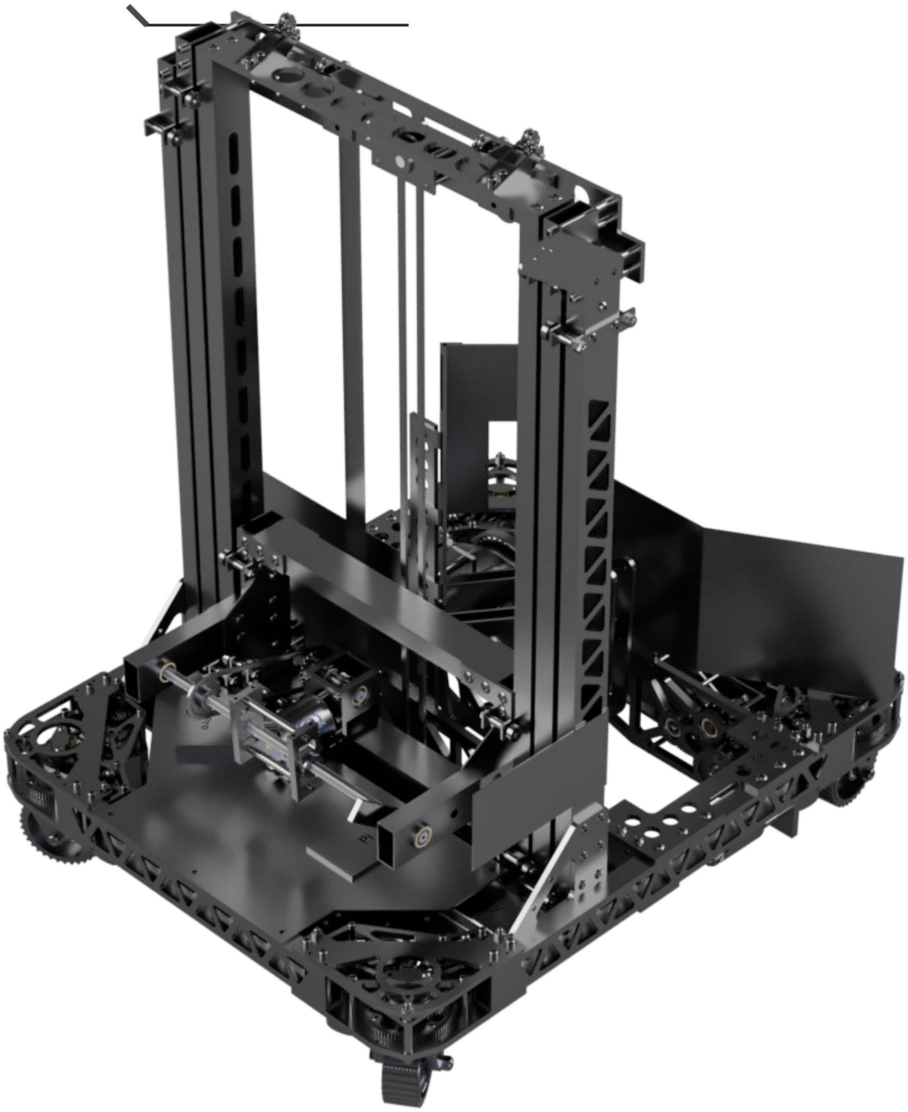

Gunn Robotics 192 Technical Binder

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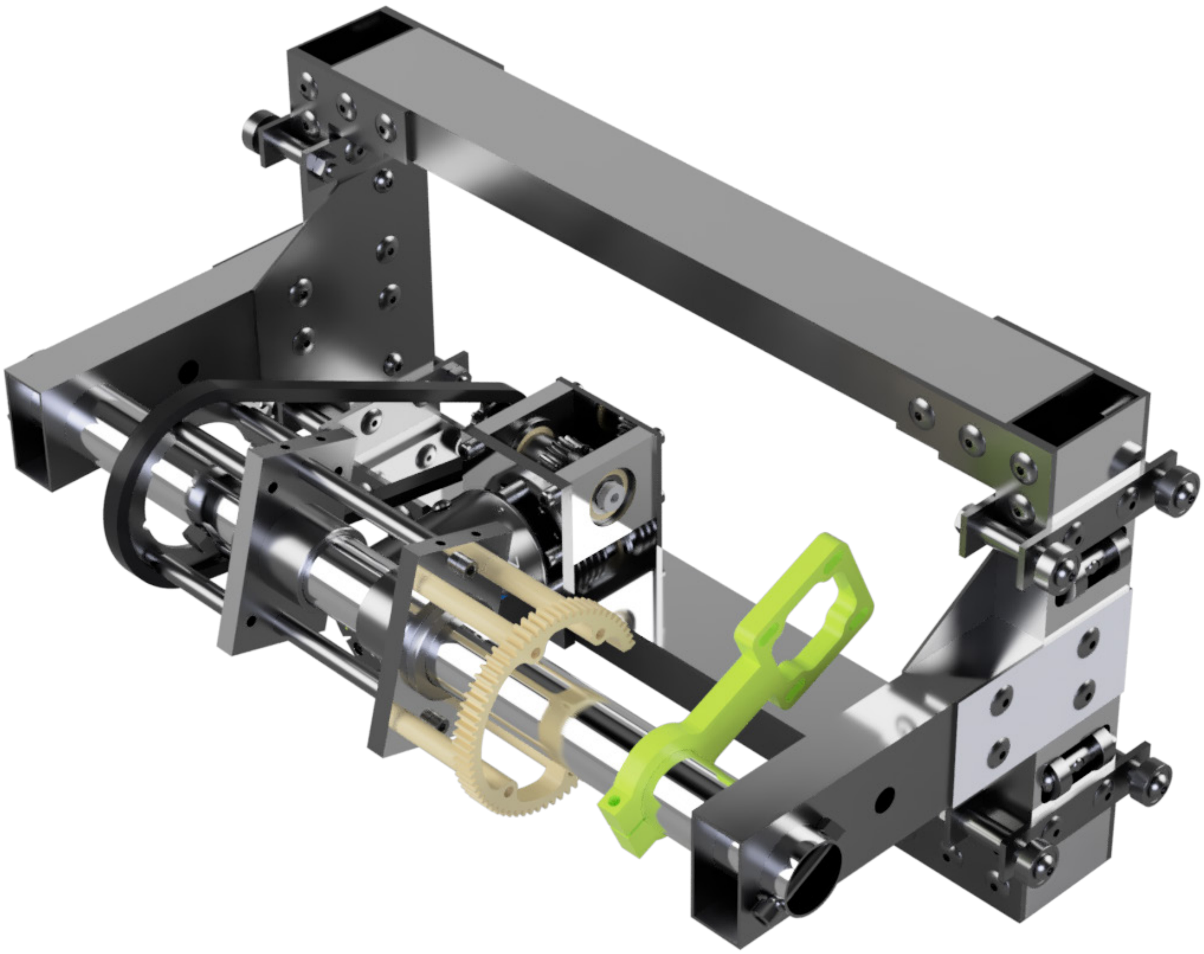
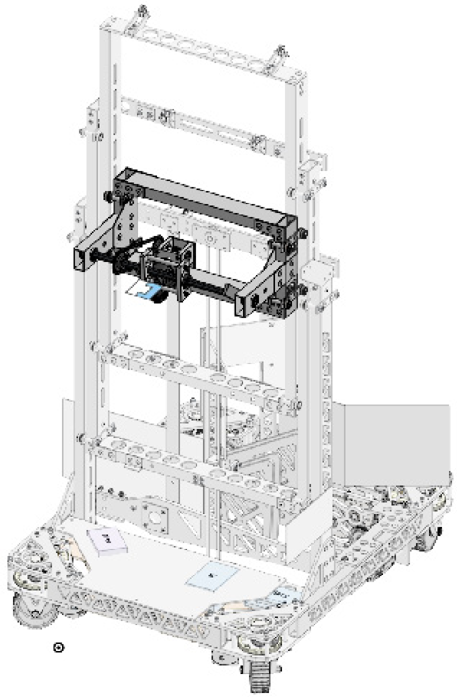
MECHANISMS

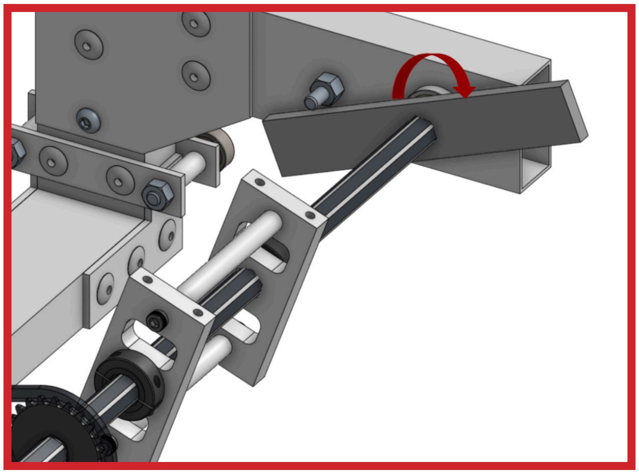


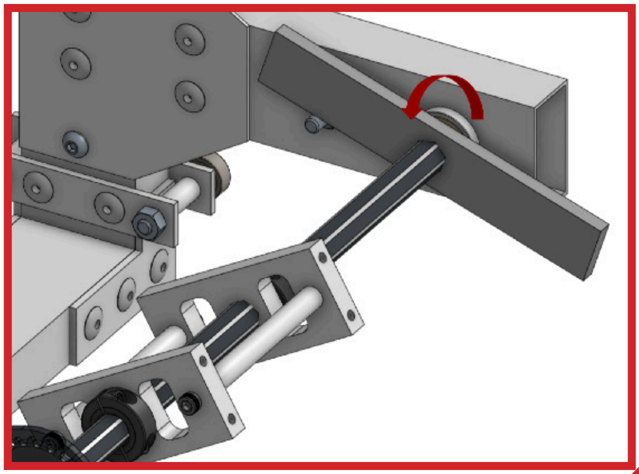
Introduction

Our pivot mechanism turns our intake up and down to dispense and pick up game pieces. It also allows the intake to stow within the robot's perimeter at the start of the match. Our pivot is built into the carriage (third stage) of our elevator so that the intake can change height in addition to pivoting.



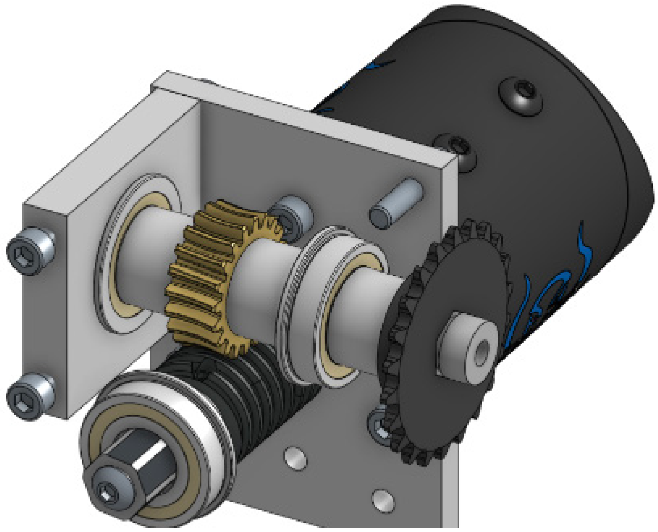
The pivot utilizes a hard stop to allow the intake to rotate between -10 degrees from vertical and 160 degrees from vertical. This ensures that the intake does not hit any of our other mechanisms and expensive components.





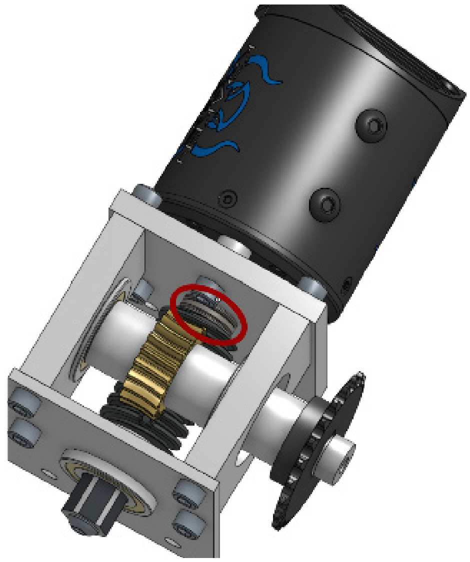
Gearbox

Our pivot mechanism is driven by a gearbox that uses a Kraken X60 motor and a 20:1 ratio worm gear and wheel.

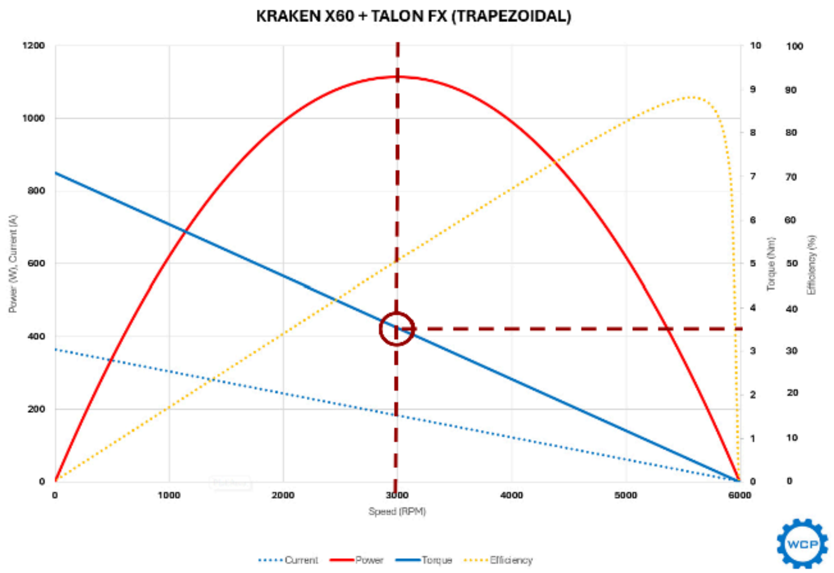


Features

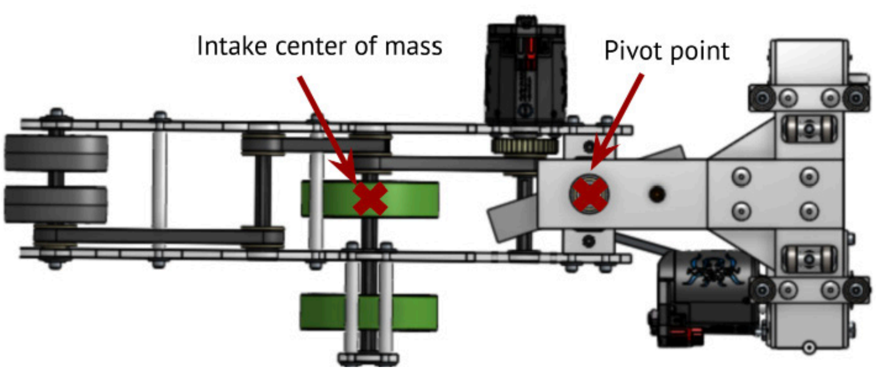
- The worm gear mechanism is not back-drivable, meaning the intake cannot move except when the motor moves. This means the intake will stay in whatever position it rotates to and will not be moved by other forces like gravity without stalling the torque.
- The 20:1 gear ratio allows us to rotate our intake and whichever game piece it is holding without needing to run our motor at maximum power
- The worm on the motor shaft experiences axial load from the wheel when running which is a strain to the motor. We added a thrust bearing on the motor side to alleviate any axial load from the motor.



Gear Ratio Calculations



- Input torque ≈ 3.5 NM (≈2.6 lb-ft)
- Output torque = weight of intake + game piece x distance from intake center of mass to pivot point.
- Intake mass ≈ 7.7lbs, game piece mass ≈ 2lbs → Total mass ≈ 9.7lbs



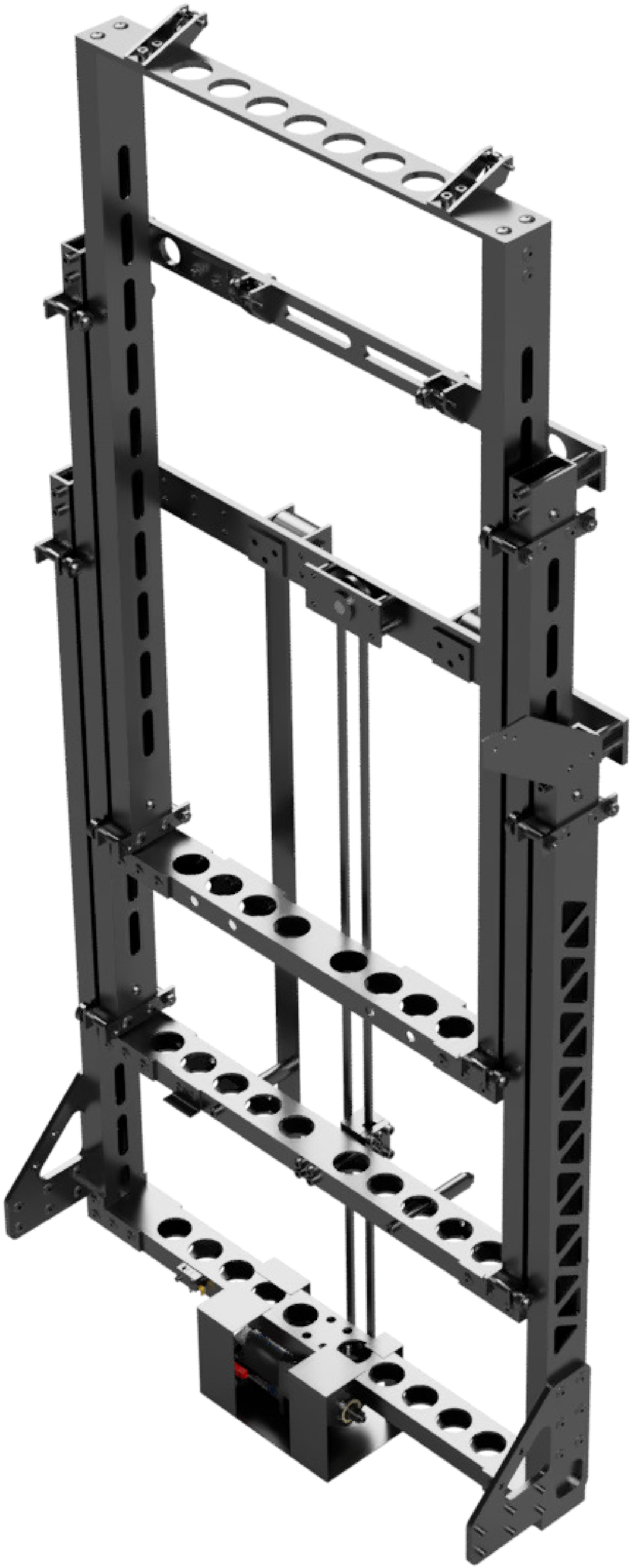
- Distance between intake center of mass and pivot point ≈ 6.45in
- Output torque = 9.7lbs x 0.5375ft ≈ 5.2 lb-ft

$$GR = \frac{\tau_{out}}{\tau_{in}} = \frac{5.2\ lb\,ft}{2.6\ lb\,ft} \approx 2$$

These calculations show the intake only requires a gear reduction of 2:1 if we run the motor at max power. Running the motor at max power is inefficient because it consumes more current and power from the battery, making other mechanisms harder to run in parallel.

Benefits of Higher Gear Ratio

As previously mentioned, we used a 20:1 gear reduction. This allows the motor to run at both low power and high precision. Higher torque also means faster angular acceleration, which translates to the pivot moving the intake faster to a desired angle.

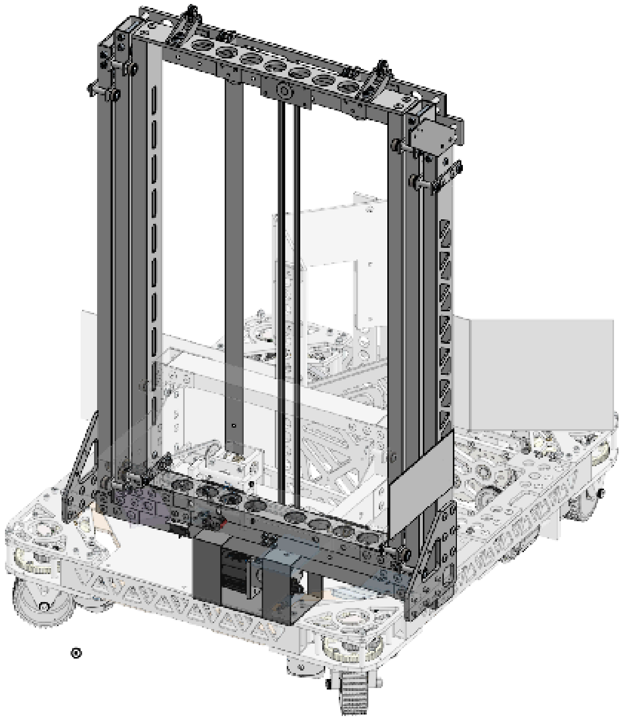


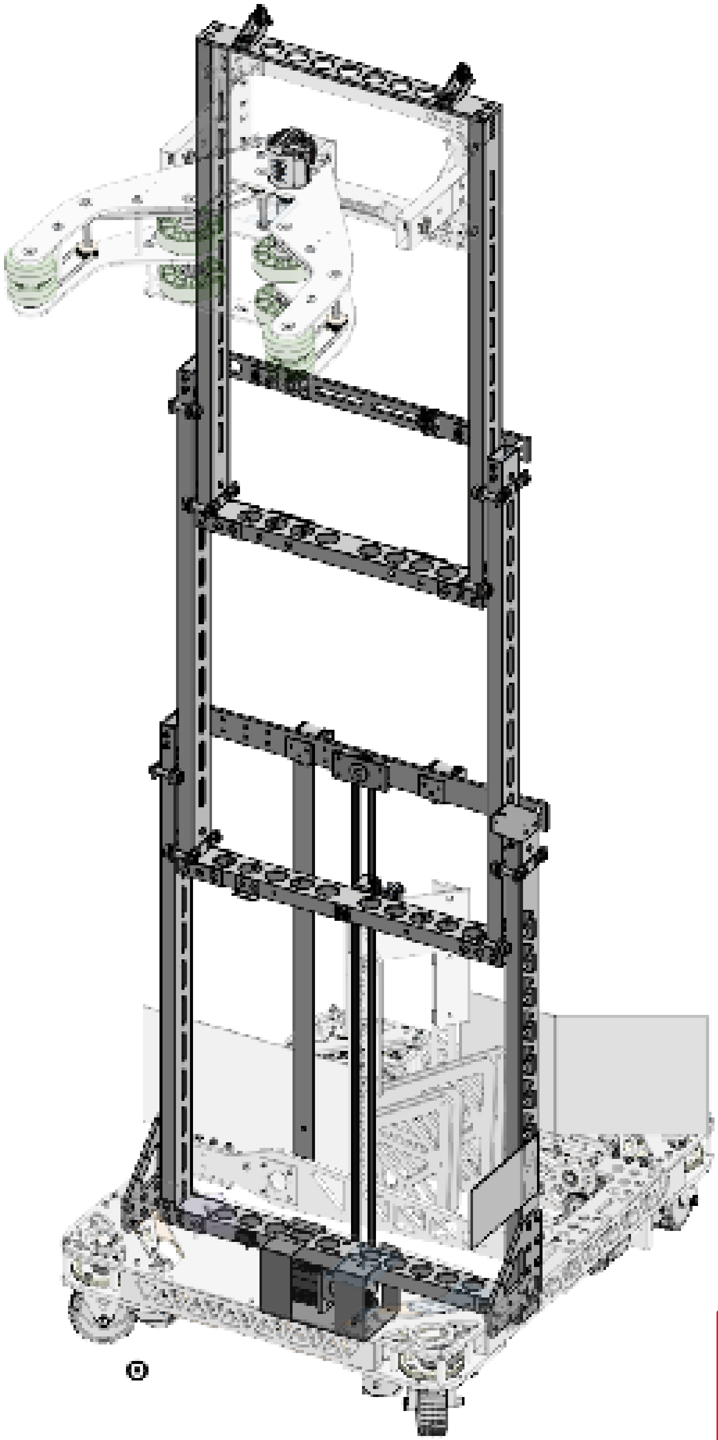
Introduction

Our elevator mechanism raises and lowers the pivot and intake mechanism, allowing it to collect and score game pieces from all necessary heights. Our elevator has three stages allowing it to reach a max height of 6 feet.

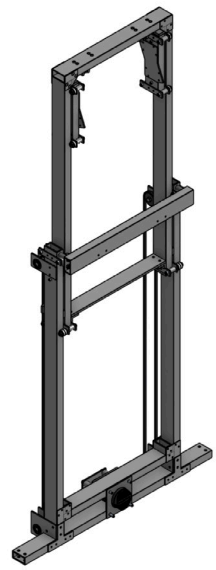
Deliverables

- To score on L4, we needed our elevator to extend to reach a height of six feet.
- Design an elevator that could lift the intake and pivot with speed and reliability
- Improve upon last years design to improve the rigidity and to make it less of a mechanical burden
- Focus on stricter tolerances to ease the assembly process and allow for a smoother elevator



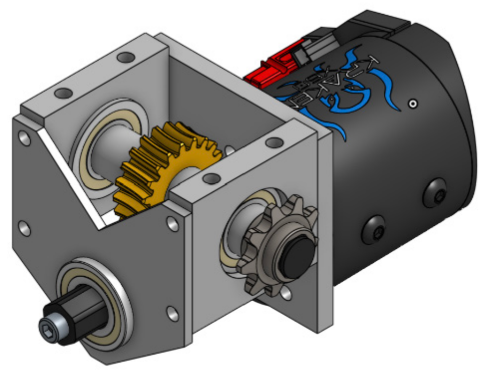


Features



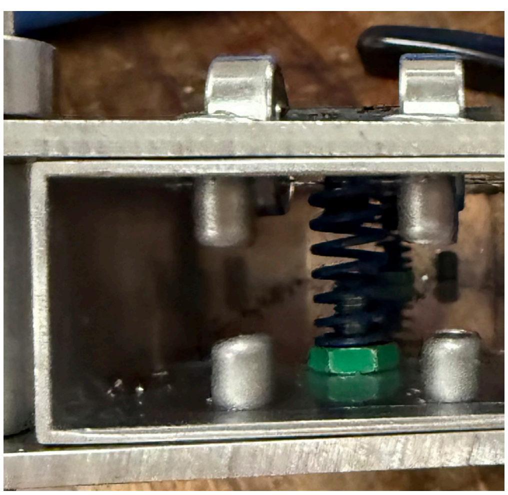
Our R1 design involved just two stages due to the simplicity of the design. This allowed us to minimize the necessary machining and assembly time.
The elevator's first stage utilizes a chain and the two other stages are cascade strung.

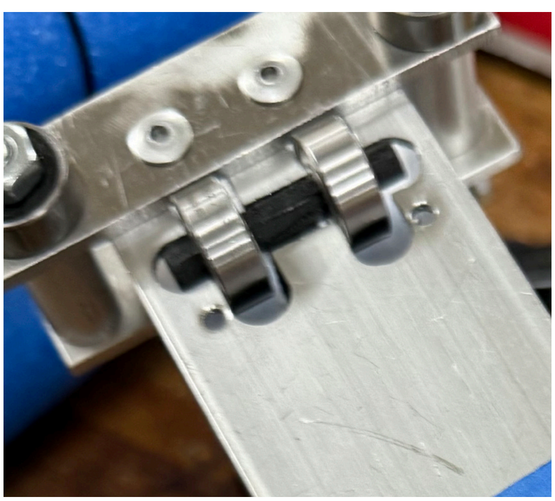
Eventually, however, for our final design, we settled on using a three-stage elevator to achieve the necessary height more easily, and then we used string on stage 3 too.

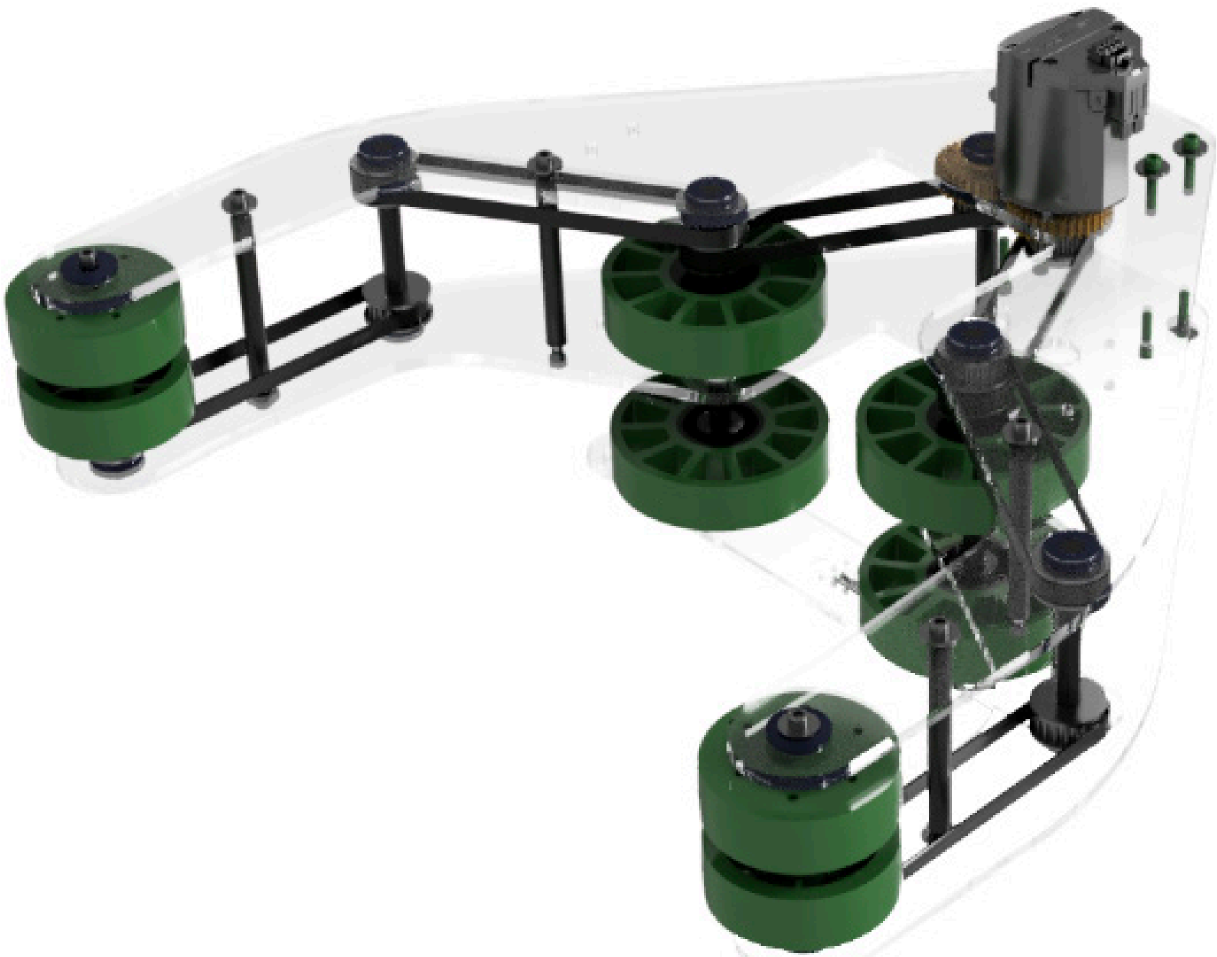


We implemented a worm gearbox to prevent backdrivability so the motor doesn't have to stall to hold position and to allow for higher gear ratios. Vulcan springs provide constant spring force up to reduce the load on the motor.

We also used springs in our elevator design to help insure constant contact w/ the sides of the elevator, helping with reliability and allowing for the elevator to take a hit and still be able to run.



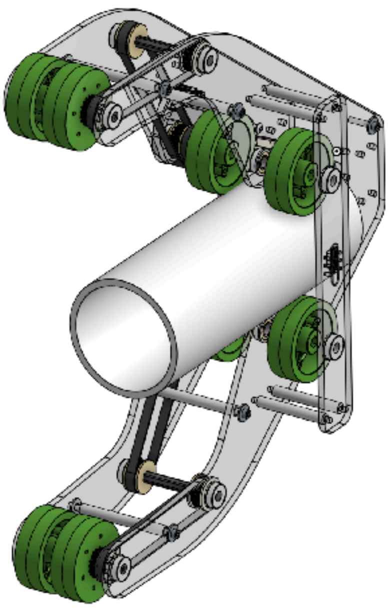




Overview

Our intake mechanism is designed to collect, hold, and score coral and algae. It is attached to the pivot mechanism, and the pivot is attached to the carriage of the elevator mechanism. This allows it to adjust its angle and height so it can score in all coral levels, the processor, and the net.

The Details



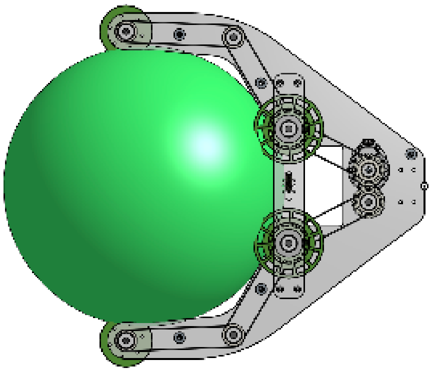
It is made of 0.25” thick polycarbonate plates cut out to match the contour of the algae, enabling the acquisition of both algae and coral from their respective stations.

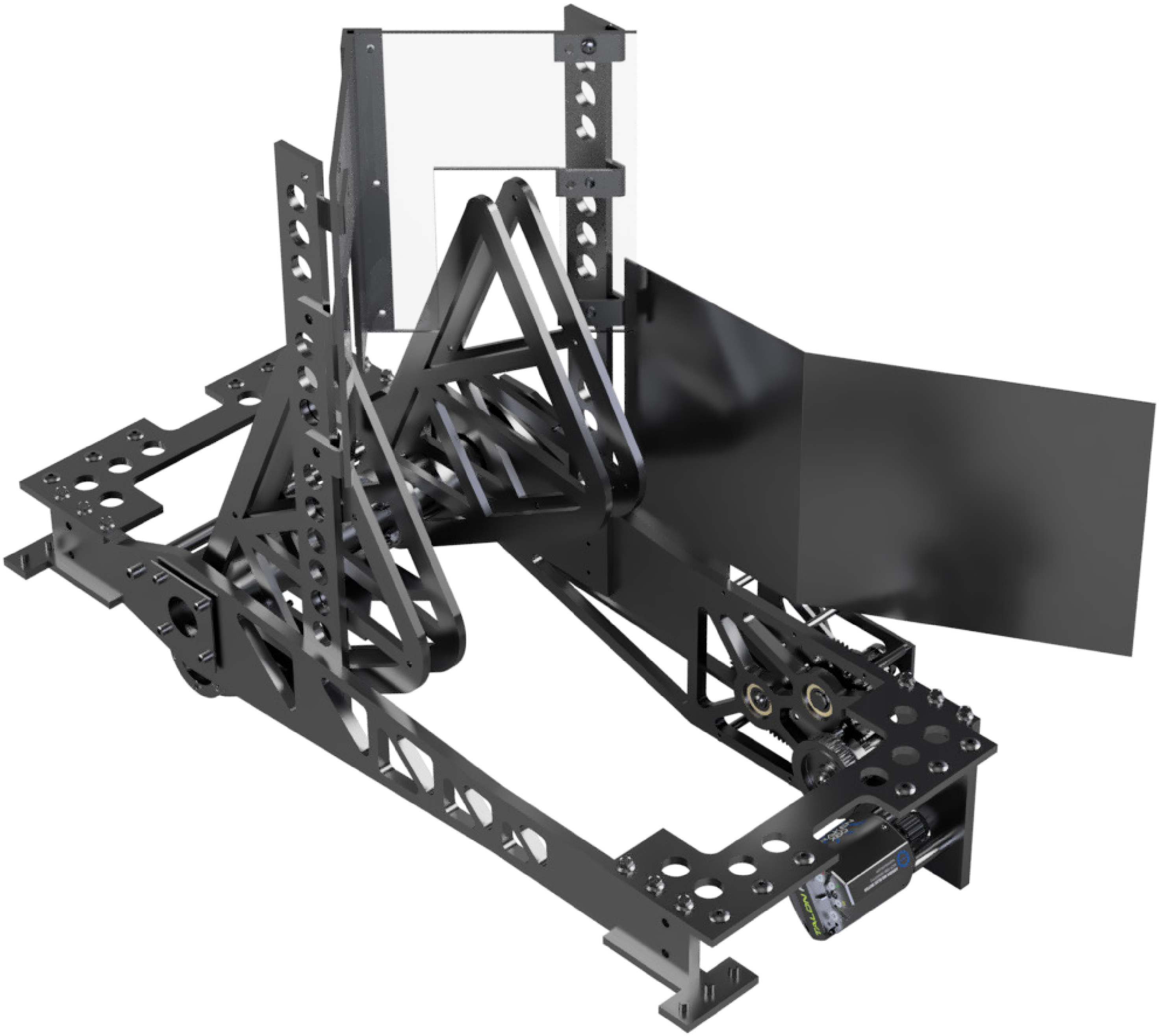
A (split plate system) increases the strength of the whole intake because of the shorter axles, which decreases the amount of deflection that the axles will be exposed to. The smaller split plate system lowers the weight and allows the intake to be more compact, enabling the intake to access tighter spaces.

All wheels are powered by one belt system, using spur gears to reverse the belting direction. Both algae and coral intake are run from the same motor.

A distance sensor mounted on the bottommost plate of the intake tells the robot when it has intaken a game piece, vastly simplifying the required driver input.

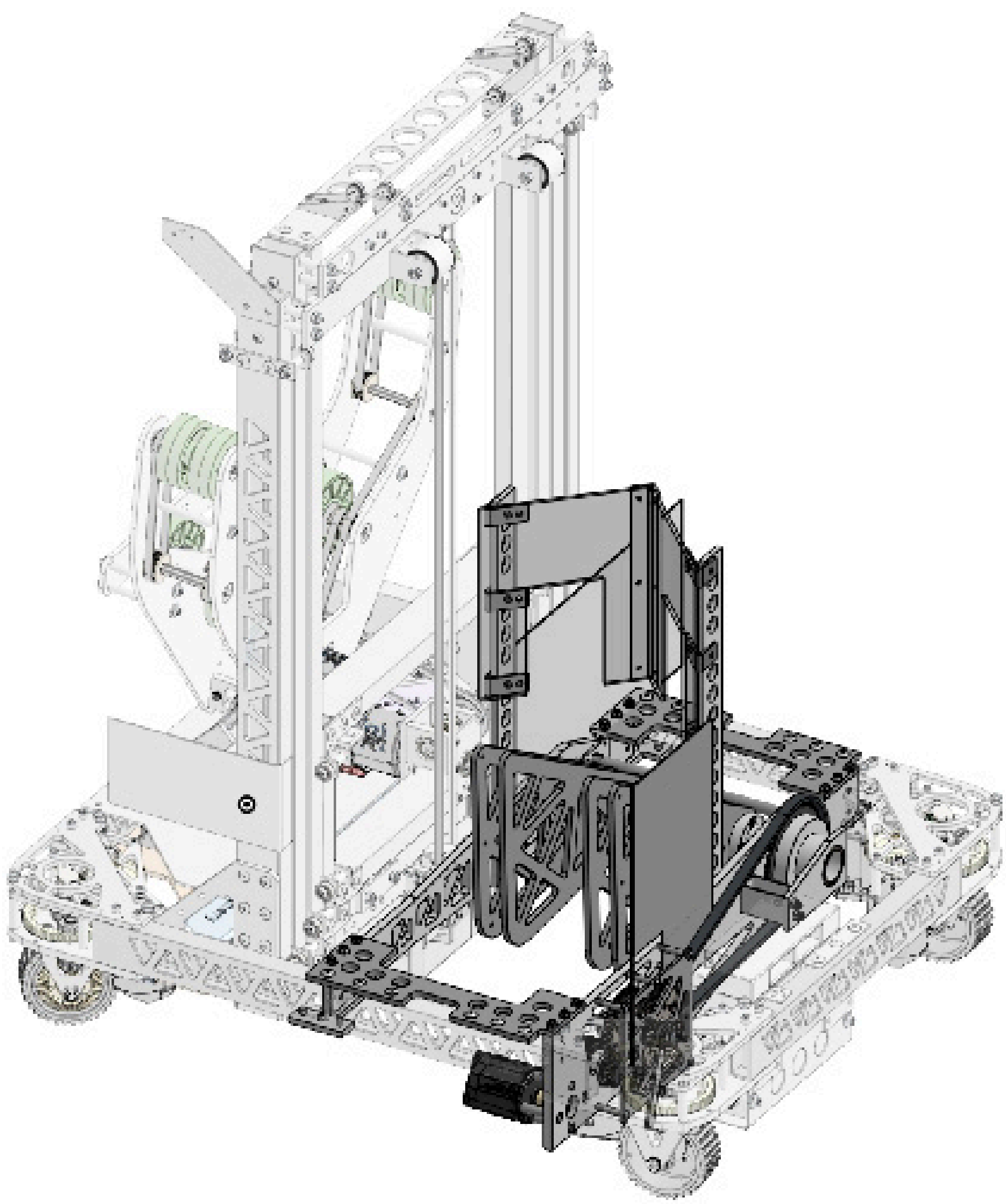
Kraken X60 motor is used to power the belt and pulley system to intake the game pieces.





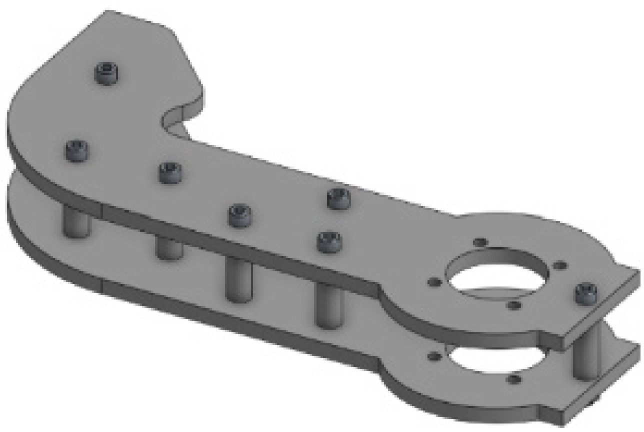
Introduction

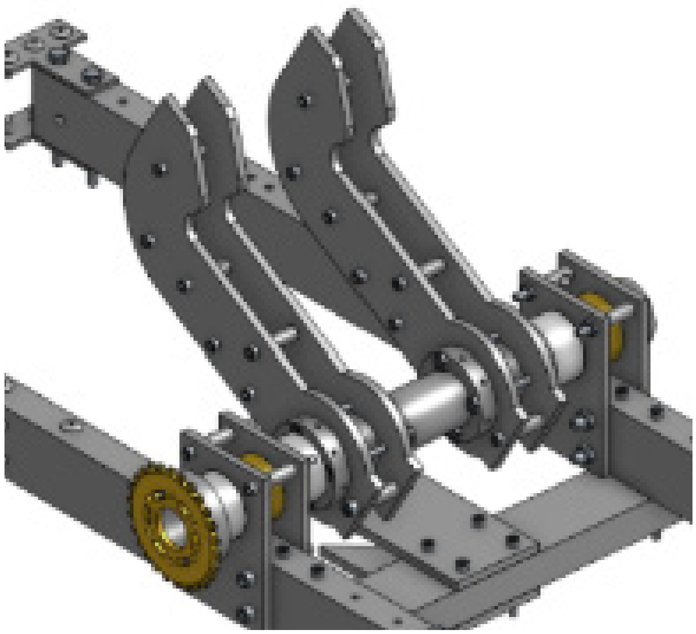
Our climb mechanism is designed to use hooks (originally "Candy Canes," later refurbished into "Orange Slices") to complete a deep climb. When run, the Orange Slices, fixed to an axle, rotates downward, pressing down on the base of the cage and lifting the robot up. We use a gearbox with a chain and sprockets to transfer the power from the motor to the axle-Orange Slice assembly. The climb mechanism is mounted to the base of the robot and does not interact much with the rest of the main mechanisms.



Prototyping

Origianally we used a candy cane shape to push down on the cage because they could easily withstand the amount of force required. Made out of 1/4" thick sheet metal and 7 standoffs a pair, these were not going to break under the pressure

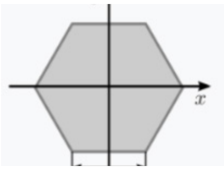




Deciding the Candy Cane Axle

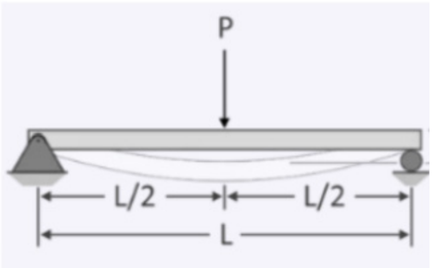
Initially we chose to use a hex axle to secure the candy canes. We started by using the Beam deflection formula to determine whether this would be feasable or not.

- Assuming a load of 135lbs (maximum robot weight)
- Modules of elasticity of Aluminum is 68.9 GPa
- The beam spans a gap of 9.5"



$$I_x = \frac{5\sqrt{3}}{16}a^4 \approx 0.54126a^4$$

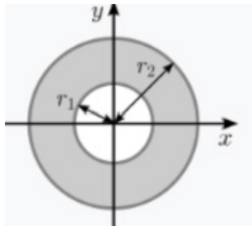
$$I_y = \frac{5\sqrt{3}}{16}a^4 \approx 0.54126a^4$$



$$\delta_{max} = \frac{PL^3}{48EI}$$

Plugging all of this into the formula we get a maximum beam deflection of 0.0642" which is far above the tolerances we can allow. The hex axles were not going to work.

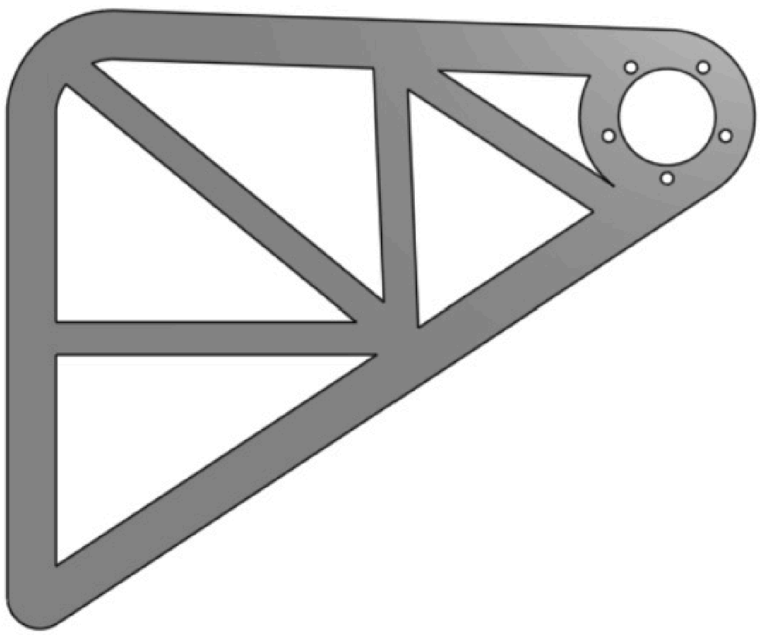
Our solution was to use tubes.



$$I_x = \frac{\pi}{4}\left(r_2{}^4 - r_1{}^4\right)$$
$$I_y = \frac{\pi}{4}\left(r_2{}^4 - r_1{}^4\right)$$
$$I_z = \frac{\pi}{2}\left(r_2{}^4 - r_1{}^4\right)$$

Applying the same calculation we get a maximum beam deflection of only 0.0002064". This is much better.

Additionally we found that because the candy canes only contacted the cage at a single point, it caused the robot to be unstable in the climbed position. To solve this issue we switched to "Orange Slices" Using onshapes stress analysis we determined this shape is still strong enough while still having a large surface area to rest on.



The Gearbox

We used a combination of pulleys, spur gears and sprokets to achieve a total gear ratio of 133:1. Additionally we decided to impliment a ratchet because we only wanted the gearbox to rotate one way. The ratchet allows us to easily reset the mech.