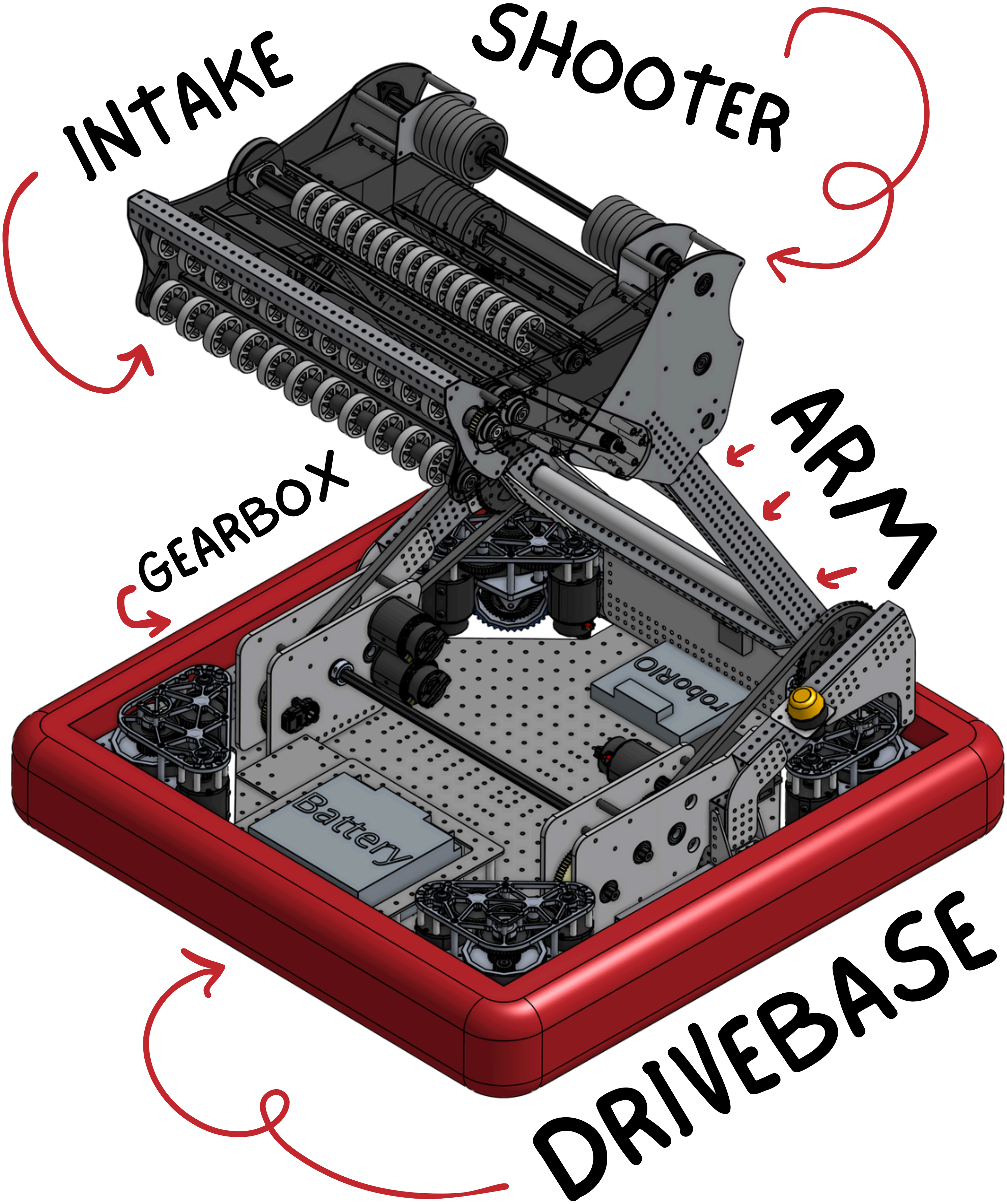
Fremont High Robotics | Sunnyvale, CA | FRC Team #3501

Firebots Technical Binder

3501 FIREBOTS


INTAKE
SHOOTER
ARM
GEARBOX
roboRIO
Battery
DRIVEBASE

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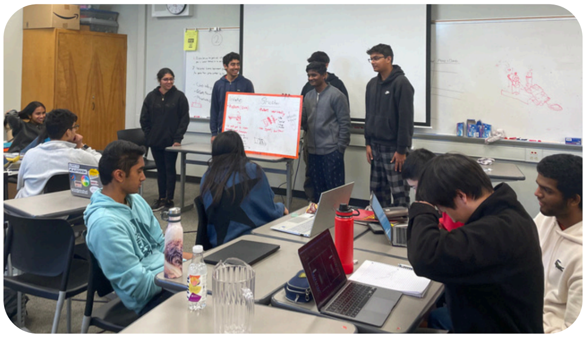
Game Analysis

We set out this year intending to design a reliable robot that is both within our means and successfully achieves the primary scoring method. For Crescendo, this was scoring to the speak at rapid cycle times to complement our alliance partners during playoff matches. With our week 1 competition staged in Utah Regional, our decisions and tradeoffs revolve around simplicity and efficiency.

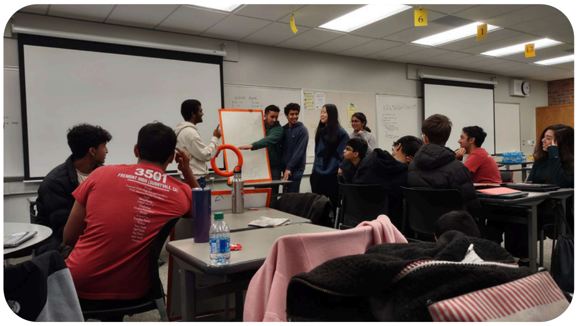
During kickoff, we first focus on the overarching strategy and what we want to accomplish before moving on the details of mechanisms

Match Strategy



Our drive team will rely on a ground intake to effectively collect notes, allowing us to score centerline notes, missed shots, and stray notes from the opposing alliance. For efficient cycles, we aim to quickly shoot during movement and to traverse under the stage.

Subsystem Strategy



General

- Fast and maneuverable drive train
- Ability to drive under the stage
- Low center of gravity

Intake

- Touch it, own it at different driving speeds or angles
- Avoid contact by passively retracting after in control of the note
- High durability to withstand collisions
- Feed notes consistently to the shooter

Shooter

- Reliability shots into speaker
- Quick aim and alignment from anywhere near the subwoofer
- Shooting in motion

Climber

- Packagable as an add-on after completion of main subsystems
- Strong enough to support the robot for sufficient time after the end of a match

Potential Ideas

<table>
<tr><th>1. FIXED CONTINUOUS</th><th>2. HANDOFF</th><th>3. VARIABLE ARM</th></tr>
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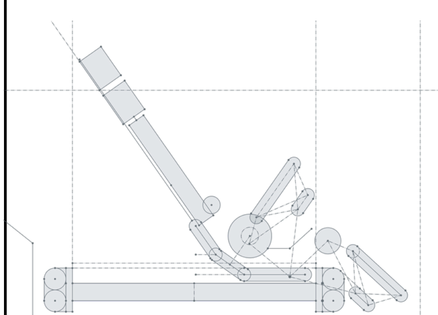
Kitbot-inspired
Under-bumper or 4-Bar Linkage Intake
Permenantly mounted fixed single-side shooter angle
Pros

Minimal DoF
Shooter gives spin on the note like a frisbee

Cons

Unable to shoot from farther distances
May require tradeoffs of smaller intake width or centering capabilities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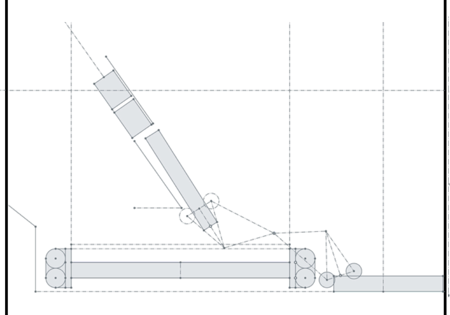
Cranberry Alarm Ri3D Inspired
Over-Bumper intake on a pivot
Dual-side shooter wheels
Pros

Protected intake when not intaking, avoid damage during collisions
Stable shots that stay flat

Cons

Inconsistent feeds would make shots more unreliable
Would require secondary mechanisms for climb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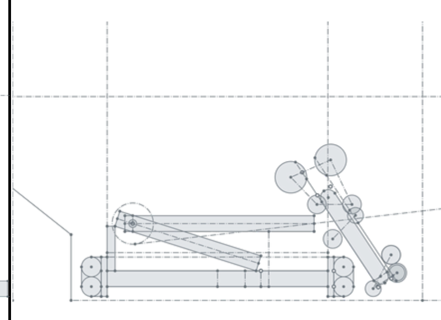
Quokkas Ri3D Inspired
Intake is integrated as part of the arm
Vertical Shooter Wheels
Pros

Easily traverse stage area
Potential for climb using the same mechanism
Short and straight path from intake to shooter w/ few rollers

Cons

Potential for tipping if robot has a high CG
High power shots, may cause notes to flex up/downwards
Vertical shooters may require more narrow intake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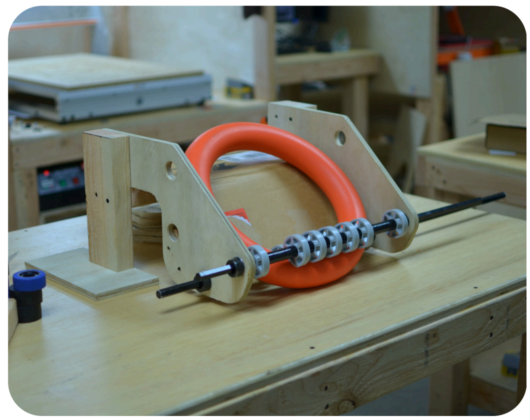
Robot Architecture

2D layout drawings enable us to translate our brainstorming sketches into Onshape, confirm robot geometry with field elements, check for interference between mechanisms, and calculate all gear reductions and motor placement.

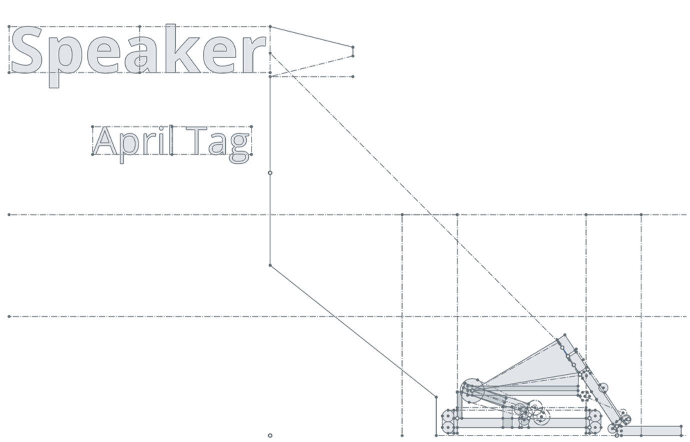
Prototyping

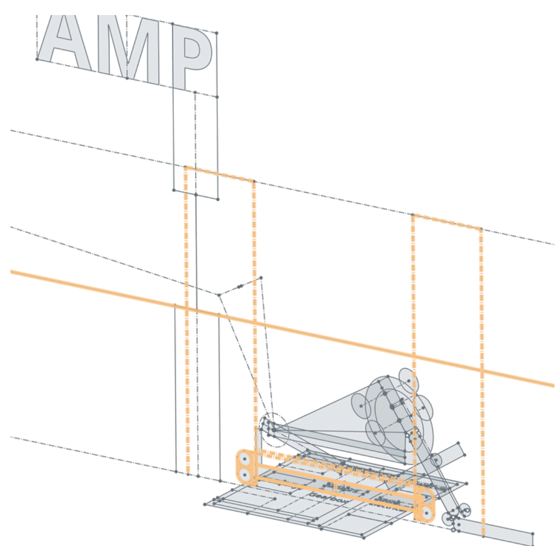
- CNC'ed 1/2" Plywood, scrap 2x4s, and parts around shop help us identify mechanism geometry and the best of competing designs
- We noticed:
  - Offset 30A compliant wheels with pressure around center and sides work well for intake, with the rear wheels being the first point of contact
  - Horizontal shooters offer less horizontal variability and more compatible with a wide intake



Current Design

- We choose a combination of arm & dual horizontal shooter design as the best fit for our goals this season. It's ease to traverse all areas of the field, including under the stage; the simplicity of just using 3 rollers for the intake; and the variable shooter angle's potential ability to score from distance achieve all of our primary objectives.
- In the robot architecture, we designed a nested gearbox between swerve modules to give enough space for in-line tensioners. The arm is the right length for amp scoring and also has the ability for built-in climbers as part of the arm later this season





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Drivebase

Requirements:

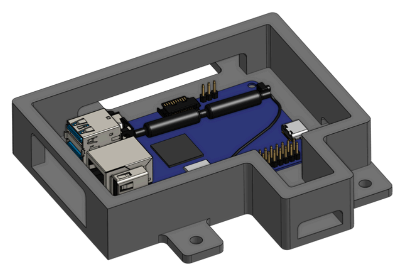
- Robust, consistent, reliability
- Maneuverability to avoid obstacles and robots in the field
- Fast and agile

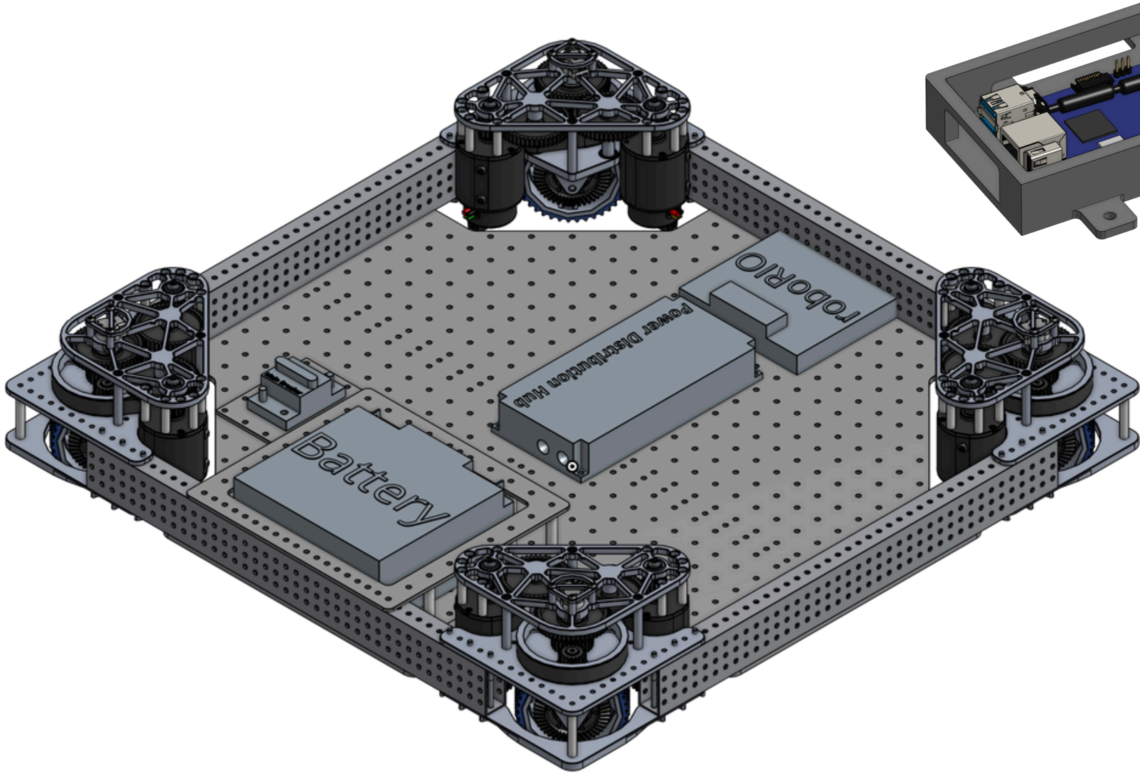
Chassis & Swerve:

- Built upon what we learned from last year from our first swerve drive base
- MK4i with L3 drive reduction driven by Kraken XS and a gearing of 6.12: 1 (17.1 ft/sec)
- Constructed out of 1 x 2 x 1/8" pre-drilled tubing
- 28" x 28" square drive base
- Custom 1/16" gussets connect bumpers and allow easy installation and removal

Bellypan

- 3/16" 1008 Steel for low Center of Gravity to prevent flipping during high acceleration
- 1" grid of 10-32 holes for wire management and zip-ties for electrical components
- Custom mounts for electrical parts

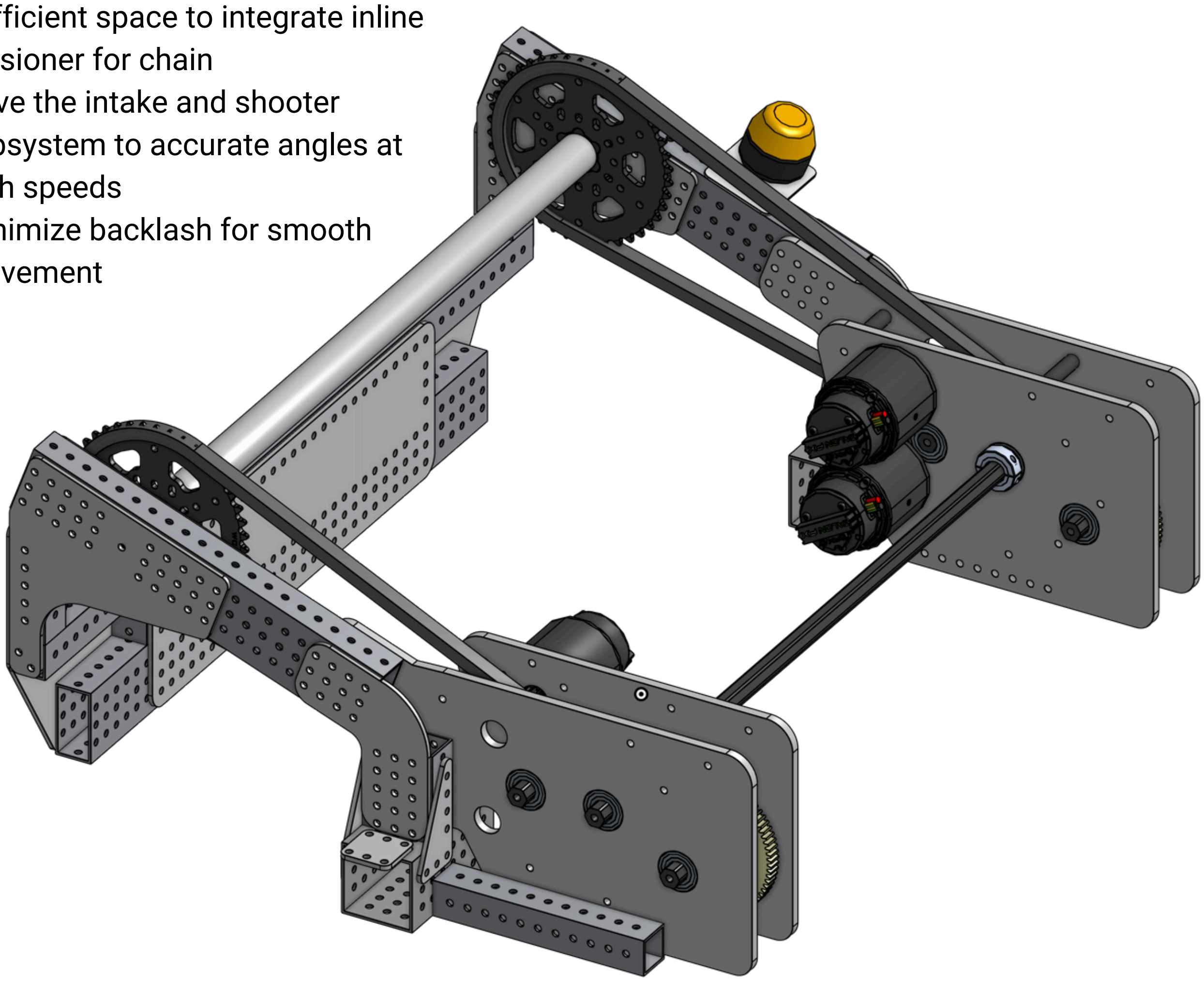




Gearbox

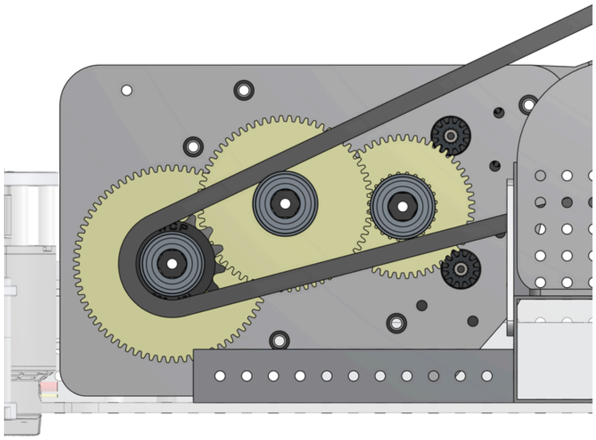
Requirements

- Sufficient space to integrate inline tensioner for chain
- Drive the intake and shooter subsystem to accurate angles at high speeds
- Minimize backlash for smooth movement



Stages

- Encased by 1/4" aluminum bolted to the belly pan and structure for rigidity
- Driven by 4 Falcon 500 motors
- 35:1 gear reduction, with retaining compound applied to the gears to the shaft
- #35 Chain with an inline tensioner
- Overall Reduction of 130.26 : 1
- ~310 degrees per second free speed
- Encoder attached to the driving shaft



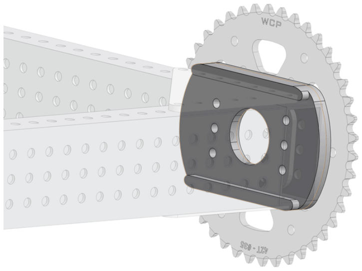
Arm

Requirements

- Rigid and sturdy under high-torque application or collision
- Ability to quickly mount on intake for iteration and pit change to backup if needed
- Correct geometry for the ability to score in amp

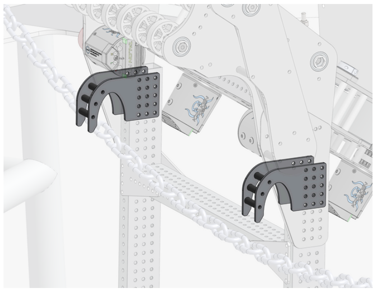
Frame

- Constructed out of pre-drilled 1 x 2 x 1/16" aluminum tubing
- Due to high load application, press-fit oil Impregnated bronze bushings connect to the dead axle shaft



Shoulder Blocks

- CNC’d 3/8" aluminum sheet metal into a 2.5-dimension part
- Hugs box tube to evenly distribute the torque into the arm
- Robust 1/8" aluminum dead axle

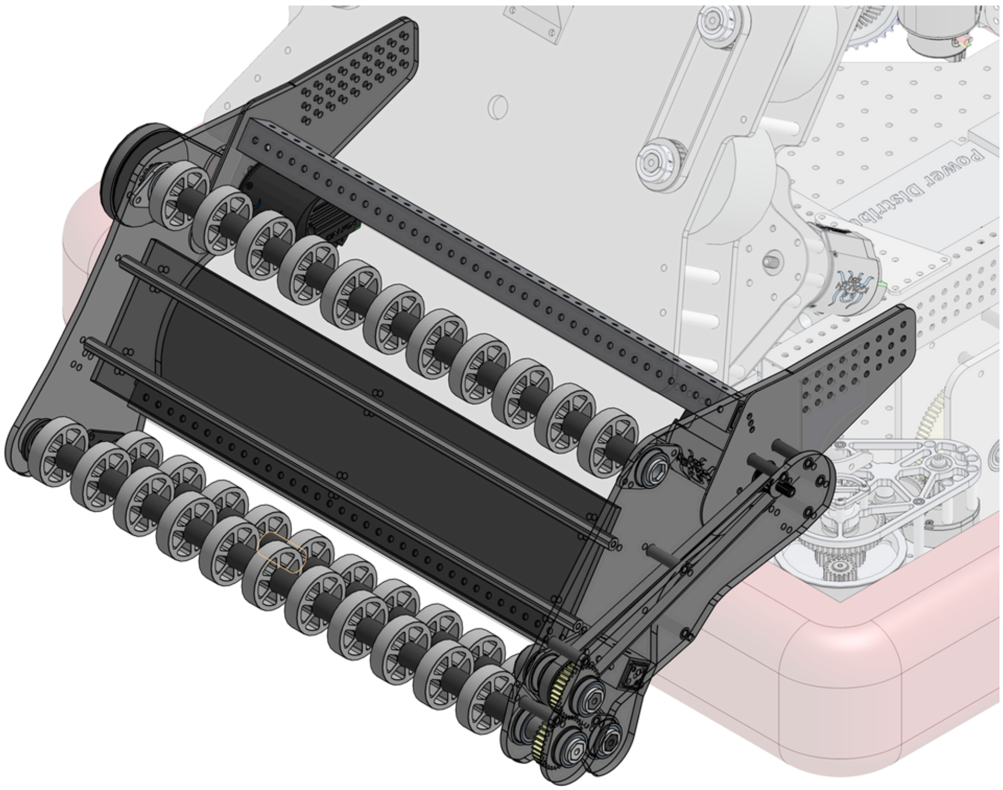


Climbers

- Passive climb with 1/8" brackets attached to the arm

Intake

Requirements
- Light, sturdy, and robust
- Wide area to touch and own notes from the ground
- Maintain strong control of note during travel



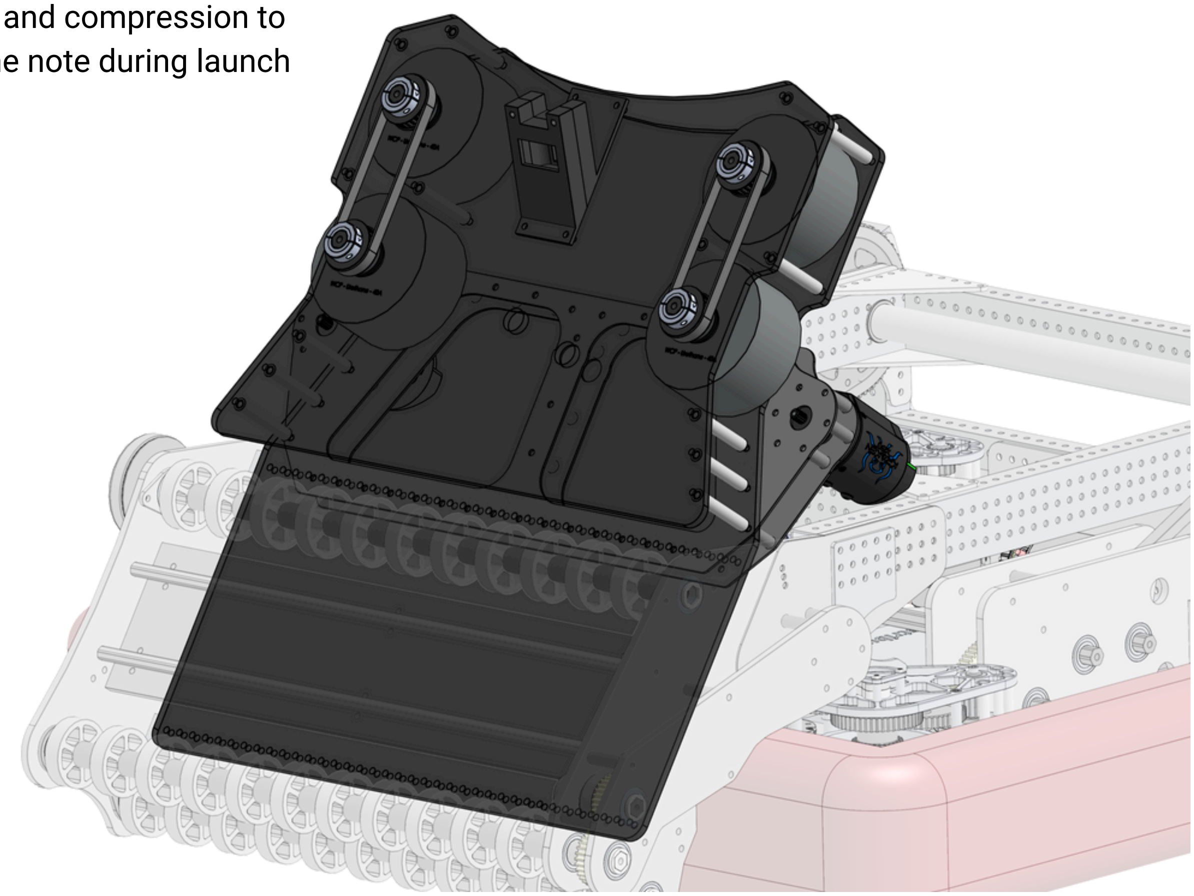
Construction
- 1/4" Polycarbonate to reduce overall weight
- 1 x 1 x 1/16" Box tubes with tube plugs across for stability

Rollers
- 2" Compliant wheels provide grip and compression to the note (45A Intake & 30A Preshooter)
- Driven by Kraken X60 motors protected within the intake
- Gears reverse direction and are shielded with a protection panel of polycarbonate
- 2 : 1 Reduction 26.2 ft/sec linear speed

Preshooter
- 4 : 1 Reduction for control of passing note into the shooter
- Nylon 3D printed 48t pulley with aluminum inserts

Shooter

Requirement
- Make consistent shots of notes fed through the preshooter
- High grip and compression to control the note during launch

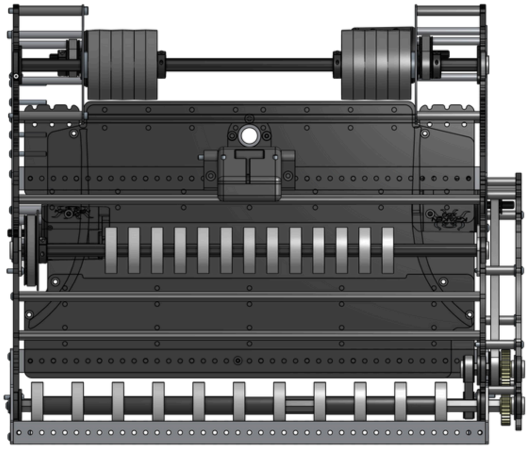


Construction
- 1/4" Polycarbonate construction, mounted to the box tubes (zip-tied to a lower set bottom tube so that the note doesn't catch on the edge
- 0.05" aluminum plates to attach motors, pulley, and light sensor
- Aluminum spacers bolted through for rigidity

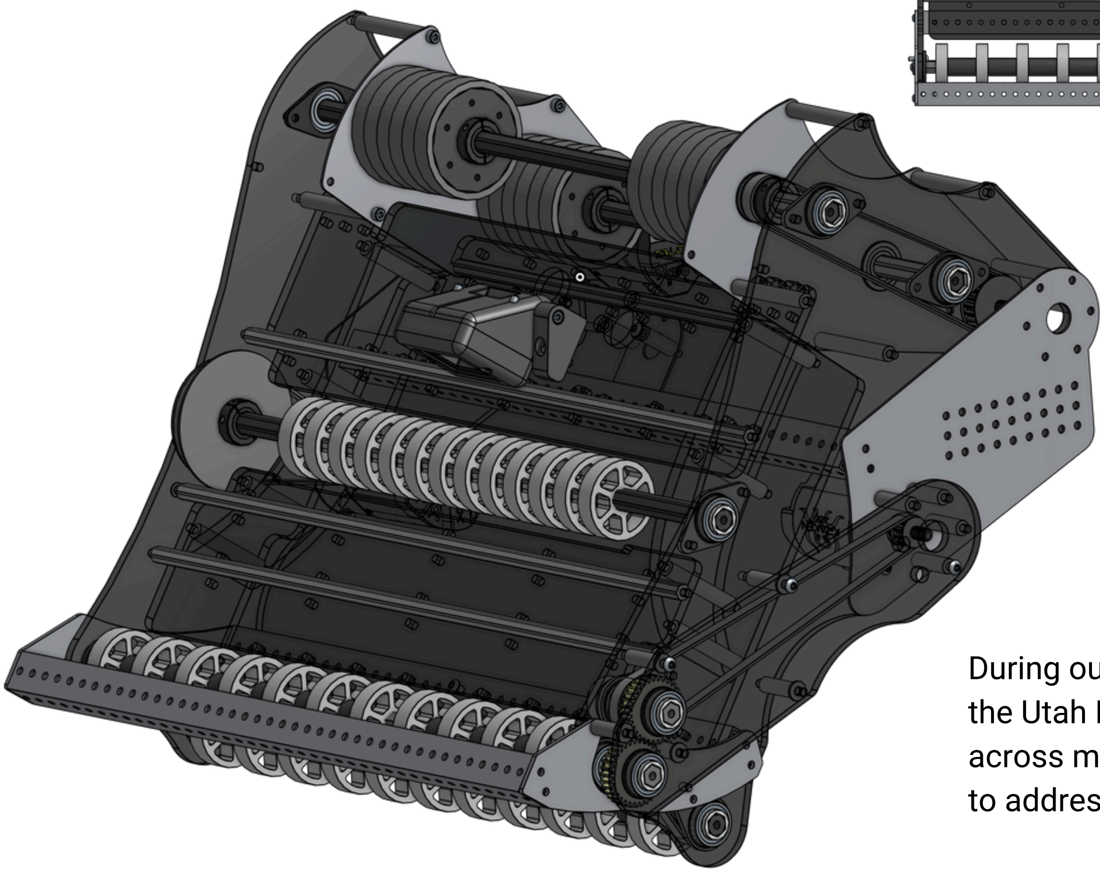
Wheels
- 4" Solid Urethane Wheel driven by Kraken X60 motors at a 1 : 1.33 Step-Up
- Side rollers chosen for the element of spin and control over shots

Sensors
- Light sensor detects note and stops preshooter wheels to give wheels time to spin up

V2 Shooter



Requirement
- Rigid shooter to avoid discrepancy in shooter angle
- Increased shot velocity by reducing inefficiency in shot compression
- Maintain advantages of wide intake and robustness



During our Week 1 competition at the Utah Regionals, we came across many issues that we hope to address through the redesign!

Same
- IR Sensor & ground pick up camera
- Arm mounting holes for easy interchangability
- Intake Geometry

Improvements
- 3" and 2-7/8" stealth wheels powered by Kraken X60 motors at a 1 : 1.33 Step Up
- Integrated beater bar to protect shafts during collisions
- Preshooter pulley now more protected on inside of mechanism

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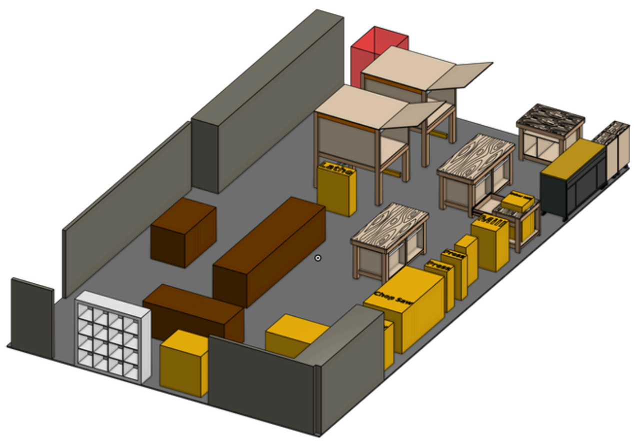
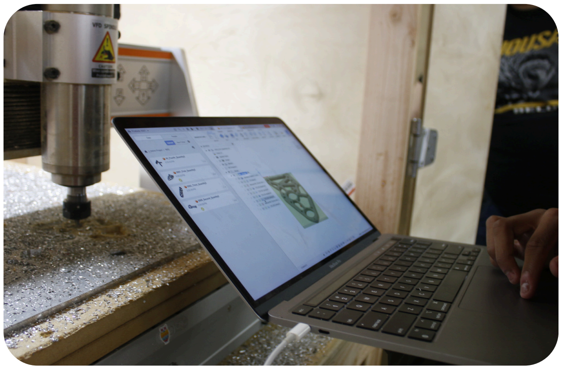
Fabrication Resources

Last year, we found that the disorganization and lack of workflow led to an unproductive use of our time. Over the summer, our team overhauled our workshop, designing and constructing tables, CNC enclosures, part organizer carts, a battery cart, and a tool wall for our portables.



From CAD to carpentry, we're excited to have unwarped tables to work on and the possibilities our new maker space has to offer!

In-House Resources



CNC Router

- For manufacturing all of our brackets and gussets efficiently with precision and speed
- Used to cut all plywood prototypes, aluminum sheet metal, and polycarbonate

3D Printer

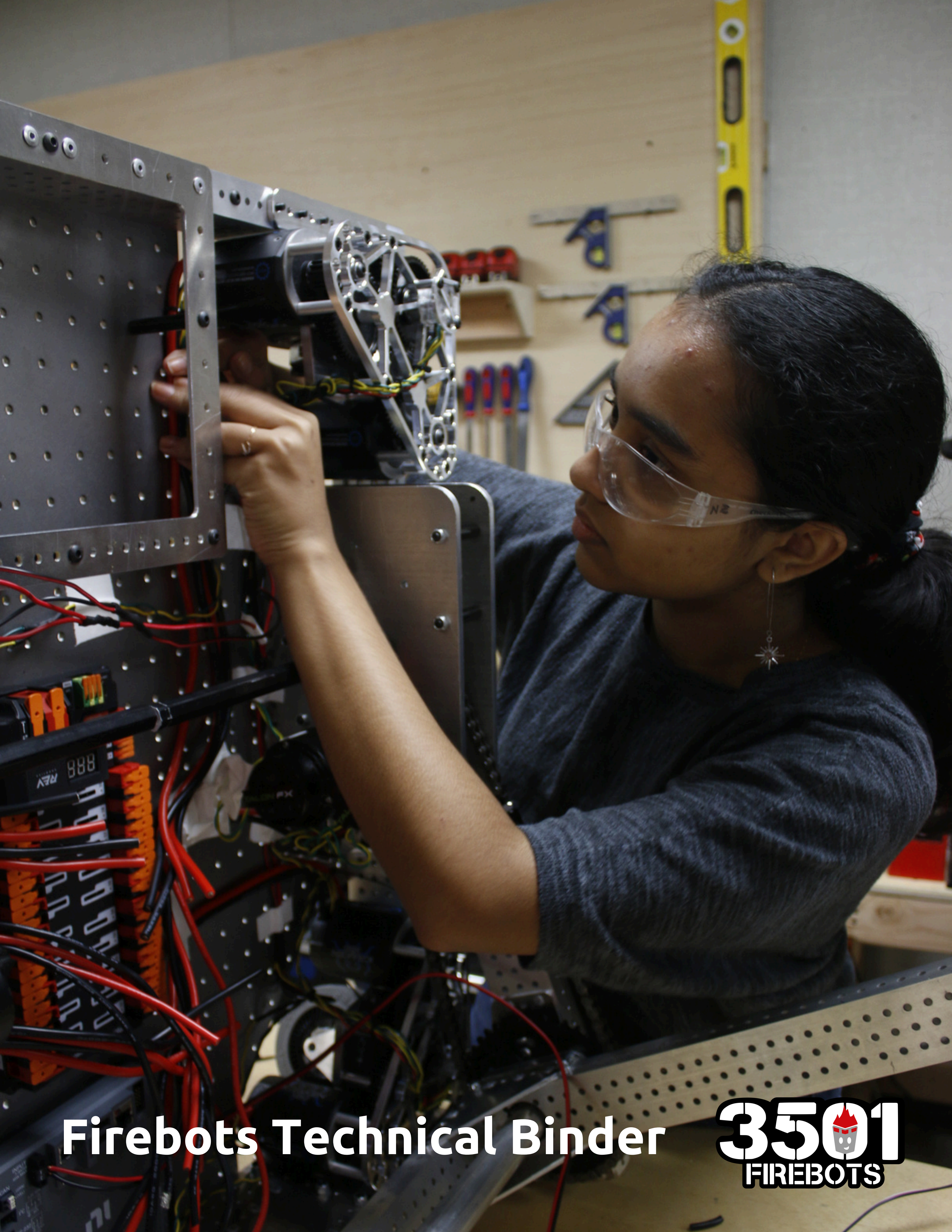
- For high-quality printing of different plastics
- Used to print our custom mounts, custom pulley, and outreach supplies

Chop Saw

- For cutting aluminum tubing, shafts, and stock

Mill

- For manufacturing holes and taking material off standoffs to right size



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Swerve and Vision

We took extra care this year to integrate odometry into our drivebase, allowing for lots of automization of movement during the autonomous and teleoperated periods. In combination with vision, the robot knows where it is and how to navigate to any other point on the field.

Functionality

- Field-centric driving, as well as locked-angle driving using PID to allow the drivers to translate freely while locking onto a certain heading– for example always aiming at the speaker.
- On-the-fly autonomous path generation, used in auton to dynamically construct auton paths that pick up notes in any order and teleop to automatically line up to the amp.
- Localization using odometry and vision through an OV9281 camera and an Orange Pi running PhotonVision.

Features

- Integrated motor controller closed-loop velocity control
- Swerve drive estimator for pose
- PathPlanner autonomous movement
- Auto-aiming using pose localization.

Peter and Arm

Our Peter mechanism is operated mainly by spinning the two shooter motors, the preshooter and intake motors, and reading data from the note infrared sensor. The Arm mechanism is held and rotated by four synced motors, and its angle can be determined by using the mounted absolute encoder as well as the integrated motor encoders.

Functionality:

- Peter can quickly intake notes on its own, by spinning the intake until the sensor detects a note
- It can spin up the shooter wheels to a constant speed, and tell if it's ready to shoot
- It can control when to shoot the note by running the preshooter when it's ready
- It can outtake the note, and run all the motors in reverse if a note gets stuck
- The Arm can smoothly and quickly move to any given angle (within a range of 0-120 degrees)
- It can move to predetermined angles, such as for scoring in the Amp, Intaking, and Climbing
- It can constantly move to aim the shooter at the Speaker, ensuring the note will go in
- It can tell if the arm is at the expected Target Angle, with a given tolerance (in degrees)

Features:

- Peter is very capable, and can intake, shoot, and operate accurately and quickly with little mistakes
- The Arm uses Motion Magic motion profiling, allowing it to move to the target position with control, respecting the specified acceleration and velocity values, and controlling the arm's inertia, even with fluctuating battery loads and motor loads
- The Arm can quickly and accurately aim at the Speaker, locking onto it, allowing the robot to shoot and score notes while moving around