



ANGLER



Droid Rage 3035

FRC 2025 | REEFSCAPE



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Overview

Before the season started, Droid Rage was hard at work preparing for the challenges ahead. The team focused on recruitment, restructuring roles, training new members through workshops, strategizing for game season obstacles, engaging in [STEM outreach](#), [mentoring FTC teams](#), and dedicating countless hours to making this the best *FIRST* season yet.

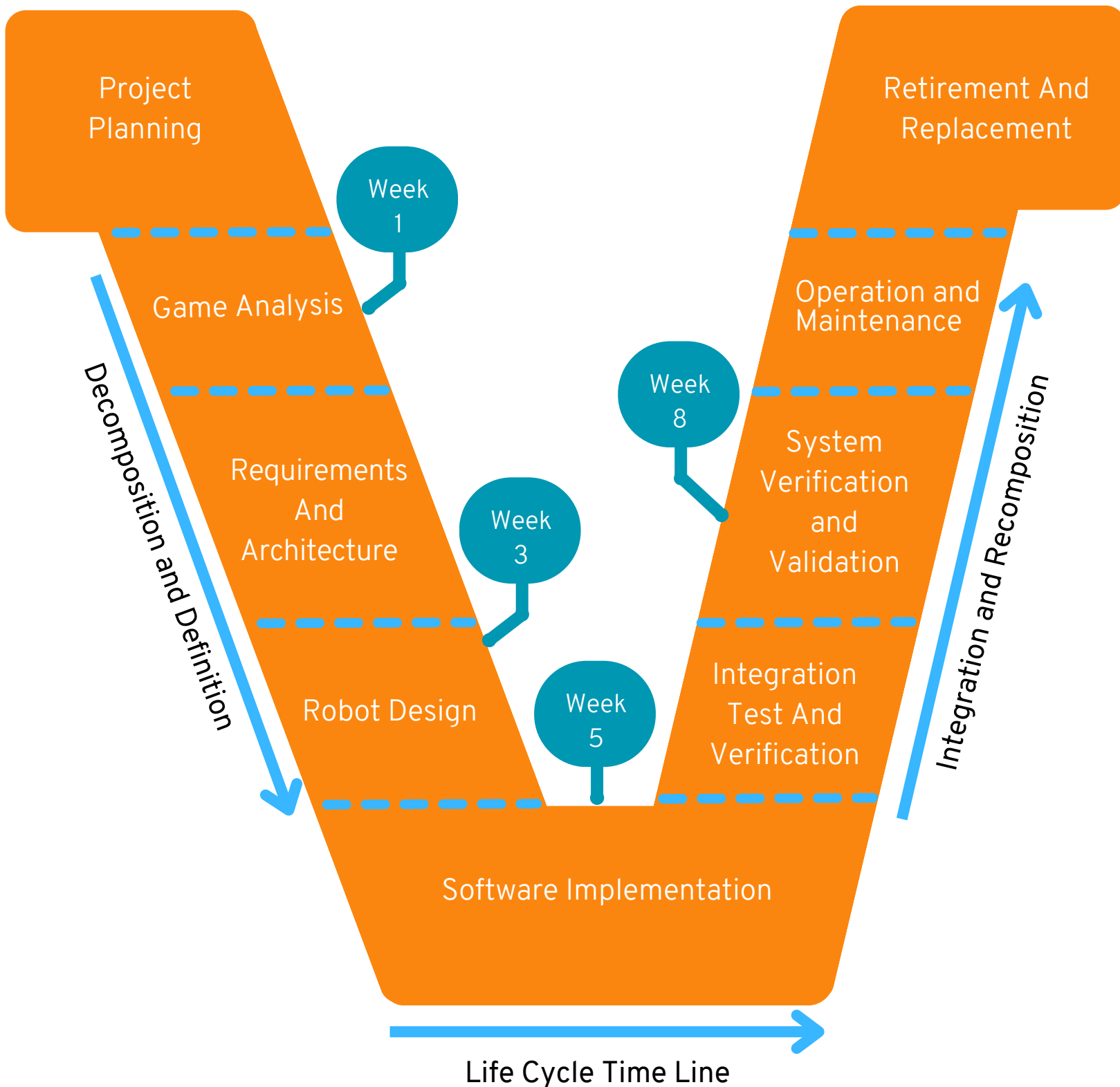
After the 2025 game season challenge, [REEFSCAPE](#), was revealed, Droid Rage team members applied the [Systems Engineering Process](#), following industry standards [introduced by an alumni mentor](#) the previous year. Throughout the season, the team has diligently worked through decomposition and realization processes to develop the optimal design.



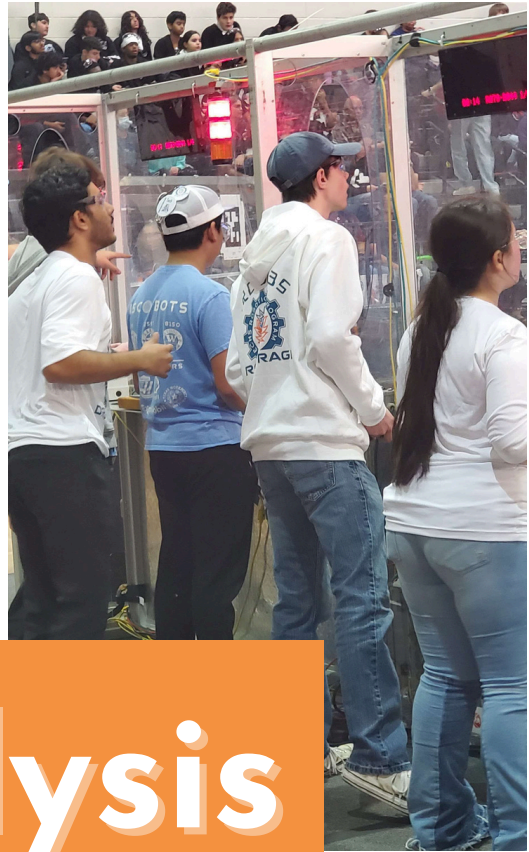
Fun fact: We named it “[Angler](#)” because the green wheel on the algae intake reminded us of an [anglerfish’s glowing lure](#). Just like the fish attracts prey, our design pulls in algae, so the name just felt right!



Systems Engineering



This season, Droid Rage 3035 began the build process through a new approach that was introduced by our teams mentor, Yedhartha Chinnasani, known as the [Systems Engineering Process](#). The process is a structured and interdisciplinary approach focusing on following a series of steps emphasizing on designing, developing, and managing complex systems while considering the entire [life cycle of Angler from concept to retirement](#).



Game Analysis



Game Analysis

Planning



Strategic Planning Process:

- Game Analysis: Carefully reviewed the game reveal and manual to understand objectives, scoring, and regulations, ensuring compliance and strategic advantage.
- Iterative Design with CAD: Developed and refined multiple design iterations using Block CAD and CAD software, collaborating with mentors to optimize functionality and performance.
- Education and Training: Organized sessions to teach team members the game rules, design basics, and technical tools, ensuring everyone could contribute effectively.

Main Goal

REEFSCAPE Scoring and Robot Design:

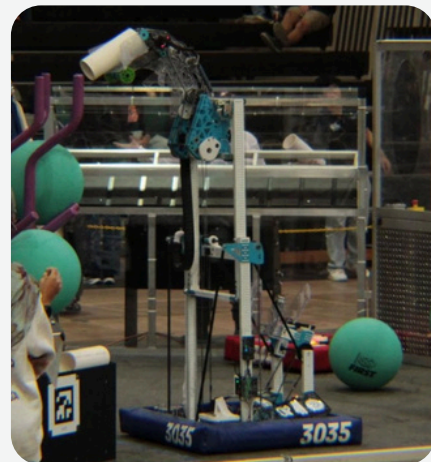
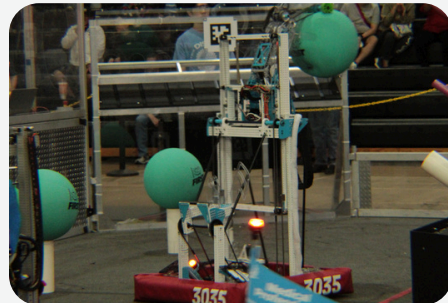
Scoring Opportunities:

- Coral Placement (Levels 1-4): Positioning coral on various levels of the reef.
- Algae Scoring in Processor for Cooperation Bonus and Barge
- Cage Hanging: Securing points by hanging from deep or shallow cages.

Robot Design Focus:

To maximize scoring, Angler is engineered to:

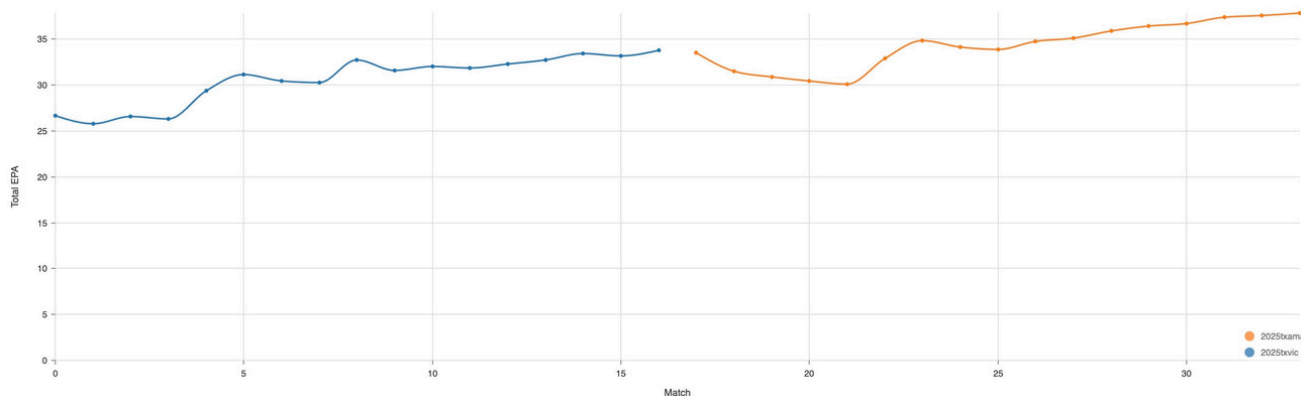
- Handle Coral Placement: Capable of reaching all reef levels (L1-L4) for versatile scoring.
- Score Algae Efficiently: Able to deposit algae in both the processor and the barge for strategic flexibility.
- Master Cage Climbing: Reliably climb from the deep cage in a quick manner.



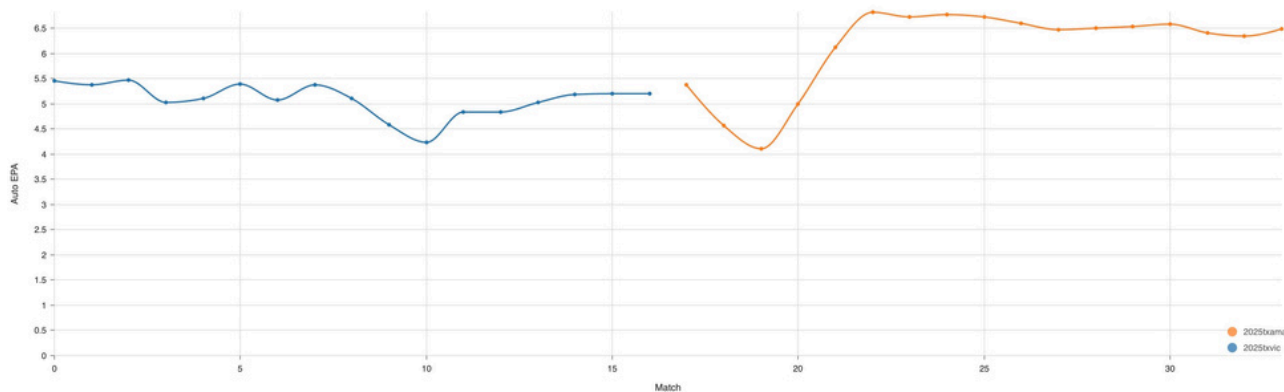
Game Analysis

Throughout the season, Droid Rage analyzes our data from each event. The charts shows the averages of all the ways we score. By creating the graphs, the team is able to assess which scoring mechanisms need to be improved, as well as how the team can improve themselves.

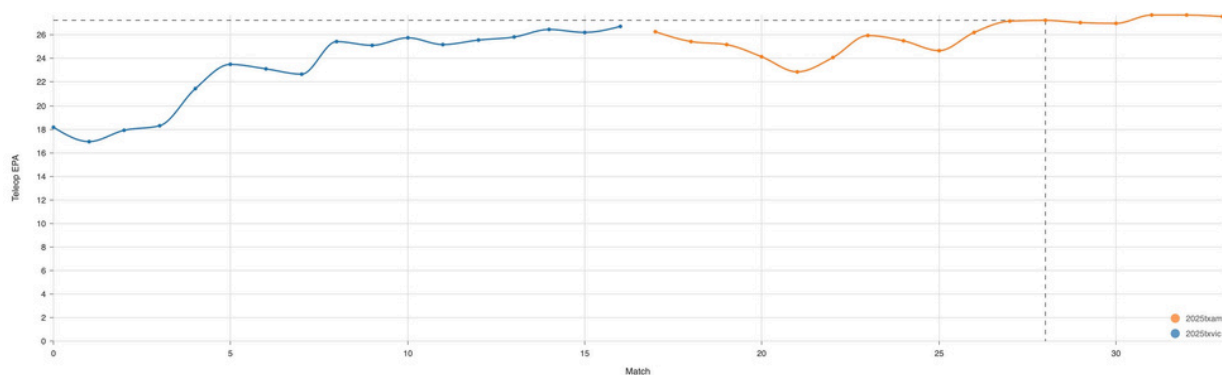
Overall EPA



Auto EPA



Coral EPA



Game Analysis

Scouting

During each match, a team of six scouts observes one team per person, gathering data on their **performance**, **scores** for different sections of the game, **defensive** and **offensive** capabilities, and key **robot characteristics** such as design. Each scout fills out a **scouting form** that covers the autonomous, tele-op, and endgame periods. The form also includes a notes section where scouts describe **standout features** of the robot they are observing.

Auto Coral *

	0	1	2	3
Trough (L1)	☐	☐	☐	☐
L2	☐	☐	☐	☐
L3	☐	☐	☐	☐
L4	☐	☐	☐	☐

Discussing

TeleOp Average				SCORE
Coral	Algae	Barge	TOTAL	TOTAL
11.24	7.65	8.94	27.82	47.59
12.73	1.45	2.18	16.36	26.09
23.33	8.00	14.00	45.33	78.50
21.39	2.58	6.45	30.42	45.84

Auto Average			
Leave	Coral	Algae	TOTAL
2.12	12.71	4.94	19.76
2.45	4.55	2.73	9.73
3.00	13.83	16.33	33.17
2.81	10.23	2.39	15.42

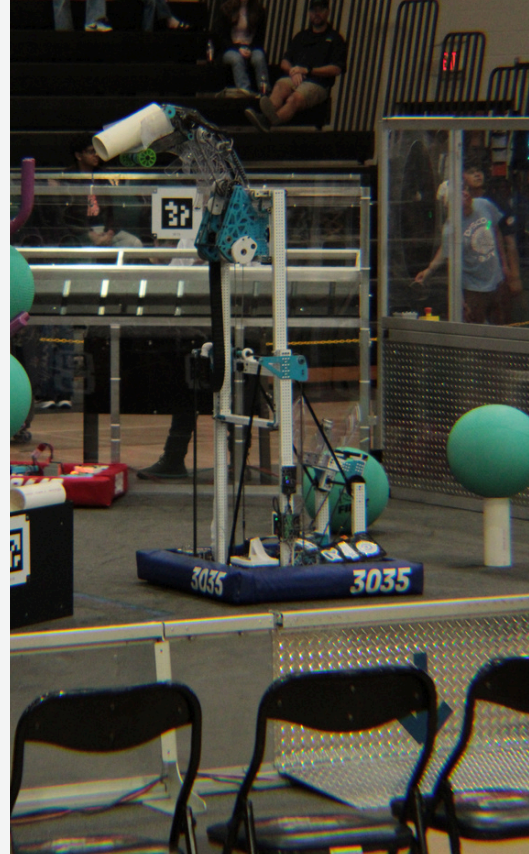
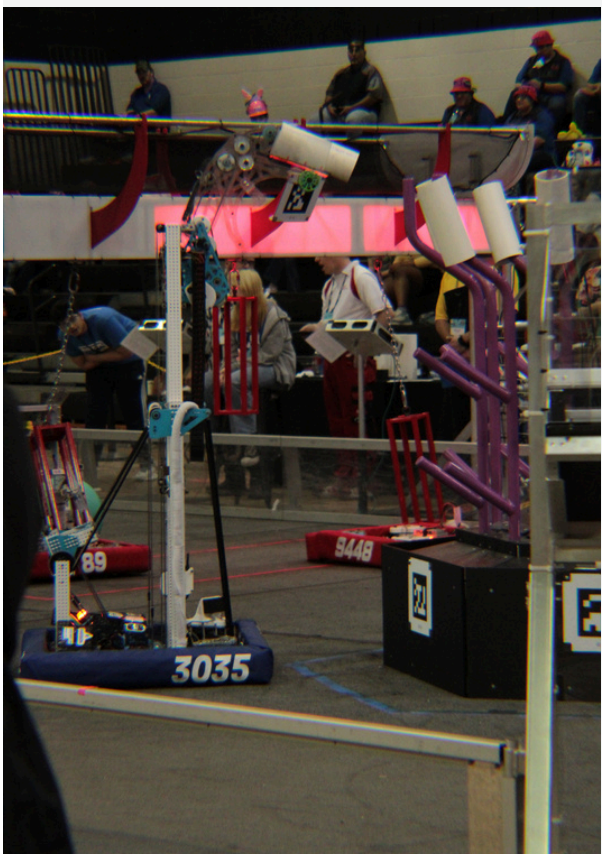
The **data collected** through Google Forms is automatically populated into a Google Sheet that **calculates** the **average scores for each team**. At the end of the first day of competition, the team holds a meeting to **discuss and rank teams** based on the **information gathered** during qualification matches. This process helps **identify teams** that best complement our robot, determine which robots would be **better suited** for **alliance selection**, and **estimate potential scores** for future matches.

Alliance Selections

At the end of each competition day, the head scout convenes with the scouting team to **analyze** the **collected data** and **discuss potential alliance** selections for the following day. This information is used to create a **prioritized pick list**, formulate strategies for upcoming qualification matches, and **develop countermeasures** against high-performing teams. This collaborative process ensures **informed decision-making** and **enhances** overall **team performance**.



Requirements & Architecture



Requirements & Architecture

Trends

- Drivetrain: Swerve
- Coral:
 - No ground intake
 - Wide human player intake
- Algae: No Shooting
- Climb: Wildstang or Every-bot climb with a winch or sprocket
- Interfaces:
 - Coral & Algae same scoring mech
 - Over the bumper intake

Needs

- Move Drivetrain
- Autonomous
- Go past bot line
 - Score 1 Coral L4
 - Intake 1 Algae
 - Score Algae in Barge
- Tele-Operated:
- Process 2 Algae
 - Intake Algae from the ground and the reef
 - Score coral all levels
 - Shoot algae barge (no spin)
 - Hold 1 algae and 1 coral
 - Starting height limit = 3.5 ft
- Endgame:
- Climb on deep cage
 - Park in barge zone

Wants

Autonomous:

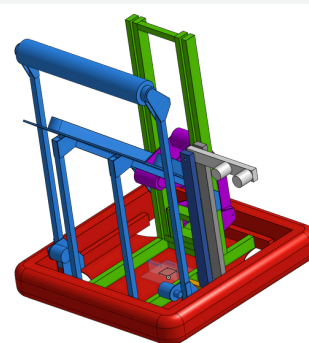
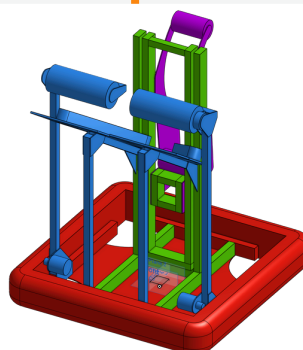
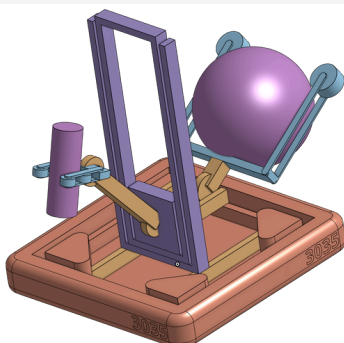
- Routines for all 3 starting positions.
- Pick up coral from the human player station.

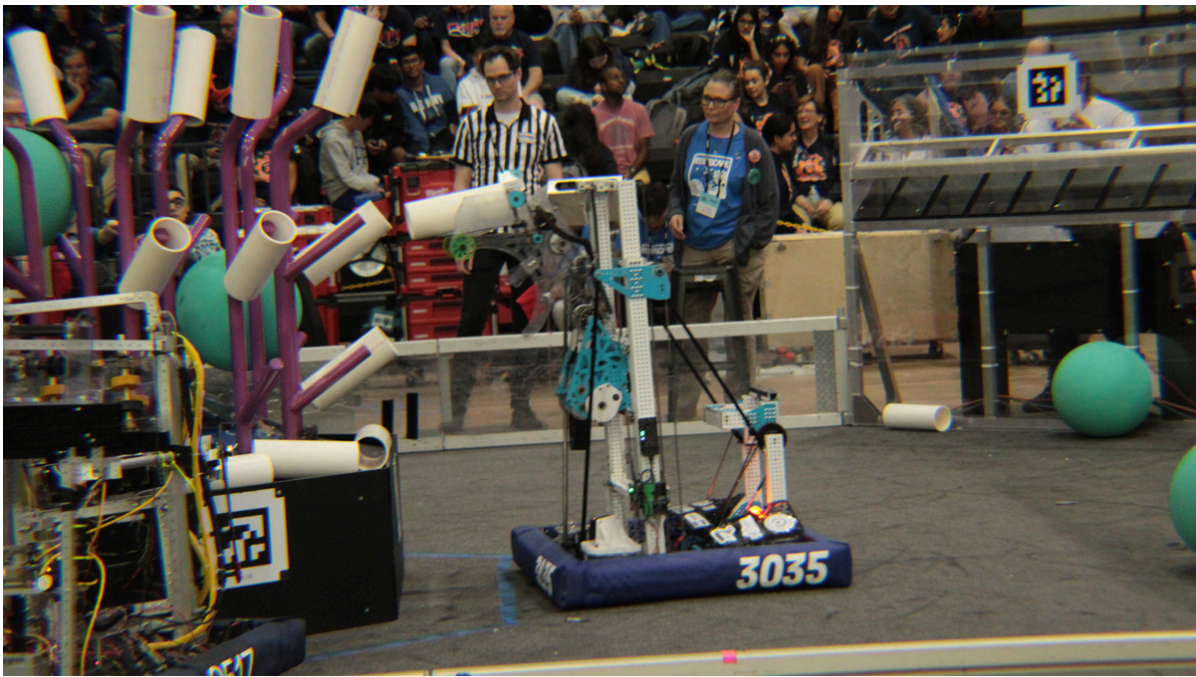
Tele-Op:

- Intake coral from the ground
- Manipulate coral (vertical/horizontal)
- Shoot algae into the barge (no spin)
- Auto align reef & barge

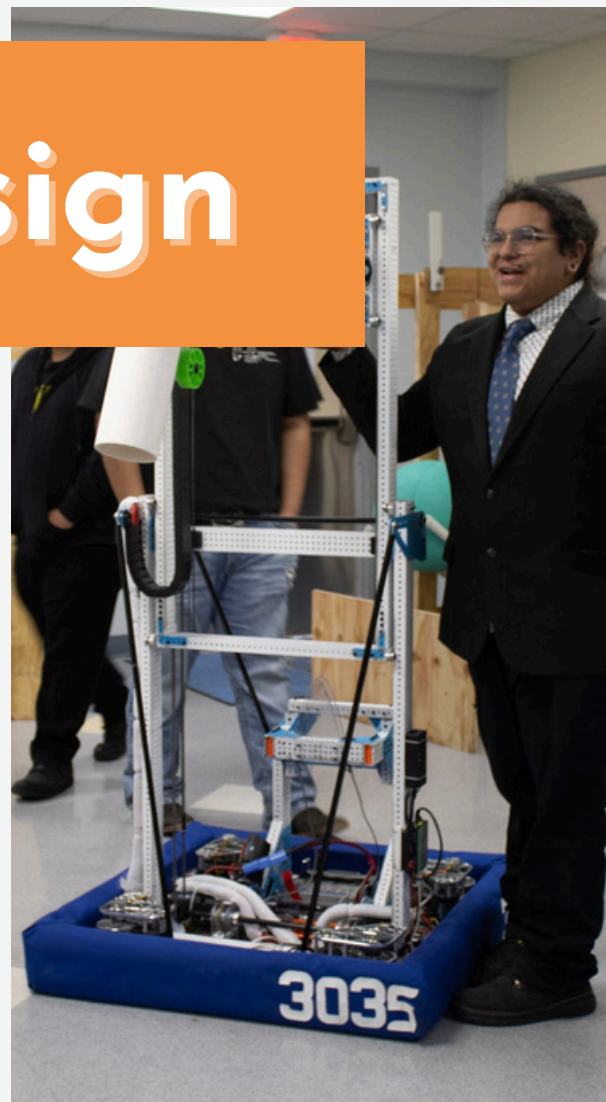
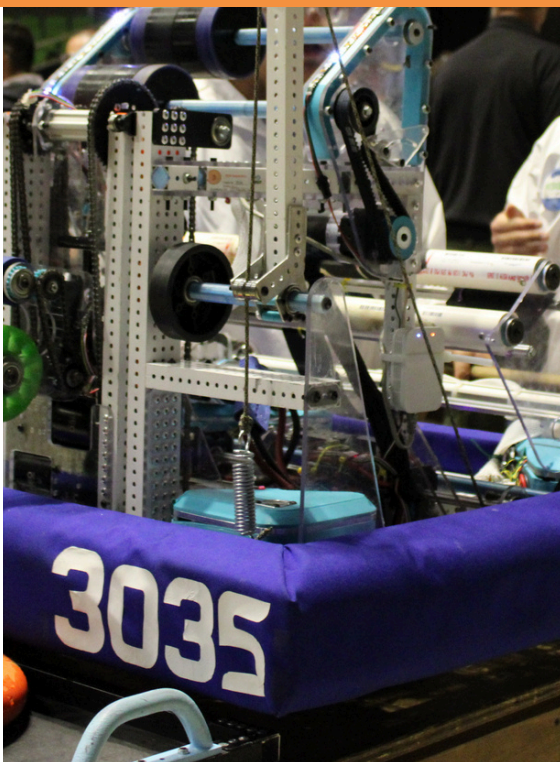
Endgame:

- Climb onto the deep cage.





Robot Design



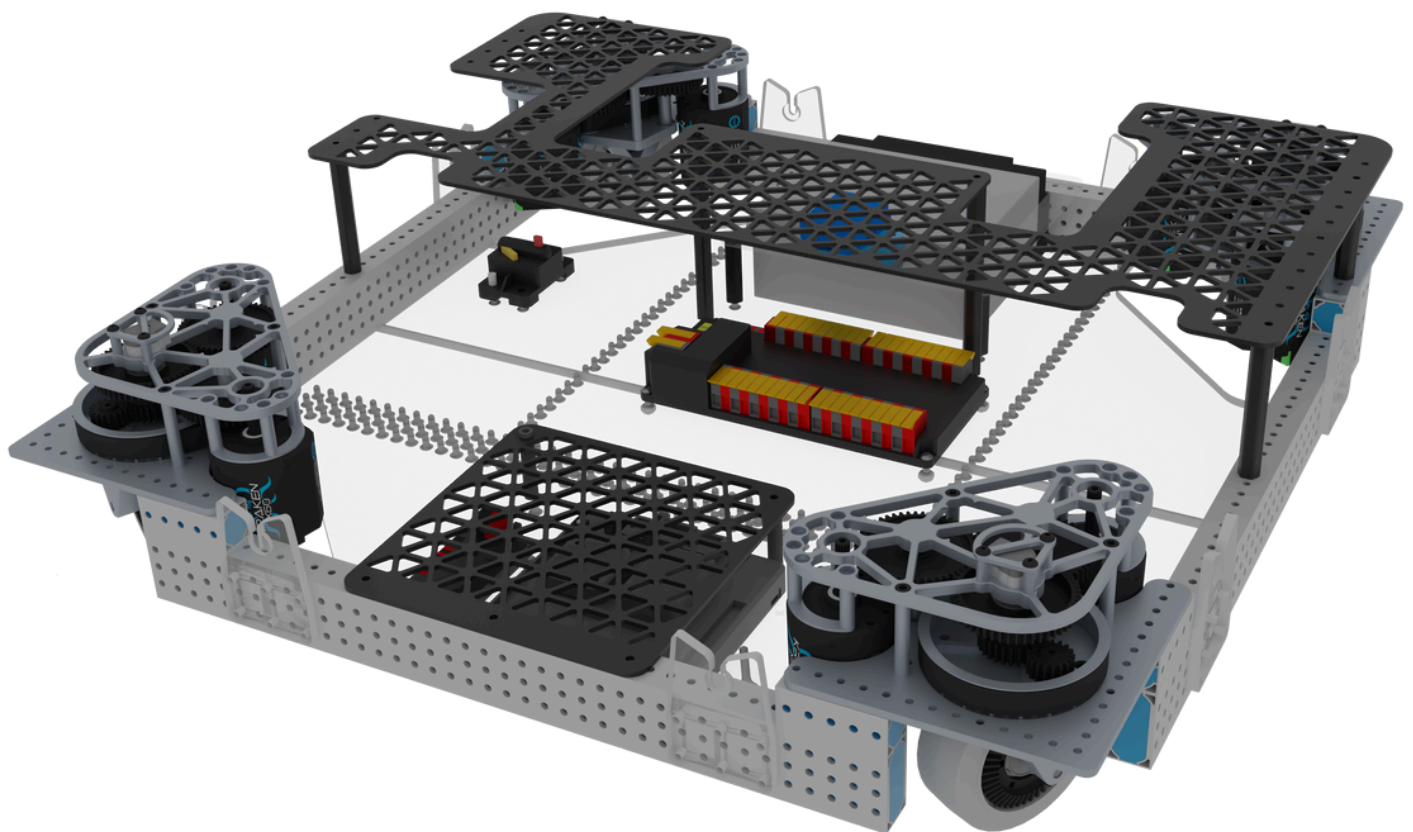
DriveBase

SDS MK4i Swerve Modules:

- Drive and Steer are both powered by Kraken X60's
- Gear ratio: 6.75:1 @ 15 ft/sec
 - Balance of torque and speed due to anticipated defense near the coral human player station
- Colson wheels for traction and grip

Chassis

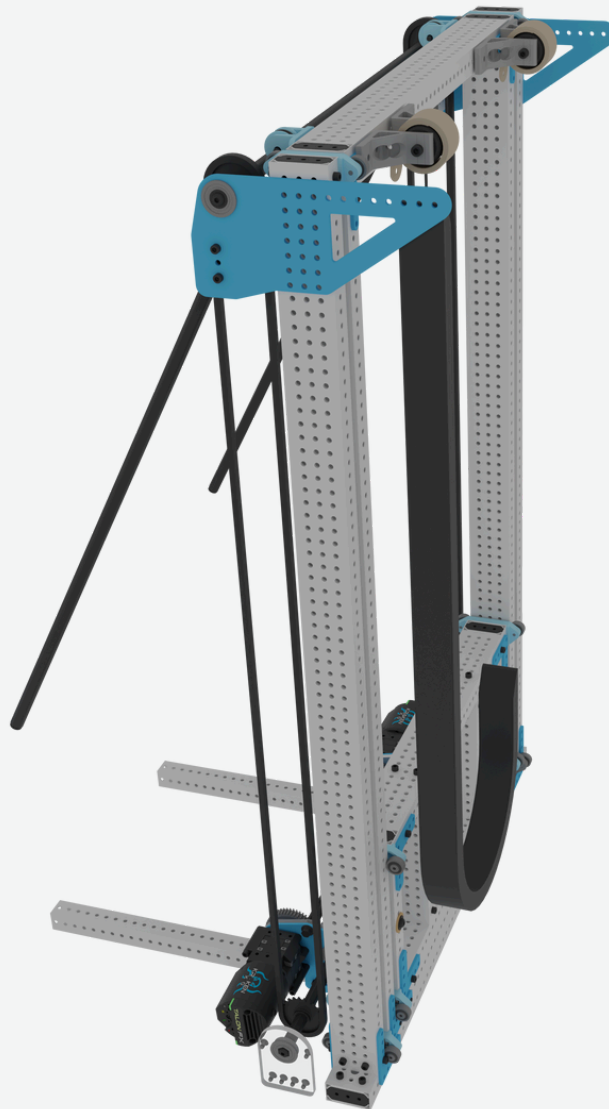
- Dimensions: 28" x 28"
- 1/4" recycled polycarbonate split belly panel
- Belly panel 1/2" off the floor, lowering the Center of Gravity (CG)



Elevator

2-stage Cascade Elevator

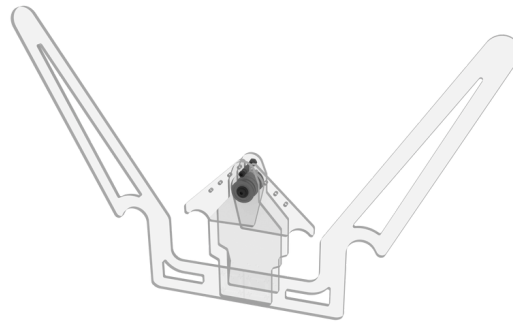
- WCP bearing blocks
- Tie Rods to structure the elevator to the drivetrain and climb
- Powered by a custom recycled polycarbonate gearbox using 2 Kraken X60's
- Gear ratio: 12:1 @ 4.1ft/s
- Load: 30 lbs
- 2 x 16.5 lbs Constant Force Springs (CFS) to reduce stress on motors.
- 0.61 seconds to go from zero to high position.



Climb

Hooks / Butterfly Wings

- Inspired by the Every-bot [carabiner style climb hooks](#)
- Butterfly Wings that allow for easier alignment for drivers



Gearbox and Winch

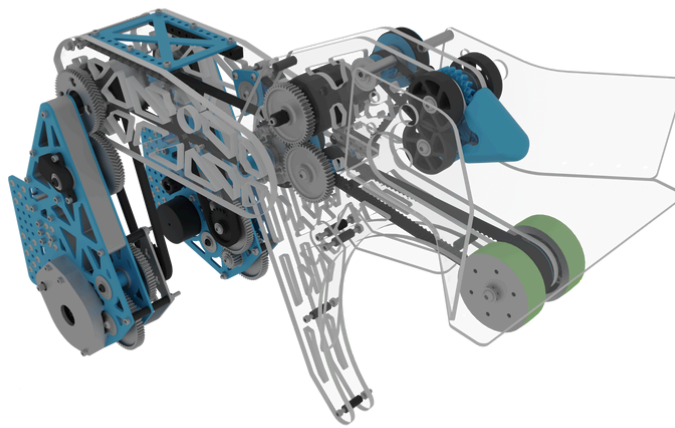
- Winch powered by 1 Kraken X60 on a MAX Planetary 90° Gearbox
- Gear Ratio: [125:1 @](#)
- Climb under [7 seconds.](#)



Scoring Mechanism

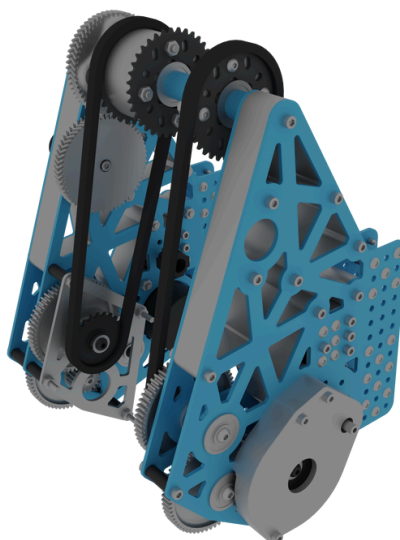
Arm and Pivot

- **Double Jointed End-effector** using 3/8" recycled polycarbonate plates.
- Arm and pivot mechanism to
 - Reach L4 and barge
 - Wide range of motion
 - High precision control



Arm and Pivot Gearboxes

- Arm and pivot gearbox powered independently by 2 Rev NEO Motors on a custom designed and manufactured gearbox.
- Gear Ratio for arm and pivot gearboxes: **61.44:1**
- **Mirrored gearboxes** for a maintainability.



Intake Mechanism

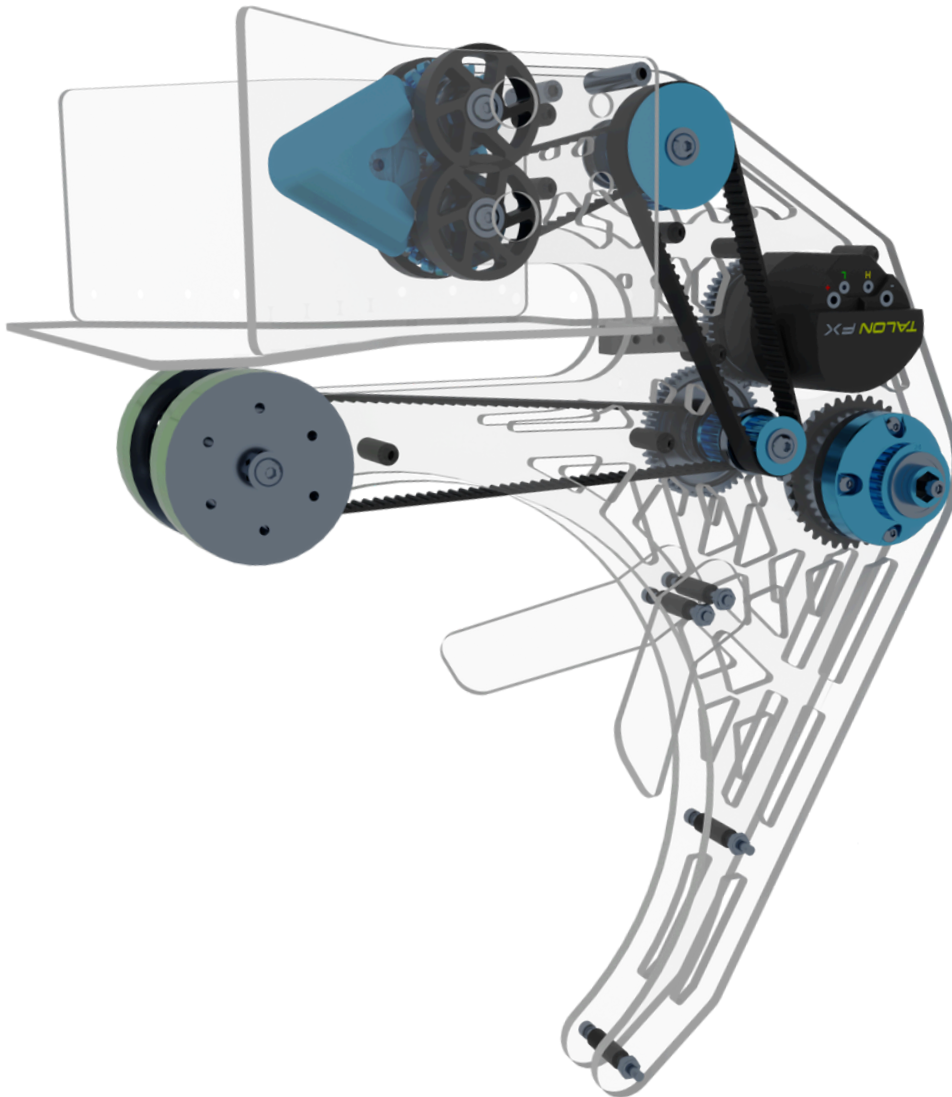
Coral Intake

- 2" Compliant Wheels controlling the inside of the coral
- Custom recycled polycarbonate funnel to widen the intake area of the coral
 - Coned "nose" to center the coral to the powered wheels from funnel
- Powered by a custom recycled polycarbonate gearbox using a Kraken X60
- Gear Ratio: 3:1

Algae Intake

Algae

- 3" Compliant Wheels with a 6.25" radius for a secure grip of the ball.
- Gear Ratio: 2:1 powered by the same motor that is used for coral





Software Implementation



Software

Alerts

- Implemented alerts to [signal key warnings](#), such as low battery voltage, CAN errors, and hardware overheating
- [Identifies issues early](#), preventing longer diagnosis time

/SmartDashboard/Alerts



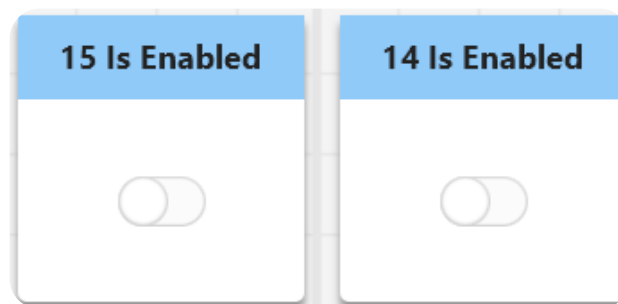
Battery Voltage Low: 10.5



Safe Hardware

- [Intuitive interface](#) for controlling motors and subsystems
- Writers [stay active](#) even when motors are off, enabling telemetry checks to verify [functionality without power](#)
- Standardizes [motor implementation](#) using Java abstraction for [consistent hardware management](#)

```
motor.setEnabled(isEnabled);
```



=



Software

Simple Motor, Encoder, and Subsystem Configuration

- Forces implementation using [Method Chaining](#) of various constants: offsets, idle mood, position conversion factor, velocity conversion factor, current limits, and more
- Creates a clear and easy base to work from
- Creates writers on Shuffleboard with voltage given and encoder positions

```
private final SwerveModule frontRight = SwerveModule.create()
    .withSubsystemName(this, POD.FR)
    .withDriveMotor(driveMotorId:3,Direction.Forward, isEnabled:true)
    .withTurnMotor(turnMotorId:1, Direction.Forward, isEnabled:true)
    .withEncoder(absoluteEncoderId:2,
        SwerveDriveConfig.FRONT_RIGHT_ABSOLUTE_ENCODER_OFFSET_RADIANS::getValue,
        EncoderDirection.Forward);
```

Amount of Voltage
going to the motor if
enabled

Location of the
Current Mechanism

The Goal of the
Current Mechanism

Climb

Name

Info

16 Output

0.3151012223954953

PositionDegree

90.4884689015129

PositionRadian

1.5793217174198966

TargetDegree

90.0

TargetRadian

1.5707963267948966

Element Tracking

- Use a series of tracking between the carriage and intake to identify the game element
- Drivers alerted about current element using the driver's station
- Changes intake speed according to the Element

```
//All possible elements
public enum Element{
    ALGAE,
    CORAL,
    NONE
}
```

Software

PID and Feedforward Control

Pure Feedforward

- Controls velocity and acceleration, but not position
- Works for small movements only
- System noise builds up errors over time

VS

Pure PID

- Less predictability as it reacts to errors
- Can have systems oscillate near setpoint
- Does not compensate for gravity on arms and elevators

Combination

- Smoother motion
- Faster Response
- Better stability - Reduces overshoots and oscillations
- Feedforward counteracts gravity and provides base control, allowing PID to focus on fine movements and precision using only kP

By using feedforward control on our Angler, we can model the behavior of any system to **intelligently guess** the ideal output without feedback from sensors.

Arm, Pivot, and CLimb - $k_s \cdot \text{Sign} + k_g \cdot \cos(\text{Angle}) + k_v \cdot \text{Velocity} + k_a \cdot \text{Acceleration}$

Vertical Elevator - $k_s \cdot \text{Sign} + k_g + k_v \cdot \text{Velocity} + k_a \cdot \text{Acceleration}$

Intake - $k_s \cdot \text{Sign} + k_v \cdot \text{Velocity}$

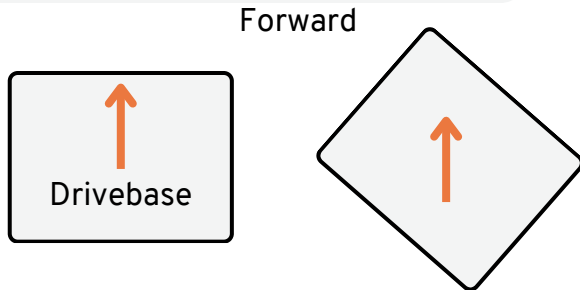
Drive - $k_s \cdot \text{Sign} + k_v \cdot \text{Velocity} + k_a \cdot \text{Acceleration}$

All mechanisms utilize voltage compensation to improve consistency and reliability.

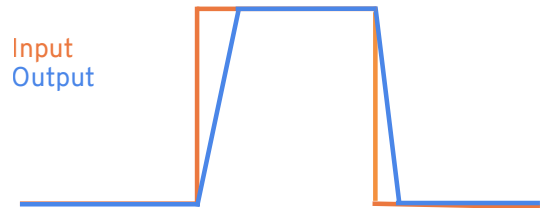
Software

Driver Controls

Field-Oriented Driving using Joysticks



Slew Rate Limiter: Prevents quick rates of changes for the swerve drive to avoid tipping



Anti-Tip Controller on both axis to prevent robot from tipping over

```
private static final PIDController antiTipY =  
    new PIDController(kp:0.006, ki:0, kd:0.0005);
```



- Auto Alignment in both Autonomous and Teleoperated Period
- Aligns based on alignment mode (LEFT or RIGHT)
- Angler detects the April Tags on the Alliance Reef to collect vision data on the drive's position
- Utilizes vision data with PID Controllers to correct for alignment error
- Reduces cycle times by 3-5 seconds
- Improves scoring accuracy by 10%

Change to Left Alignment

Barge

Climb Deploys/Retracts

Reset Yaw Button

Change to Right Alignment



Slow Mode when the elevator is more than half extended

Start Alignment

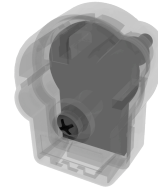


Intake/Outtake: Speed changes based on element and carriage position

Software

Encoders

- Used on [MK4i Swerve Modules](#) to control the Kraken X60 Steer Motor
- Tracks the absolute position of Colson Wheels, which stay upon robot restarts



CANcoder

Through Bore
Encoder



- Tracks the absolute position of Arm and Pivot in rotations
- Software converts rotations into radians and degrees

- A gyro used to track Angler's pitch, roll, and yaw
- Data used to implement anti-tip code and Field-centric driving

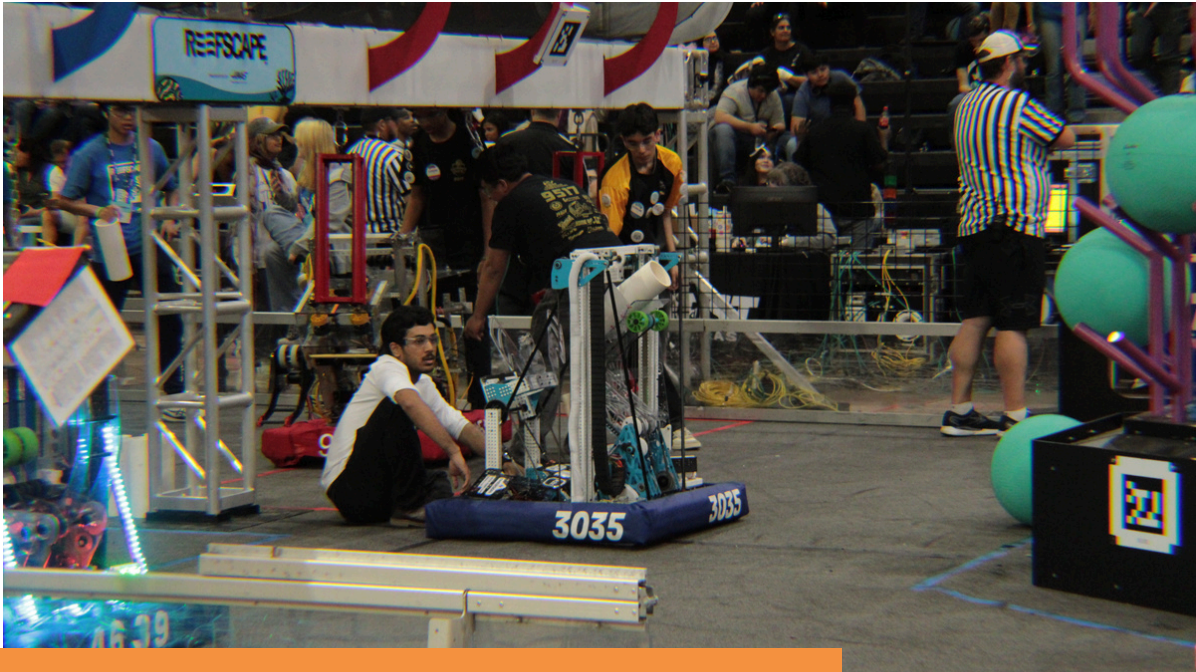


Pigeon 2.0

Organized Wiring

- [Labeling](#) all of our [wires](#) allows for us to be [both](#) safe and more efficient
- [Wiring Diagram](#) ensures [every wire is accounted for](#)
- Allows for [quick identification](#) of wires for [quick troubleshooting](#)

Power Distribution Hub											
CAN Order	Device Type	CAN ID #	Fuse	Name	Slot #	Slot #	Name	Fuse	CAN ID #	Device Type	CAN Order
C10	Kraken	9	40A	9-C-BLD	10	9	10-C-FLT	30A	10	Kraken	C11
C8	Kraken	7	30A	7-C-BLT	11	8	12-C-FLD	40A	12	Kraken	C13
					12	7					
					13	6	18-PIVOT	40A	27	Neo	
1	Kraken	14	40A	14-LELV	14	5	19-INTAKE	40A	19	Kraken	
3	Kraken	15	40A	15-RELV	15	4	17-ARM	40A	17	Neo	
				EXTRA	16	3					
	2 Kraken	16	40A	16-CLIMB	17	2	MINI-P	40A	N/A	MPM	
C5	Kraken	4	30A	4-C-BRT	18	1	3-C-FRD	40A	3	Kraken	C4
C7	Kraken	6	40A	6-C-BRD	19	0	1-C-FRT	30A	1	Kraken	C2
C9	CANCoder	8	5A	8-C-BLE	20						
	Roborio	10A		RIO	21						
	Ethernet Switch	10A			22						
C6	CANCoder	5	5A	5-C-BRE	23						
	Mini Power Module 2					Mini Power Module 1					
					5	5	10A			CANivore	
					4	4	13-C-PIG	5A	13	Pigeon	C1
					3	3	LLL	5A		Limelight	
					2	2	RPM	10A	2	RPM	
					1	1	11-C-FLE	5A	11	CANCoder	C12
	Limelight	5A		LLR	0	0	2-C-FRE	5A	5	CANCoder	C3
				Ethernet Switch							
				Roborio	1						
				Limelight L	2						
				Limelight R	3						
				Radio	4						
					5						



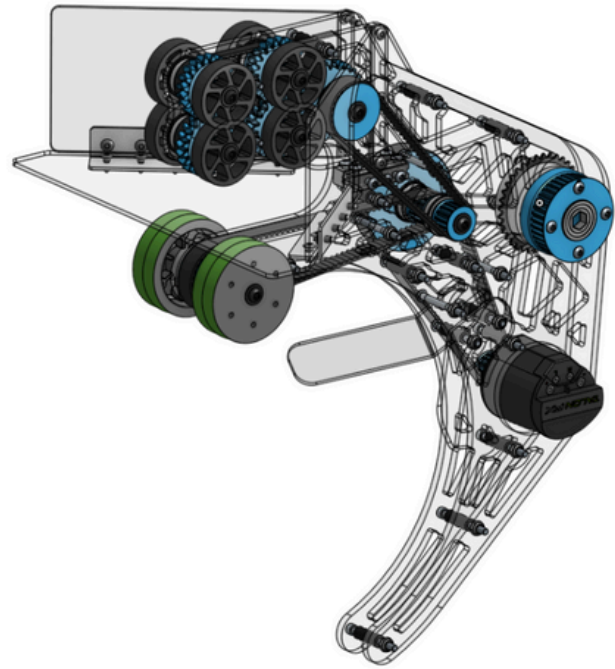
Integration Test & Verification



Integration Test & Verification

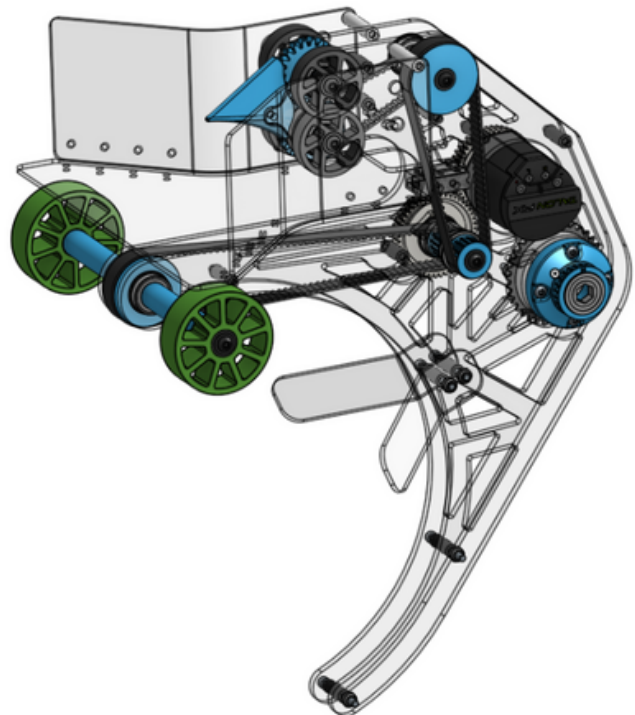
Intake V1 - Three Stage Intake

- Pros:
 - Both Algae and Coral
- Cons:
 - Low grip on algae due to the distance between the top and bottom roller
 - Placement of the top wheel hit the human player station
 - 30% function due to coral not sliding into the coral intake



Intake V2

- Pros:
 - 90% function for intaking coral and algae
 - Could hold both game elements simultaneously
- Cons:
 - Complex mechanism to build
 - Mechanism weight is 8.75 lbs



Integration Test & Verification

Elevator

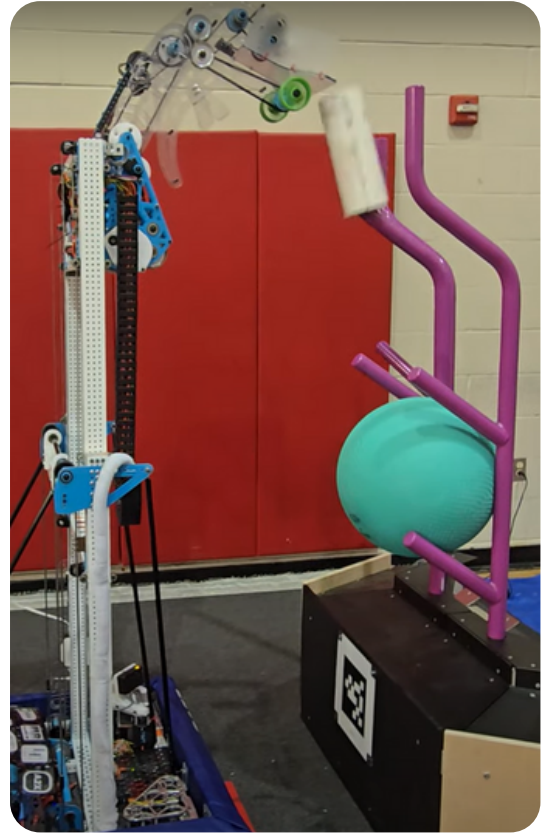
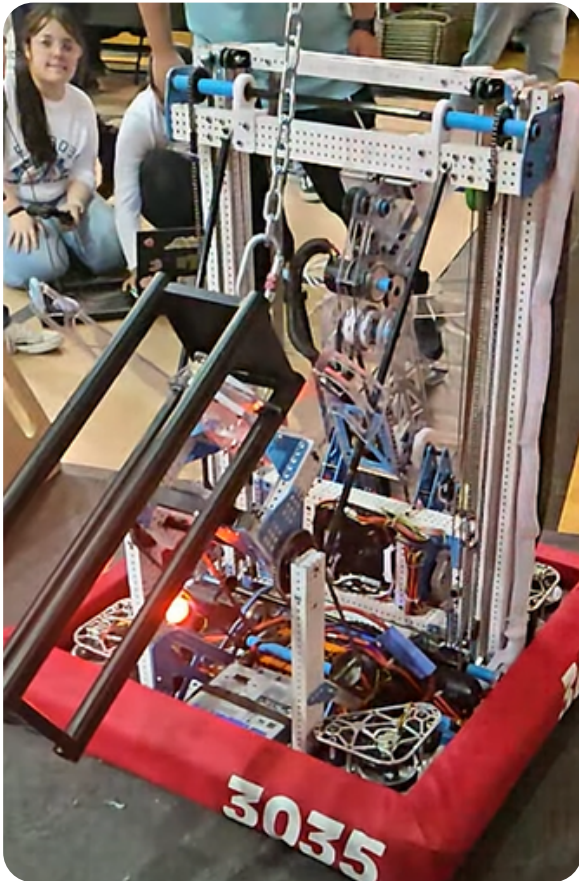
2 Stage Cascade Elevator

Pros

- Extends 78 inches vertically
- Extends to all levels on Reef and Barge

Cons

- Mechanism weighs 30 lbs



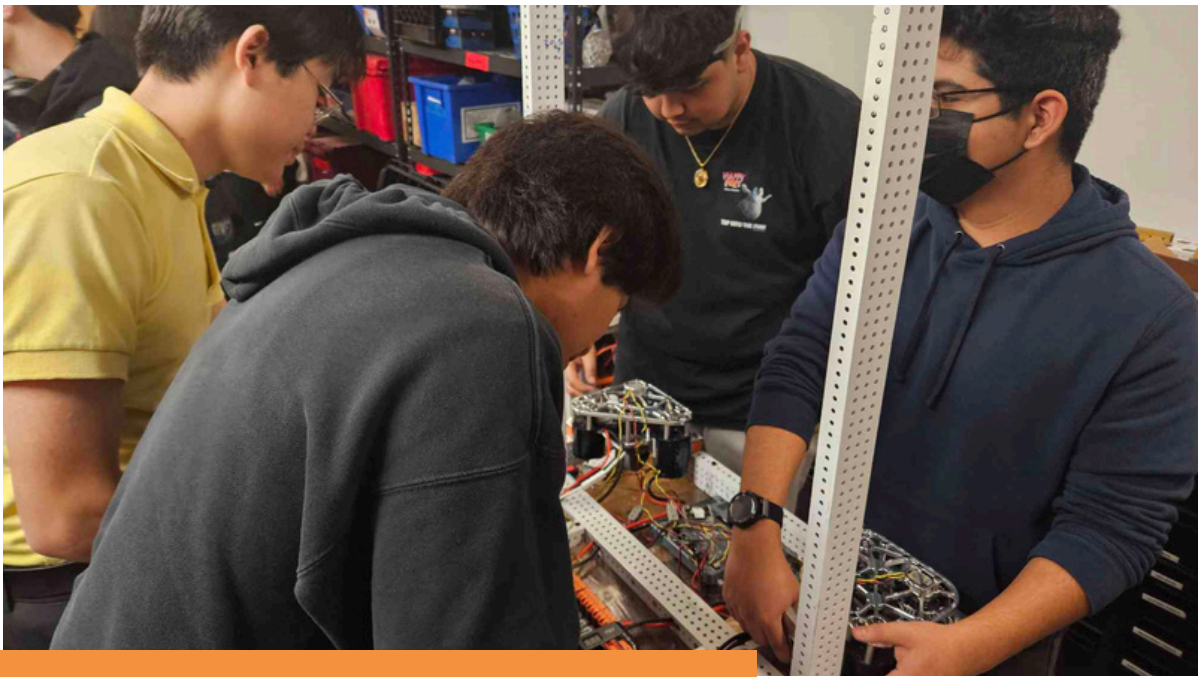
Chained Climb (V1)

Pros

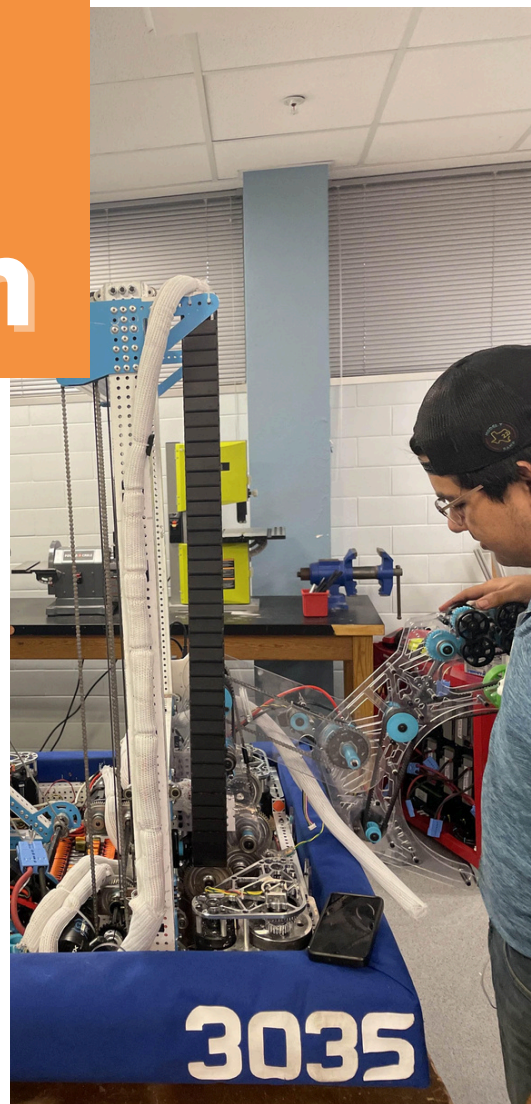
- Reach deep climb
- Aligned 90% with wings
- Held bots weight without failure during initialization

Cons

- Not able to hold Angler's weight for more than 1.75 seconds after de-initialization



System Verification & Validation



System Verification

System Testing Digitally

- Conducted operational trials to test and evaluate the Angler's systems.
- Focused on thorough testing of how each individual sub-system worked together for optimal performance.
- Reviewing older code for inspiration and verification

Driver Practice

- Coached drivers with mentors and past footage
- Reviewed matched to identify errors and improvements required

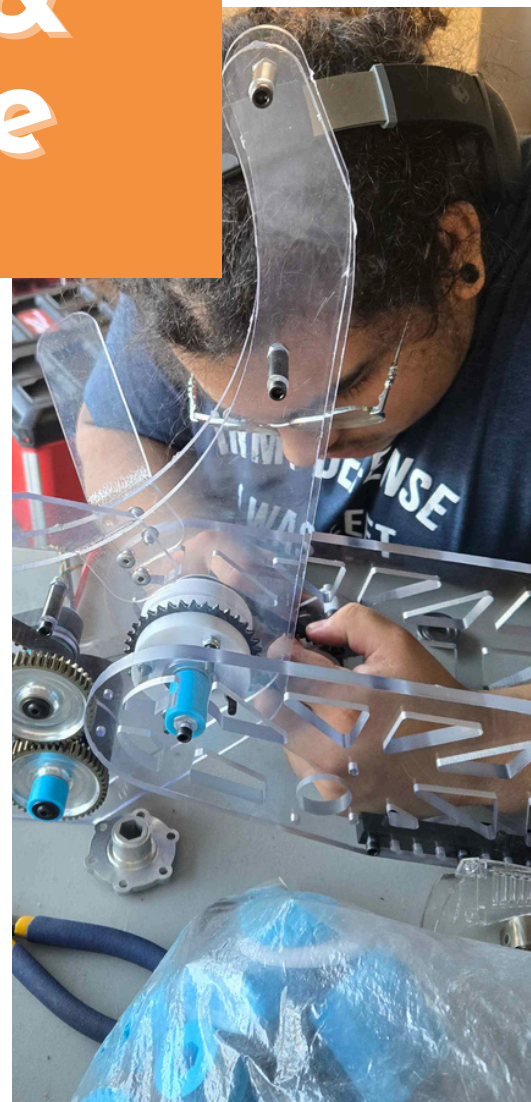
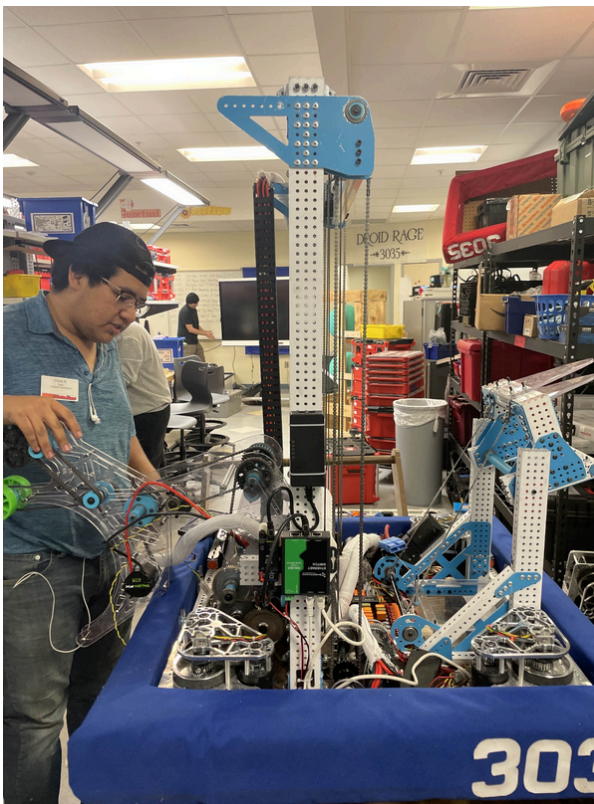


System Testing Mechanically

- Utilized a custom-built reef for testing and refinement
- Systems check with coral pieces and algae
- Tested climb among other teams and worked together to improve it



Operation & Maintenance



Operation & Maintenance

Standard Operating Procedures

SOP, or Standard Operating Procedures, is a set of written procedures for Droid Rage operations. We use the SOP to track: Attendance, Manage Team Equipment/Tools, Equipment/Tool Certifications, Incident Reporting, Competition Checklists, and Usage of Fabrication Equipment/Materials.

Pre-Match Checklist

- Electrical: Check Battery and Check Wire Connections
- Mechanical: Tighten screws, Check for wear and tear, lubricate gears, etc
- Programming: Systems Check in Teleop, Ensure All Subsystems are on, etc

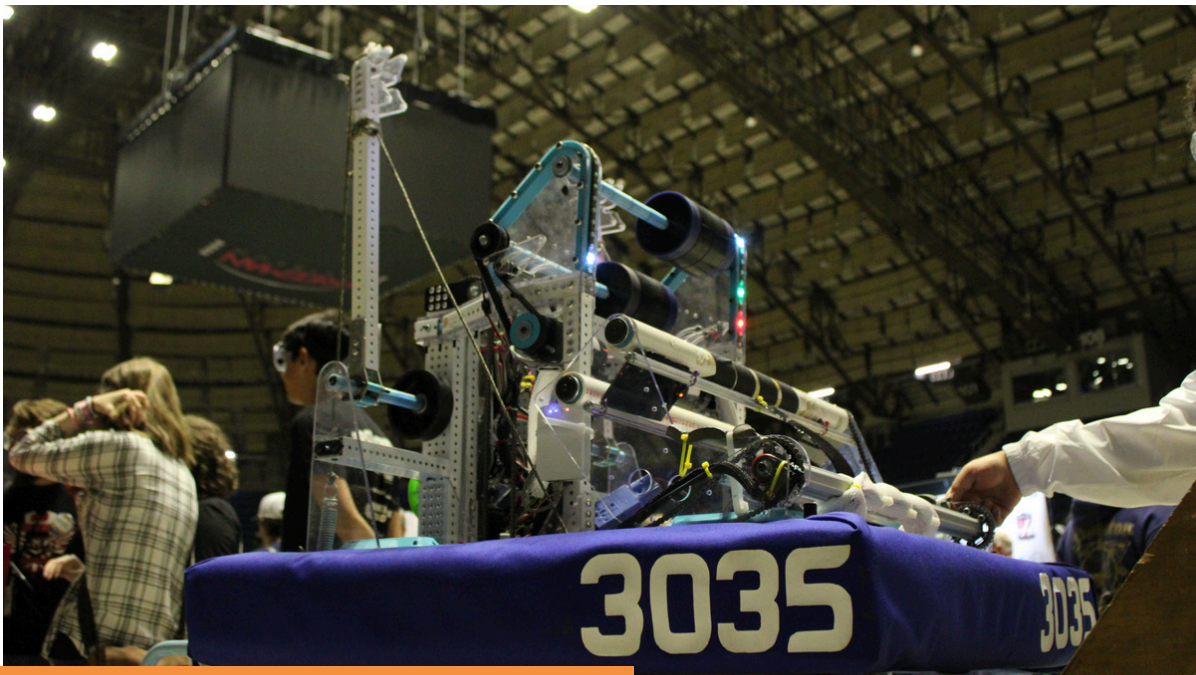


Throughout the Season

- Inspect Parts that are getting wear and tear to improve design
- Lubricate Mechanisms
- Clean debris
- Manage Batteries

Programming

- Optimize Auto Paths
- Add failsafes
- Improve Robot Control
- Improve responsiveness and control loops



Retirement & Replacement



Retirement

Off-season

- April 2025: Reevaluate the successes and challenges of Angler during the Reefscape Season; Use these as lessons on how to improve for the future
- April to December: Angler will continue to function throughout the off season.
 - Buc Days FRC Robotics Rodeo - May 1st-4th
 - Outreach Events
 - Serve as the primary robot for driver's practice and software updates

Preparing for New Season

December 2025: The robot is disassembled to prepare for the next season. Parts are taken apart and separated using the below graph.





Future Plans



Future Plans

Future Robot Plans

Once the game season is over, [Droid Rage 3035](#) still has plans for [Angler](#) to be put into good use for both [outreach](#) and [recruitment](#) events. During the off season, Droid Rage 3035 plans to participate in a plethora of [outreach events](#) in showcasing Angler. The team also plans in hosting our annual [robotics mixer](#), where we showcase and present both [FRC and FTC robots](#), allowing students in all grade levels to participate and meet each of our FTC teams and FRC 3035 team.



Off-season Plans

After recruiting season, we plan for our [new team members](#), specifically our programmers and engineers, begin their [training](#) throughout the [off season](#). During this time, we plan in using [Angler](#) to allow rookie members to gain hands on experience, [rebuilding](#) drivetrains, and [practicing](#) with programming autos. Through this training, new members are [assimilated](#) into their individual roles and are prepared for when KickOff season begins.

