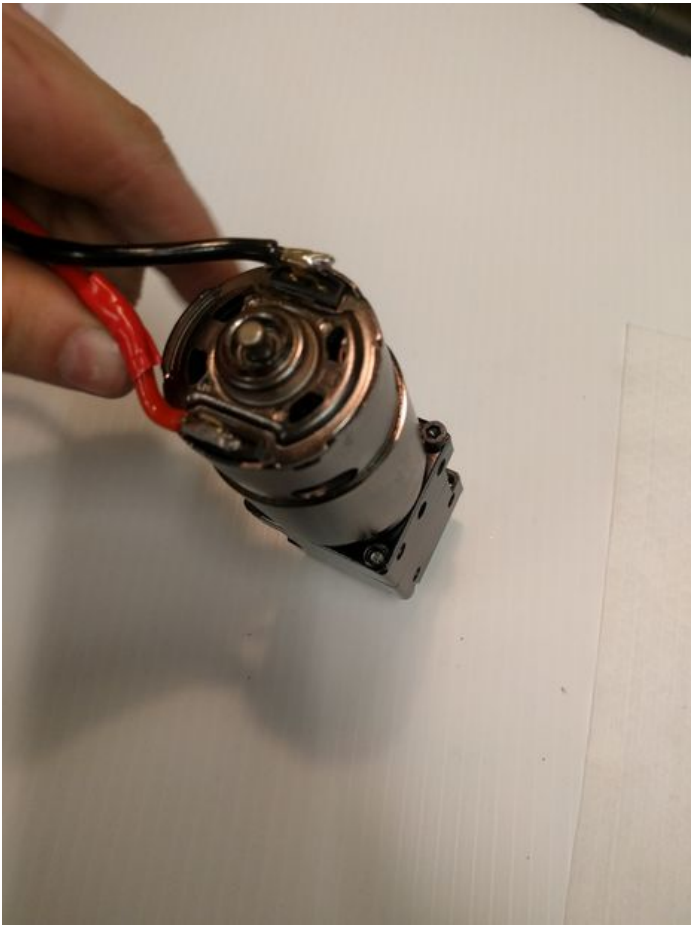


Step 27: Solder Positive and negative wires to 775pro

Pre-tin motor leads before soldering. An alternative is to use .187 x .020" crimp terminals.

I prefer to solder these connections on FRC robots for vibration robustness.





Step 28: Cut two 1/4" hex shafts

- These shafts are used as input and output shafts for the magnesium right angle adapter.
- cut one shaft to 2.5" with lathe or bandsaw
- cut one shaft with 3.25" with lathe bandsaw
- Debur cut ends with a fine file to ensure a good slip fit



Step 29: Make Collector Arm Bar

This is the Aluminum Box tube which everything mounts to in our demonstration piece.

A detailed drawing is above if you want to make this part.

We use a drill press and layout the holes with a dial caliper.

Bearing holes are drilled pilot drilled to 1/4" and then finished with a 1.125" Rotabroach.

We have a whole set of these,

<http://www.amazon.com/Large-Diameter-Rotabroach-Cu...>

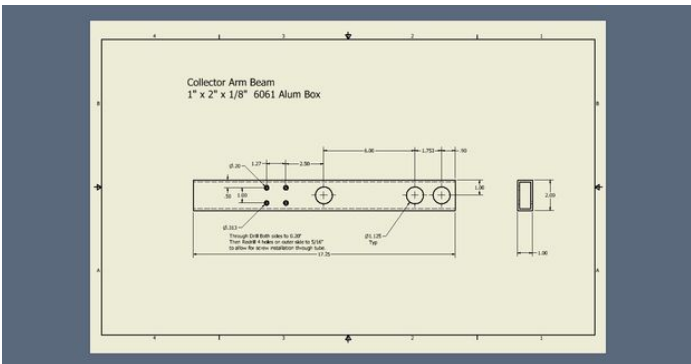
but you can buy this one individually below.

<http://www.mcmaster.com/#4093a56/=11xc3h5>

<http://www.mcmaster.com/#4093a73/=11xc3pi+>

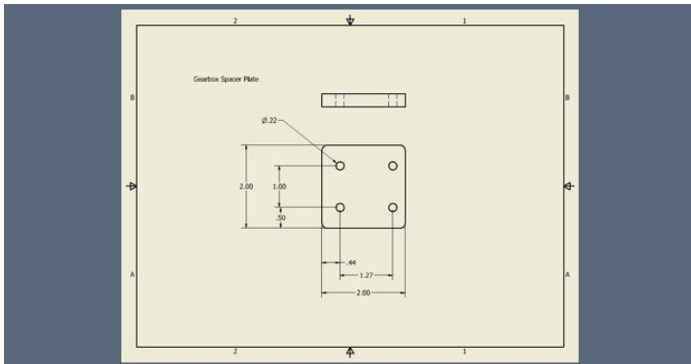
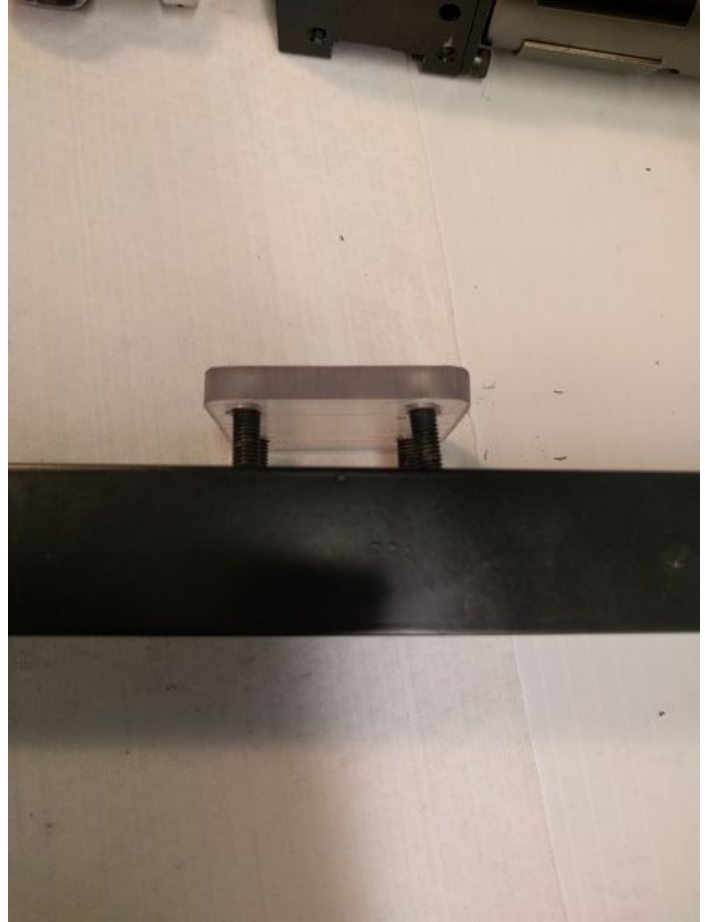
Do not use a standard hole saw, the fit will not be good enough for a bearing seat.

We made a large rectangular hole in outer wall of our demonstration tube for visibility which you will see in the photos. This is not required for assembly, This feature is not in the drawing.



Step 30:

Use 1/4" polycarbonate to make 2" x 2" " spacer for Versaplanetary block against the wall. Change spacing if needed with 1/4" washers or a thicker material. Transfer hole pattern from gearbox and drill with 7/32" drill bit.

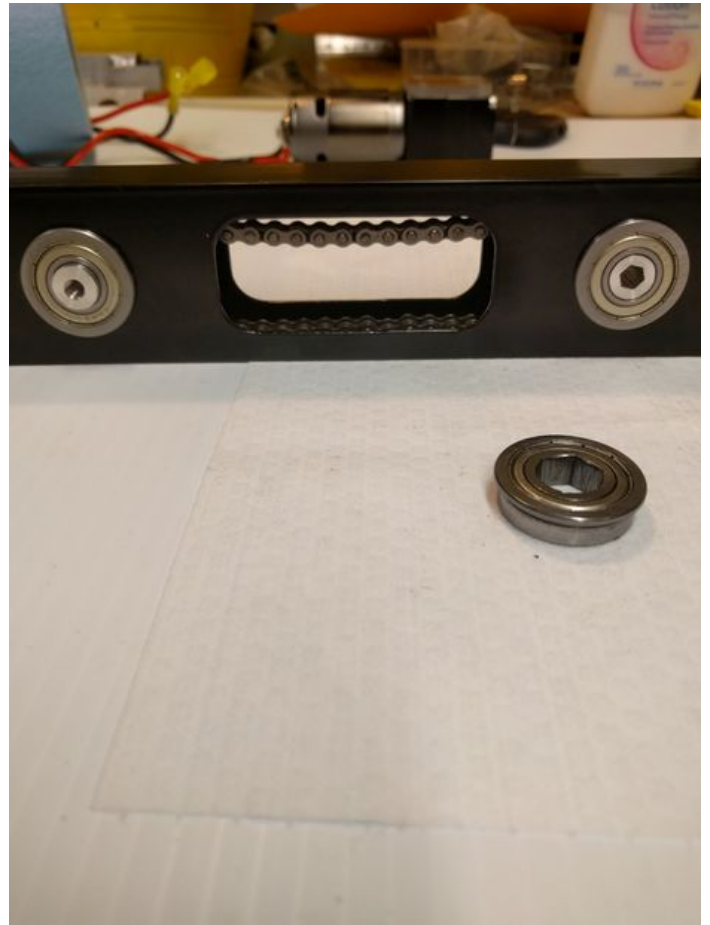
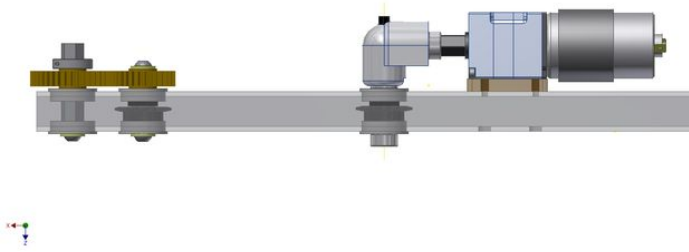


Step 31: CAD MODEL / Begin Assembly of axles and bearings

The section view above provides a clear view of the proper arrangement of the axles, bearings, sprockets, gears and spacers.

A complete STP file of the assembly is included here and can be imported into any CAD program.

Begin by installing 3 round bearings on outer side of tube, opposite from the side where the motor/gearbox will mount.



File Downloads



Collector_Mockup.stp (11 MB)

[NOTE: When saving, if you see .tmp as the file ext, rename it to 'Collector_Mockup.stp']

Step 32: Use two 16 tooth 25 pitch chain and space centers of sprockets 6" apart

This chain and sprocket are particular to our chain-in-tube installation.

Use two 16T #25 sprockets with 1/2" hex hub. VexPro PN 217-2642

<http://www.vexrobotics.com/vexpro/motion/sprockets...>

Our chain loop is a 1:1 ratio (16:16) and uses 6" center to center spacing.

Chain loop length is 64 pitches, or 16.0"

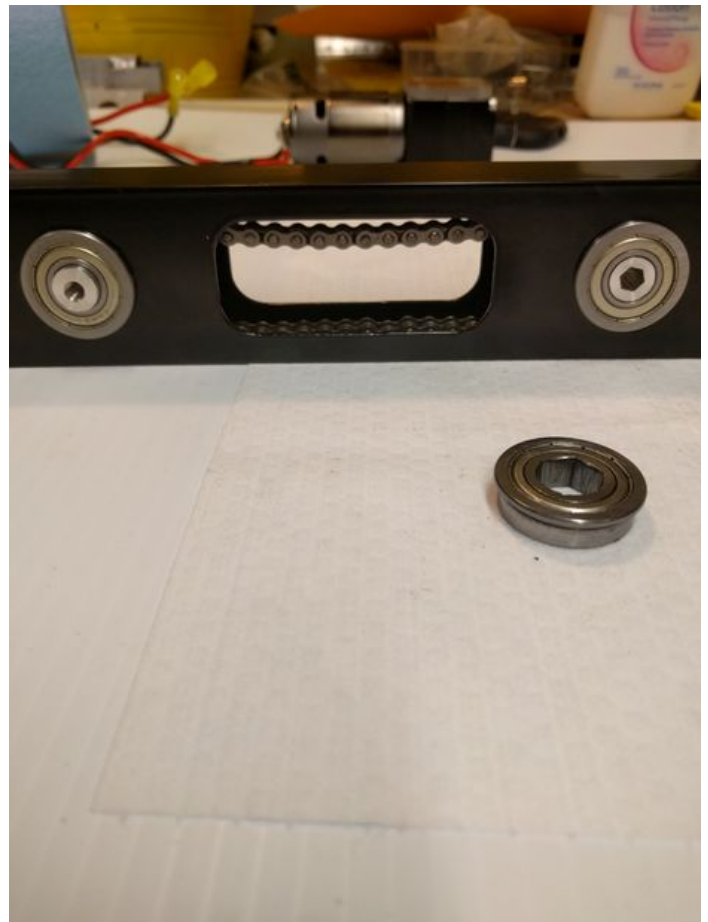
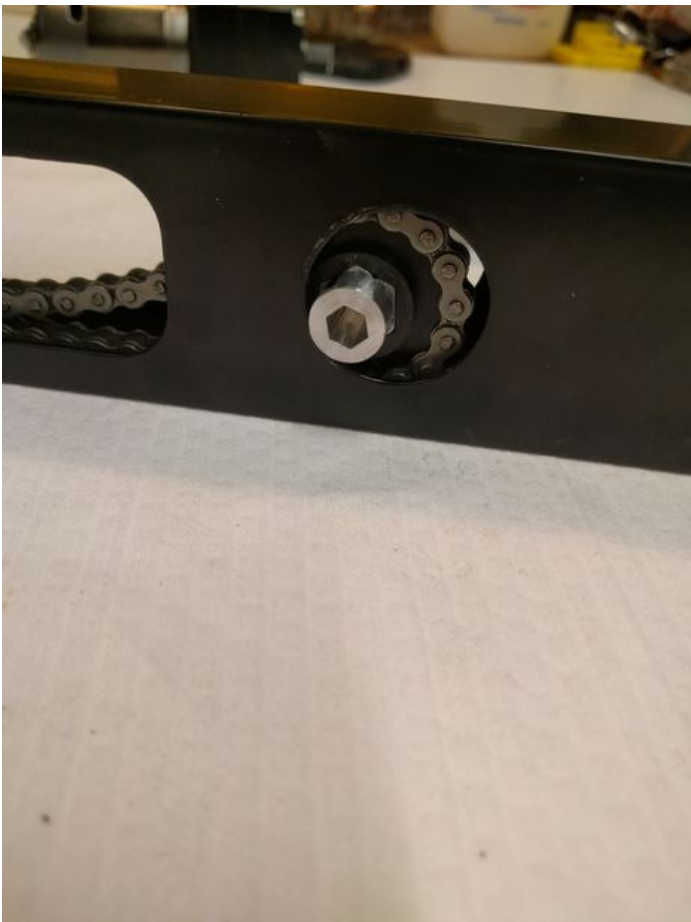
Seam chain with #25 master link or use the awesome DarkSoul Chain tool to make a seamless chain

<http://www.davesmotors.com/DarkSoul-25-Chain-Break...>



Step 33: Install drive shafts

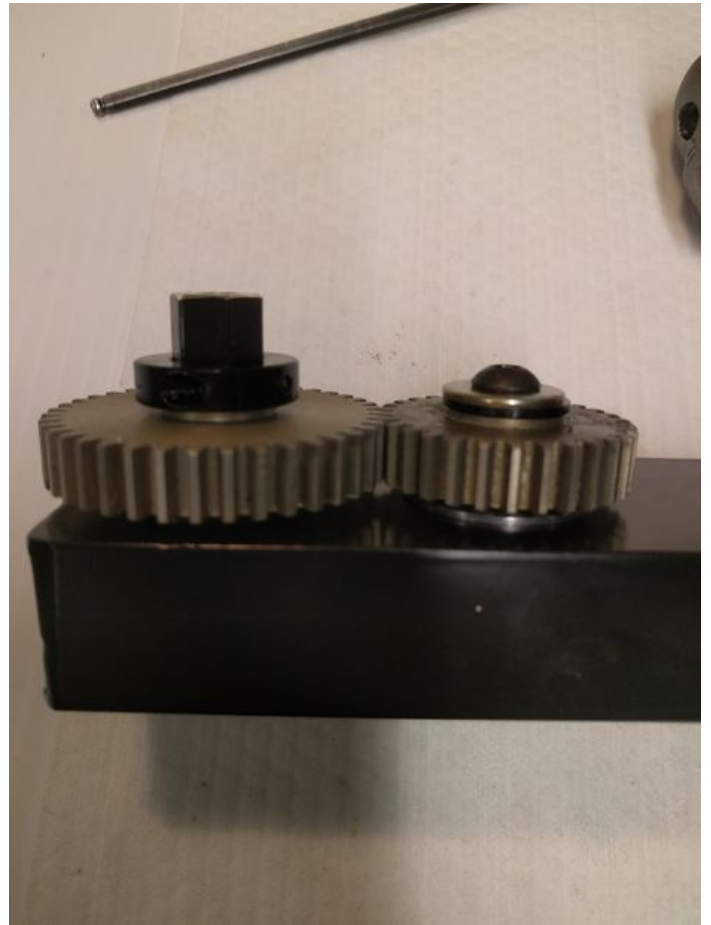
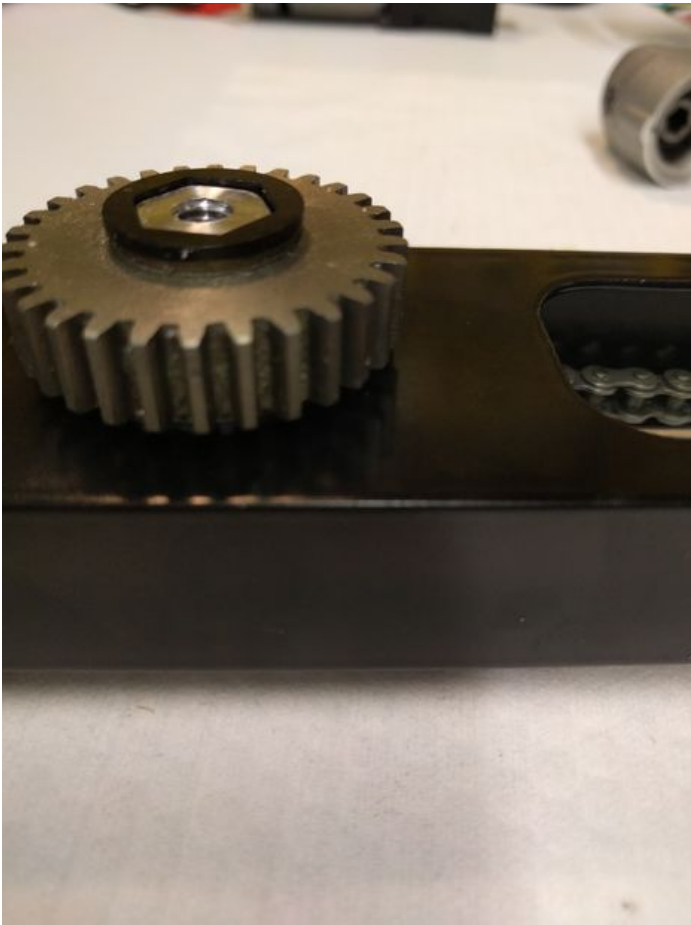
- Installing a chain-in-tube assembly can be tricky but many teams do this successfully every year. We recommend building this mock up so you can get the hang of this method.
- The following technique works pretty well:
 - Hold tube vertically
 - carefully lower chain loop with both sprockets into tube.
 - Through the bearing hole use a small screwdriver to hold upper sprocket in place as you install the axle, spacer and bearings.
 - once upper axle is in place, repeat for lower axle.
- put the Intermediate shaft with 1/8" spacer on shaft (or 2-1/16" spacers)
- place round bearing on outside
- place hex bearings on inside sides
- cap this shaft with 1/4" button and 1/4" washer to hold shaft in
- put 1.20" Adapter Shaft in the hole closest to the motor
- put long Output shaft in round bearing, through hole, and hex bearing in the final hole at the end.





Step 34: Install Spur Gears

- Put 30 tooth gear on short shaft, and 40 tooth gear on long shaft
- put 1/16" hex spacer on 30 tooth gear
- Install 1/4-20 button head screw and washer to retain 30T gear.
- Put 1/2" Vex shaft collar on long shaft and tighten



Step 35: Prepare 1/4" Shaft collars

- Broach shaft collars with the 1/4" hex broach
- install shaft collar on end of long hex shaft
- install shaft collar in middle of short hex shaft, roughly 1" from the one end.



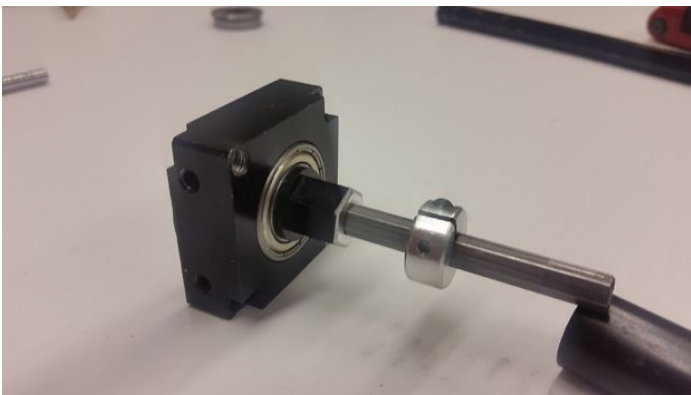


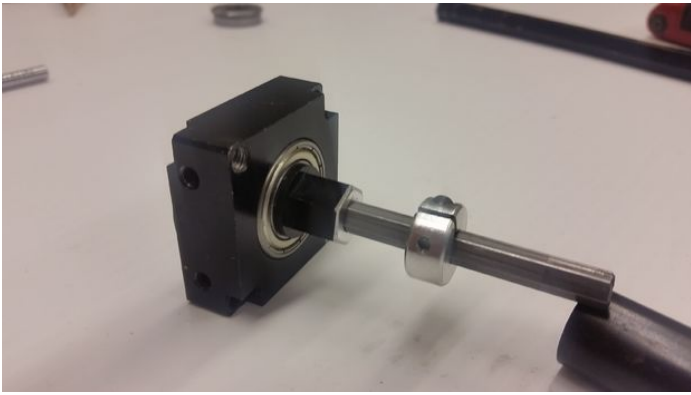
Step 36: Install short shaft in the gearbox assembly

The shaft collar limits the insertion of the shaft into the gearbox assembly.

Make sure that the shaft does not contact the internal gears inside the gearbox.

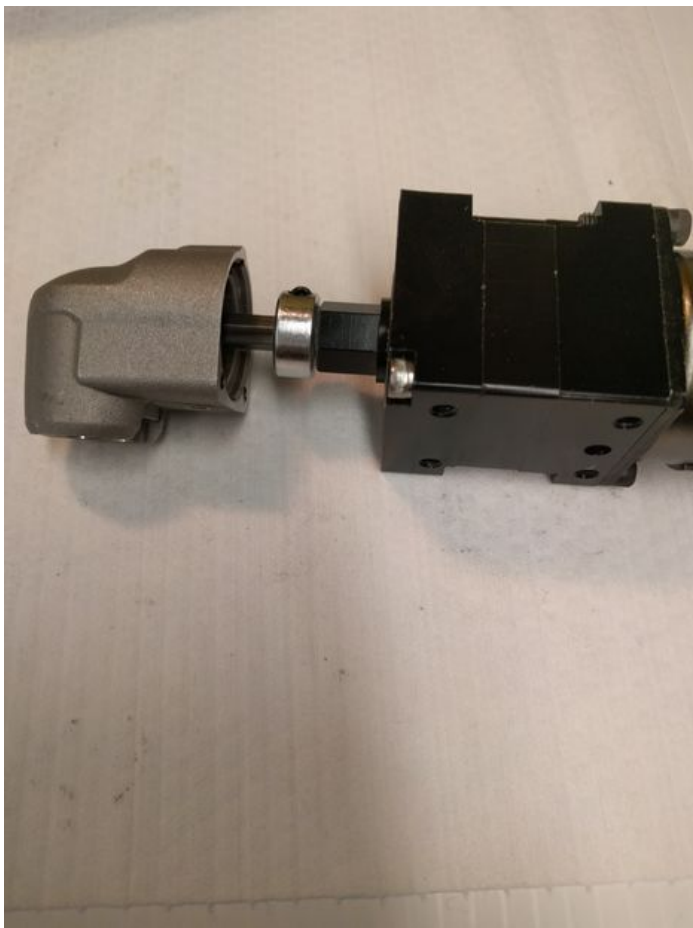
Adjust placement of shaft collar as needed.

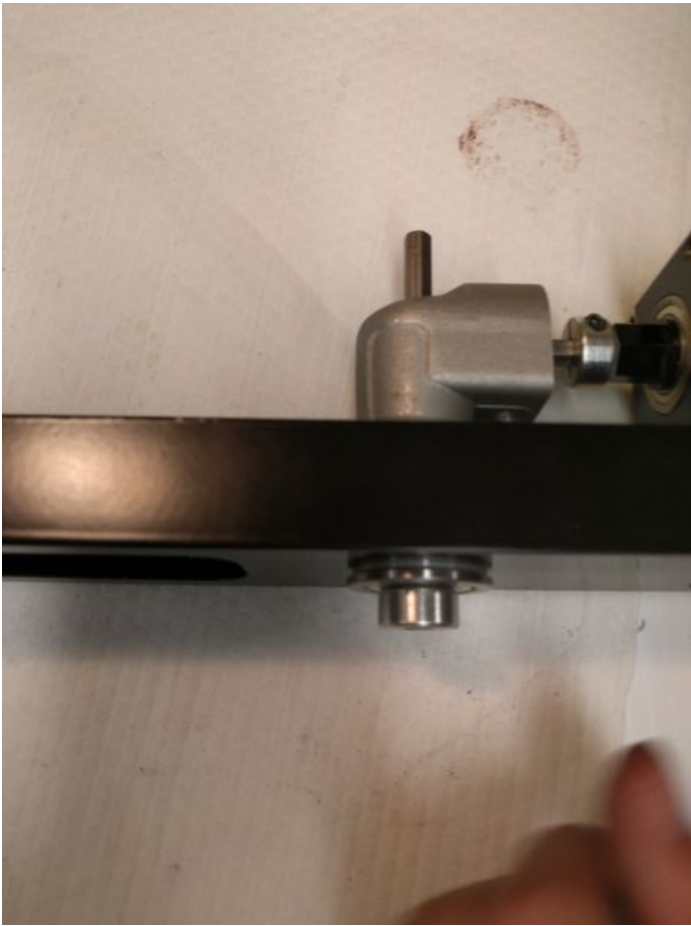




Step 37: Place 90 angle adapter on short shaft and begin mounting

- put shaft collar on inside of adapter
- put shaft inside and shaft collar on outside of bar
- tighten shaft collars, make sure there is no end play in adapter shaft bearings, these are retained by the shaft collars.
- It is important that the 90 degree adapter is allowed to float slightly on the 2 hex shafts. Our testing has shown that this setup is most efficient if left unconstrained. While this might seem a little unconventional, it works very well in practice and has never failed in any application we have used it on.

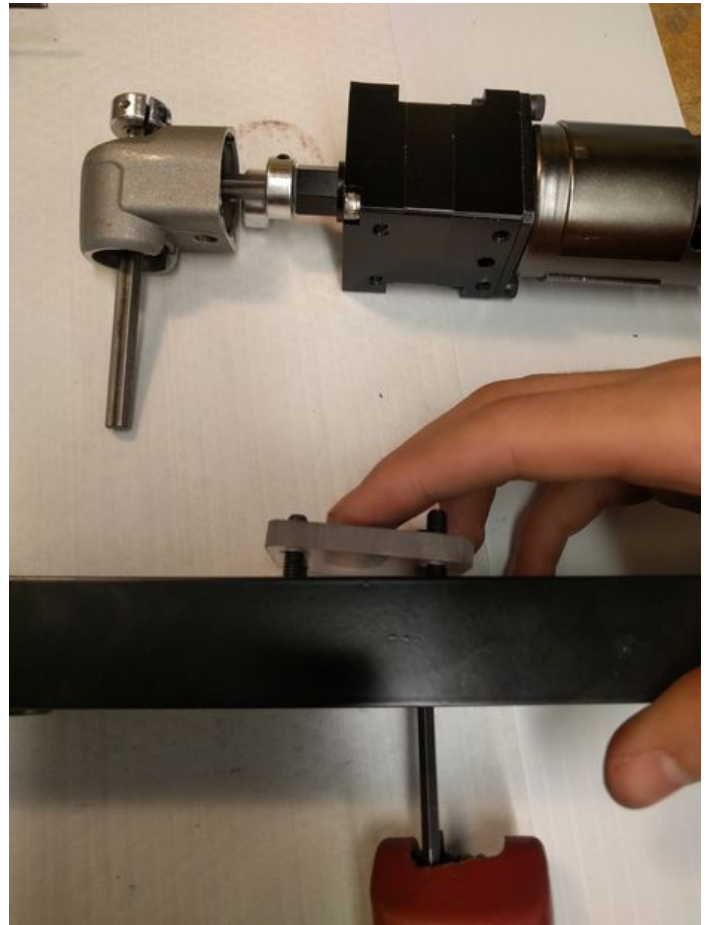




Step 38: Mount VersaPlanetary gearbox with polycarb spacer and the 10-32 mounting screws
use 4 - 10-32 x 3/4" button head screws to mount gearbox assembly to box tube.

Use Allen Key wrench to load screws through the tube. Loose fit all 4 into gear box before tightening.





Step 39: Assembly Complete

At this point, the assembly is completed.

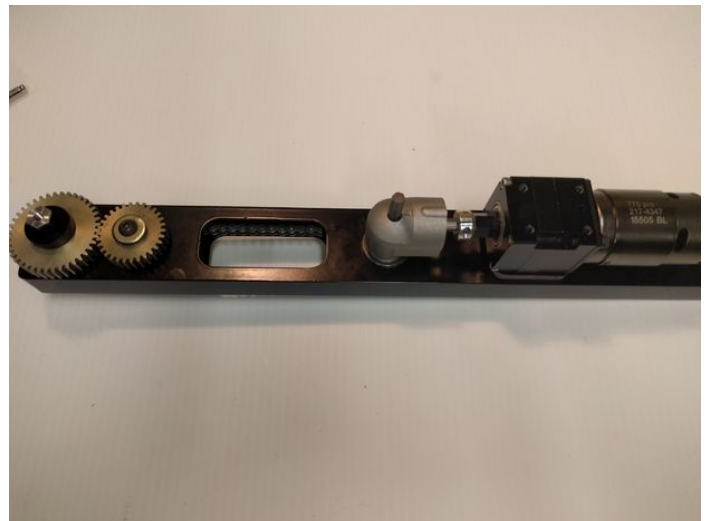
Turn gears to make sure everything spins freely

Lubricate gears with dry lube silicone spray or similar.

Connect power to motor leads to run a full powered test.

Congratulations, you now have a new weapon in your robotics arsenal.

Happy Hunting!



Step 40: Other Applications

You can use this same Dewalt adapter in many other robotics applications.

These are some of the many things we have done:

1. Use a standard 1/2" socket adapter and a bronze bushing to create a 90 degree drive to 1/2" hex.
2. Broach a 1/4" bore XL timing pulley and provide bearing support on both sides of adapter for a compact belt drive solution.
3. Create a small hex-hex plug to adapt standard VexPro Hex-core Sprockets and Gears.

All sorts of other things are also now possible:

The 1/4" hex drive is a universal interface in power tool interfaces. Pivot drives, flex shafts and all sorts of other adapters are now available to use once you have a Versaplanetary gearbox which accepts a 1/4" hex drive.

Good Luck in all your robotic creations!





Step 41: Special Thanks:

Special thanks to the great Killer Bees students who create this tutorial.

- Mary Riss
- Perry Outman
- Adam Calvaneso

Thanks to all the other Killer Bees Mentors and Students who build our competition machines.

Also, Thanks to Innovation FIRST International and VEXPro for sponsoring our team, and for all the great products and expertise they bring to FIRST Robotics.

#TeamIFI



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Related Instructables



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Dewalt Battery Charger multi-use adapter by Pyro667



Dewalt Tool Box PC by capth00k



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Arduino Drill Battery Adapter
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Technicians tool box pc by ulsterscooby

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tomatoskins says:

Very cool build! I love the detail in your documentation! Keep up the great work!

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