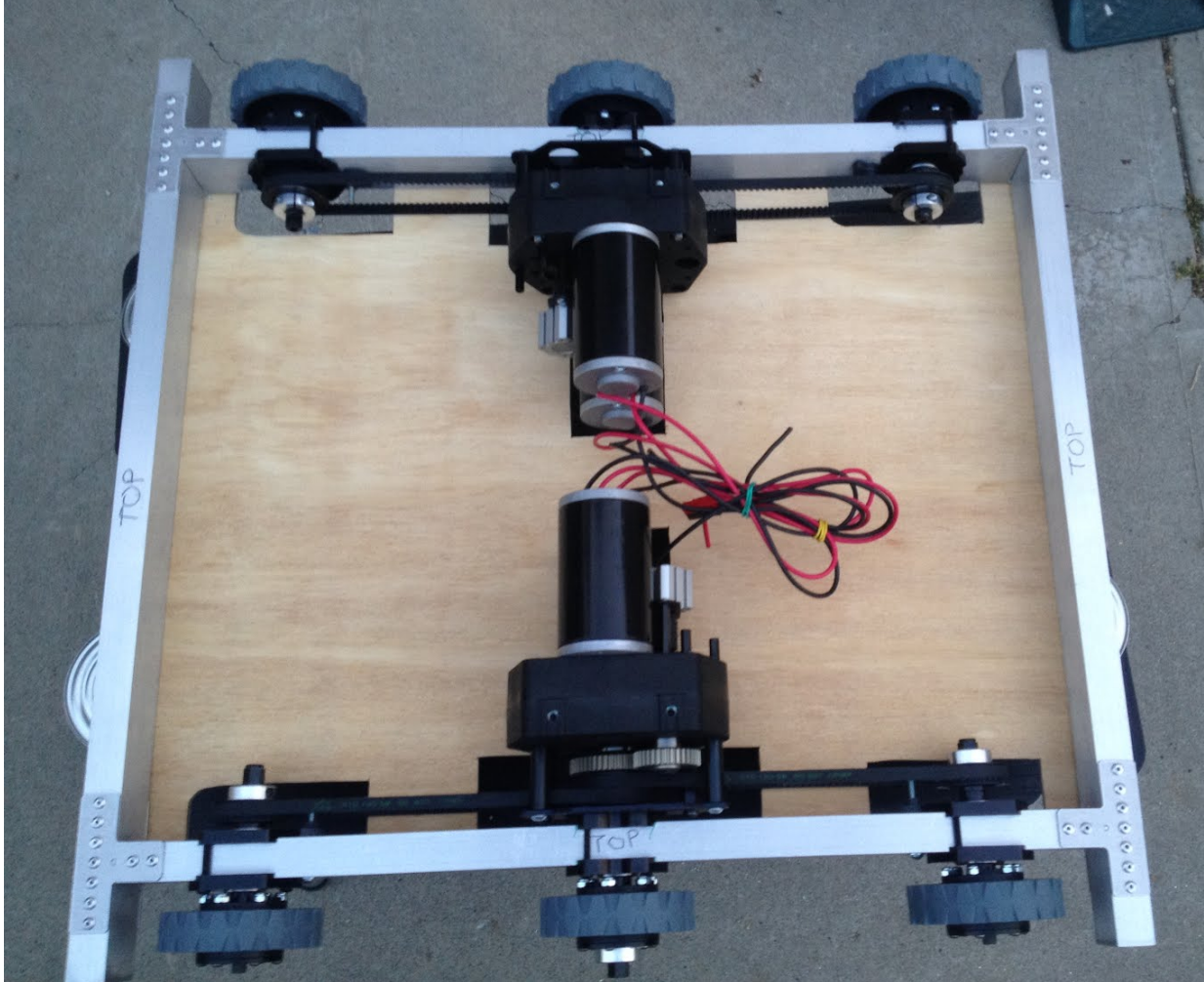


Team 4719 presents:

Belt driven West Coast Drivetrain - Step by Step guide

Using the VEXPro VersaChassis System with 3 CIM ball shifter



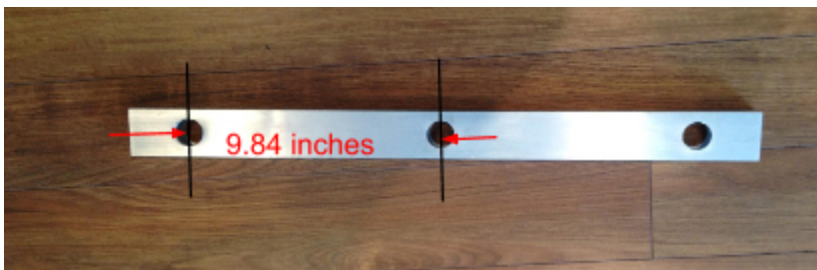
1. Configuring a drive train - things to consider:
 - a. Drivetrain design in general.
 - i. <http://www.simbotics.org/files/pdf/drivetraindesign.pdf>
 - ii. http://first.wpi.edu/Images/CMS/First/2007CON_Drive_Systems_Copioli.pdf
 - iii. <http://www.firstroboticscanada.org/main/wp-content/uploads/FIRST-Robotics-Drive-Systems.ppt>
 - b. Frame perimeter as per Game Manual (112 inches for 2014).
 - c. Design of the superstructure.
2. We will use a 28" x 27.75" (length x width) square base drive, which is frc legal for 2014, as an example for this guide. This guide can be easily adapted to a drive train of any dimension.
3. The powertrain utilize the 3 CIM ball shifter with pulley and belts driving 4 inches VEXPro VersaWheels.

4. Building a 28" x 27.75"(length X width) frame for six wheel drive using 4" wheels
 - a. Materials
 - i. Two 26" 2" x 1" aluminium tubing for the side beam
 - ii. Two 27.75" 2" x 1" aluminium tubing for the front and back beam
 - iii. A gusset pack of 8 Verachassis gusset
 - iv. Seventy two 5/32 rivets
 - b. Choices of tools to cut the beam to length from stock 2" x 1" aluminium tubing:
 - i. Minimum
 1. Hacksaw and mitre box
 - ii. Ideal
 1. Horizontal/vertical 4x6 metal bandsaw - 2 version available
 - a. Inexpensive version: Needs more tweaking out of the box to cut square
 - i. <http://www.harborfreight.com/horizontal-vertical-metal-cutting-bandsaw-93762.html>
 - ii. <http://www.busybeetools.com/products/BANDSAW-METAL-4IN.-X-6IN.-1%7B47%7D3-HP-CSA-CRAFT-EX.html>
 - b. Better version: Cut square out of the box without much tweaking, usually market as 5x6 horizontal/vertical metal cutting bandsaw
 - i. <http://www.kingcanada.com/Products.htm?CD=150&ID=12028>



- ii. <http://www.jettools.com/us/en/p/hvbs-56m-5-x-6-horizontal-vertical-bandsaw-115-230v-1ph/414458>

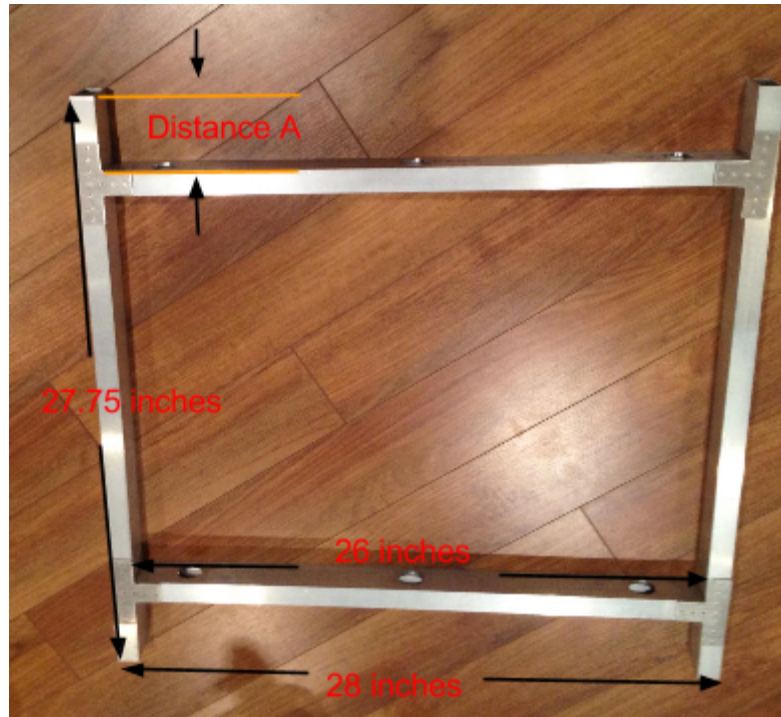
- c. Finding the front/back wheel to middle wheel distance and belt size
 - i. The front/back wheel centre must be at least 2.5" from the front/back beam to provide clearance for the wheel from the front and ensure the vesablock not hitting the gussets.
 - 1. So we start with an approximate center to center distance of 10.5" ($26"/2 - 2.5"$)
 - 2. We will be using 30t pulleys. Anything bigger the belt will hit the bellypan.
 - 3. Go to <http://www.wcproducts.net/how-to-belts/>
 - 4. Enter the above numbers we get two sets of numbers
 - a. 130t gives a distance of 9.84
 - b. 140t gives a distance of 10.83
 - c. We have to pick the shorter distance to allow adequate clearance for the wheel and versablock. We have therefore ordered four 130t 9mm wide belt.



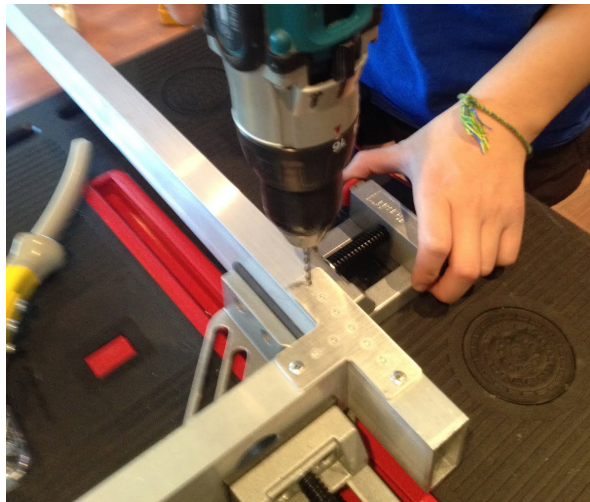
- d. Choice of tools to drill the knockout holes
 - 1. Step drill
 - a. <http://www.kleintools.com/catalog/titanium-nitride-coated-step-drill-bits/titanium-step-drill-bit-9t>
 - 2. Carbide hole cutters - we have great success with this
 - a. <http://www.kleintools.com/catalog/carbide-hole-cutters/1-18-29-mm-carbide-hole-cutter>

- e. Once the aluminum tube are cut to length and the knockout holes are made we can rivet them together.

NB Distance A have to be 3" to allow .25" of clearance for the stock 3 CIM ball shifter hex drive shaft from the side bumper. If you trim the drive shaft you can shorten the distance accordingly.

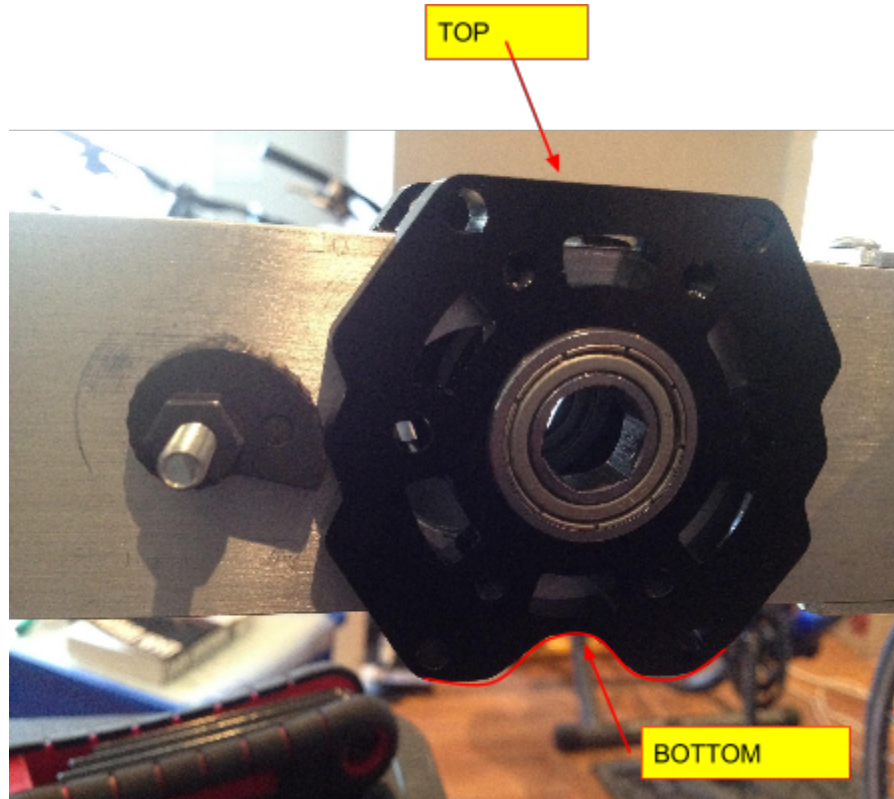


- f. Use a 90 degree jig to help align everything.

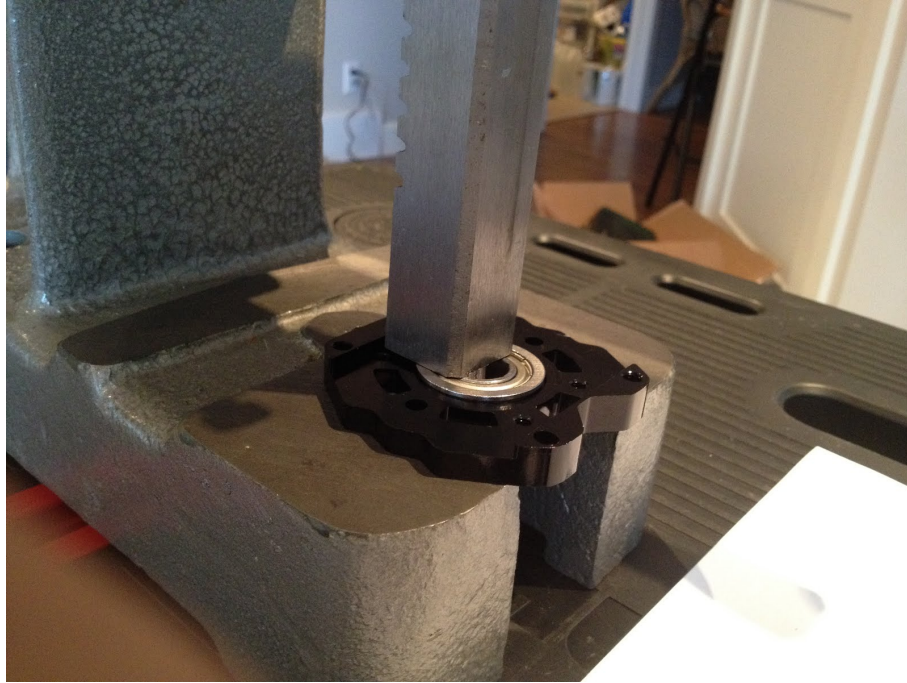


- g. Frequent check with machine square and check diagonal distance with measuring tape to ensure everything is square.

5. Install $\frac{1}{2}$ " Hex Bore Flanged Bearing into the VersaBlock
 - a. Every Half Versablock is fitted with one $\frac{1}{2}$ " Hex Bore Flanged Bearing bearing except for the Half VersaBlock that is attached to the WCD 3dr stage plate
 - b. The Versablock have a top and bottom to allow one to drop the center wheel by flipping the middle versablock upside down



- c. Some bearing need to be pressed in with a one ton press and some you need a retaining compound like loctite 680 to keep it in place



6. Building a VersaWheel

a. Material

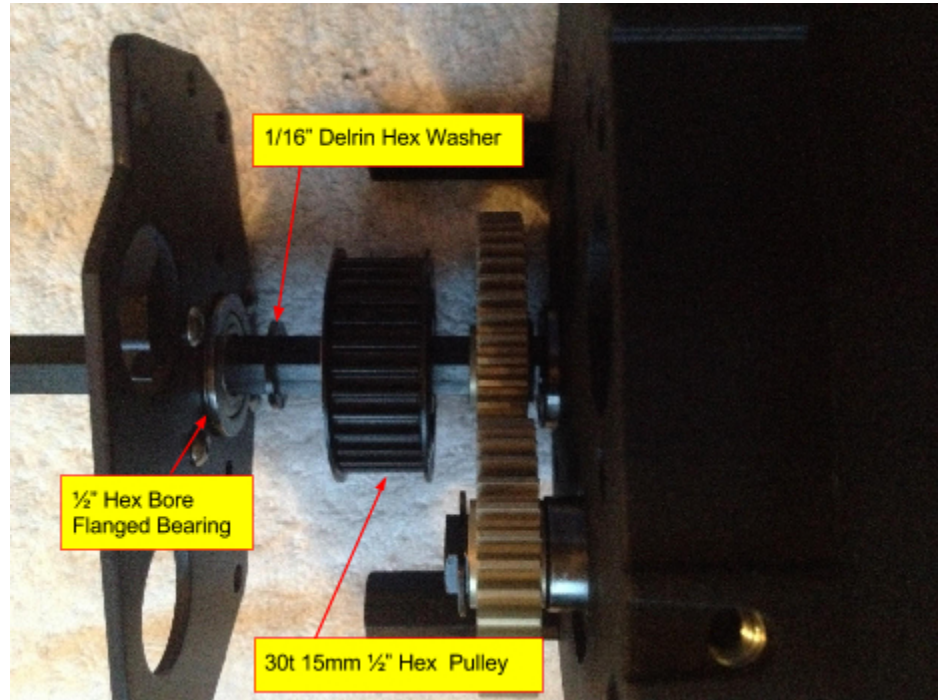
- i. 4" VersaWheel
- ii. One VersaHub
- iii. One ½" Hex bore Flange bearing
- iv. Six 1.75" 8-32 button head socket screw
- v. Six hex locknut

- b. VersaHubs are not aligned therefore cannot use two hub per wheel. Instead use one VersaHub and one flange bearing per wheel.
- c. Use the bearing inside so after sliding the wheel on to the hex shaft one can still rotate the wheel to align the hexhub with the hex shaft.
- d. If one wants to use a colson wheel there is a colson hub available.



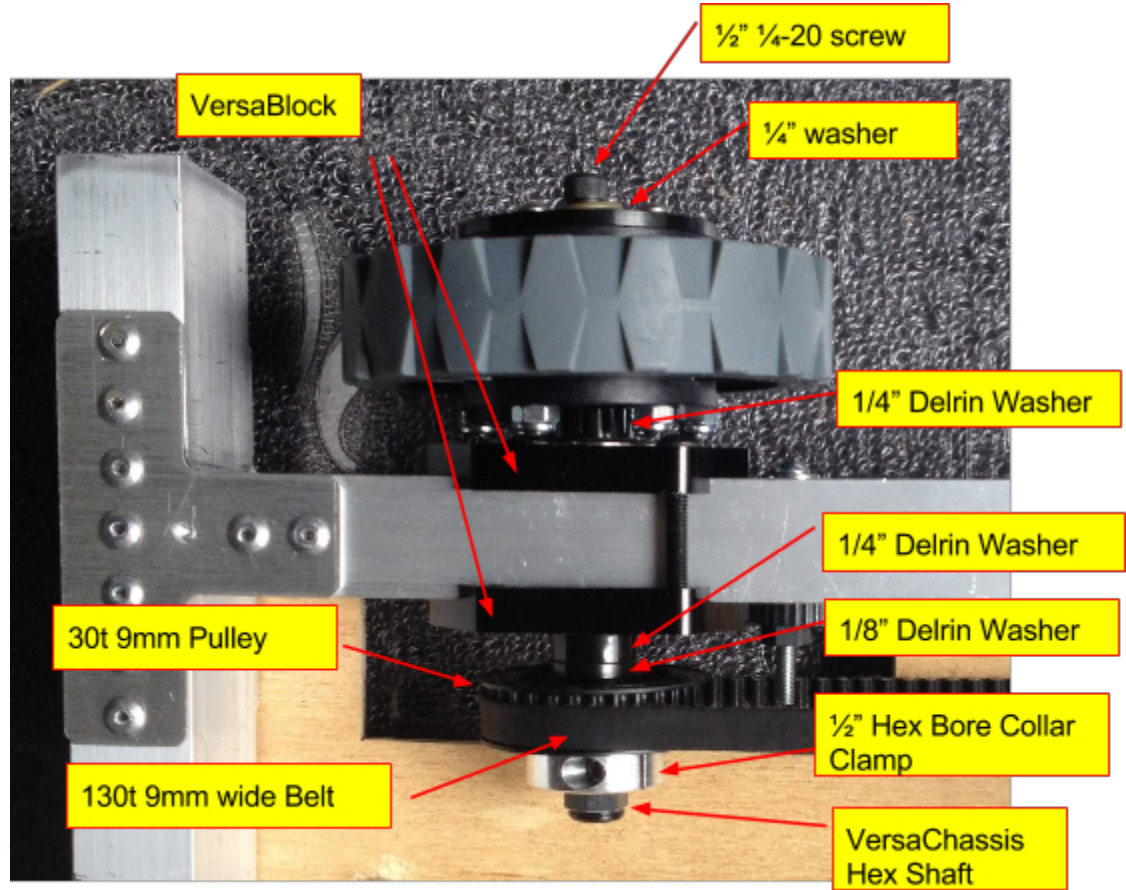
7. Building a 3CIM ball shifter and attaching to a Half VersaBlock
 - a. <http://content.vexrobotics.com/vexpro/pdf/217-3269-3-CIM-Ball-Shifter-WCD-Assy-Instr-Rev1-20140124.pdf>
 - b. The wave spring mentioned in Step 4 is definitely optional. In one gear box that we have there is absolutely no slop without the spring and in the other one there is still slop even with the spring.
 - c. The WCD 3rd Stage Plate is attached to a Half VersaBlock with four .375" 8-32 screws.
 - d. The VersaBlock have a top and bottom. To drop the center wheel one have to flip the VersaBlock upside down.



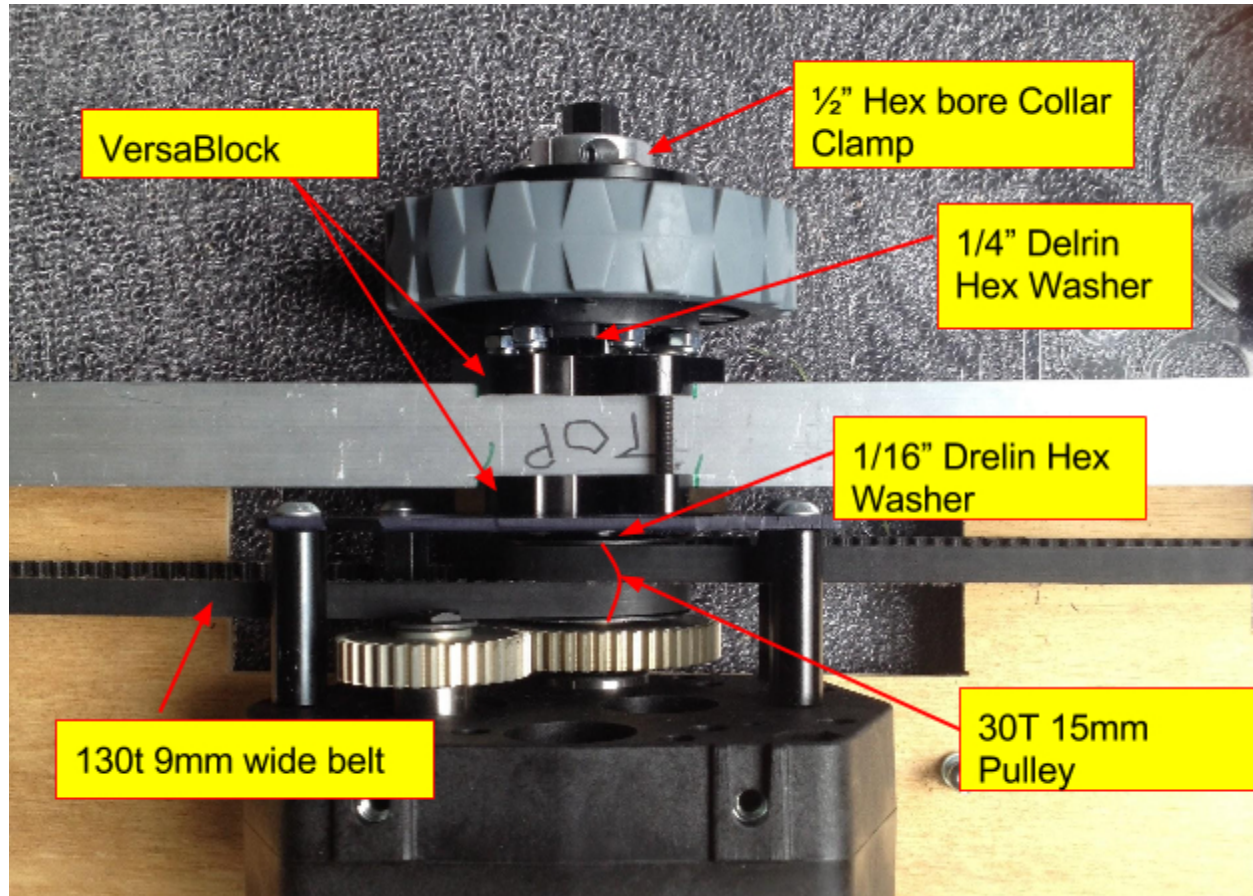


- e. You also need a 1/16" delrin hex washer between the pulley and the flange bearing of the WCD 3rd stage plate.

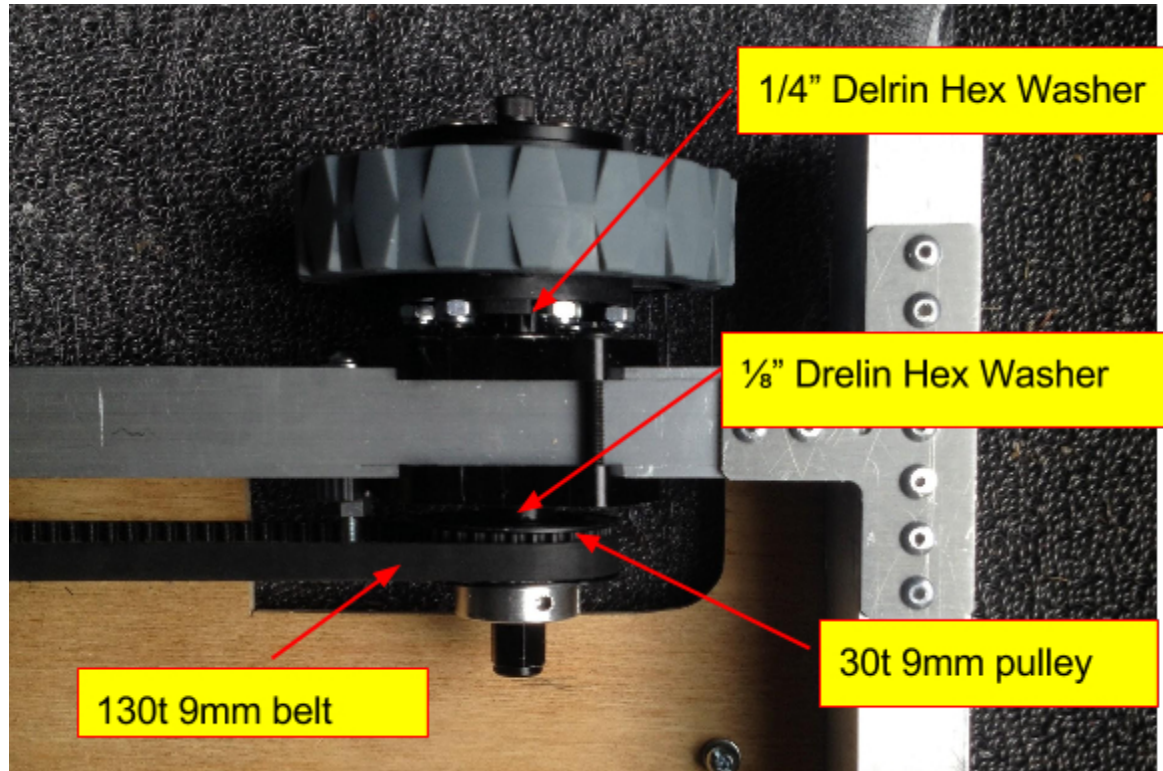
- 8. Putting it all together:
 - a. Wheel one



b. Center wheel:

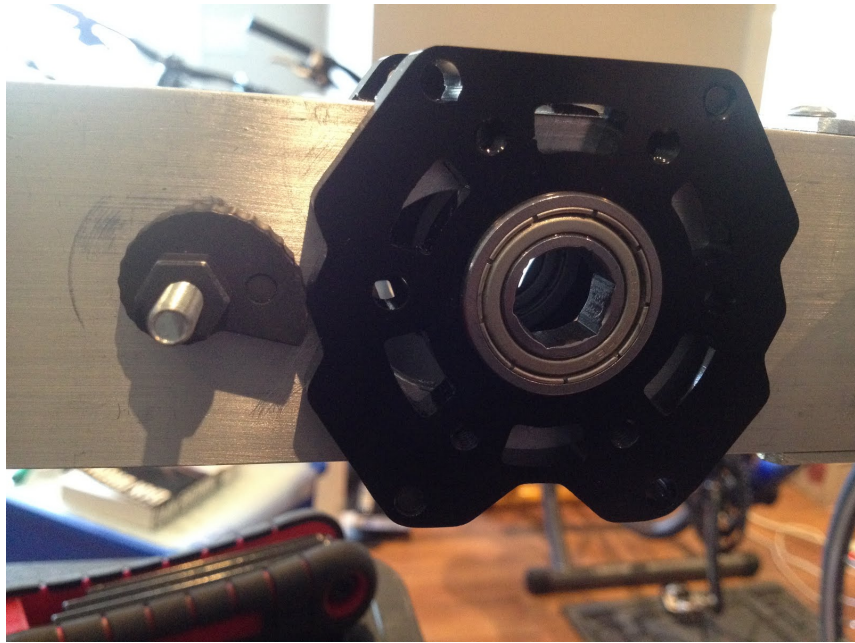
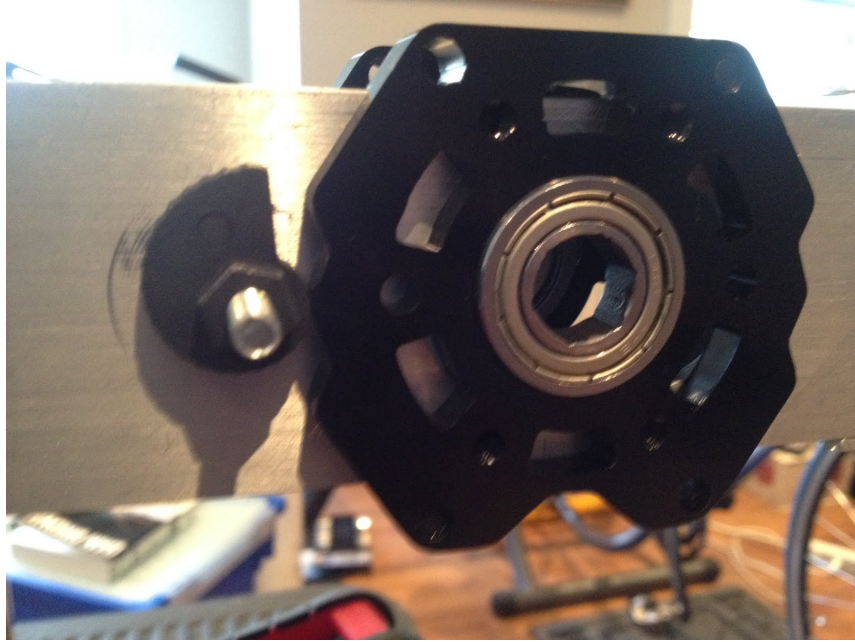


- c. Wheel three (Same as wheel one except for the inside Delrin Washer thickness):

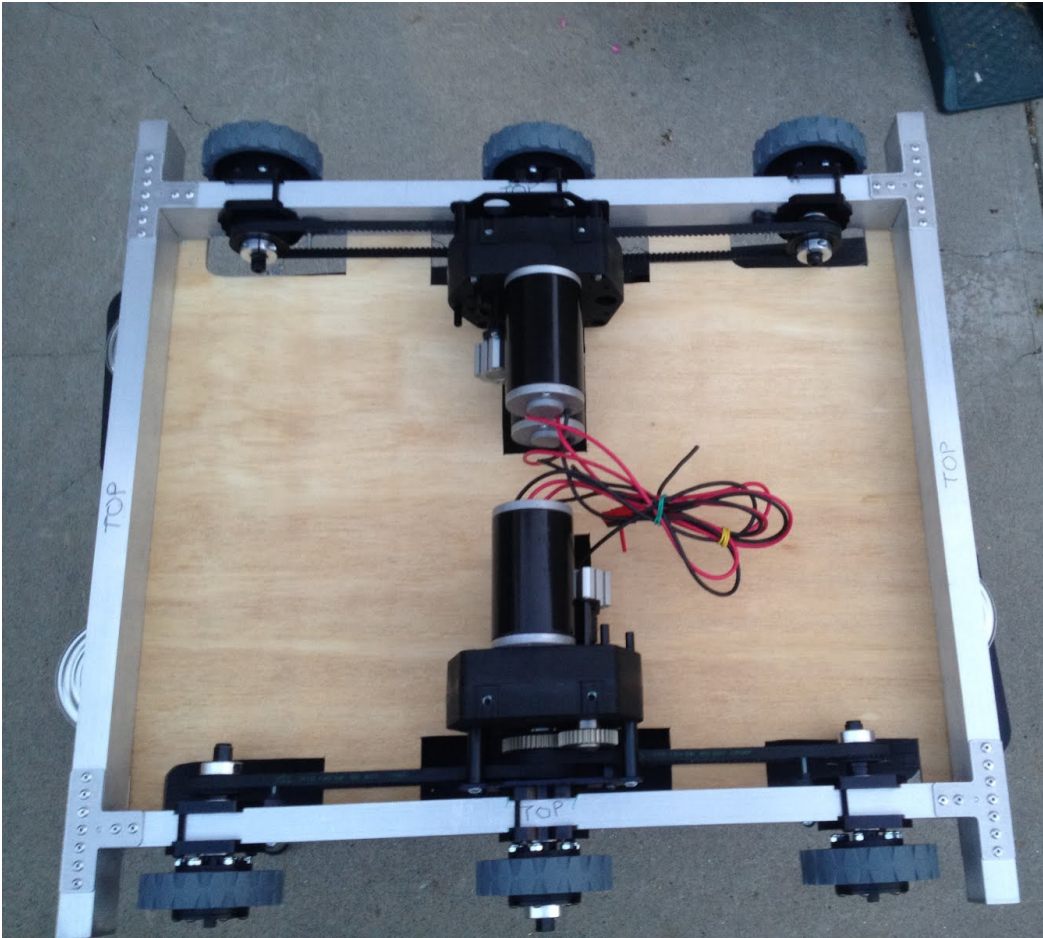


9. Belt tensioning using the WCD Cam(NB The photos below were taken without the pulley and belt system for clarity)
 - a. First hand tighten the belt and temporary clamp down the VersaBlock.
 - b. Use the cam as a guide to drill a 3/16" hole through both walls next to the VersaBlock.
 - c. Install the Cam using a 1.75" 10-32 button head screw with washer, button head on the outside of the frame.
 - d. Tension the belt by rotating the Cam.
 - e. Tighten the 10-32 screw after belt tensioning.





10. Add a plywood belly pan and you're done!!



11. Final Parts List for the Chassis

- a. 1" x 2" Aluminium Tube - 10 feet
- b. 1 x VersaChassis gusset pack(pack of eight)
- c. 72 x 5/32 Rivets
- d. 6 x VersaBlock Kit(2 x half Versablock and 2 x 10-32 screws included per kit)
- e. 4 x WCP Cam
- f. 4 x 1.75" 10-32 button head screw
- g. 4 x #10 washer
- h. 16 x 1/2" Hex Bore, Flanged Bearing
- i. 6 x 4" VersaWheels
- j. 6 x 1/2" Hex VersaHub
- k. 36 x 1.75" 8-32 Button Head Screw
- l. 36 x 8-32 Hex Lock Nut
- m. 4 x VersaChassis Hex Shaft
- n. 2 x 1/16" Drelin Hex Washer
- o. 4 x 1/8" Drelin Hex Washer
- p. 8 x 1/4" Drelin Hex Washer
- q. 4 x 1/4-20 1/2" Socket Head Cap Screw
- r. 4 x 1/4" Washer
- s. 6 x 1/2" Hex Bore Collar Clamp
- t. 4 x 130t 9mm Belt
- u. 4 x 30t 9mm 1/2" Hex Pulley
- v. 2 x 30t 15mm 1/2" Hex Pulley