Operation P.E.A.C.C.E. Robotics
2025 Technical Binder

REEFSCAPE℠

PRESENTED BY HAAS Gene Haas Foundation

OPERATION PEACCE 3461

4-H FIRST ROBOTICS TEAM 3461

Forward

This document was created for the purpose of documenting and demonstrating the mechanical processes used for designing and building Team 3461's 2025 FIRST Robotics Competition robot for Reefscape presented by Haas.

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Planning

Before kick-off, we analyzed our previous seasons and current circumstances. Last year, we did well with awards and team structure but faced design troubles. We overemphasized constraints, which skewed our robot design smaller, making iteration difficult. We also had changes in our manufacturing capabilities. The team no longer had access to our primary construction technique: laser cut sheet metal. It was clear we would need to adapt as a team for the next season.

Given our limits, we decided that unless expressly required by the game, we would use 4 MK4i swerve modules and a standard swerve setup for our drivebase. We would also use fabrication we knew, including REV MAXtubing, 2.5 axis CNC machined polycarbonate, and 3D Printing, where possible.

At Kickoff on January 11th, 2025, Team 3461 assembled to watch the game reveal. After the reveal, we read through the game manual in groups. As the details of Reefscape became apparent, we began planning out the build season schedule. Our first task was prioritizing the game's elements into a weighted list. This focused our brainstorming and shaped our schedule for the build season and beyond.

NEED	WANT	WISH
• Human Player Interaction • Score CORAL on Level 1 • Remove ALGAE from REEF	• Score CORAL on Level 2-4 • Climb the CAGE • Pickup CORAL from the ground • Multiple Autonomous Paths	• Multi-Role Mechanisms • Score ALGAE in the PROCESSOR • Score ALGAE in the BARGE

We approach our build season with the following mindset:
Engineering is an ongoing and iterative process,
A solution is never final; the best can always be improved and our designs optimized.

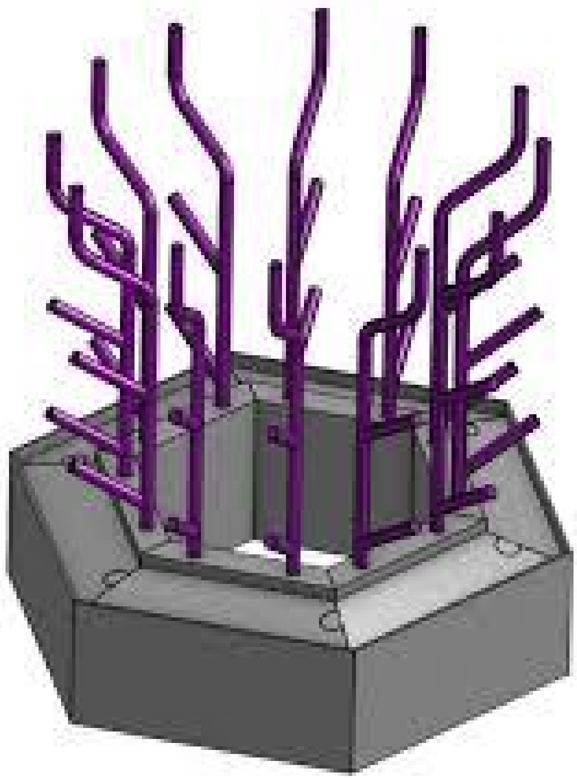
Robot design began with prototyping. We used Maytec aluminum extrusion to model the REEF. This gave us an idea of what scoring on the REEF would entail.

We studied how different wheels and their spacings interacted with ALGAE and CORAL. Maytec, bearing plates, and shafts from previous years' robots made prototyping easy.

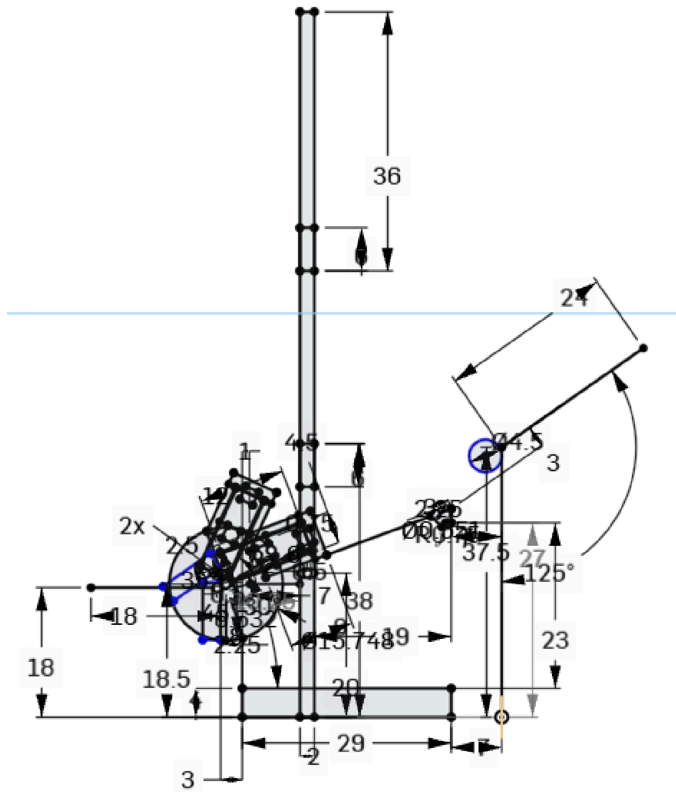
Design Process

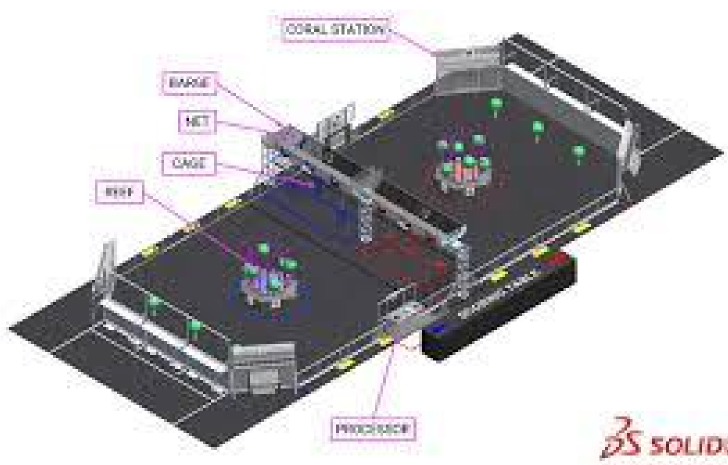
We broke into groups and created 3 concepts. We then dissected the concepts into subsystems to analyze.

We identified a jointed arm and an elevator for vertical movement of game pieces. A clam gripper, suction, and wheels for active game piece interaction. A funnel and a post for passive game piece interaction.



From this categorical list Team 3461 identified the need for a lift as the most practical subsystem for the ranging heights of scoring. Powered wheels were the best for game piece interaction. From this we began prototyping each subsystem, finding optimal angles and distance. Tools such as belt and powertrain calculators, 3D stress analysis, CAD, and knowledge from other teams guided our design process to our final product.





Final Design

For the 2025 season, Operation P.E.A.C.C.E Robotics presents Axleotl!

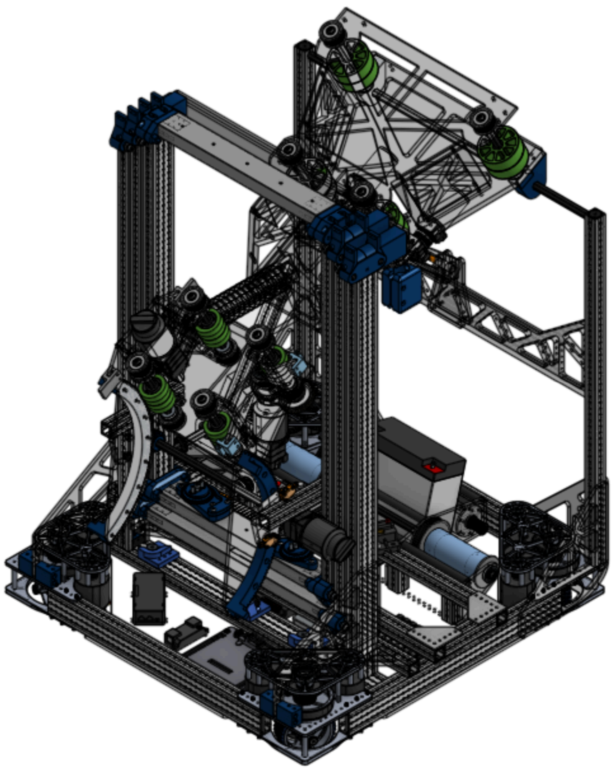
To create Axleotl, Team 3461 kept our main objectives in mind. Scoring CORAL quickly and accurately. To accomplish this purpose, Axleotl picks up CORAL exclusively from the Human Player Station with its Funnel mechanism. The Funnel loads the CORAL into the End Effector on the opposite face of the Robot. This was chosen to prevent the driver from having to rotate the robot base from Load to Unload, especially considering the short distance from the station to the REEF.

Team 3461 primarily built Axleotl out of materials such as Lexan polycarbonate, box tubing, and aluminum.

FEATURES

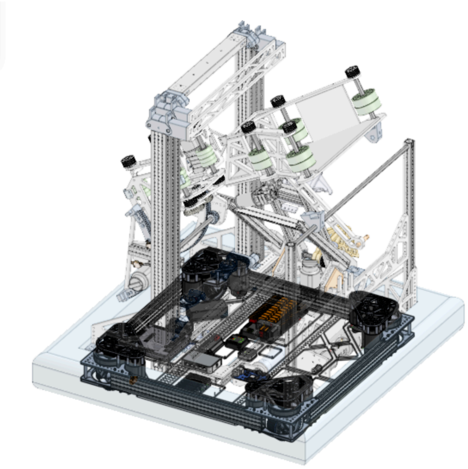
- MK4i Swerve Drive
- Level 4 CORAL Scoring Mechanism
- Human Player Station Load Mechanism
- Deep Cage Climb Mechanism
- Algae Removal Mechanism

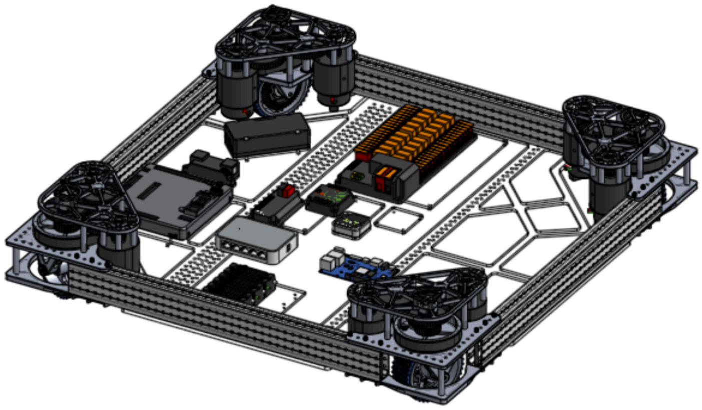
- Dimensions
    - Frame: 29.5” x 29.25”
    - Height: 41.5” (Starting Config)



Drive Base

This year, Team 3461 elected to use the MK4i Swerve Drive Modules from Swerve Drive Specialties, with Level 2 Gear Ratios, which provides us a 14.5 ft/sec top speed. The 4 modules are powered by two falcon 500 motors each and connected using 2” x 1” MAXtube extrusion. This box tubing is perforated with a hole pattern on all faces for easy and consistent mechanism attachment. The belly pan holds electronics between the modules for organization and accessibility.





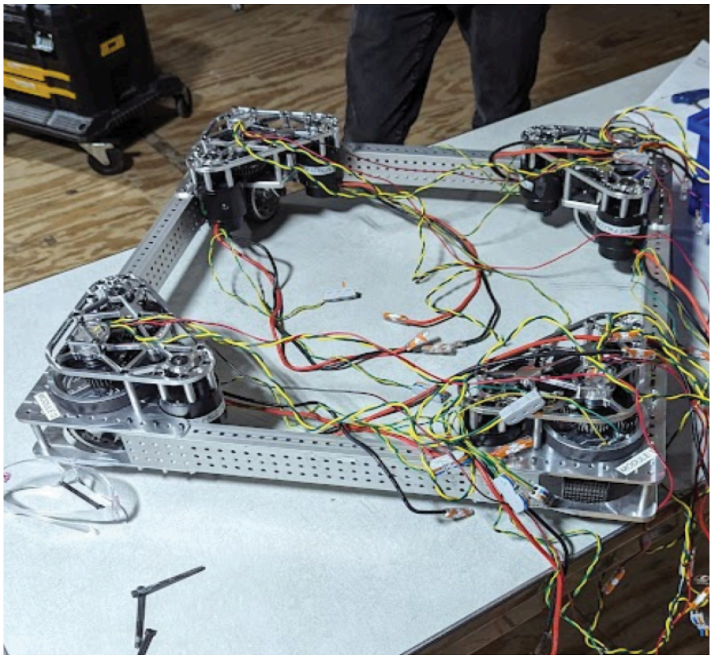
Overview

When creating the robot, the first step involves the drive train. As the base of the robot, we wanted a drive train that is easy to repair, customizable for different sizes, and competitive on the field. After much deliberation, Team 3461 decided to orient towards a swerve drive base. As a swerve drive train, we can maneuver with ease because of our SDS MK4i swerve modules, without sacrificing robot volume or size.

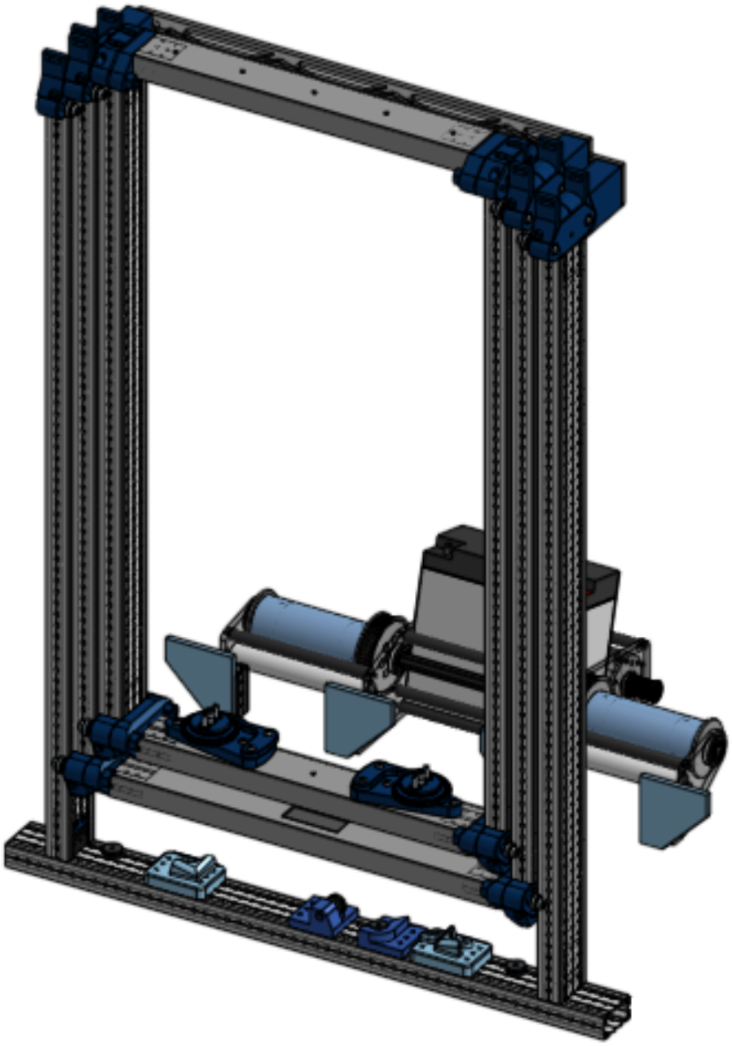
DESIGN

- 4x SDS MK4i Swerve Modules
  - 8x Falcon 500 motors
  - L2 Gear Ratio
  - 14.5 ft/sec
- 29.5” x 29.25” Frame Perimeter
- Pigeon IMU 2 for Odometry

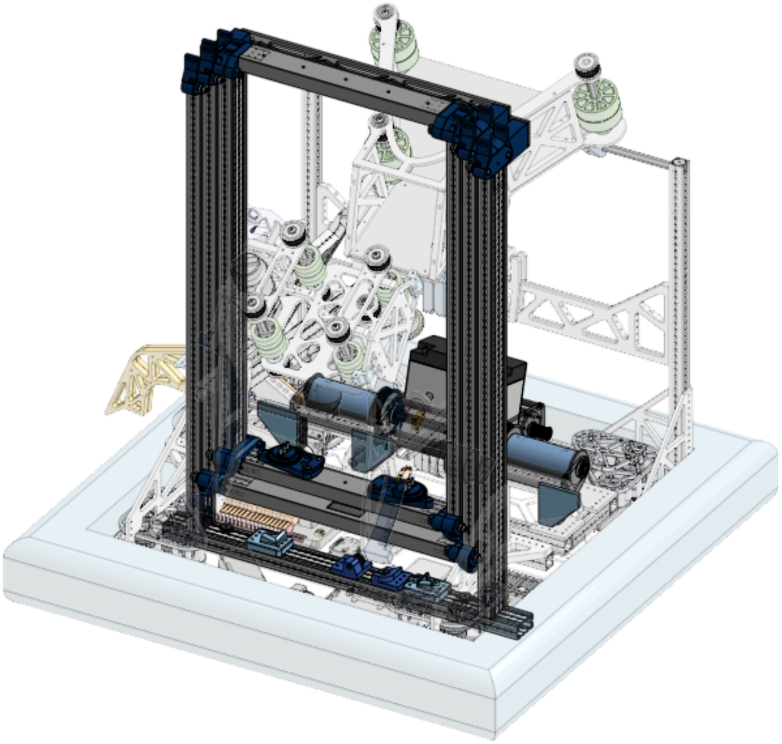
- **Why Swerve?**
  - Maneuverability
  - Serviceability
  - Flexibility



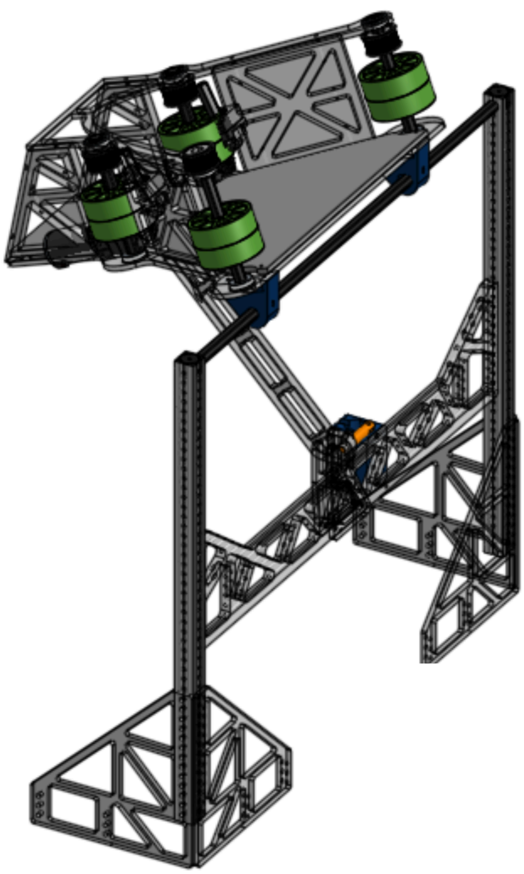
Lift



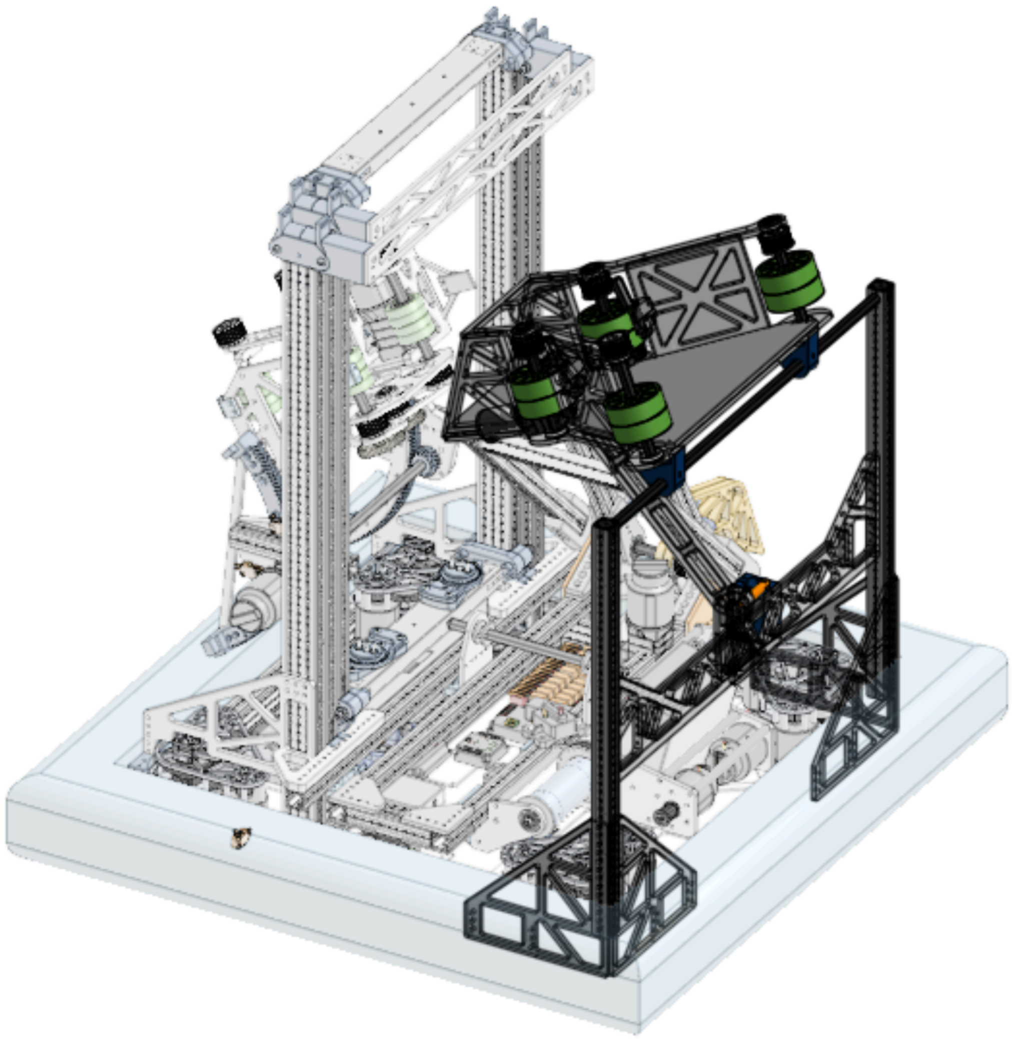
The lift of Axleotl is constructed of MAXtube, 3d printed bearing blocks, polycarbonate plates, aluminum spools, and standard hardware. The lift is powered by two falcon 500 motors and zeroed by a REV magnetic limit switch. Spools in the back pull on two cables to extend and one cable to retract the lift. The cables are tensioned by custom 3D printed ratchet spools and wind on opposite sides of the winch to ensure simple and reliable operation. The bearing blocks are also 3D printed from PETg carbon fiber filament, R4 ball bearings click into the face and screw into the sides of the blocks to ensure smooth operation. Fairlead blocks and internal rigging guide cables between box tubing members minimize footprint and tangles. Power spools are constructed from aluminum pneumatics pipe which we found to be an ideal material both in size and finish during testing. Our combination of machining, 3D printing, and COTS parts make for a reliable and simple yet highly effective design.



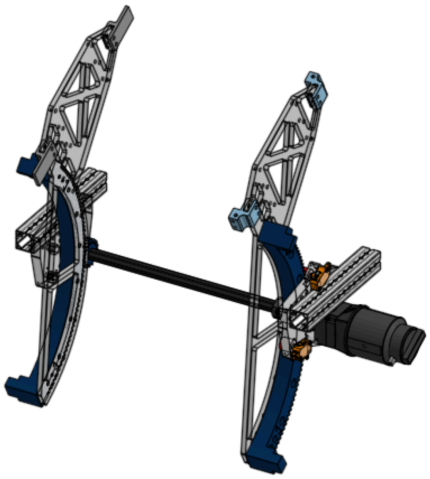
Funnel



The Funnel of Axleotl is made of polycarbonate panels, MAXtube, 3D printed blocks, wheels, and standard hardware. The funnel is powered by two BAG motors and a Johnson Electric PLG motor. This subsystem guides CORAL from the feeder station to the placing mechanism. We used 2.5-axis CNC machining on the polycarbonate and 3D printed components to save weight. We also added a drop system with a pull pin latch to move the funnel out of the way during climbing. The funnel height was found by experimentation to capture CORAL even when there is a game piece between the feeder station and the robot. CPVC sheet makes up the bottom contact surface to maximize game piece slide and minimize weight.



End Effector

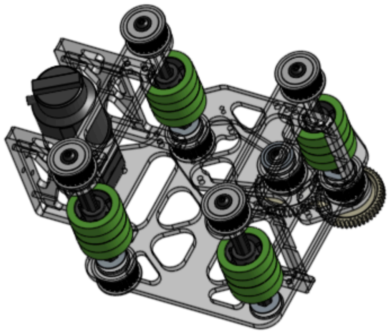


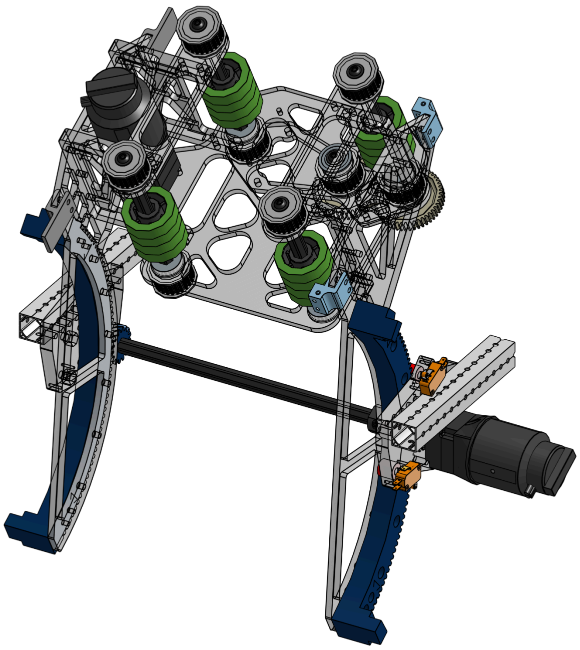
Rotator

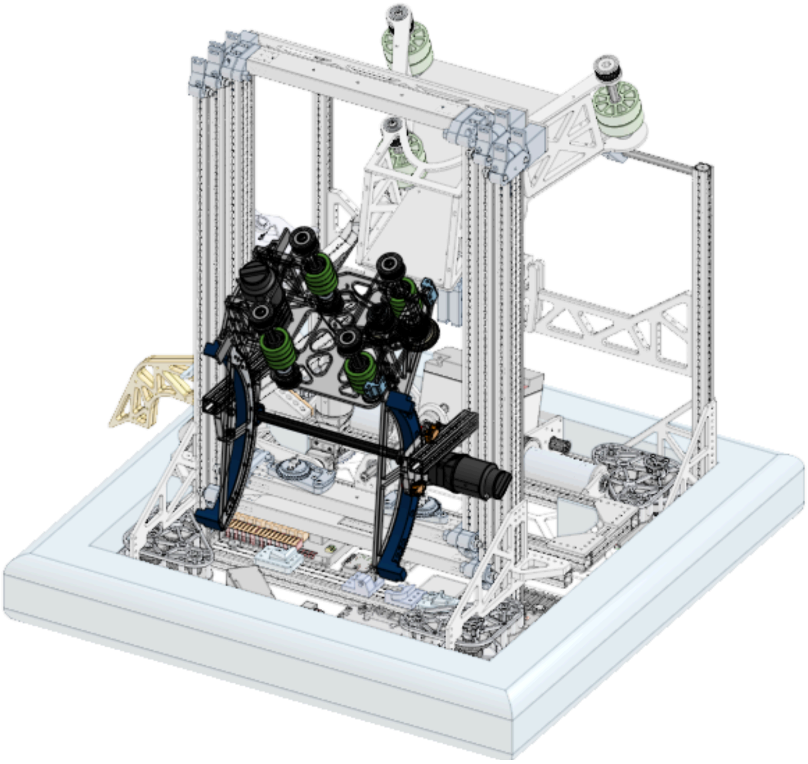
The End Effector Rotator of Axleotl is constructed from polycarbonate plates, standard hardware, and a 3D printed double helical gear. The design is powered by a falcon 500 motor with a separate absolute encoder for accuracy. Thanks to bearings, the main gear acts like a track, allowing the rotator never to connect with its rotation axis. This conserves space and allows the robot to reach outside of its frame perimeter while angling game pieces for placing. Additionally, the removed axis of rotation moves the game piece upward to minimize lift travel for L4 scoring. This design is consistent and durable, moving CORAL outward, upward, and rotationally to position it precisely.

CORAL Placing Mechanism

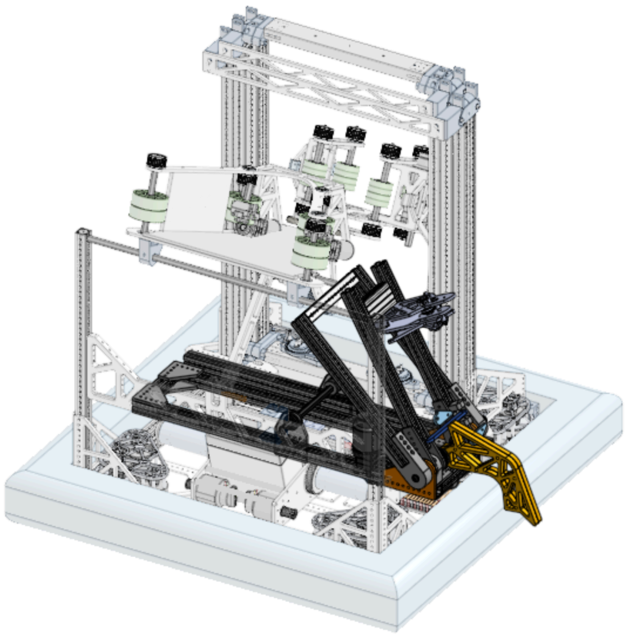
The End Effector of Axleotl is composed of polycarbonate plates, wheels, belts, pulleys, retroreflective sensors, and standard hardware. The mechanism mounts to the rotator and is powered by a falcon 500 on a 5:1 VERSA gearbox. This system holds the CORAL in a precise spot between break beams after intaking, allowing for consistent placement and
ejection after lining up to score.



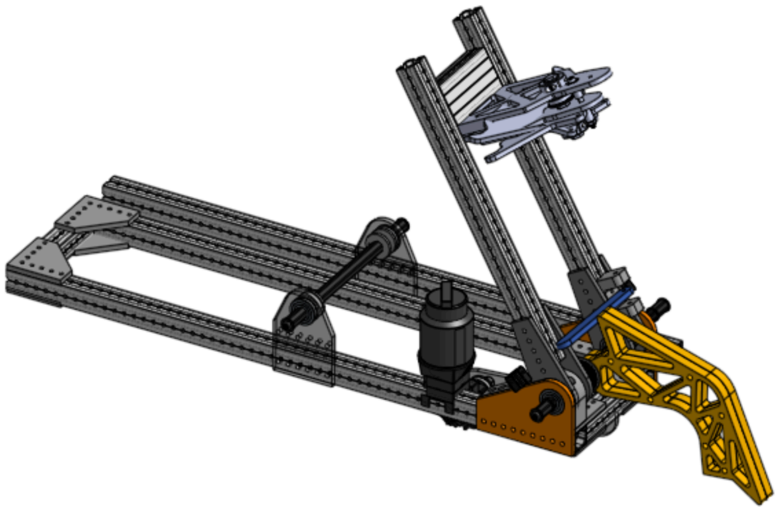


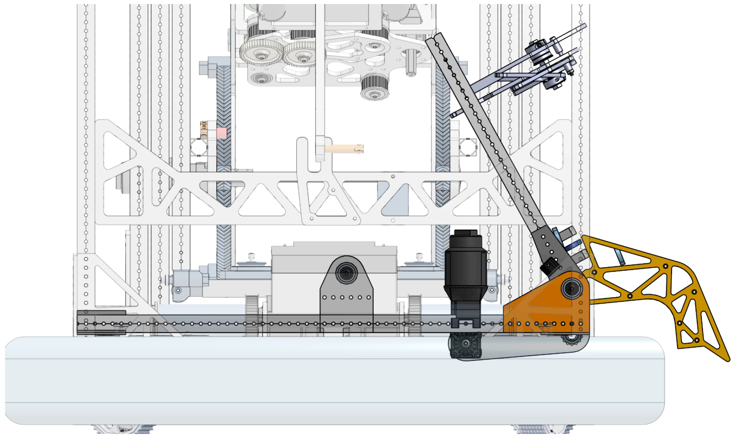


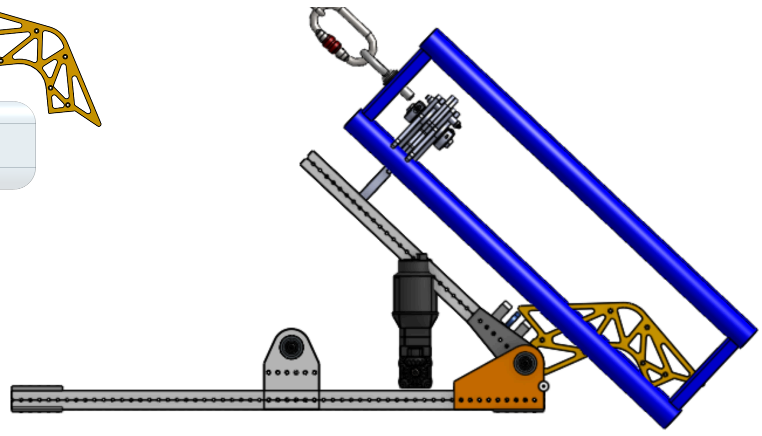
Climber



The climber sub system of Axleotl was designed and altered multiple times, we ended up going with the climber design from the Everybot with some modifications. Our design uses a set of box tubing as the pull down arm and polycarbonate as the interface material between the robot and the cage. In addition to using the base design of the Everybot climber we determined we would also need a reaction bar foot to keep the cage at the right position to keep the chain over the center of gravity in the down position. The mechanism uses a trap door to allow the foot to be deployed outside of the frame perimeter and acts as a support to keep the foot at the desired position relative to the draw arm. The foot reaction arm is driven by a single falcon and has a second falcon set up as a cable winch to draw the arm down when ready.







Service Log

Below, Team Members may log any and all repairs or changes to the robot over the season, because this document is static the service log trumps the documentation.

Name	Date DD - MON - YY	Service Completed

Name Date DD - MON - YY	Service Completed

Signoff And Approvals

By signing this approval form, you state that this documentation is correct and up to date. “Post Event Check” boxes include the Service Log above as part of the “documentation” and signing includes that the service log is up to date and correct as well;

Initial Student Approval: --

Initial Mentor Approval: --

Post MAWNE Event Check: --

Post CTHAR Event Check: --

Post 3rd Event Check: --

Post 4th Event Check: --

Pre-Fair Season Check: --

Hartford District Event Update

General Changes

1. Refine information throughout the documentation to be more accurate.
2. Update CAD renders on pages where changes occurred.

End Effector

The End Effector mechanism had a flogger attached to it in order to allow the robot to remove ALGAE from the REEF. These floggers have a long history of success with Team 3461 and we decided to test one on the ALGAE. We chose this method after observing other teams using wheels attached to their end effectors to remove ALGAE. Knowing how well floggers worked, and the fact that we could easily attach one to the powered shafts on the end effector.

Climber

The Climber mechanism was overhauled between the NE District Western New England Event and the NE District Hartford Event. The mechanism was non-functional at WNE due to the mechanism being unable to extend far enough outside of the robot frame perimeter without external assistance. To rectify this, the team redesigned the climber using a better geometry inspired by FRC Team 3255. This resulted in a new locking mechanism and a new stabilization bar being implemented to allow for faster deployment time, as well as a combined deployment motion. This mechanism functioned to a satisfactory level in testing and allowed us to fulfill all of our design requirements.