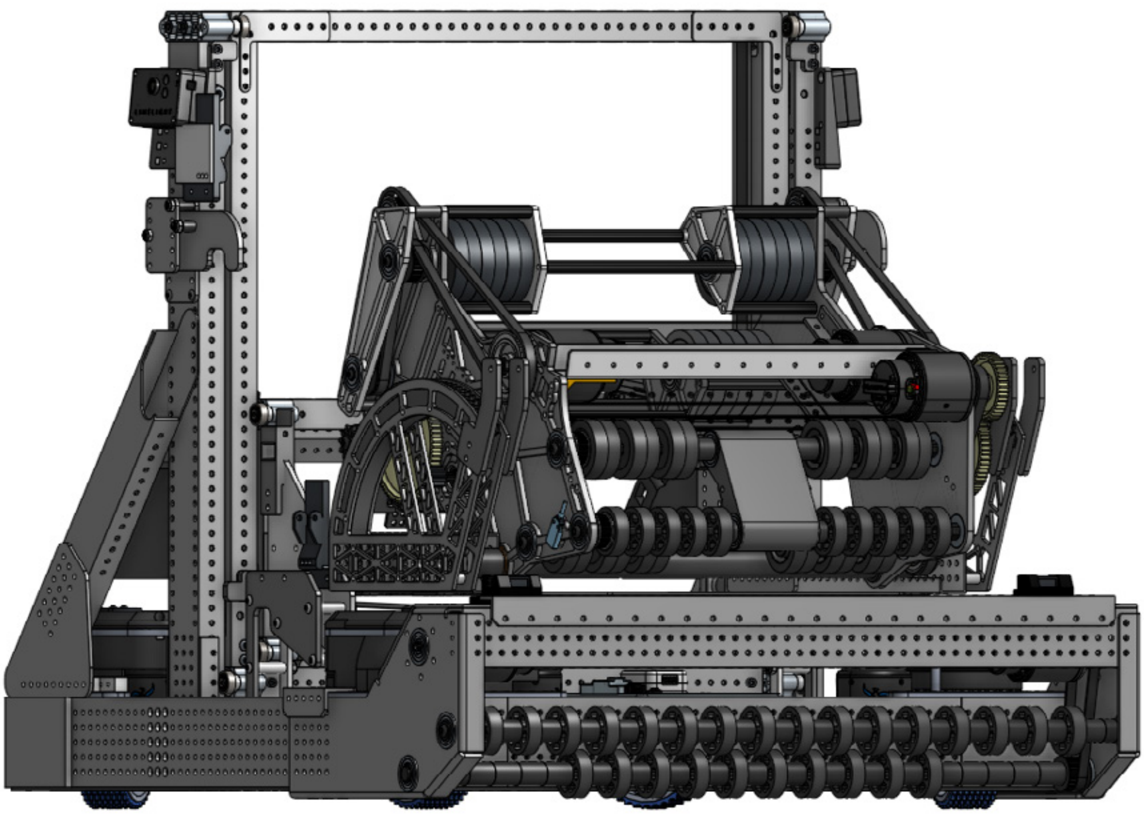
The Broncobots

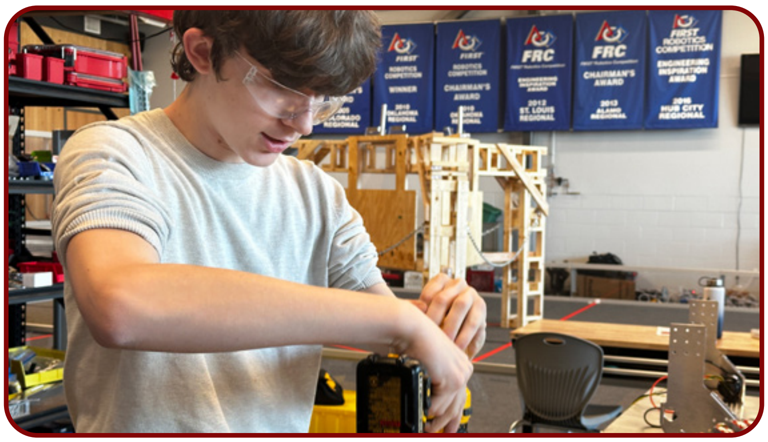


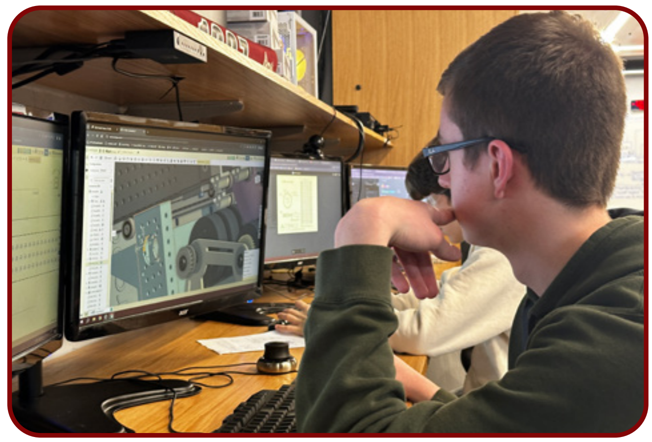
SHOCKWAVE

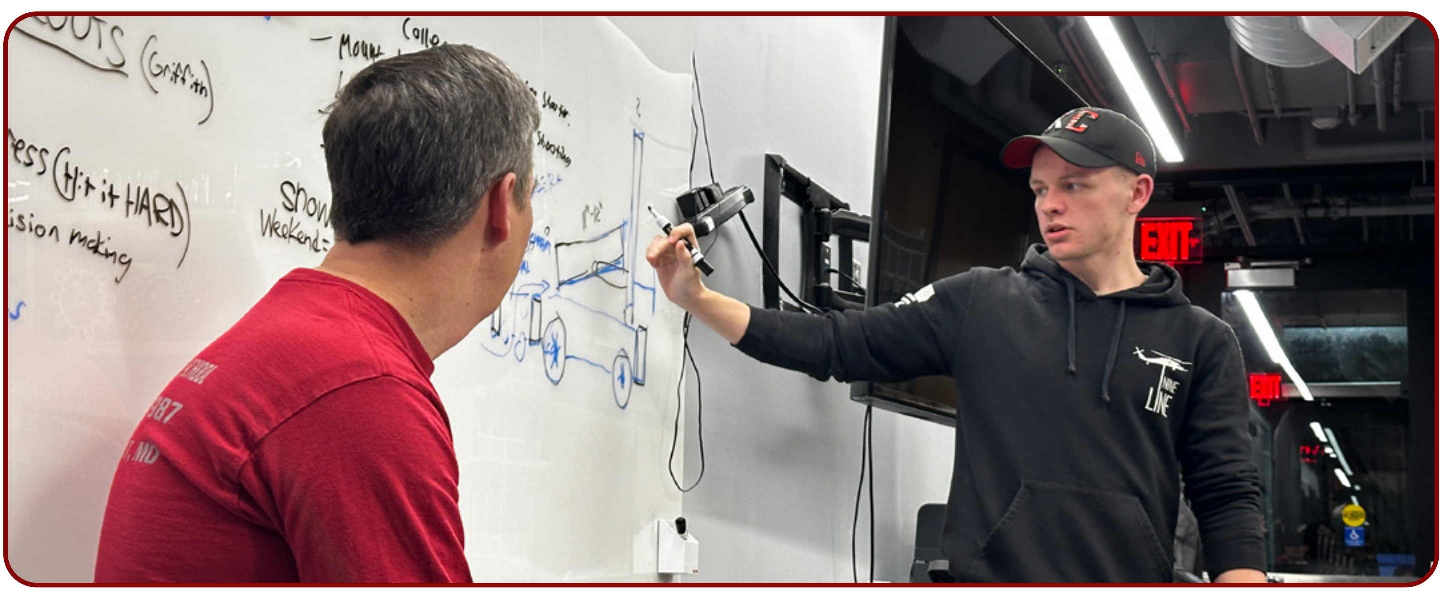
2024 Technical Book

5,500+

Student Hours







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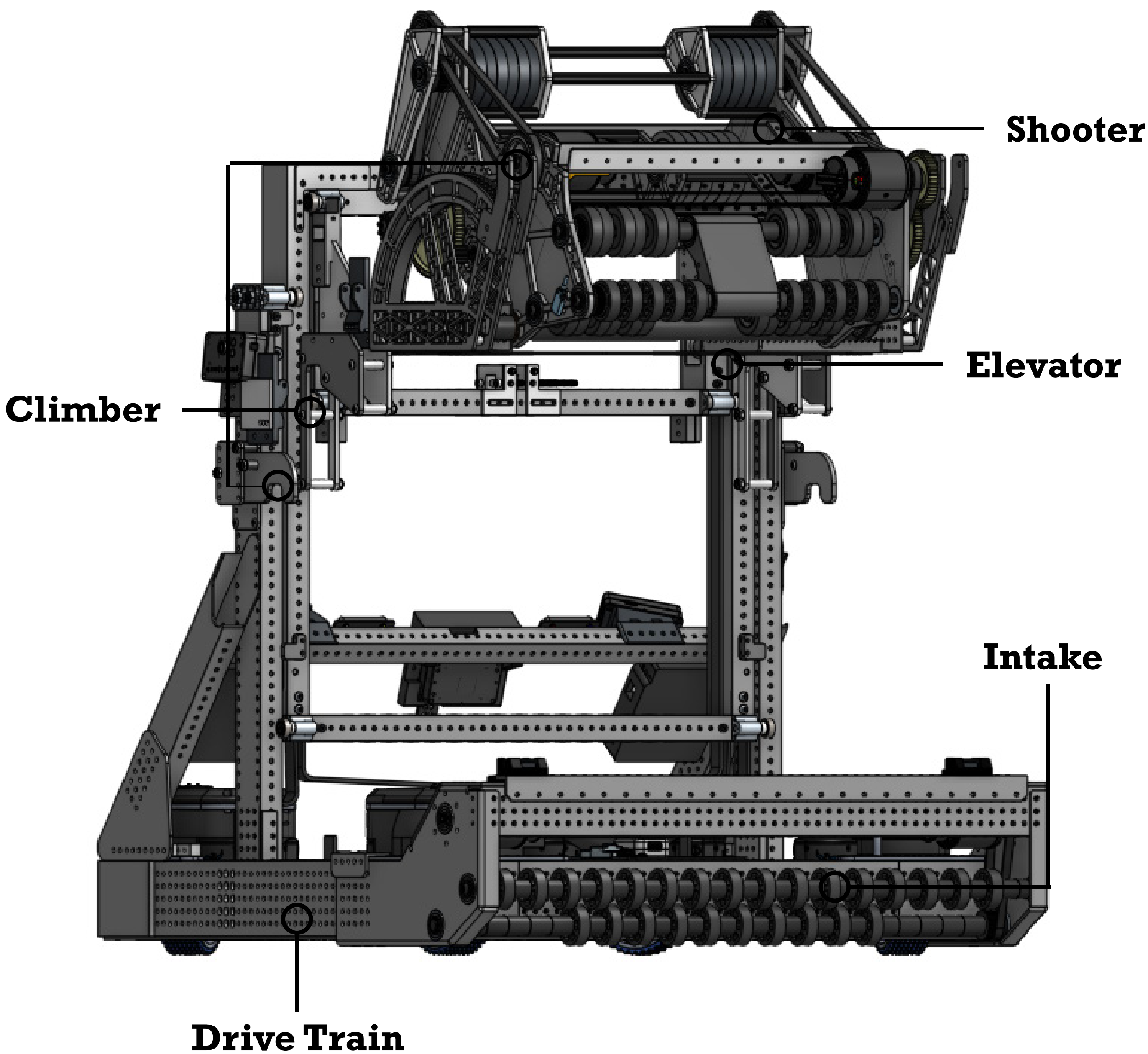
Robot Overview

Meet ShockWave, Team 1987's 2024 robot. The Broncobots are excited to share the design of this all new machine. With 5 subsystems, this year's robot is built to address every challenge Crescendo has to offer.



Robot Overview

Strategic Design

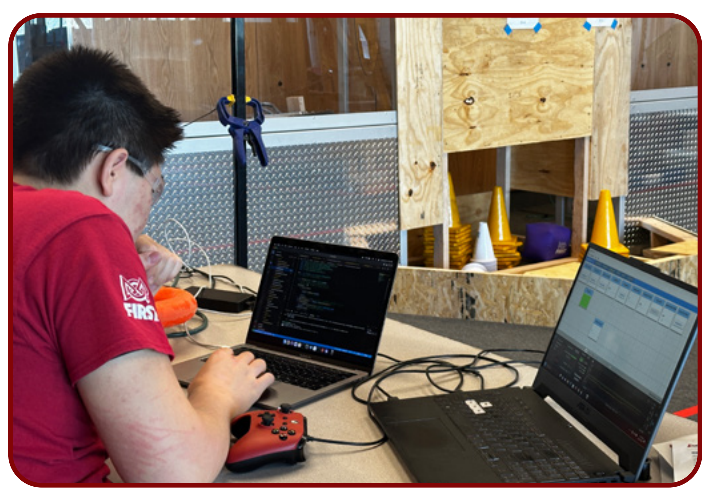
- Note shots exit opposite the intake for autonomous efficiency
- No extensions beyond the frame perimeter to reduce potential damage and risk of G417 & G418 fouls
- Low ground clearance prevents driving over Notes
- Capable of driving under the Stage with 1" of clearance
- A low Center of Gravity (under 6") prevents tipping and improves climb stability

Design for Manufacture

- Heavily utilizes COTS components to limit manufacturing need
- All components go through a manufacturability review for sponsored sheet metal or in-house fabrication
- Extensive 3D Printing and CNC fabrication ensures consistent tolerances for repeatable parts

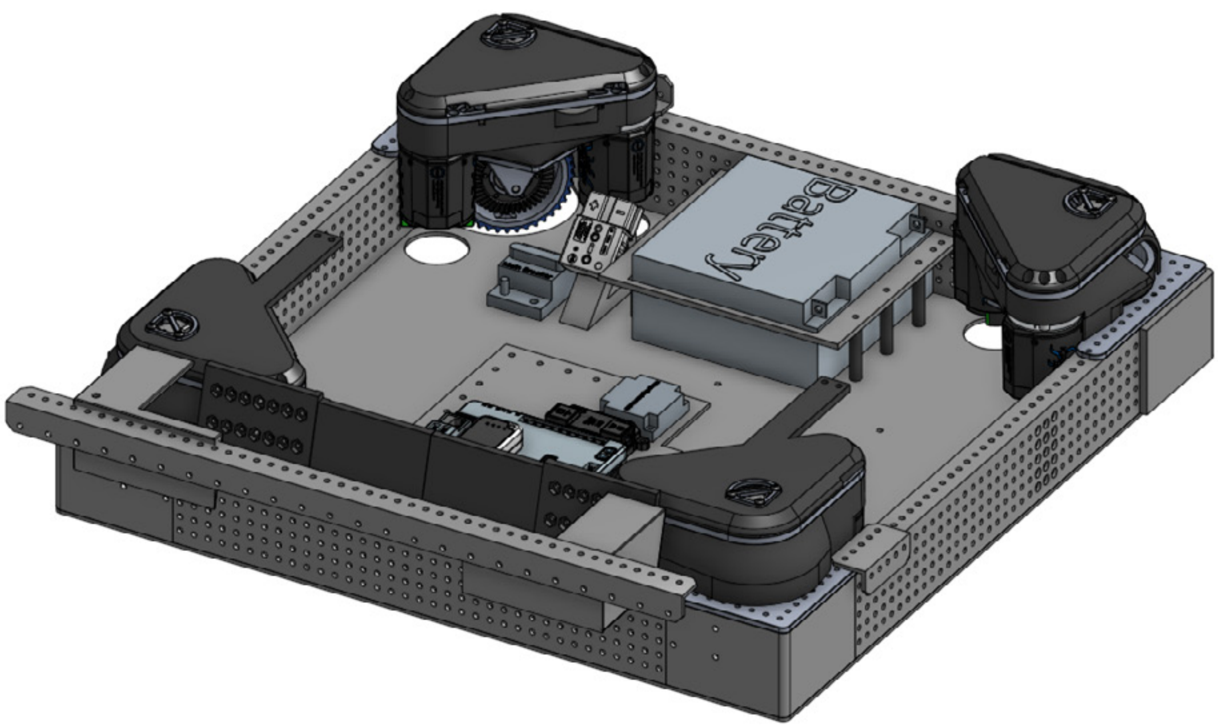
Design for Maintenance

- Subsystems utilize minimal varieties of COTS components
  - Reduces cost
  - Reduces pit storage space needs
  - Increases speed and efficiency of repairs
- Subassemblies are easily swappable with spares
- No buried hardware philosophy prevents frustrating repairs



Drive Train

- MK4i L3 Swerve Drive w/Kraken Drive Motors
  - 18.9ft per second
  - Upgraded sealed ring bearings for protection from field debris
  - Nylon 3D printed swerve covers keeps grease in and dirt out
- Deep 3" frame reduces ground clearance and increases space for mechanisms and electronics
- Hinged electronics shelf above PDH for improved packaging
  - Polycarbonate panel permits for visiblity to PDH status lights
  - RoboRio placement for easy FTA viewing
- Robust single-piece bumpers



Shooter

Fly Wheels

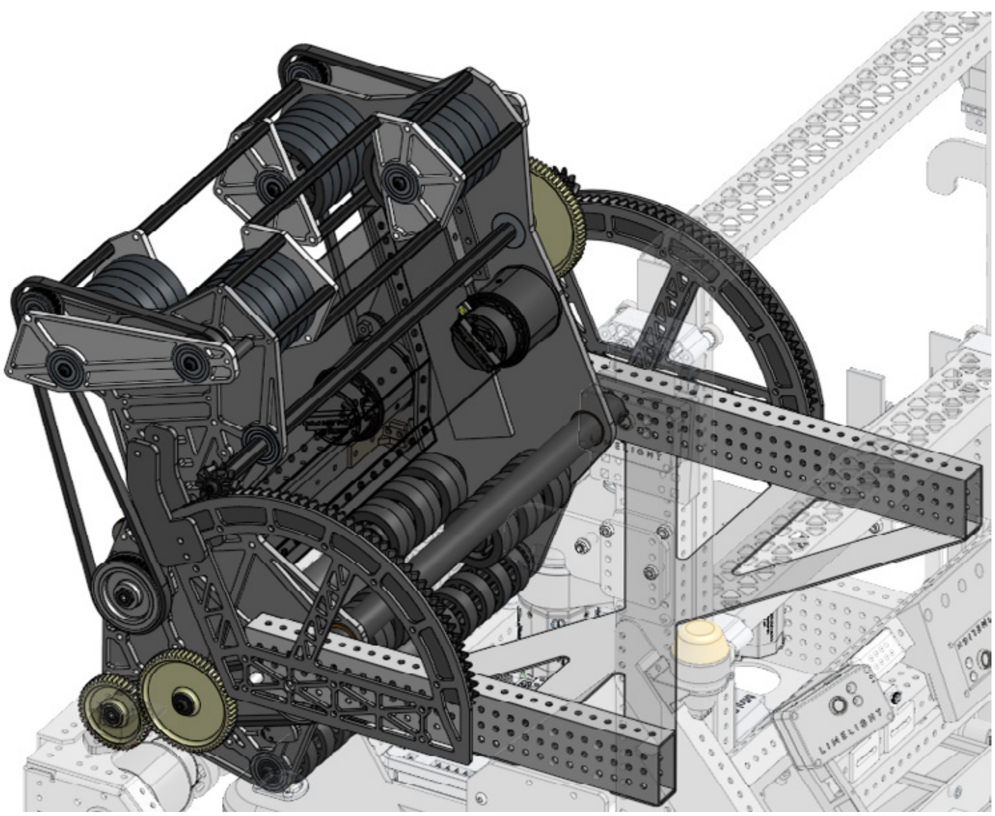
- Differential L/R shooter speeds induces spin, improving Note stability
- Shoots through the elevator with a low launch height for improved scoring consistency
- Double-sided belt eliminates need for gears, reducing size and weight

Feeder

- Feeder handoff from intake holds Note prepared to shoot
- Dual Keyance through-beam sensors automaticaly control note position

Wrist

- 120-degree range of motion, hard stop minimum ensures consistency
- Flip-up position ejects Note to score in the amp and trap
- 80:1 gear ratio reduces power consumption and software complexity



Elevator

- Belt-in-tube 2-stage elevator
  - Continuous rigging
  - Kevlar reinforced belt
- 4lb constant force spring ensures carriage rises first
- Carriage travels to max height in 0.5 seconds
- Compact gearbox integrated into elevator base
  - 13.5:1 gear ratio
  - Driven by 2 Kraken X60s
  - Lifts robot at end-of-match in 0.87 seconds (w/voltage as low as 8V)
  - Dual motor shaft bearings prevent shaft bending

Climber

Elevator Hooks

- Extended rear leg allows driving right into the chain
- Funneling front leg corrects misalignment
- Stacked design to widen stance

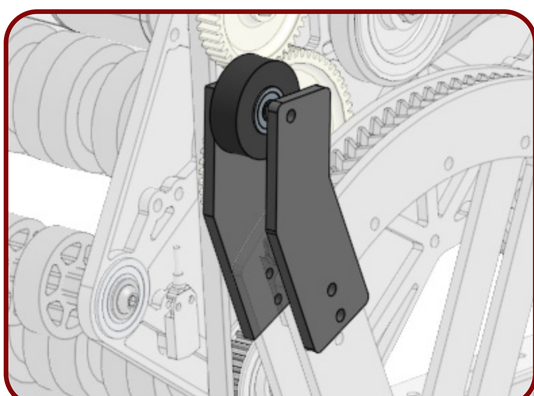
Spring Latches

- Passive hooks; eliminates need for power, control, and software implementation
- Returns to position rapidly during the climbing sequence
- Eliminates backdrive at the end of the match

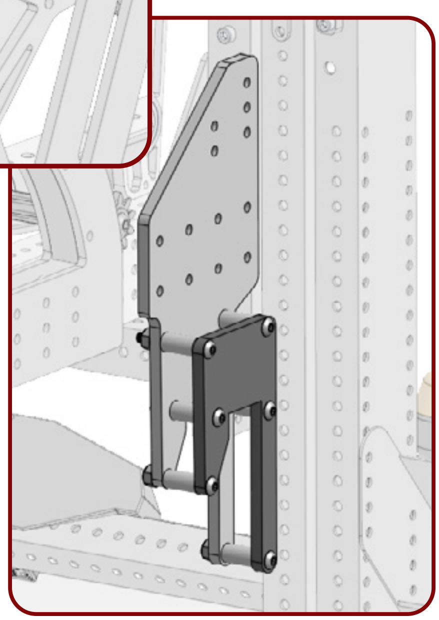
Stabilizer Wheels

- Stabilizes robot tipping
- Aligns trap scoring location

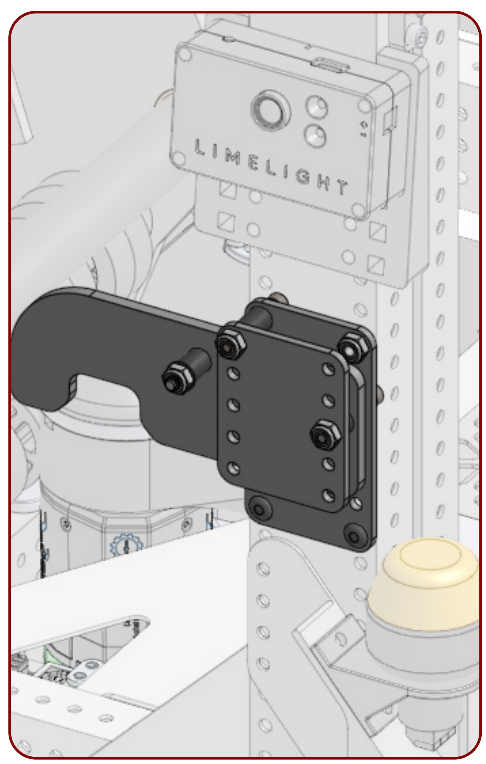
Stabilizer Wheels



Elevator Hooks

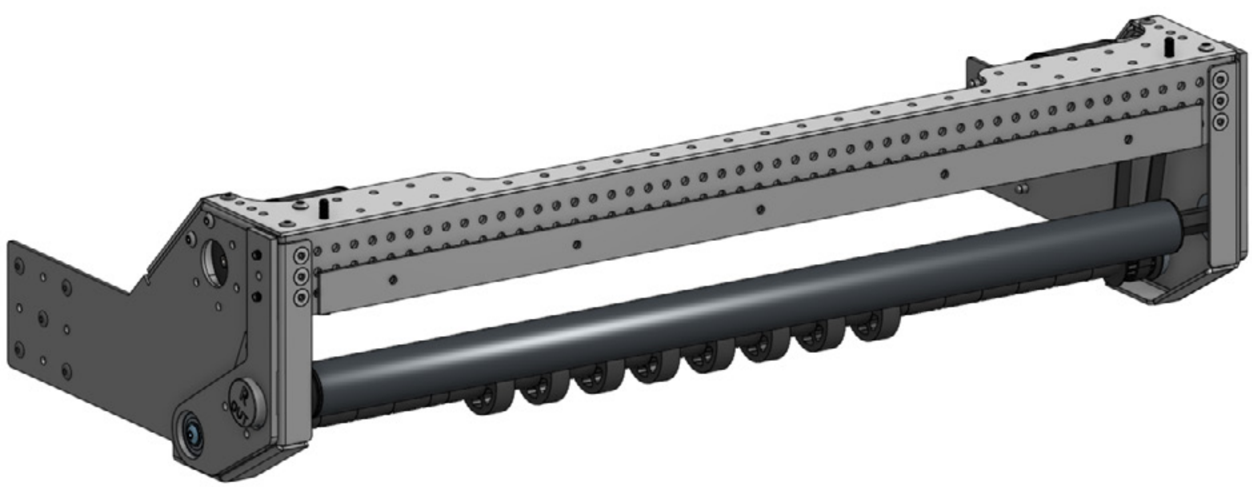


Spring Latches



Intake

- Under bumper design prevents damage, especially during autonomous collisions
- 3D printed funneling system quickly centers Note
- Rollers are belt driven by independent Falcon 500 motors
- Polycarbonate upper roller and compliant bottom roller balance compression, grip, and funneling
- Robust sheet metal frame and steel reinforcement stands up to heavy defense



Programming

Drivetrain

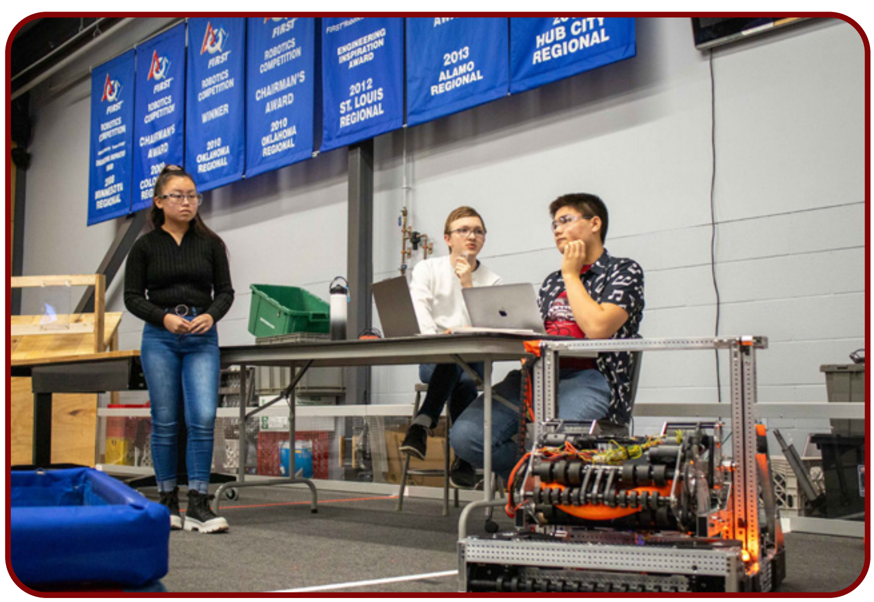
- The magnetic encoder on the four swerve modules measures steering absolute position (CANCoders).
- Closed loop PID control for velocity and position of the swerve moduled using TalonFX.
- Autonomous commands utilize the Path Planner tool to follow paths using motion profiling.
- Odometry fuses data from TalonFX internal encoders, CANcoders, and a pigeon to track field-relative pose.
- TalonFX motors and CANcoders within the drivetrain are linked via a CANivore, which provides a differentiated CAN bus and allows for more bandwidth, as well as redundancy in case of a single CAN bus failure.

Elevator

- Extension movements are controlled using synchronized closed-loop motion profiles from the Phoenix 6 MotionMagic API and use a feed-forward value to counter act gravity.

Wrist

- A Phoenix 6 MotionMagic profile, which references the internal motor encoder for absolute position, maintains the desired wrist position using a dynamic gravity feed-forward constant based on the angle. The sensor-to-mechanism rotations ratio is all done in a closed-loop control.
- The Talon motor is stalled while holding position throughout the match. Additional voltage and current limits are set to protect the motor and ensure it operates within manufacturer specifications.



Programming

Intake

- The intake roller speeds vary based on the Note position in the robot to allow for consistent and reliable positioning of the Note.
- Intake uses haptic feedback to notify the driver immediately when a Note is collected.
- LED lights on the robot indicate the collection state of the robot so that all drive team members can easily see when a Note has been collected.

Shooter

- The shooter has two beam-break sensors that detect the position of a note within the shooter assembly.
- The shooter continuously updates vision data to always aim at the Speaker AprilTags when a note is collected, ensuring a quick shoot time.
- The shooter has an idle speed throughout the match to ensure rapid firing.

Vision

- The robot a Orange Pi 5+ processor, dedicated to machining learning-based Note object detection as well as 2 Limelight 3G's and 2 Limelight 3's for Apriltag position Updates.
- Vision is used for the SquareUpToApriltag to align perpendicular to any Apriltag automatically.
- A continuously running command ensures that the wrist is always aimed at a speaker Apriltag when a Note is collected.
- An additional command ensures that the entire robot faces the Speaker upon the driver's request, allowing for fast scoring.
- A drive-to-note command simplifies the automation command by driving to a note automatically with the driver's input.

Programming

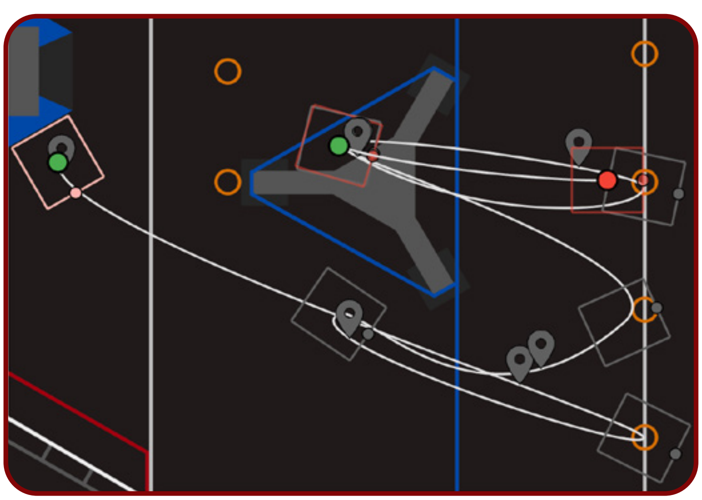
Driver Controls

- The driver uses an Xbox controller with commands and command groups assigned to buttons.
- The driver can reset the gyro, making field orientation a single button press.
- The co-driver can initiate the robot's climb sequence with a single button.
- Using the d-pad, the driver can lock the robot heading to any cardinal direction.
- Should the robot display any unexpected actions, the co-driver can reset all subsystems, allowing the robot to continue playing during a match.

Automation

- The superstructure and drivetrain work synchronously to optimize autonomous routines by dynamically sending subsystem commands as the robot drives.
- Before each match, the drive team can choose between multiple autonomous paths, some of which will end automatically, given the match strategy.
- PointAtApriltag and DriveToNote are automated PID controllers that dynamically drive and rotate at positions.

Four Note - Source Side



Six Note - Amp Side