2020 FRST Competition - Gear Intake Mechanism Design

CS450H0 - Robotics Design and Fabrication Honors

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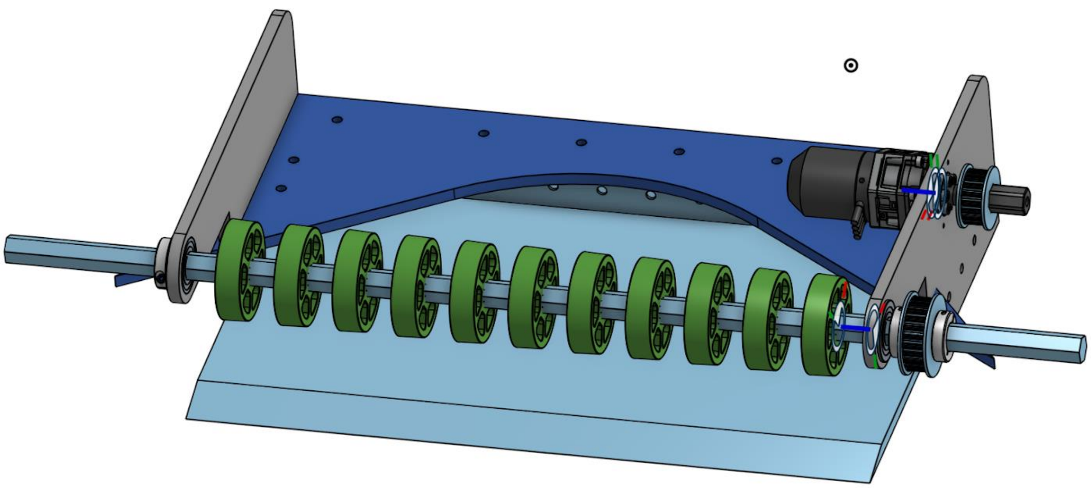
November 12, 2021



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Introduction

During this course, we were tasked to recreate a single portion of the 2017 FRC competition, Steamworks. We had to design and manufacture the Gear-Intake portion of 2017 FRC competition robots. The challenge of the 2017 FRC competition was to intake the yellow gears and hang the gear on the hook, where then the human player would take the gear and loaded it onto a gear train, and once the train was full it would add to the point score in the end. We had to replicate and successfully design the gear intake that was used in this competition. It was difficult to figure out how to design the most effective and efficient robot, because it differed from those in the competition because it was not the full robot. Our robot had to pick up the gear off the floor and intake it effectively.

Strategical and Functional Requirements Design Analysis

Before starting our sketches and preliminary designs, we had to create a spreadsheet containing our function requirements and design analysis. We ranked, from top to bottom, what we needed our robot to accomplish by importance. Our only major function we needed our robot to do was to intake the gear successfully, as well as be able to attach to our drivetrain that was pre-manufactured. In the picture below, you can see we wrote out of functional and strategical requirements, ranked them in importance, and then integrated our requirements into our initial and final designs.

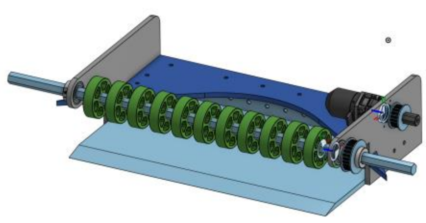
SCORING GEARS IN FRC STEAMWORKS	
Strategic Requirements	**Functional Requirements**
Curved intake	Ability to attach to drive train
chanfeaured lip	Capable of running the rollers

Priority Ranking
Ability to attach to drivetrain
Running rollers
Curved intake
Chanfeaured lip

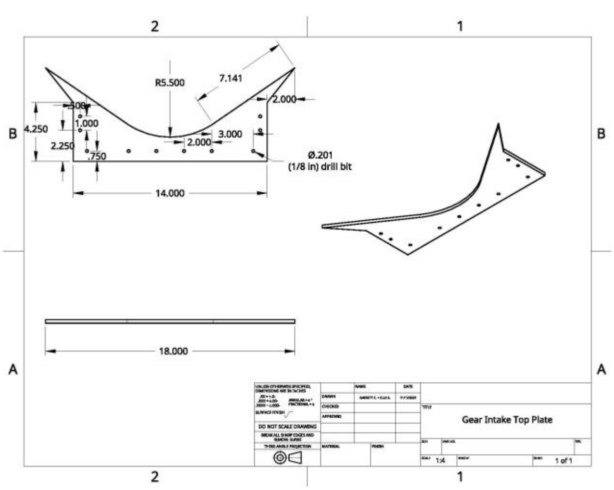
Computer Aided Design Process

We used Onshape as our CAD software for this project. CAD, or computer aided design Is a way for engineers to visualize and be able to prototype their designs without having to waste materials. It also helps make the actual manufacturing process a lot easier, especially for 3D printing or CNC. Onshape is software extensive, however easy enough for a beginner to understand how to create a 3D model. We would basically start with a simple 2D sketch of each of our pieces, using our dimensions and changing them as fit along the way. Then, we would extrude the sketches into 3D diagrams, and then we would add any linear patterns or special details that we wouldn't include in our simple 2D sketch. Once all our pieces were complete, we would export those pieces into the assembly, and fasten mate our pieces together to make our actual robot versus just the singular pieces. Fasten mate simply puts the pieces together so they don't just appear to be attached, but when rotating the piece, they are. Another tool that is very useful in onshape is the MKCAD part library. Here we imported the CAD file models of the motor, collars, pulleys, and wheels. This is very helpful, so we don't have to CAD the pieces that are premade in the first place.

Final CAD model:



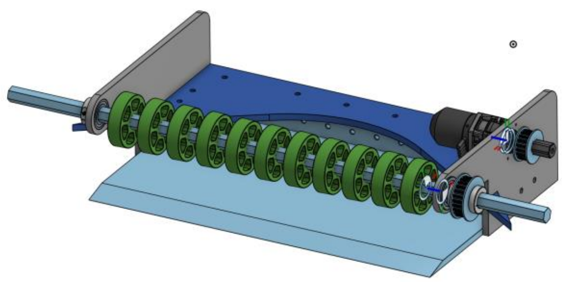
Parts drawing:



Manufacturing & Assembly

During the manufacturing and assembly portion of our assignment, we had to think a little out of the box.

3D CAD model:



As you can see above, in our CAD model, we had a few parts that we had to cut/print specially. Both two grey side plates had 3D printed, the large bottom plate, as well as the dark blue curved. intake plate, we CNC'd. We ran into a manufacturing error when we forgot to include the chamfer in the CNC g-code. We got creative and belt sawed a chamfer, which you can see below. The bars and shafts were ordered parts, but we cut them to length. We used the CNC router the most, which is sort of like a laser cutter, but it uses a drill bit to cut and is attached to a mill with x, y, z planes. We also used our MakerBot 3D printers, which are self-explanatory. To cut the Chassis bars and the Shafts we used the horizontal band saw, which is a saw that you drop on your part that you're cutting after lining it up with the fasten mechanism.

Half-done Manufacturing:

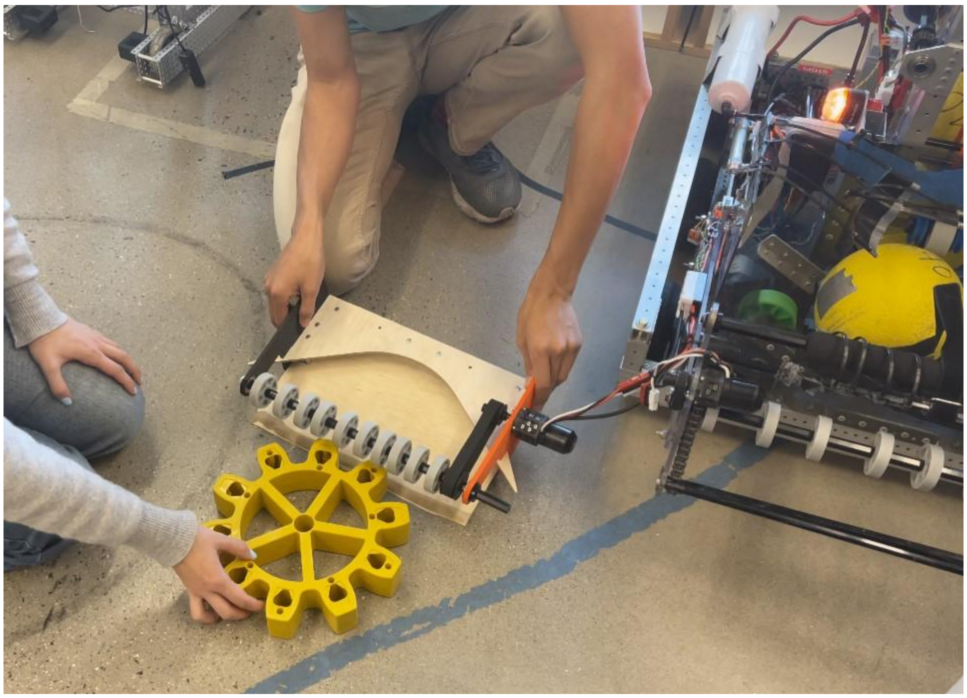

Below is our Hardware list, listing all the pieces we used/ordered that weren't special made/cut.

Part Number	Name/Description	Price	Quantity	Total Price	Vendor	
91251A340	*10-32 x 3/8" bolts, 100 pack*	*12.28*	*1*	*12.28*	*McMaster Carr*	*https://www.*
217-4006	13.75mm(1/2" ThunderHex ID) x 1.125" OD x 0.313 WD (Flanged Bearing)	4.99	2	9.98	Vexpro	
-	Hex Shaft 0.577" OD x 22" L	-	1	-	3D Print	
217-6353	Straight Flex Wheel (2" OD x 1/2" WD, 1/2" Hex Bore, 30A)	4.99	11	54.89	Vexpro	
-	Neo 550 Brusheless motor	25	1	25	Andy Mark	
-	HTD 5mm Pulley (W 9mm x 18 tooth)	-	1	-	3d Print	
-	HTD 5mm Pulley (W 9mm x 24 tooth)	-	1	-	3d Print	
217-5885	GT2 Timing Belts, 9mm W x 70 tooth	4.99	1	4.99	Vexpro	
217-2737	Clamping Shaft Collar - 1/2" Hex ID	4.99	4	19.96	Vexpro	
	5/32" Rivet	-	x	-	already acquired	

Final Product:

Testing Setup & Results

To test our design, we connected out intake mechanisms to the BB2 robots drive train. We turned on the robot and enabled the intake mechanism to run. On our first attempt, we found out that the intakes rollers turned the wrong direction, creating a highly effective Ex-take. We also noticed the mechanism ran too fast. We changed the side of the motor from being on the inside to the outside, moving the pulley and belt into the inside. Then we also geared down the motor, so it was not as fast; from 5:1 reduction to a 20:1 reduction. We then retested after iterations, and then our robot worked very well.



Conclusion

In conclusion, during this course we had to design and manufacture the Gear-Intake portion of 2017 FRC competition robots. We designed and manufactured an intake mechanism fit for the gears designed for the 2017 FRC competition. We took many weeks to design, CAD, assembly, and test, but in the end, we created a successful intake mechanism. We would take away from this project that we should create more detailed sketches and preliminary planning, instead of diving into the project CAD right away. In addition, we would probably change the material from wood to polycarbonate, and design it so the motor could be on the inside without turning the wrong way.

Bibliography

References

Pierce, D. (n.d.). *NASA RAP guide*. Nasa. Retrieved November 18, 2021, from https://robotics.nasa.gov/nasa-rap-robotics-design-guide/