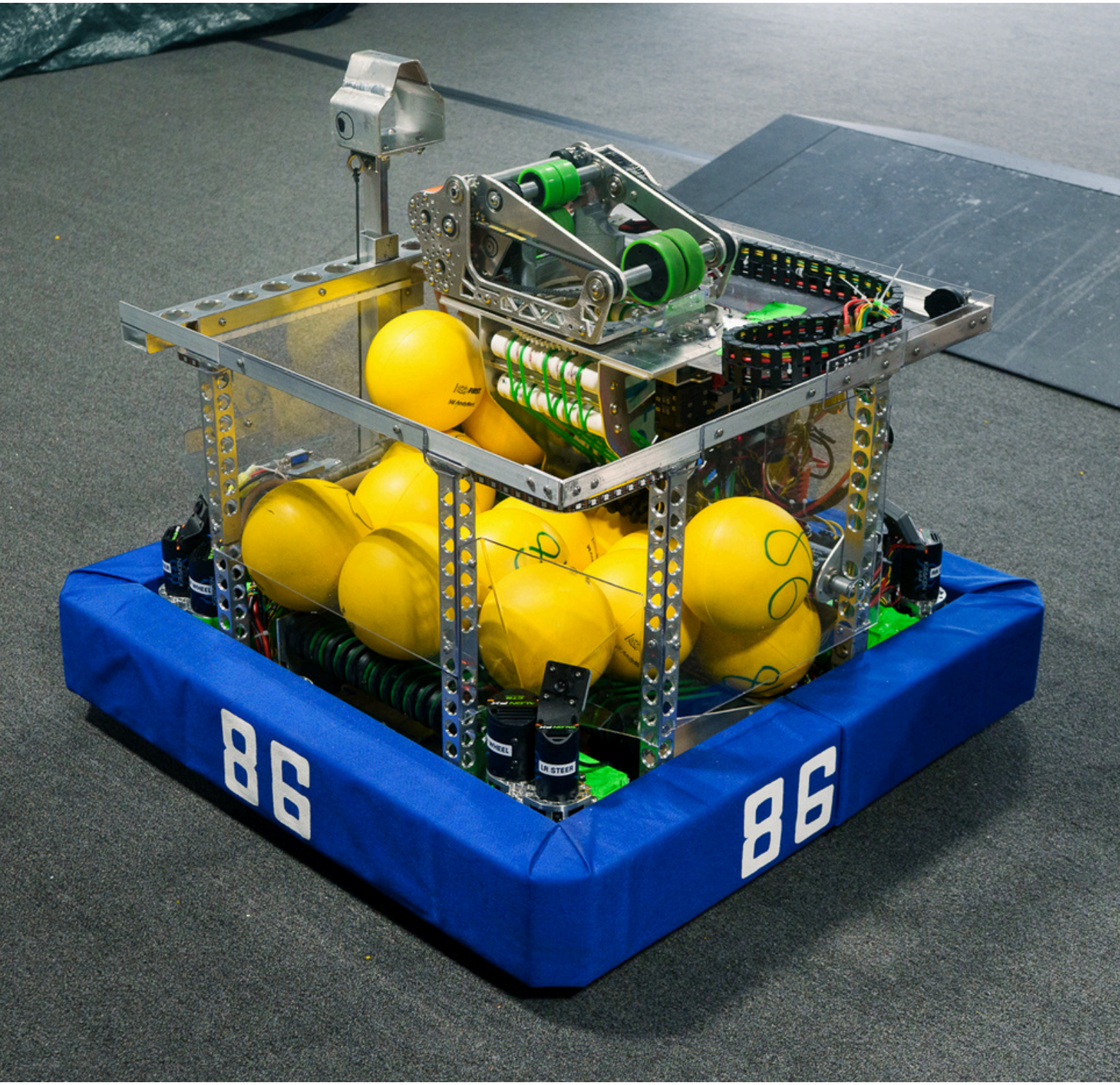
Team Resistance Technical Binder



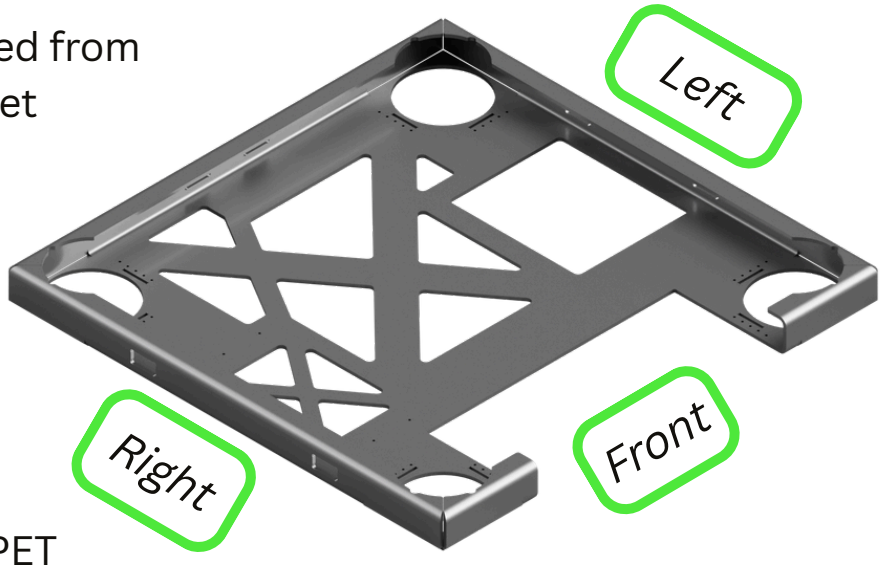
FIRST ROBOTICS COMPETITION

REBUILT
PRESENTED BY HAAS

Frame & Drivetrain

Frame

- Laser-Cut, Bent, and Welded from **single** .190" **aluminum** sheet
- **Holes** for:
  - Swerve Drive
  - Intake
  - Weight (11.345 lb)
  - Battery
  - Bumpers
  - Optimized CG
- **Frame** is 1.75" off the CARPET
- **Bumpers** are 1.75 in. off the CARPET



Dimensions: (27.4375 x 27.4375 in)



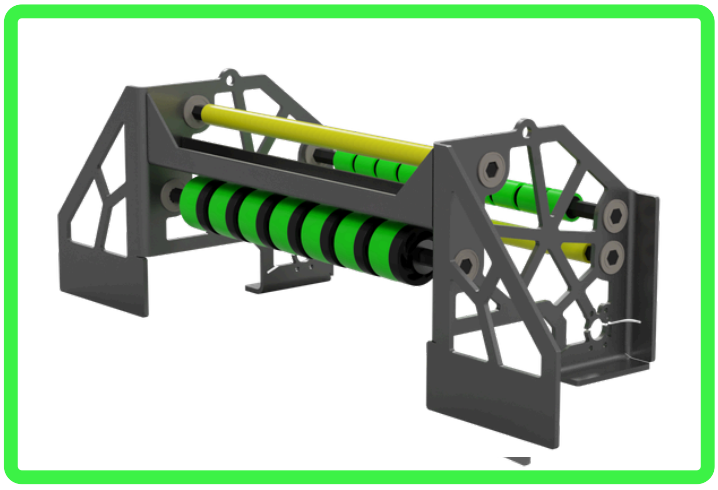
Swerve Drivetrain

- WCP X2 Swerve
  - **X2** Gear Ratio (6.82:1)
  - Kraken **X60** Propulsion
  - Kraken **X44** Azimuth
- To maximize Hopper space:
  - **Custom mounting** solution: Azimuth motor is closest to frame's edges
    - Custom-bent support brackets are **welded** to frame for strength and **mounting** the modules.
  - Propulsion motor **moved** to right and left flanks to **maximize** intake, hopper, and indexer **space**

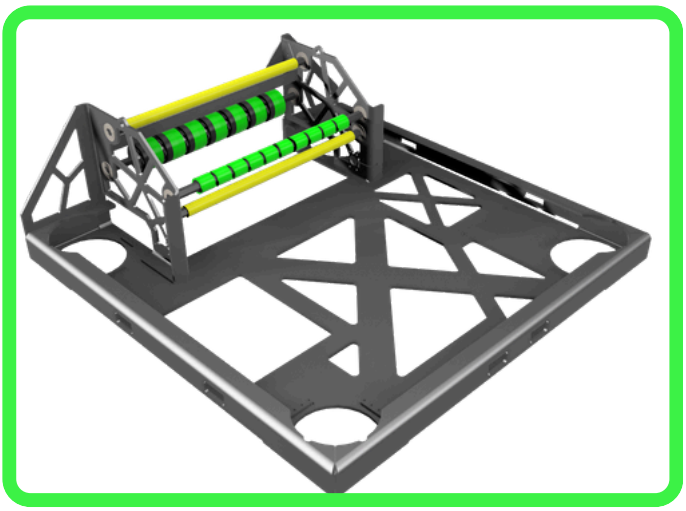
Intake

Requirements

- The **Intake** must be **robust** due to the following:
  - **Opponent** robots playing Defense
  - Traversing the BUMP
  - Intaking near the **ALLIANCE** WALL
- Capable at **various Drivetrain** Speeds
  - Faster - Autonomous SHIFT midline race
  - Slower - Shooting and intaking during our ALLIANCE SHIFT



Laser-Cut at OP Machine & Fab.



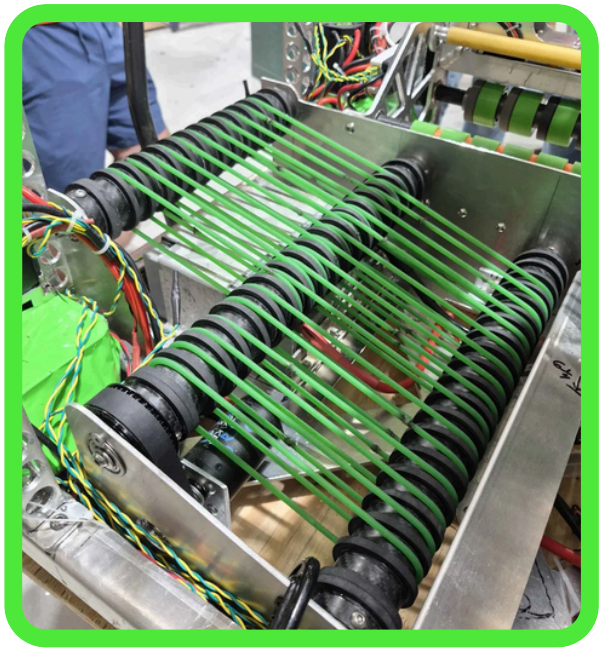
Our Implementation

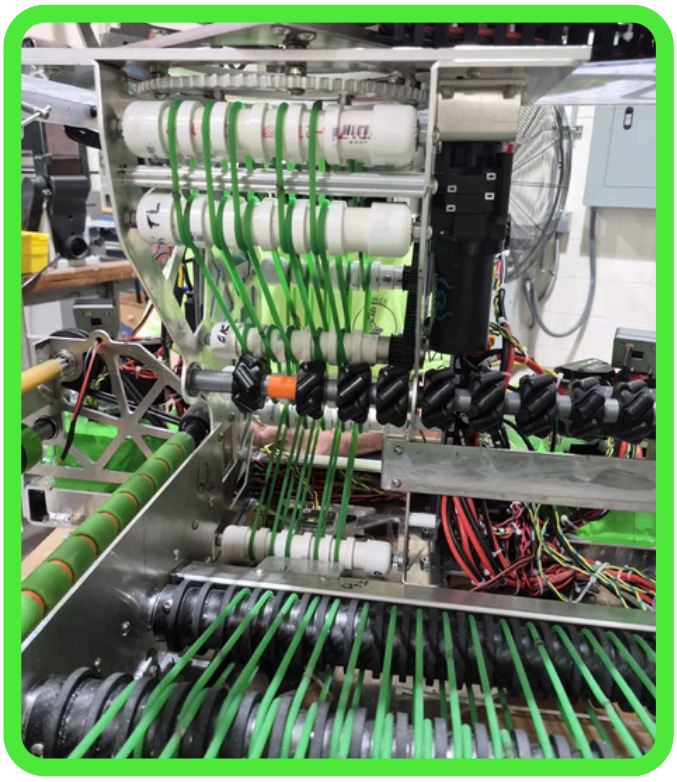
- **Through** the Bumper (TTB)
  - Protected from any contact
  - Intakes FUEL at high rate
  - Reinforces robot's front
- **Lifts** FUEL up to Hopper
- Semi-**Compliant** Rollers
  - Grips FUEL and compresses it
    - 2" Andymark Stealth Wheels and Shushi Rollers
    - Surgical tubing on Hex Shafts
    - Powered by a Kraken **X44**
- **Kicker** - Compliant Polycarbonate Plate with Griptape
- **Redirect** with surgical tubing into Hopper when at **low** capacity

Hopper & Indexer

Requirements

- **Maximize** FUEL storage capacity
- **Unload** all FUEL fast to allow for at least 2 complete **cycles** during our ALLIANCE SHIFT
  - **Actively** prevent jams
  - Quickly **singulate** FUEL
  - **Move** FUEL instantly after singulation





Hopper

- **Top** of Hopper is 22.5" above CARPET
  - Holds more FUEL
  - **Protects** Turret and other important subsystems
- Clear **polycarbonate** walls for best **vision** of remaining FUEL
- **Agitation** rollers are Thin Wall Carbon Fiber and connected by Polycord
  - **X44** (2:1)

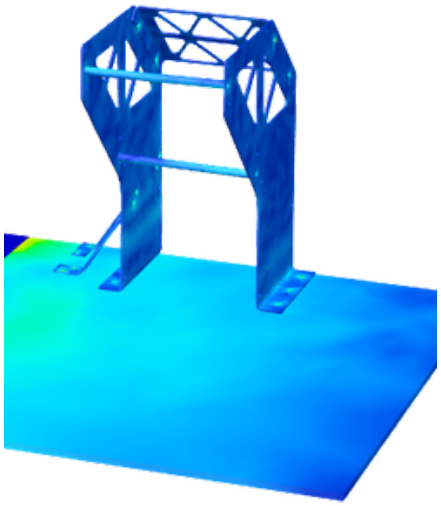
Indexer

- **Mecanum** (Vectoring) Wheels across **width** of the Hopper
  - Powered by a Kraken **X44**
  - Touching Mecanums = *Not* Touching Agitation Rollers
  - Custom **aluminum** rollers wrapped with **50A silicone**
- Pushes FUEL **horizontally** towards Tower
- **Opposite** direction Mecanum Wheel pushes FUEL into tower **consistently**

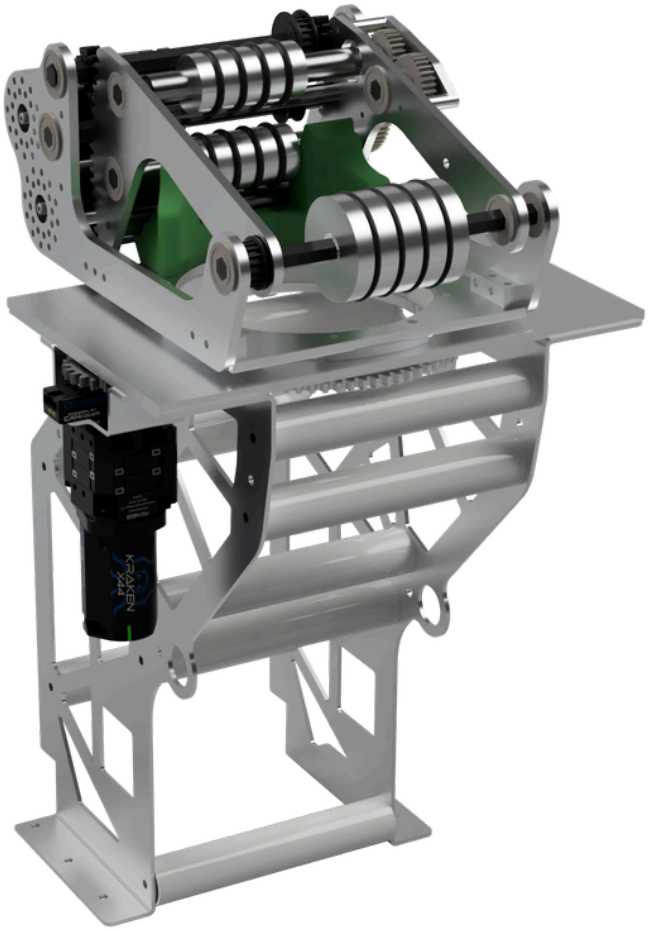
Tower

Requirements

- Nearly **instantaneous** transfer of FUEL from the Hopper to the Turret
- Transfer FUEL from the **bottom** of the Hopper **up** to the Shooter
- Give the FUEL an **initial velocity** when entering the Turret (~15 ft/s)
  - Shooter wheel does **less work**
  - Less **time** to spin back up wheels to needed speed
  - Increases our **maximum** range
- Extremely **rigid** as many other subsystems **mount** to it (Ex. Turret)



- FEA of The Tower V3 to test rigidity duirng 15ft/s → 0ft/s dynamic event.
- Proved more pocketing was possible and it was rigid enough.



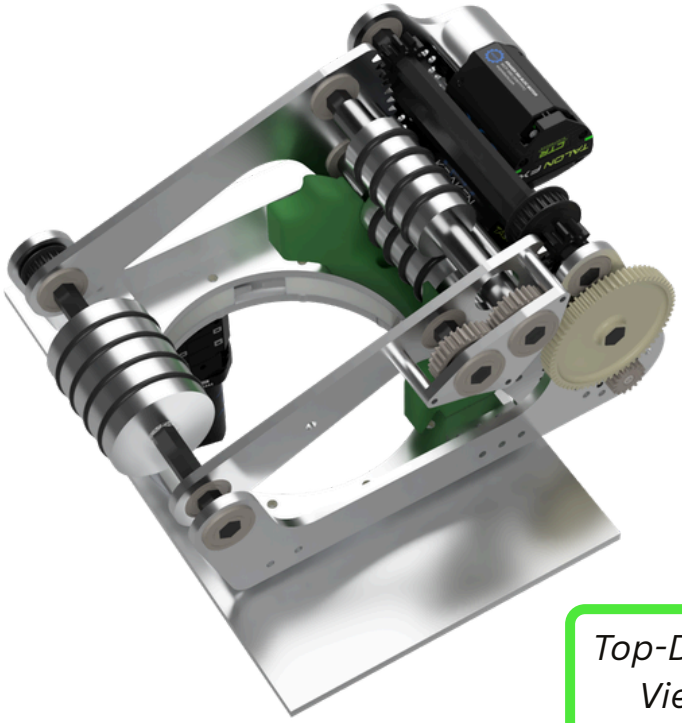
Our Implementation

- Carries FUEL from a **single point** in the Hopper to the Shooter
- Thin-wall PVC Rollers with **polycord** maintain a tight **grip** on FUEL during its **transfer** up the Tower
- Powered by a single Kraken **X44** (1:1) at ~4000 RPM
  - Polycord transfers rotation so only one roller per direction rotation needs to be powered
  - Up to ~10 FUEL per second

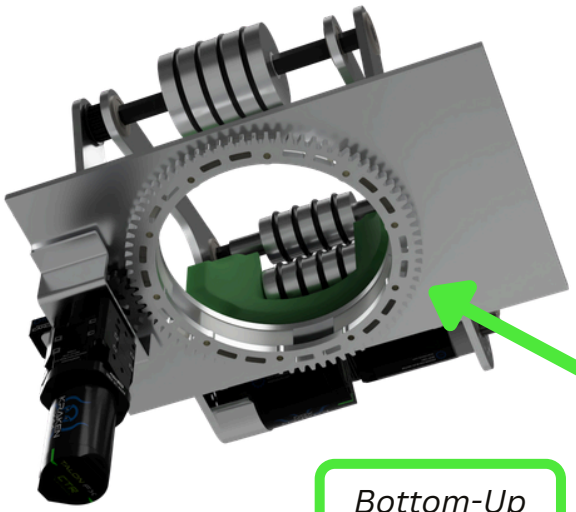
Turret

Requirements

- Ranged, **accurate** shooting within all of ALLIANCE ZONE
- Consistent shooting angle, **speed**, and direction while **rapid-firing** FUEL
- **Mitigation** of other teams' oppurtunites for **defense** with reduced need to **rotate** the Drivetrain



Top-Down View



Bottom-Up View

Our Implementation

- Turret mounted on the top of the Tower
- Wiring allowed for **270°** of rotation, as our Swerve Drivetrain can make up for the last ±45° in **rare** scenarios
- 3in Stealth Wheels
  - Meets requirements for Maximum **Tangent Speed**
  - **Smaller** than 4in wheels
  - Works better with shooter geometry
    - 17.2° to 45.6 degrees launch angle
    - Shot Dist. to HUB:
    - Min: ~3 feet
    - Max: ~18 feet

- Azimuth powered by a Kraken **X44** with an 80:1 ratio (5:1 + 5:1 + 3.2:1)
  - **HDPE** "Shoes" for low **friction** with mounting plate
- Shooter wheel powered by two Kraken **X60s** at 1:1
- Hood driven with a **10DP** gear powered by a Kraken **X44** on a 4:1 ratio from a single large gear

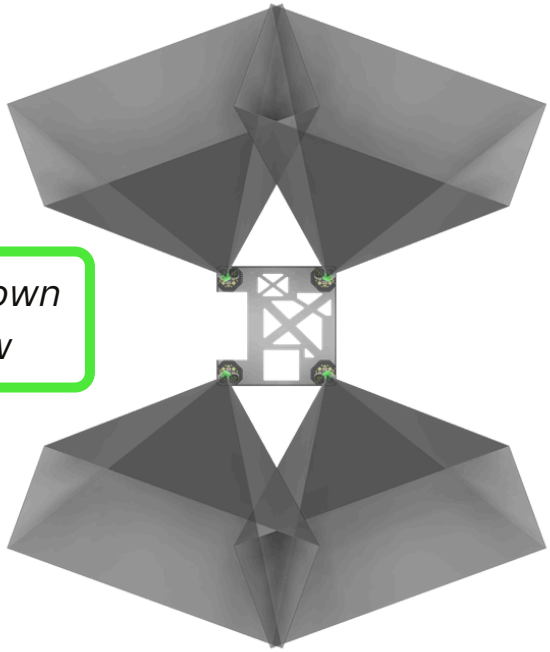
Vision & Cameras

Requirements

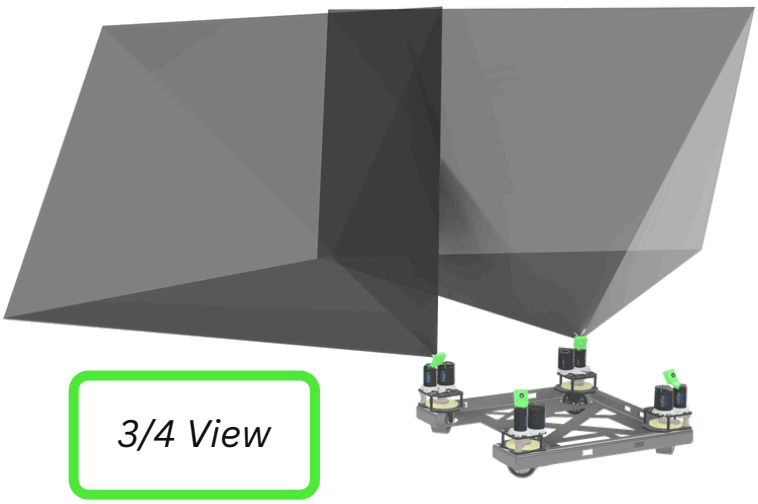
- Maximize **AprilTag** coverage without compromising accuracy
- Use only **2 Orange Pis**
- Seamless and optimize space allocation
- While shooting, ensure accuracy by making use of as many **AprilTags** in our ALLIANCE ZONE as possible



Mounts onto a Kraken X44 in place of the regular terminal cover



Top-Down View



3/4 View

**Some Field of Views Omitted*

Our Implementation

- **4 Arducam OV9281** mounted on our Swerve Drive Azimuth **X44s**
- **PhotonVision** running on **2x Orange Pi 5 Plus**
- Freeform-modelled camera mounts designed for optimal strength printed out of **PA6-CF**
- Angled upwards at 30° and 35.5° outwards, **mirrored** on both sides of the robot
- Maximizes **AprilTag** coverage in our ALLIANCE ZONE immediately after crossing the bump to counteract any related **odometry** issues
- Nearly-optimal view of **AprilTags** while shooting

Controls



Climb **Up**

Climb **Down**

Reverse Hopper

Drive Translation
*(Push in to align **Turret** to zero)*

Drive **Rotation**
*(Push in to **lock** Rotation)*



Pass

Reverse Intake

Shoot

Intake



Rotate Assist **Activate**

We used an XBOX Elite 2 controller for its **button remapping** and **back paddle** features

Software

Requirements

- Eliminate need for a co-driver or operator with robot control increase efficiency and reduce miscommunications
- Automate most actions to reduce cognitive load on driver and improve performance
- Keep turret on-target to reduce shooting delay from start up
- Combine shooting and passing triggers to reduce complexity
- Mobile shooting with minimal loss of accuracy
- Eliminate need for a dashboard with LED indicators on the robot
- Maintain driver awareness of shifts



LED Indicators

- Powered by a **CTRE CANdle**
- Shooting and passing indicators blink faster or slower based on the shooting confidence algorithm's output

- **Inactive**
  - Feeding
    - **Confident (≥50%)**: Varying speed of **flashing blue**
    - **Not Confident (<50%)**: Varying speed of **flashing red**
  - Intaking: **Flashing yellow**
  - Default: **White**
- **Active**
  - Shooting
    - **Confident (≥80%)**: Varying speed of **flashing green**
    - **Not Confident (<80%)**: Varying speed of **flashing red**
  - Feeding
    - **Confident (≥50%)**: Varying speed of **flashing blue**
    - **Not Confident (<50%)**: Varying speed of **flashing red**
  - Intaking: **Flashing yellow**
  - Default: **Solid purple**

Software (Cont.)

Shot Calculation

- An **interpolating tree map** determines shot selection - based on distance from the HUB, the robot code determines an **optimal hood angle and wheel velocity**
- An alternative strategy was also proposed during the season: using a **complex, dynamics calculation system** for instant targeting instead of **pre-sets**. This was scrapped due to accuracy and maintenance concerns
- For mobile shooting, a few simple methods were coded to account for imposed movement on FUEL exiting the robot, including:
  - **Robot Velocity** imposed onto the FUEL
  - **Turret Center** → robot center translation
  - **Time of Flight** - a recursive time of flight calculator computes the "virtual distance" to the HUB, which is used by the **interpolating tree maps** to output shot parameters

CANivore



The **CTRE CANivore** was used to split the **CANbus** between our Drivetrain and the remainder of the robot:

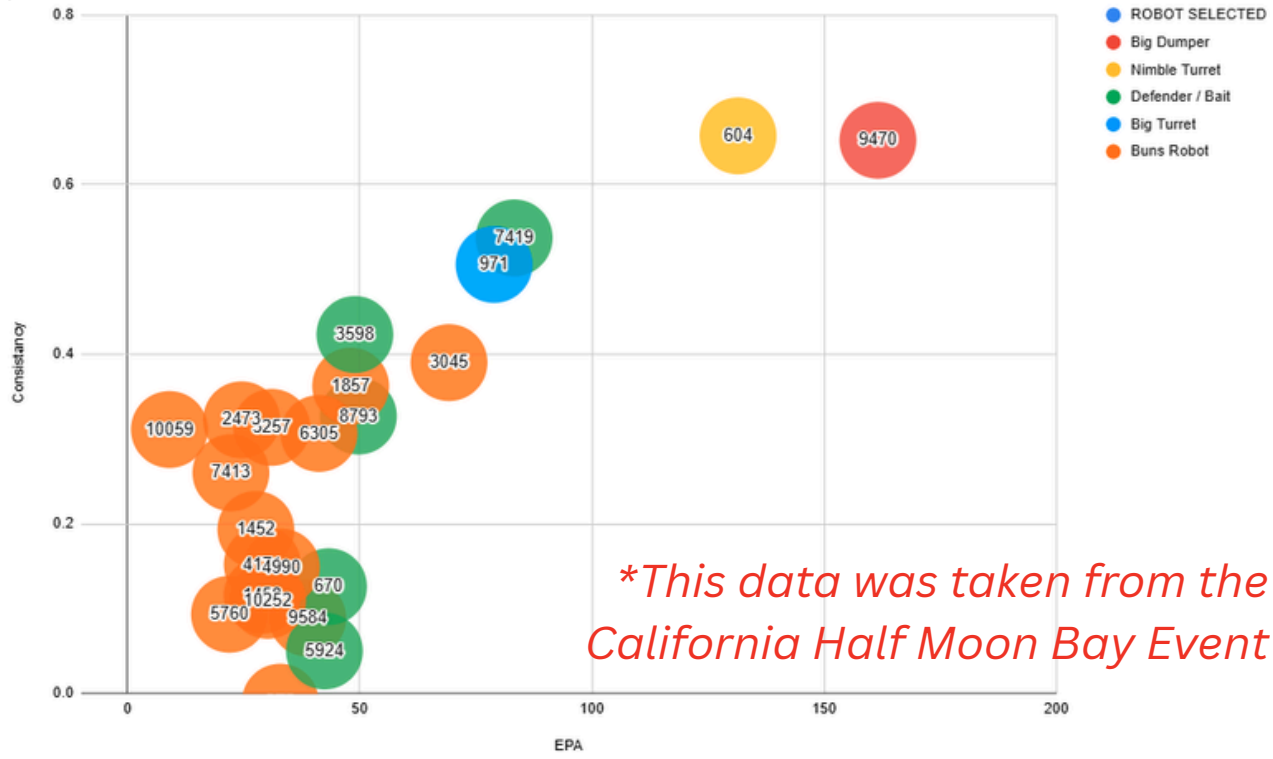
1. Greatly reduced CAN Utilization
2. Added a backup in case either CAN line fails, so that we can either still drive or still shoot.

Fun Fact: Only **two** non-CTRE devices were used this year: the **REV Power Distribution Hub** and a **REV SparkMAX** for our climber.

Scouting

Bubble Chart Analysis

The bubble chart shown takes into account driver scores, achatypes, reliability, and EPA. This combination of variables creates an easy to read analysis of multiple data points at a glance.



This data was taken from the California Half Moon Bay Event

Getting the Data

In order to receive data to analyze, we use a variety of methods including API calls (TBA and Statbotics) as well as scouting forms for Drivers, Pits, and General Matches

Data Analysis

The data analysis we perform is resistant to poor or a lack of human collected data from our scouts. As the event goes on, our analyzed data continuously improves, but because our analysis is designed to be used without human generated data, we will still have accurate analysis even in the early matches.

Scouting (Cont.)

- Standard FRC Event rankings are inherently flawed, since they are affected by the randomized nature of qualification match schedules.
- To overcome this, we have designed a proprietary Adjusted Expected Points Added (aEPA) algorithm, which is heavily influenced by Strength of Schedule (SOS) coefficient.

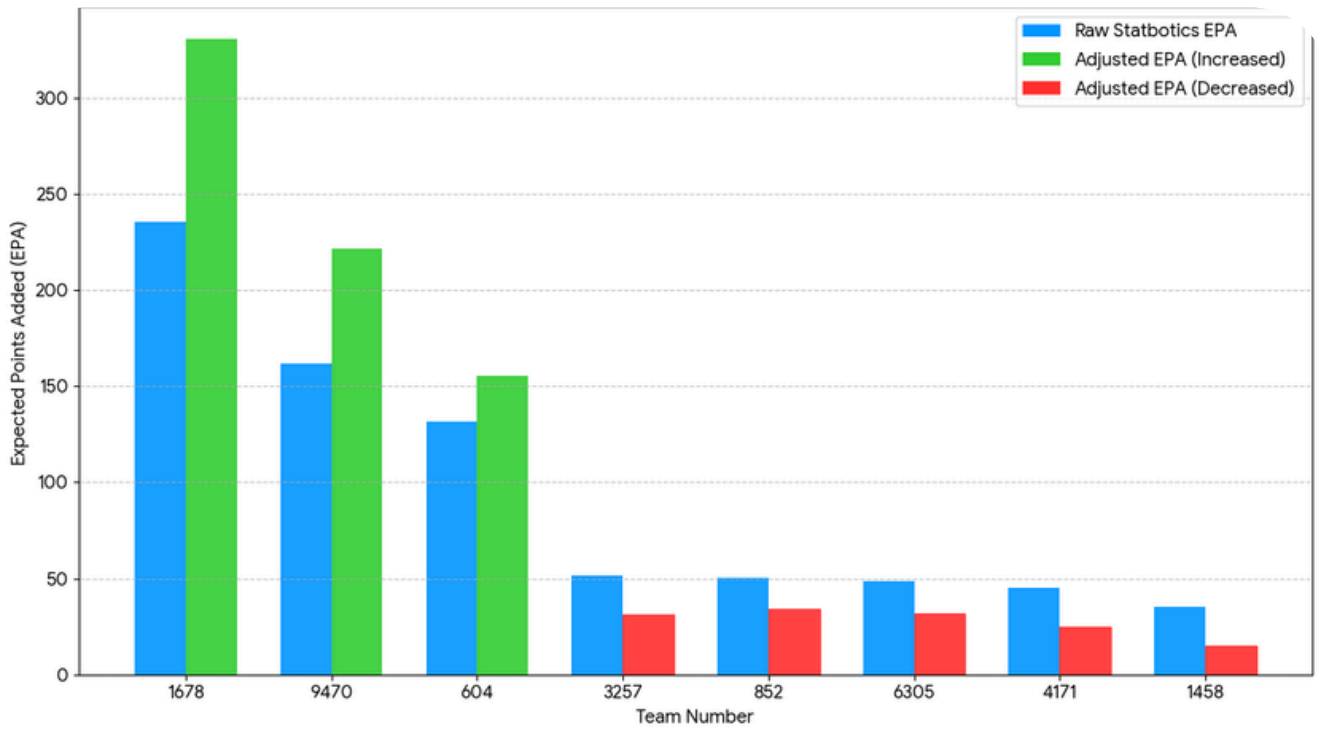
Adjusted EPA

Metric	Statbotics (Baseline)	Team 86 aEPA	Reliability Gain
Win Prediction Accuracy	80.8%	**89.7%**	**+8.9%**
Mean Absolute Error (MAE)	39.9 pts	**25.5 pts**	**-14.4 pts**

*Data taken from 2026 Orlando Regional

- To calculate our aEPA, we take into account three core variables- the Statbotics EPA, our live pit and match scouting data, and a SOS adjustment factor to best capture a robot's scoring ability.

- We also have a Strength of Schedule adjustment, which takes the differential of the average opponent alliance EPA and the average partner EPA.
- These factors together help us generate an Adjusted EPA which aims to get as close as possible to what a team should truly be ranked.



A Special Thanks To:

JEA®

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FSCJ

Florida State College at Jacksonville

MACHINE & FAB.