FRC 2017 Steamworks – Gear Floor Pick Up Mechanism Design (AVALANCHE)

CS450HO – Robotics Design and Fabrication Honors

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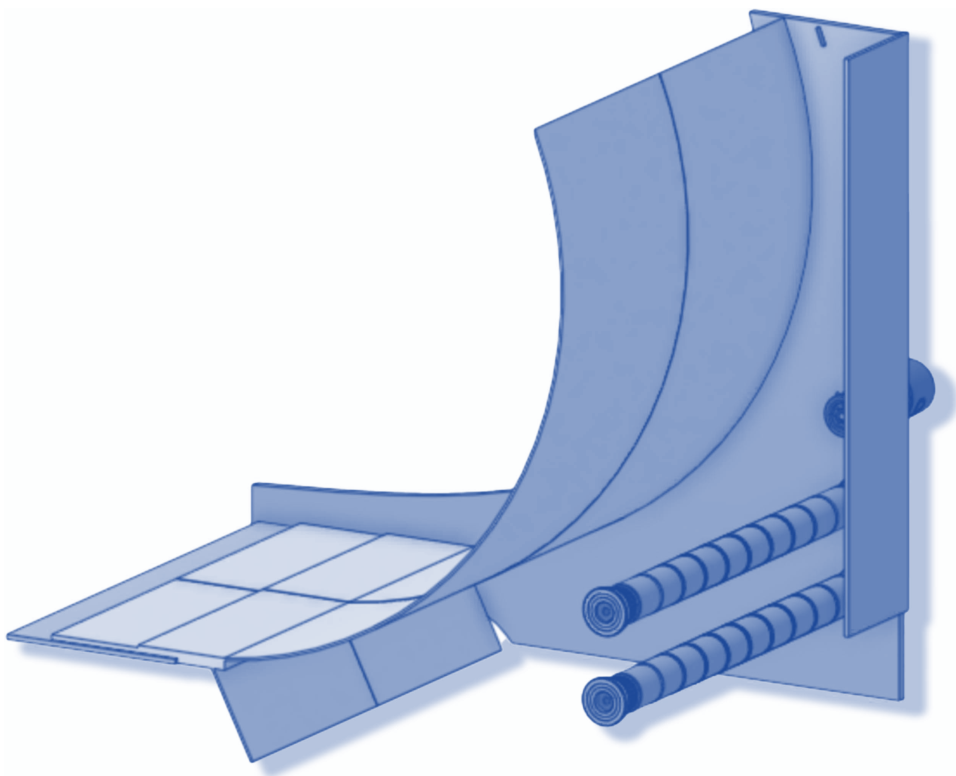

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Introduction

For the project of this term, we were assigned to design and manufacture a mechanism to collect gears from the 2017 FRC game – Steamworks, off the ground. After background research, we started to design our gear intake in CAD (using OnShape and Fusion360). To make our assembly as realistic as possible, we included necessary parts such as belts and pulleys that we found online.

The gear as described earlier, is a game piece of the 2017 FRC match, in which FRC or otherwise known as first robotics competition, a competition for high school students and adult mentors participates in a five-week robotics challenge of building and competing in various situations for points.

The FRC 2017 game 'Steamworks' was a game of ball shooting action and fast-paced driving where teams had to shoot balls through hoops to fuel airships centered across the field, as well as delivering gears to the human players located on the airships. As the match drew to a close, the robots would have to latch onto their respective airship and take to the skies.

We looked to already-manufactured gear intakes for inspiration. The main robot was created by FRC team 4481, or the 'Rembrandts.' Their gear intake involved rollers that applied pressure to a gear, which would then roll the gear to the front of the robot for easy access.

Strategic and Functional Requirements Design Analysis

The Strategic and Functional spreadsheets are essential in prioritizing objectives and strategizing a successful build timeline. AVALANCHE's design chart includes strategic requirements of acquiring a gear, lifting a gear, and releasing the gear to a human player. The functional requirements include holding one gear at a time, lifting a gear, and driving while carrying a gear.

SCORING GEARS IN FRC STEAMWORKS	
Strategic Requirements	**Functional Requirements**
Acquire a gear	need to be able to hold one gear at a time
intake a gear	need to be able to lift gear
lift a gear	need to be able to drive while carrying gear
robot needs a drivetrain	
need to be able to release gear to human player	
Priority Ranking	
CAD design	
Obtain Parts	
Revision and revising	

Figure 1: Strategic & Functional Analysis Spreadsheet

These strategic and functional requirements did not change throughout the entire build process.

Computer Aided Design Process

We used an online CAD program, OnShape, to sketch parts for our project. CAD, Computer-aided design, is the use of computers to aid in the creation, modification, analysis, or optimization of a design. OnShape is a CAD software that is operated through a browser, as opposed to being an application installed onto a computer. It allows for the collaboration of multiple people to edit a singular project.

We started off with multiple 2D sketches to picture the entire build space and subject, from then on we moved to extrusions and holes the measure of specific objects like bearings and motors. The main extrusion of our build was mirrored so the side panels of our gear intake was doubled from one to two. We also incorporated the pattern tool to repeat the rollers so they were equally dispersed across the shafts. In the assembly, we used regular, connector, shaft, and free movement mates.

MKCAD has a wide library of parts that are accessible from an add-in in OnShape, specific to FRC. We used MKCAD to import sprockets, bearings, shafts, and rollers. This was quite useful, as modeling parts is time-consuming and sometimes inaccurate, so having the ability to import parts was a relief.

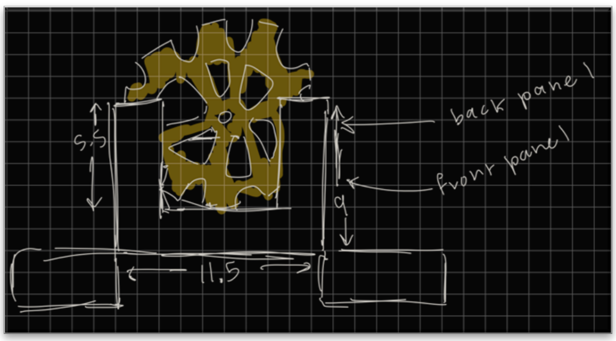

Figure 4: Handmade Sketch with Measurements

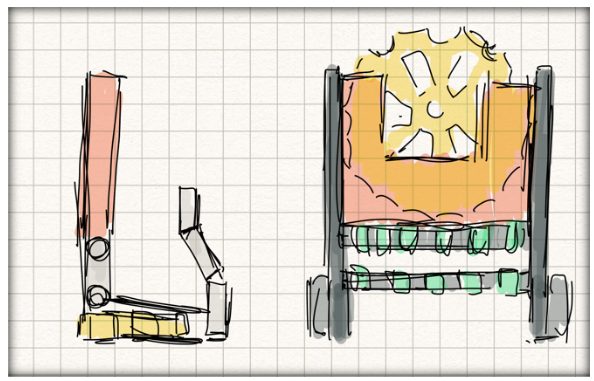
Figure 3: Front and Side View of Gear Intake

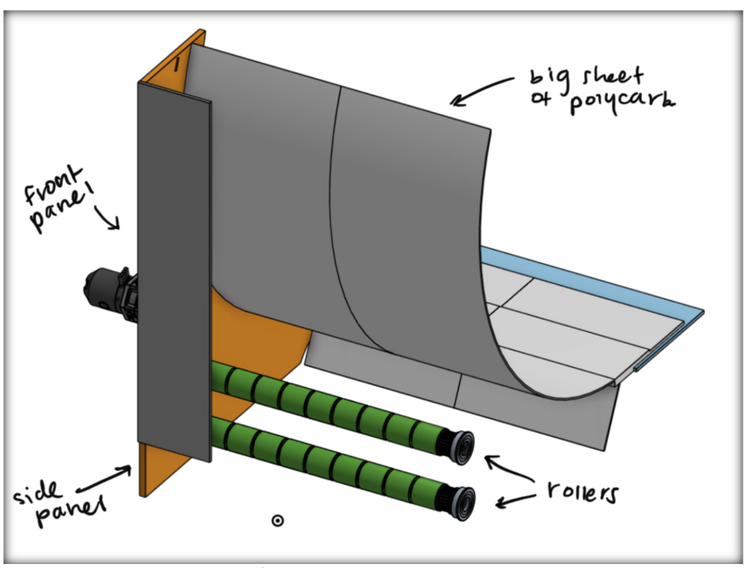

Figure 2: CAD Rendering of Gear Intake

Manufacturing & Assembly

To manufacture the different parts of our gear intake, we used the CNC router, horizontal bandsaw, vertical bandsaw, and used other power tools like drills to assemble.

We used the following machines:

- CNC Router
    - Uses commands derived from a computer to automate the route of the tools. The tools are programmed to cut material from 9mm to 19mm.
- Horizontal Bandsaw
    - Has a thin metal blade that is swung through a stationary object to make exact cuts.
- Vertical Bandsaw
    - Has a stationary blade that cuts moving material. The material that is being cut must be fed through towards the blade.

The fabrication process was a lot of trial and error. To make the side panels, we first tried to cut ¼" plywood on our laser cutter. As we couldn't figure about how to operate it, we weren't able to cut our parts on the laser cutter. We moved on to the CNC router, which successfully completed our job.

The vertical bandsaw was used to cut the two front polycarbonate sheets (which keeps the gear in a stable position above the top rollers) and large back polycarbonate sheet (which applies pressure to the back of the gear).

The horizonal bandsaw was used to cut the three standoff shafts and two shafts that held the rollers. After the shafts were cut to the right lengths, the raw edges were sanded down with the sander, threaded with a tapping kit.

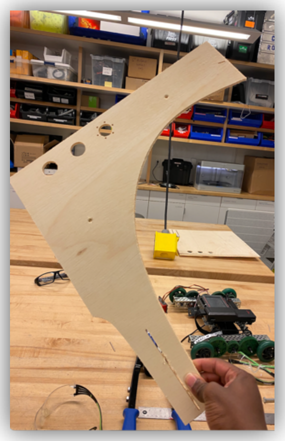

Figure 5: Side Panel

Figure 6: First Assembly

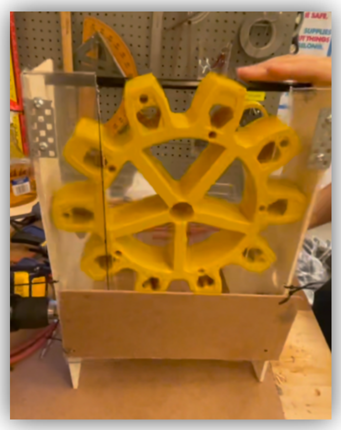

Figure 7: Finished Product

Part Number	Name/Description	Price	Quantity	Total Price	Vendor	Link
91251A340	*10-32 x 3/8" bolts, 100 pack*	*12.28*	*1*	*12.28*	*McMaster Carr*	*https://www.mcmaster.com/screws/socket-head-screws/thread-size~10-32/socket-head-screws-6/alloy-steel-socket-head-screws-8*
217-4017	1/2" Thunder Hex Stock (36")	15.99	1	15.99	VEX	https://www.vexrobotics.com/thunderhexstock.html#description
217-5875	4t GT2 1/2" hex bore 9mm double flang	0	4	0	made at shop	https://www.idesignsol.com/24t-x-9mm-Wide-Double-Flange-Aluminum-Pulley-GT2-3mm-1-2-Hex-Bore-217-5875
	24t GT2 5mm hex bore	0	1			already at shop
	1" OD 1/2" hex ID hex sushi roller	4	18		andy mark	ıshi-roller-intake-wheels?Bore=1%2F2+Hex&Durometer=35A&via=Z2lkOi8vYW5keW1hcmsvV29ya2FyZWE6OkNhdGFsb2c6OkNhdGVnb
	neo550 brushless motor	25	1		revrobotics	https://www.revrobotics.com/rev-21-1651/
	5:1 ultraplanentary gearbox	50	1			
	0.75" 5mm shaft		1			
	60 tooth 3mm belt	4.99	2			
	Polycarbonate					
	Belt:					https://www.vexrobotics.com/gt2-timingbelts.html
ılculator-belt?pitch=3&calc_unit=in&vex_modifield=true&pulley1t=24&pulley2t=24&desired_center=2.322&extra_center=0.000						

Figure 8: Bill of Materials

Testing Setup & Results

To test our design without committing to any permanent modifications, we used clamps to hold pieces together. For instance, clamps were used to determine the best placement of the front panels when the gear slid upwards. Instances like these were vital, as they helped decide where to place parts to make the most efficient build.

In place of a motor, we used a drill to test our design. The drill bit was replaced with a screw that moves the shaft holding the rollers. To simulate our gear intake moving on top of a drivetrain, we placed the gear intake on the ground, and moved to gear towards the opening.

Figure 9: Testing Phase of AVALANCHE

Our design worked rather rapidly. The drill used to rotate the shafts had two different power settings. When the drill was on the low-power setting, AVALANCHE took in the gear, but failed to move the gear on top of the upper rollers. As a result, the gear would stay on the ground under the sheet of polycarbonate. When the drill was on the high-power setting, though, AVALANCHE worked exceptionally. The gear was received by the bottom rollers and moved upwards for easy access in a quick manner.

Although the speedy rollers proved to be helpful when receiving the gear, we noticed one set back during some of our trials. After the gear was on top of the upper rollers, sometimes the speed from the rollers would cause the gear to fly out into the air.

To overcome this issue, we would add supports that would pressure the gear downwards before it could fly out. The supports wouldn't be too restrictive, as the gear would still need to be loaded onto a rod.

Speed of drill	Result	Notes
Low	Controlled, but not as quick and didn’t allow gear to be raised on top of upper rollers.	Not ideal
High	Quick and efficient, succeeded in raising gear on top of rollers but sometimes made gear fly out of intake.	Ideal if supports are added

Figure 10: Testing Table

Conclusion

Following the Steamworks 2017 competition, our goal was to create a gear intake that could receive a gear and load it onto a rod. After brainstorming about possible designs, we decided on one example found in a video on YouTube. During the CAD process we scrapped two fully defined models before finally settling on one. We looked back to YouTube frequently, in attempt to recreate the design, but in a simpler way.

As we started manufacturing our parts, we gained experienced using different power and milling tools, such as the two bandsaws, drills, CNC router, sander, just to name a few. The assembly of AVALANCHE allowed for us to notice defects in our build and resolve those.

Once AVALANCHE was ready to be tested, more issues within our build became apparent, and necessary modifications were made. Our results from testing showed how efficient and powerful our gear intake was. At the same time, AVALANCHE had some issues, one of them being that it was sometimes *too* powerful. As the rollers were rotating at a high speed, the gear would fly out of our intake on multiple occasions. To resolve this issue, supports would be added to keep the gear from going into freefall.

We learned three major lessons from this project:

1. Do not wait until the last second to complete tasks. If you do this and you're in a group project with someone, the majority of the work will most likely be dealt by that person.
2. The importance of asking questions. Before completing this project, asking questions and working with males was uncomfortable. After working with Cam and Sebastian, though, I realized how useful communication is.
3. Do not give up! Many times during the CAD, manufacturing, assembly, *and* testing stages, we felt defeated after our design wouldn't seem to be coming together. With help from our mentors, we gained our hope back, and continued work on our gear intake.

Works Cited

4481 Team Rembrandts 2017 Robot Reveal - Steamworks. (2017). Retrieved from https://www.youtube.com/watch?v=yFXGRE5xvGA.

FIRST. (2017). 2017 Game & Season Manual (Steamworks).

National Aeronautics and Space Administration. (n.d.). Robotics Alliance Project -- Robotics Design Guide.