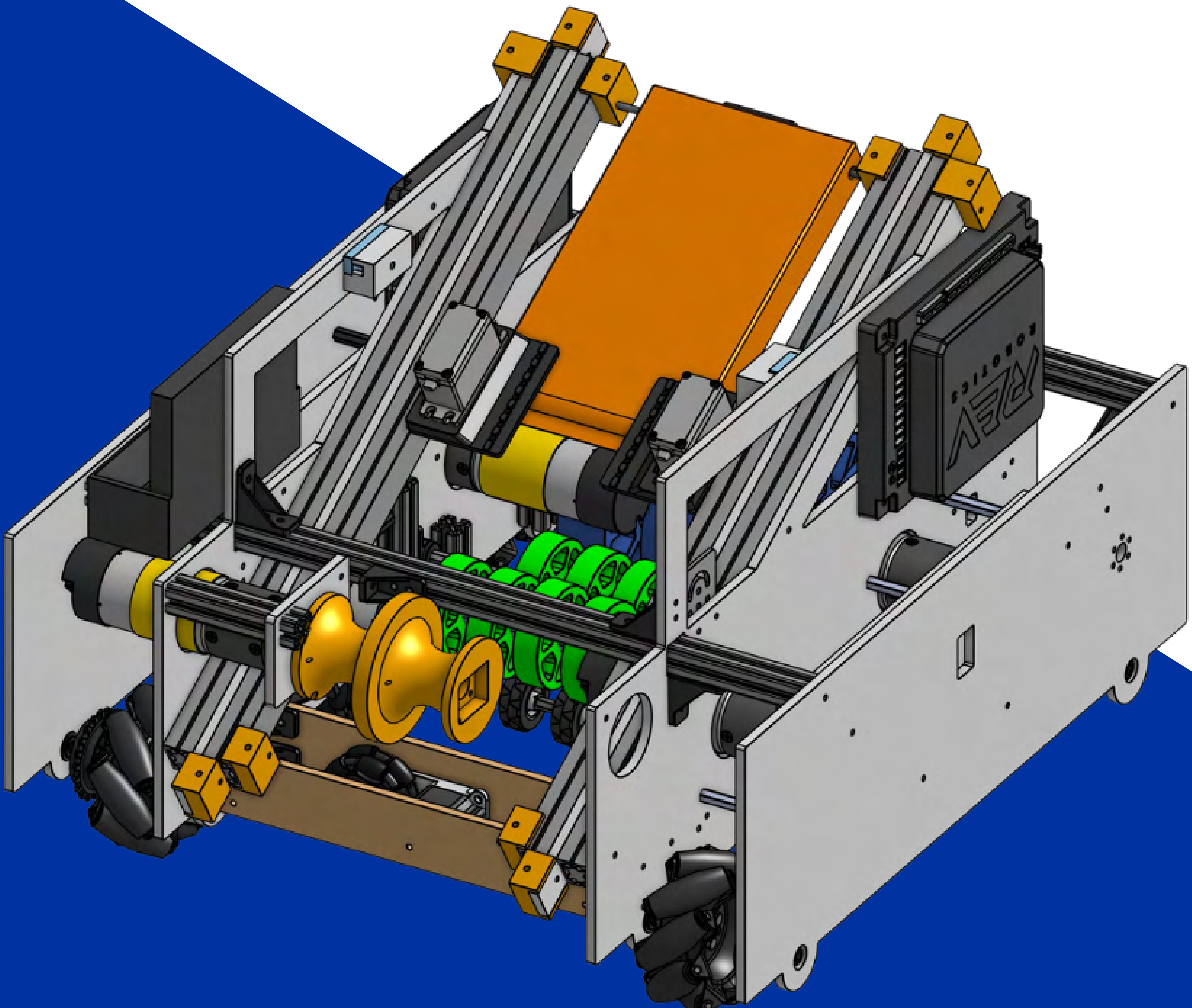
TEAM 14365

SUMMIT ROBOTICS



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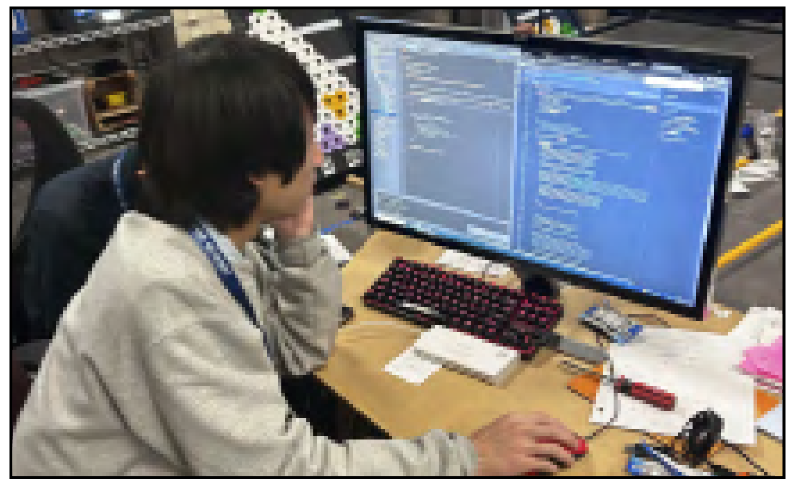
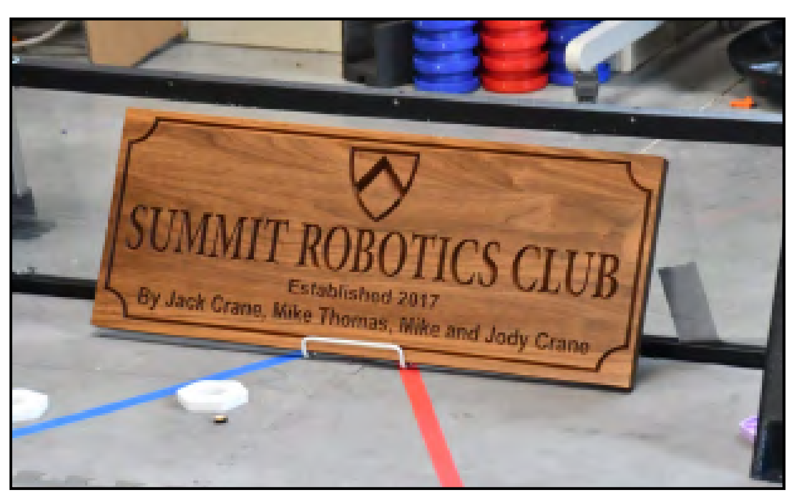


TEAM GOALS

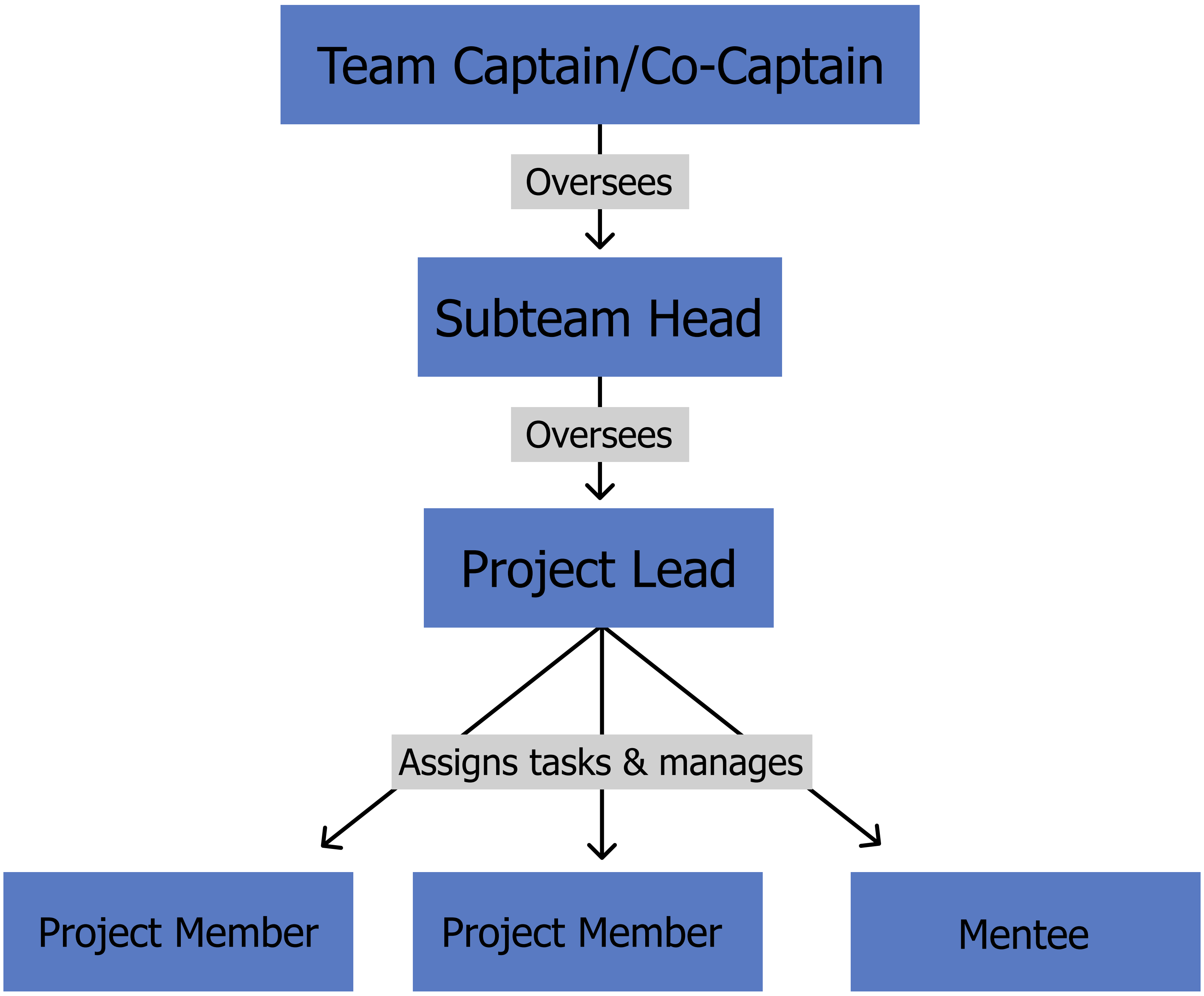
- Reach out to two other FIRST teams and assist them
- Inspire our school and spread awareness of FIRST Robotics
- Achieve one award for each tournament and go to state
- Perform 50 hours of service to better our community



ORGANIZATION

Project-Based Organization

After having hardships halfway throughout the season, we implemented a project-based organization system, as detailed below in the diagram.



Mentorship

Our team is a high school team. To keep us alive when students graduate and new members join, we have developed a two stage mentorship program:

Stage 1

When new members join the team, they are put on projects that they're interested in with a more experienced member. They're guided by their mentor to learn the skills necessary to succeed.

Stage 2

Once members have enough experience and attend enough meetings, they are eligible to become project leaders and teach other members. These members also become more active in the tournament.

Our Challenges

Throughout the season, like many other teams, we have run into some challenges. As a team, however, we have been able to figure out solutions to resolve these challenges. Some of the challenges include:

The build of the robot has been behind. We did not have a robot ready for the first tournament

↓

Once we realized the problem, we made a strict schedule to keep us on track for programming to have enough time to make a teleop and autonomous program.

Attendance has been low throughout the season due to other extracurricular activities, like the play and sports

↓

We completely revamped our attendance format to a 2/3 system, where members must attend two thirds of meetings to ensure a spot during the tournament, along with working with team members to conform to their schedule.

Attendance and announcements were unclear at the beginning of the season. Some members were not getting notifications about important events

↓

We changed our attendance format from Discord to TeamSnap so we can easily track who is able/unable to attend each meeting.

There has been a surplus of programmers this year, so there was a shortage of build members

↓

Some of the programming members have pitched in with other sub-teams and projects.

Our Approach To Budgeting

- We created a detailed plan for income and expenses, identifying priorities, and allocating funds accordingly
- This helps our team manage events ensuring that we can meet our financial goals and obligations

Team Budget

Amount	**Vendor**
$ (71.87)	GoBilda
$ (599.92)	Pitsco Education
$ (515.41)	AndyMark
$ (408.95)	GoBilda
$ (303.00)	OH Ed Outreach Foundation
$ (224.20)	Logitech
$ (164.51)	AndyMark & ServoCity
$ (274.79)	REV Robitics + Misumi
$ (80.00)	TeamSnap
$ (646.17)	Custom Ink
$ (200.00)	WaterJet Cutting of Indiana

Amount	**Source**
$ 4,000.00	Summit Country Day School
$ 200.00	WaterJet Cutting of Indiana
$ 272.00	Team Member Contributions
$ 800.00	The McDulin Family
$ 500.00	The ARM Family

Total Expenses: ($3,488.82)
Total Income: $5,772.00

TOTAL: $2,283.18

COMMUNITY OUTREACH

Our Team Outreach, Community Service, and Fundraising Goals:

- Recruit more members
- Perform 50 hours of outreach
- Create long-lasting connections with teams
- Expand our love for FTC and FIRST to a broader audience
- Collaborate with student body and events outside of school

MOTIVATE

The Greater American Cleanup

How we made and reached our goals:

This year we have decided to mentor other teams in FIRST which broadened our audience to many new people. As a team we set a goal of 50 hours of service as a team; we accomplished that goal with 78 total hours. Additionally, we have decided to give back to the community by volunteering for organizations such as Keep Cincinnati Beautiful.

St. Ursula Villa FLL Mentorship

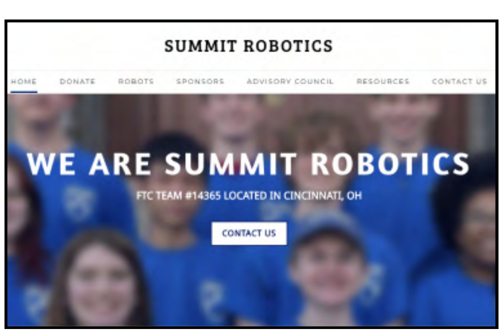
We actively facilitated the efforts of St. Ursula Villa's First Lego League Team by visiting their space every Tuesday.

Keep Cincinnati Beautiful

As a team picked up trash with The Great American Cleanup in Colerain.

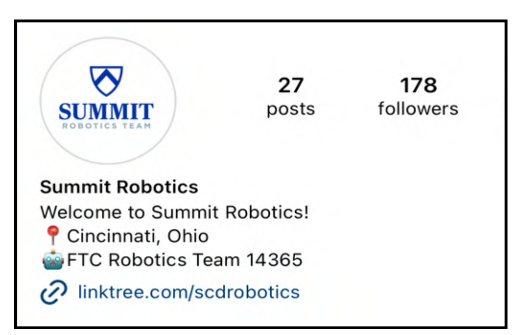
Seven Hills FLL Tournament

Went to Seven Hills High School and assisted in tournament operations and supported SUV.



We also use our website to centralize all information about our team. On this, teams can view current and past year's portfolio

On our Instagram, we inform our community about the current workings of the Summit Robotics Team. We have 178 followers.



IN-SCHOOL OUTREACH

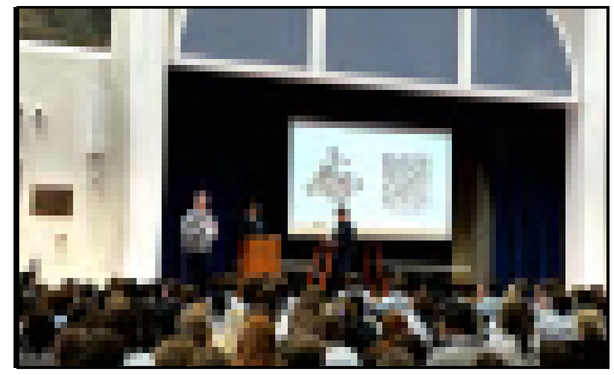
Summit Open House

Introduced 6th, 7th, and 8th graders to what FIRST is and how they may get involved.

Class of 2028 Welcome Reception

Future Summit families are introduced to our school and we welcomed them.

Assembly Involvement

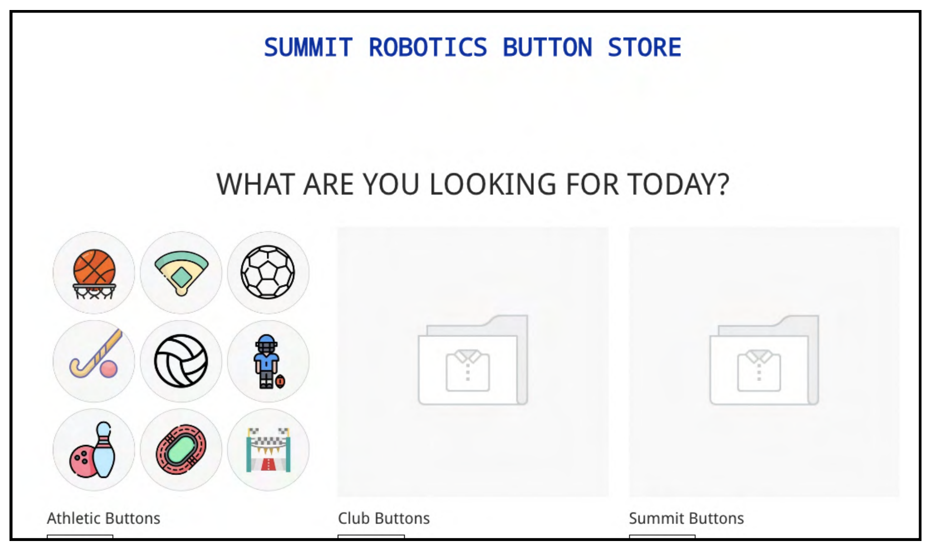


Recruitment and creation of a game that engaged the student body with FIRST robotics

Fundraising and Sponsors

Our season goals would not be possible without our sponsors:

- We are grateful to have The Summit as our official team sponsor.
- Additionally, as a student-driven team we have had discounts on accounts for Figma and our CAD software, Onshape.
- Metal drivetrain from Waterjet Cutting of Indiana
- Smaller donations from ARM and McDulin Family have made a tremendous impact.



We also have an event in progress in which we will sell Summit themed buttons to our student body for them to accessorize their ID lanyards. This fundraiser has been approved by our assistant head of school and we plan to start in the next 2-3 weeks. This image above is the plan for the online ordering platform.

Thank you to our team sponsors...

WATERJET CUTTING OF INDIANA

onshape

The ARM & McDulin Family

THE SUMMIT COUNTRY DAY SCHOOL

STEAM OUTREACH

Mentors and Professionals That Helped us Along the Way:

Our team seeks out professionals in the STEAM field through our Professional Advisory Committee. We meet and invite professionals to mentor us by attending this event. We enjoy sharing FIRST with our technical community by setting up robot demos and presentations.

Matdan FASTENERS · University of CINCINNATI · GE · Raytheon Technologies · Vera Bradley

General Electric:

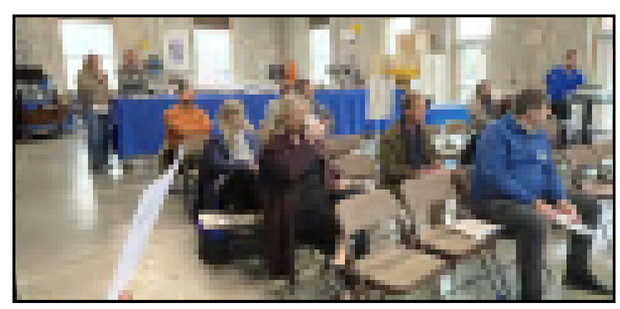
- **Michael Shuey, Technical Sales General Manager** specializes in areas of business. He gave us valuable advice on our presentation and various other logistical items.

University of Cincinnati:

- **Todd Foley, Computer Science Professor** specializes in coding and computing principles. Additionally, he is the coach of St. Ursula Villa's First Lego League team and advised us on team organization and group discipline.

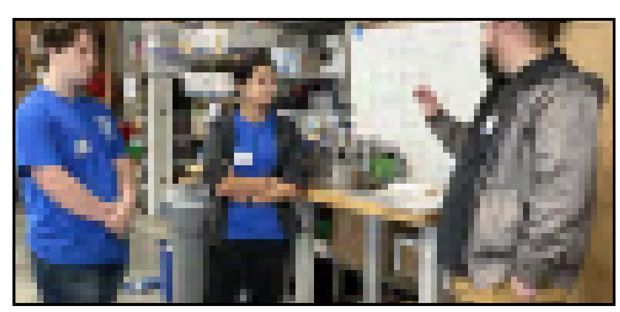
Vera Bradley:

- **Jackie Ardrey, CEO** specializes in decision-making and problem-solving. She is a mentor of our team and provided guidance on how best to organize our team and approach leadership.



Matdan:

- **Dan Arand, Engineer** works closely with our project team on the airplane shooter. He advised us to use a counter weight in the back to form an arc to the trajectory of the plane.



Raytheon Technologies

- **Tanner Catherman, Software Engineer** suggested we should periodically merge the branches of code. Additionally, we explained the SDK we use for FIRST and this year's challenge.

DESIGN PROCESS

Problem Definition
We gather as a team to discuss which challenges our strategy will focus on.

Concept Development
Each member, regardless of subteam, contributes component ideas on notecards that are decided as a team.

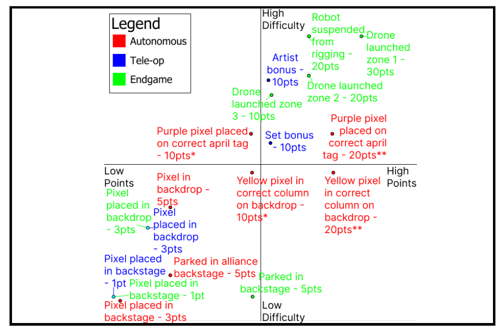
CAD & Prototyping
Make prototypes out of cardboard, then design with CAD to see how our ideas work in a 3D environment.

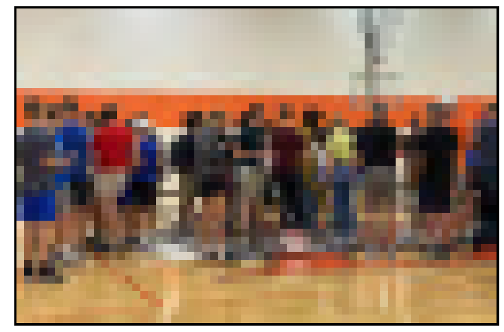
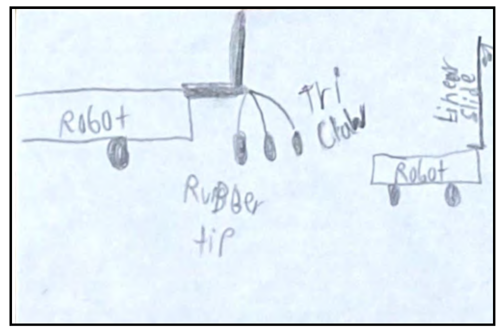
Build
We turn our prototypes into real components.

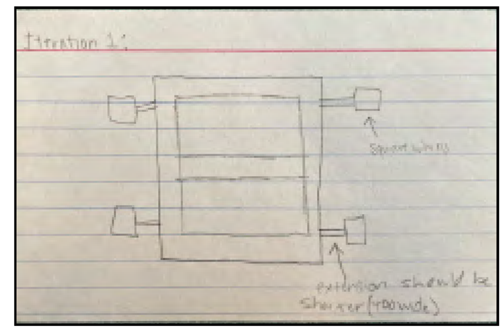
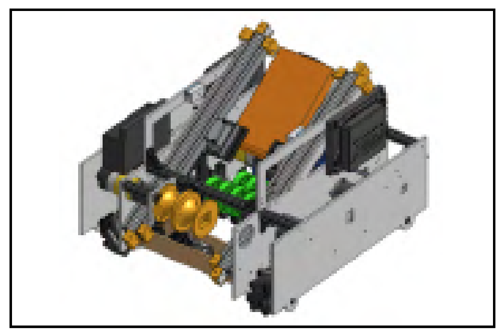
Testing
Evaluate pros and cons of our design and see what may improve functionality.

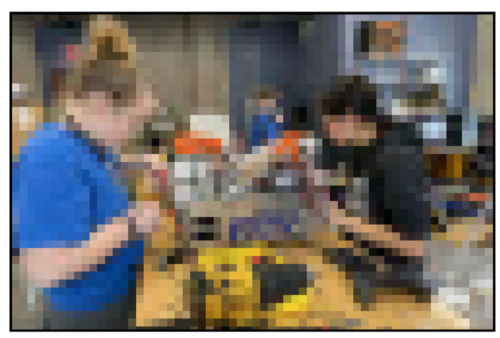
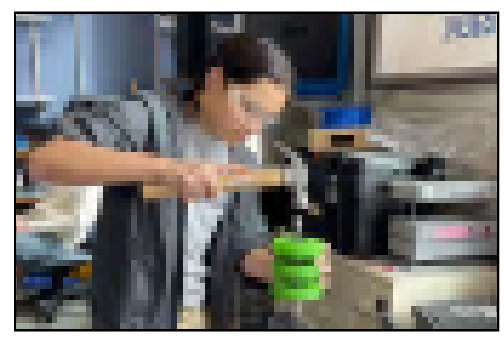
Iterate
If we determine that there is a potentially more functional solution, then the component is redesigned.

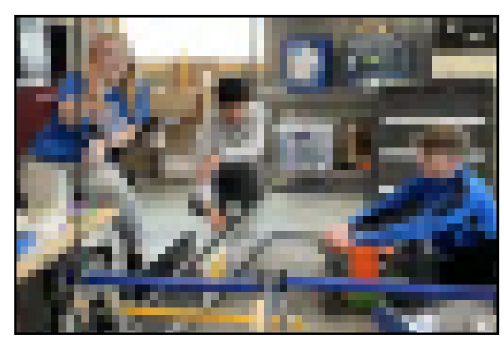
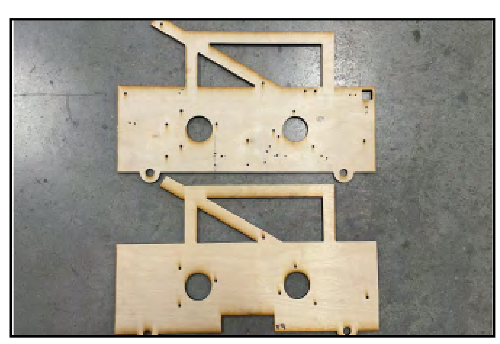
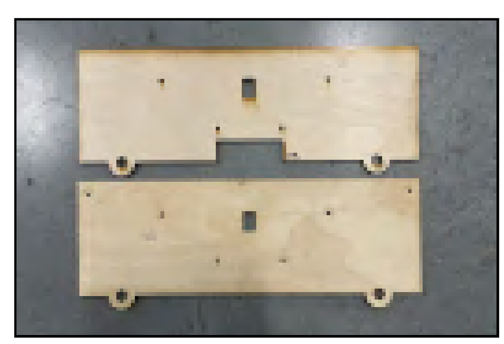
Compete
Observe how our robot interacts with others and the game in real life to develop ideas so we can further refine our robot.



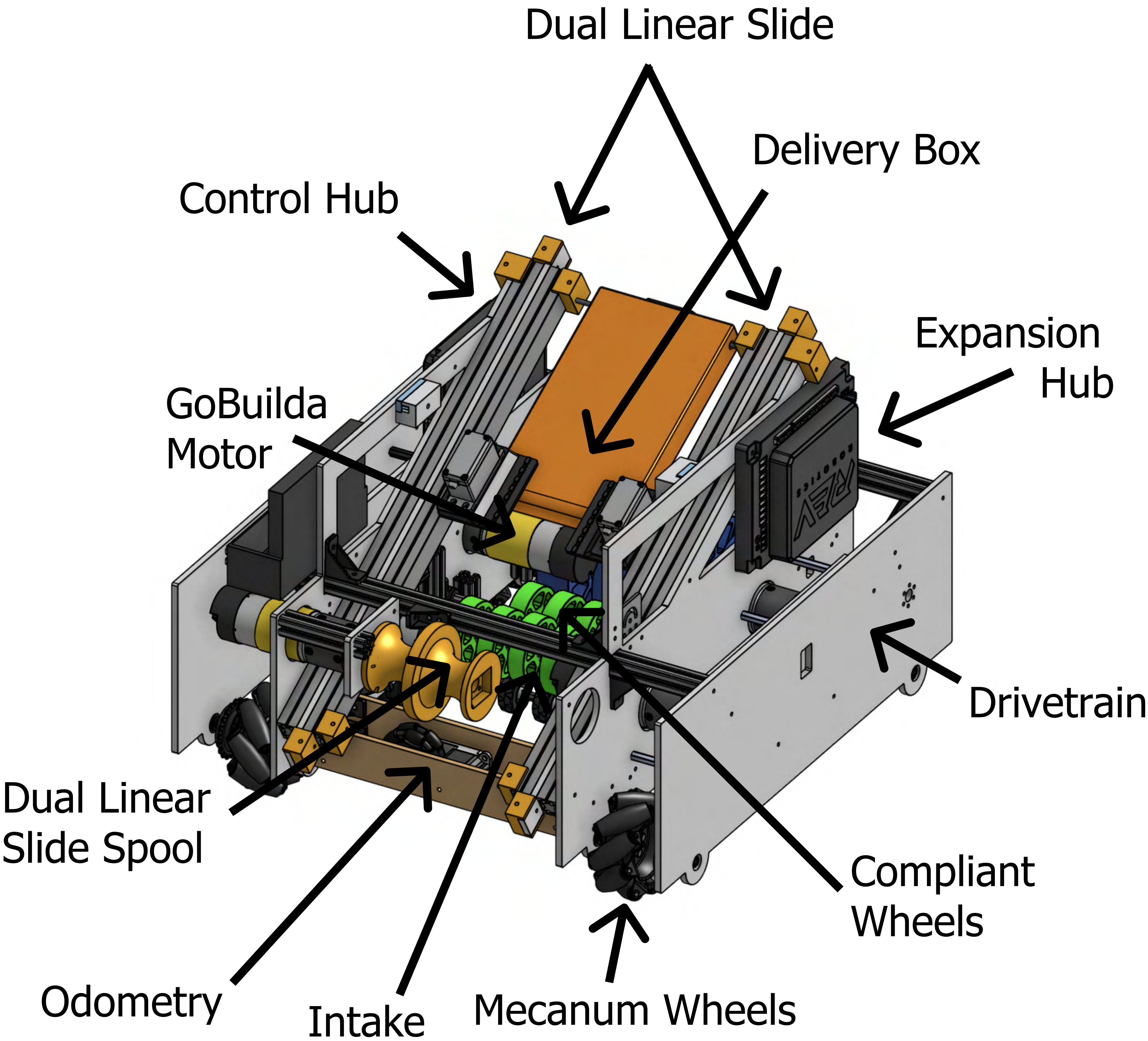



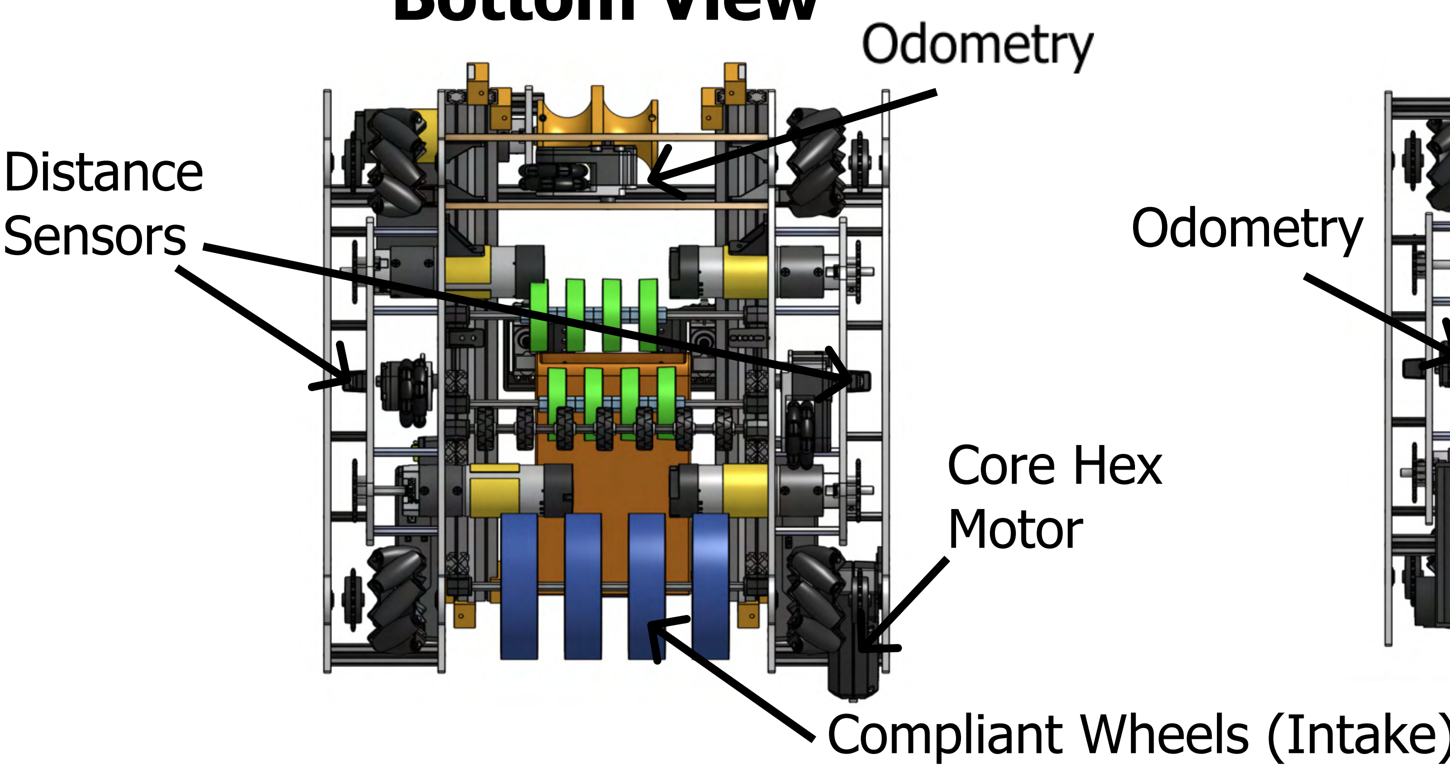



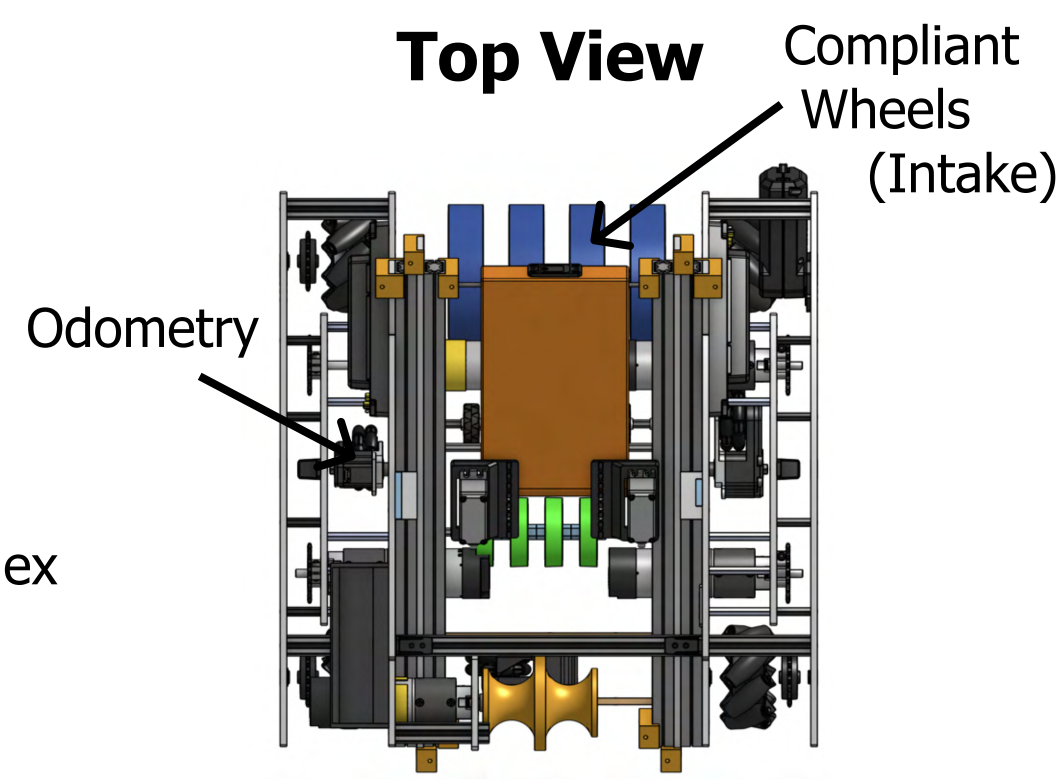
ROBOT OVERVIEW



Bottom View



Top View

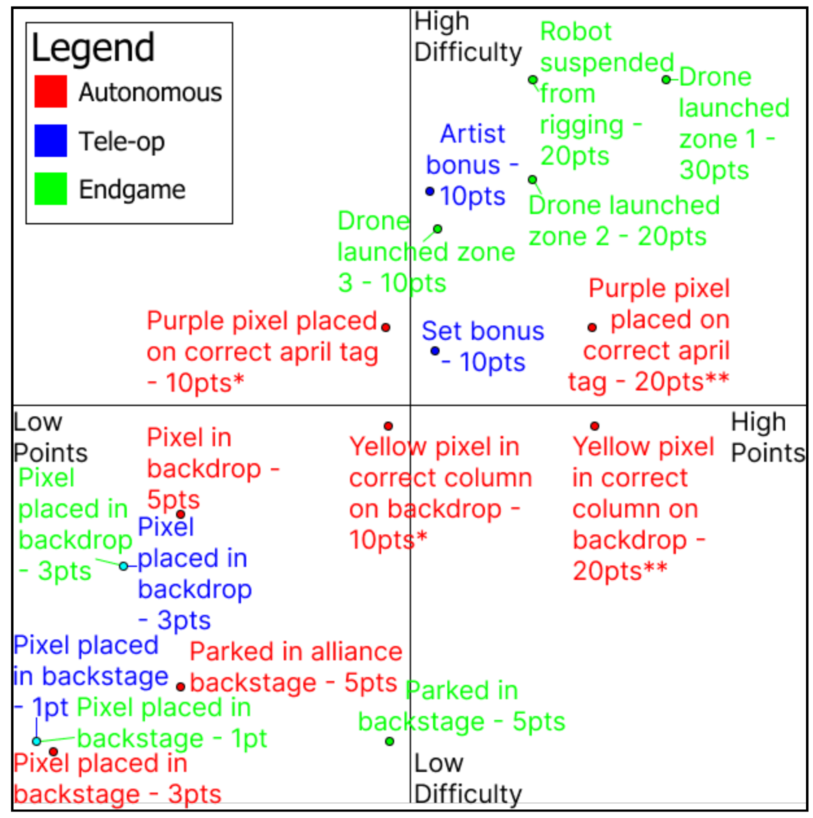


PROTOTYPING

Prioritization

- We began by creating a graph for each scoring method based on the points earned and subjective difficulty
- We then chose which scoring methods to include based on their proximity to quadrant IV (high points, low difficulty) or whether they are easy and repeatable

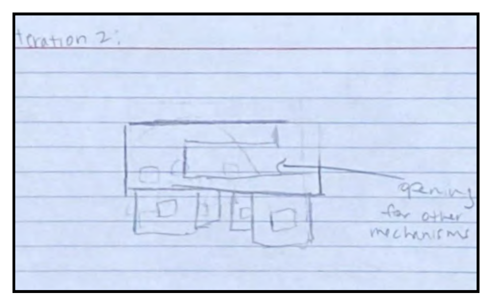
Scoring Methods Graph:

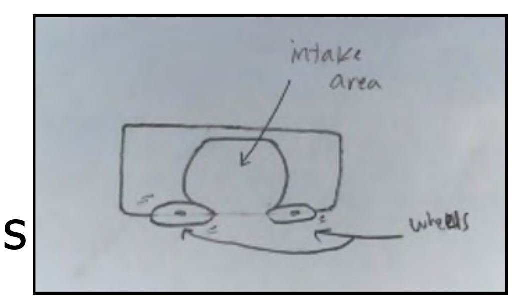


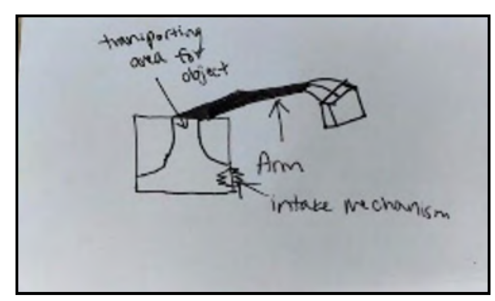
The prioritization graph where we figure out which scoring opportunities we want to aim for

Ideation

- We begin by researching concepts to find the best way to achieve each task.
- Every member of the team, regardless of subteam, draws their ideas on notecards, which is followed by discussion of the pros and cons of each idea.
- We go through the mechanisms of the robot and review all notecards to ensure we have the most effective design for each component.



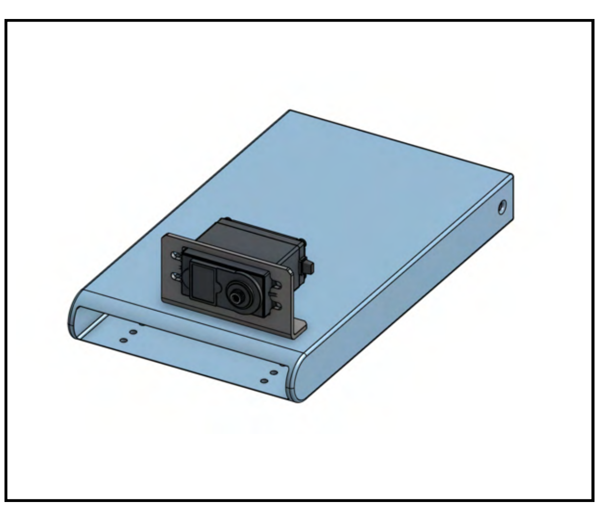


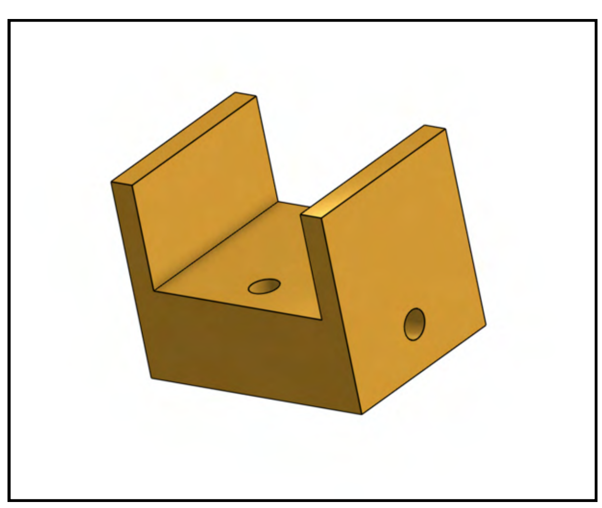


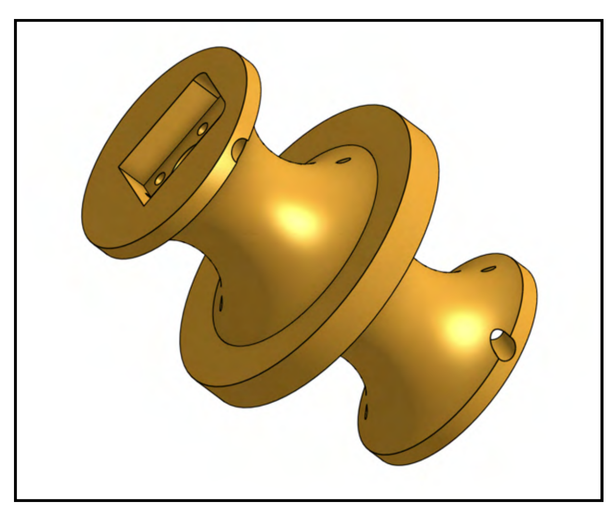
Team member notecards during our ideation process.

Prototyping

- Cardboard and wood prototypes are developed to visualize how different systems work together.
- The designs are then transferred into CAD.
- Our Glowforge laser cutter cuts each iteration for rapid testing







CAD models of various parts of the robot.

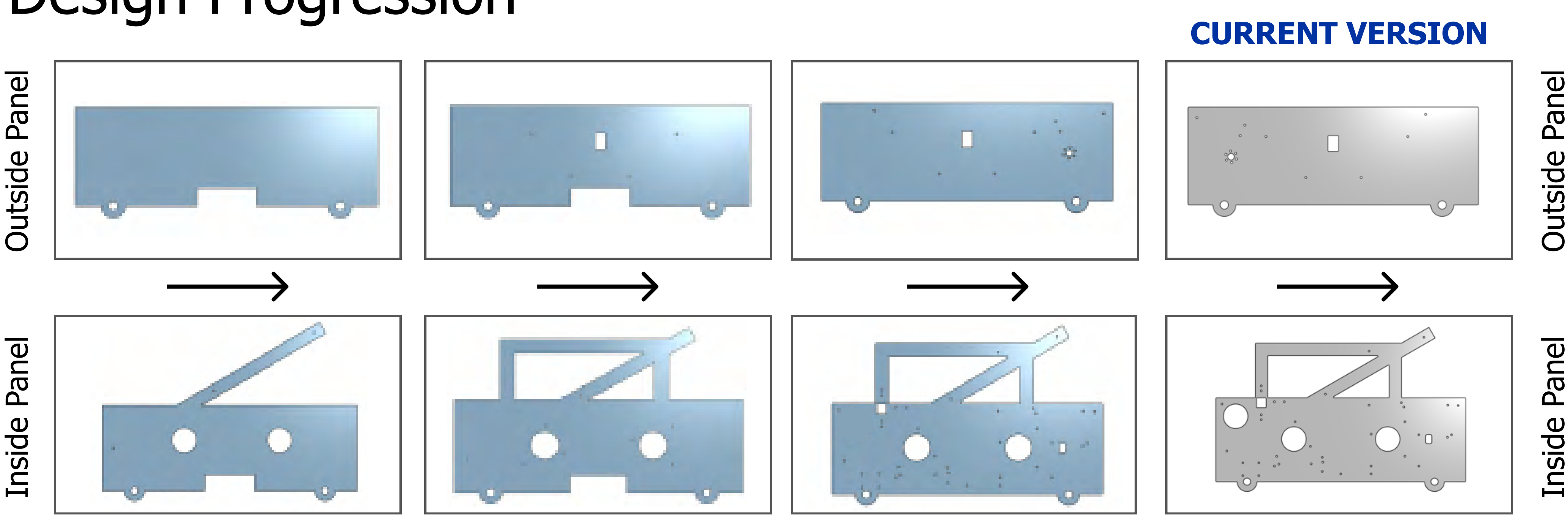
DRIVETRAIN

Our Design Strategy

Taking inspiration from years past, we opted for a 2 sectioned design. Each section has 3 panels: an outside panel, an inside panel, and a motor panel.

- Mecanum wheels allow us to go any direction and allow for easy driving on the field.
- Custom metal drivetrain panels allow for utmost precision and customization
- With a height of just under 12”, we’re able to easily pass under the truss, making sure we don’t limit ourselves to the stage door.
- With a 16”x16” robot frame, we can fit all components inside the robot while not risking size difficulties.

Design Progression

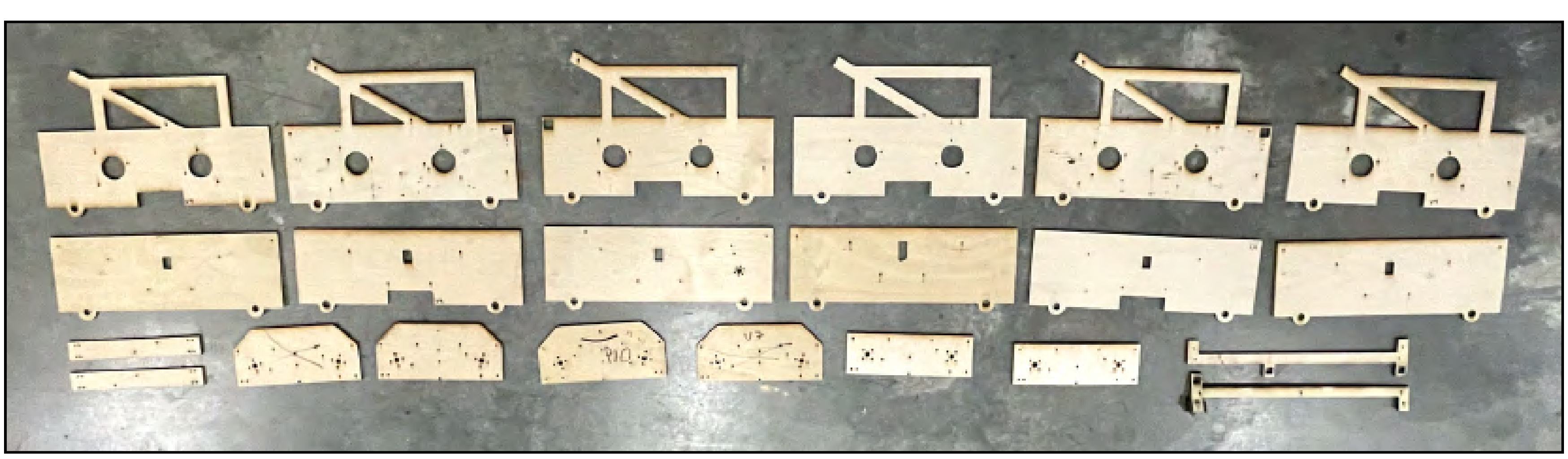


The outside panel has 2 holes for wheels and a rectangle cutout for custom odometry wheels. The inside panel is similar and has a rectangle protrusion to mount the linear slide.

During our revision process, we determined that the inside panel linear slide mount didn’t have enough support, so we added a square bracket system.

The inside panel added a tiny square hole to add an extrusion support to combine the 2 main drivetrain panels. The outside panel added motor holes for the intake motor.

In the last version, various screw holes were finalized and a motor hole was added to the inside panel to accommodate the linear slide motor.



A layout of all the drivetrains cut out and used this year.

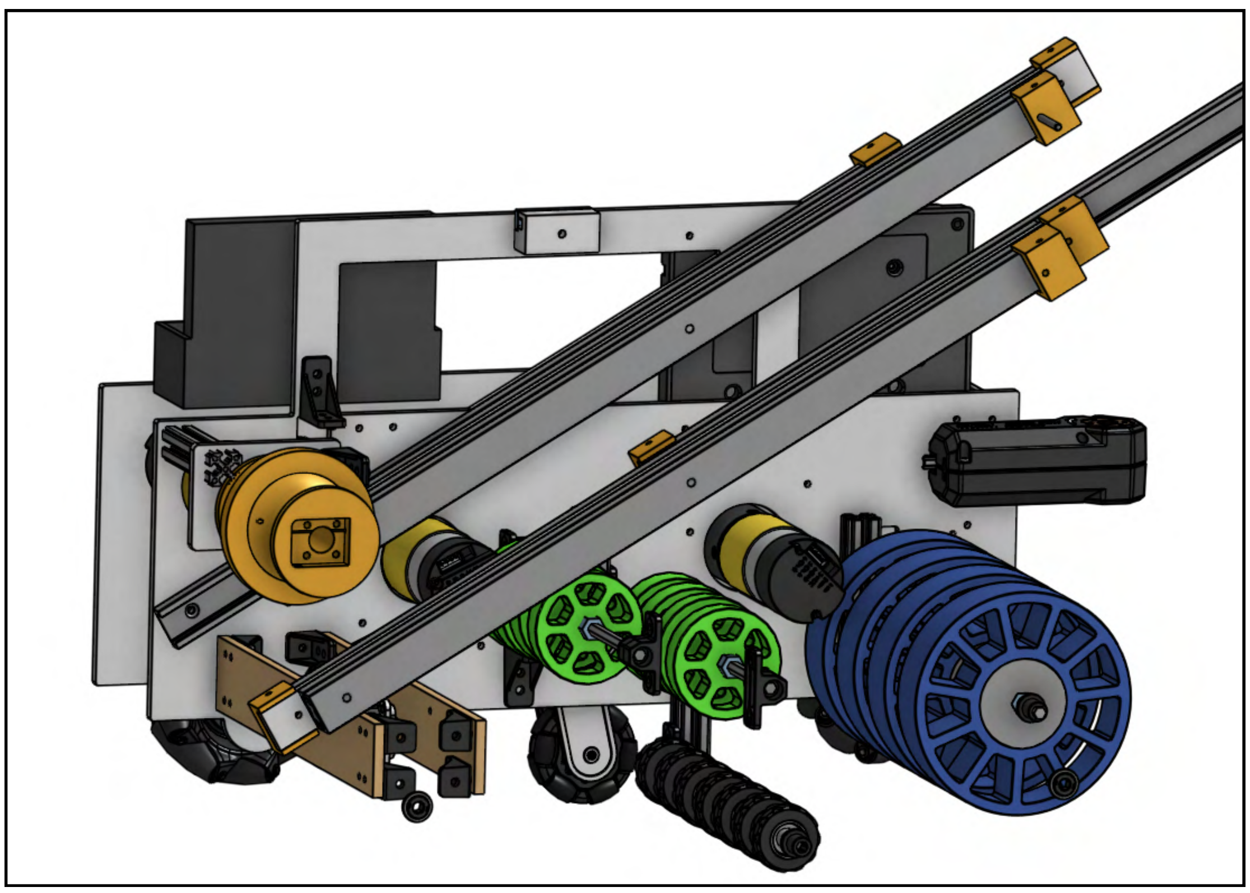
INTAKE

Our Design Strategy

This year’s deign features a row of compliant and traction wheels that pushes the pixel into the delivery mechanism, as detailed in the next page.

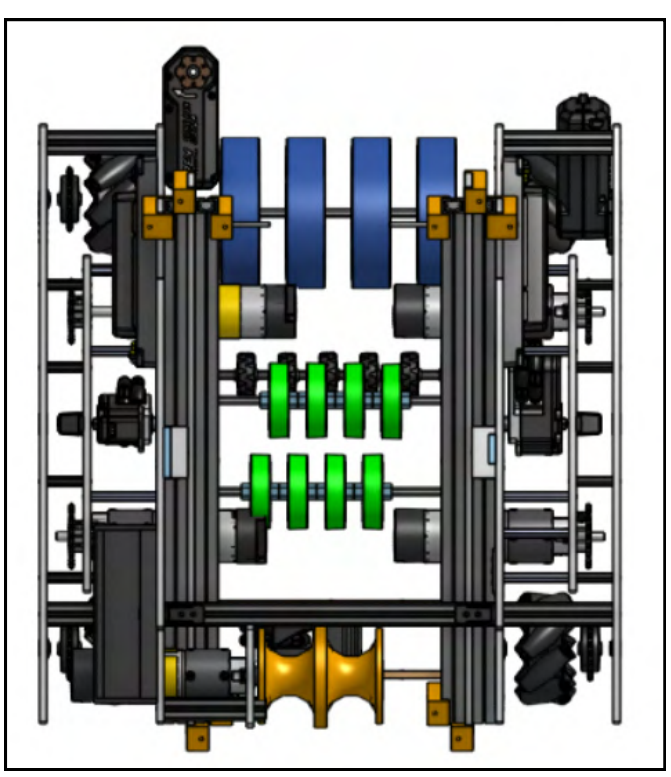
- All wheels are connected to one hex motor to ensure a consistent base speed, with gears in varying sizes to increase/diminish specific wheel speed.
- The design includes 2 plexiglass panels which are custom cut and bent to form two curves, which guide the pixel to its destination
- The plexiglass panels also secure the two halves of the robot together, and protect the first set of intake wheels from overhead debris.

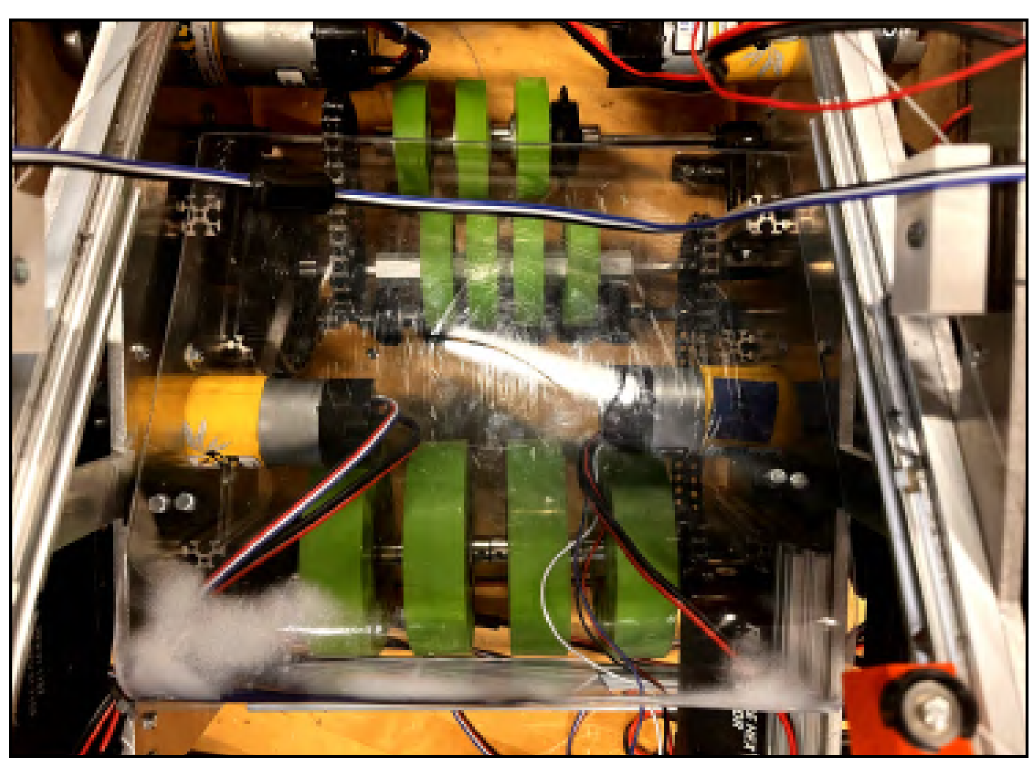
The Process of Delivery



The cross-section perspective of our robot.

Our intake system is designed to pick up the pixels near the human player drop-in space. It will follow the the largest set of wheels (the blue) through the intake system and pushed along by the two smaller set of wheels (the green). This will all be guided by custom plexiglass panels which will then lead it to the delivery system.





DELIVERY

Our Design Strategy

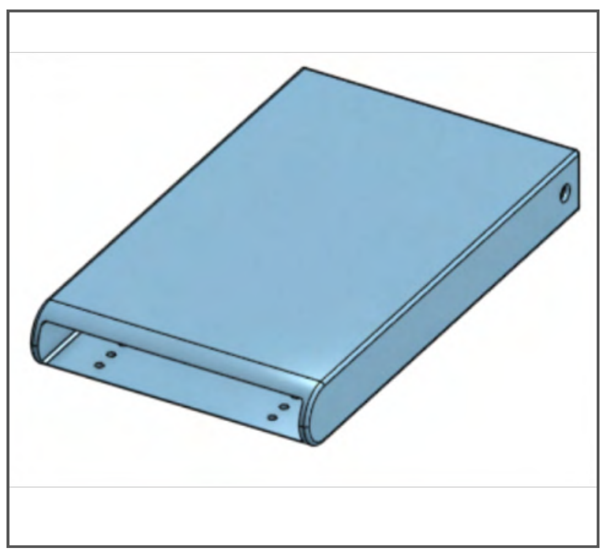
- We began our prototyping with a CAD designed model which could contain two pixels. We then 3D printed a physical model. Unfortunately, the pixels fell out consistently.
- As a result, Version 2.0 was constructed, with a filleted edge to make pixel intake more fluid, and added holes for two brackets which have Servos affixed to them. On those Servos are pieces of extrusion, which rotate inward to keep the pixels in the delivery until placed on the board.
- A distance sensor was also added to the back of the delivery container, which allows the robot to know how many pixels it contains based on the proximity of the pixel to the sensor.

Prototype

The inital design is comprised of a simple rectangle prism with a cutout, capable of holding two pixels, and a hole through the back

→

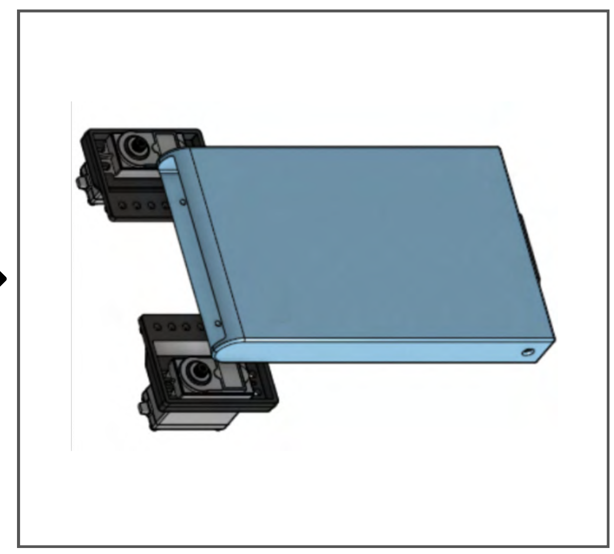
Testing



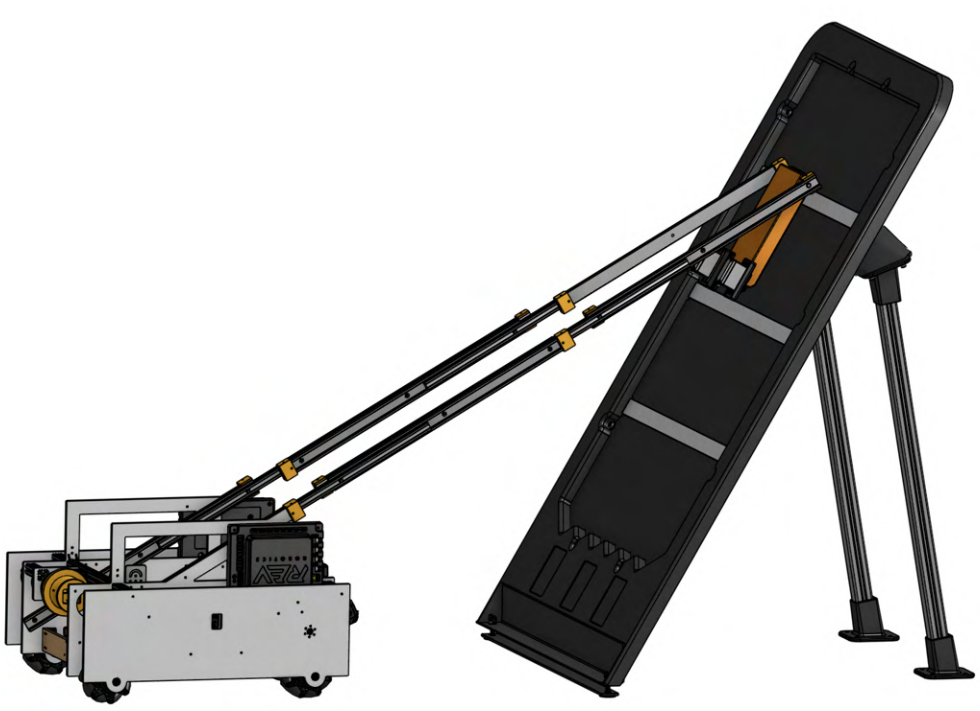
The included bracket holes and fileted edge are the only alterations to form this version, allowing for more consistent intake

→

Build



The servos and black brackets have been added, as well as a distance sensor in the back of the rectangle



As seen on the left, our delivery box utilizes gravity to conform to the angle of the backdrop. Once in place where it's resting parallel to the board, the servos activate and drop the pixel onto the angled surface.

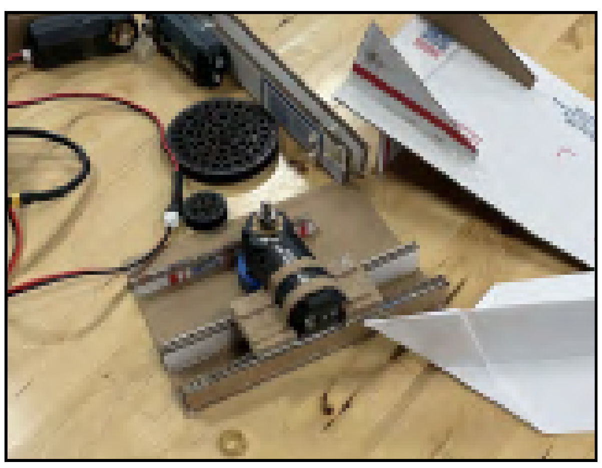
DRONE

Our Design Strategy

The drone is a great example of the engineering process. Going through each step, we constantly referred back and took chances to perfect the design.

- 3 prototypes were built, and we decided to combine 2 of the designs for our final iteration.
- After it was built, we constructed and tested paper airplanes to figure out the perfect design.
- The angle of the launcher was a big problem, but we used graphs and tables (below) to help us figure out the best one.
- The professional advisory committee played a role in this by helping us figure out that we needed a steeper angle (see the outreach pages for more info on the committee)

Prototype



Our prototype was made of cardboard, a servo, and a rubber band.

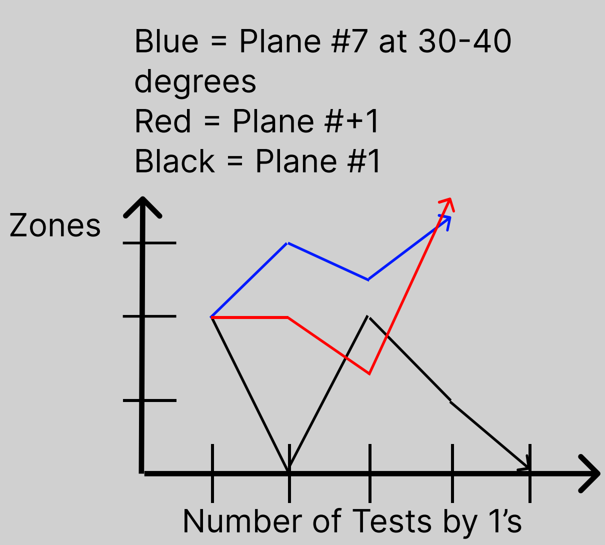
Testing

We tested our prototype on the field at different angles

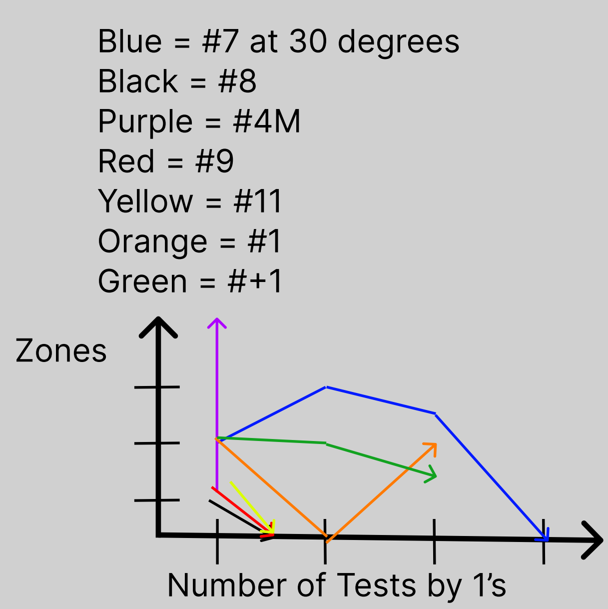
Build

This is our final version of the launcher, made of metal and wood.

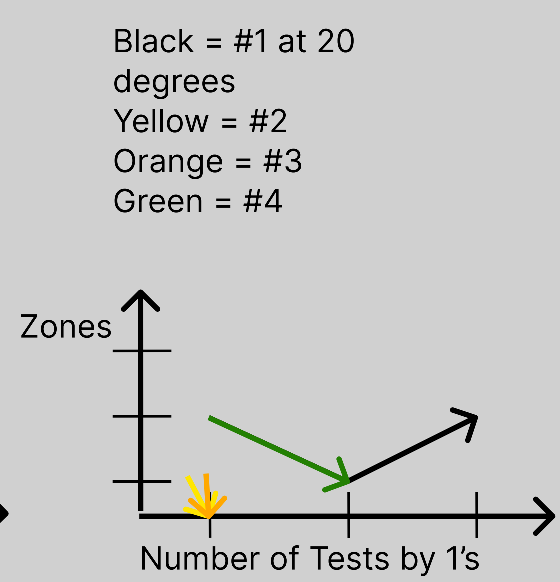
Paper Airplane Launcher Tests



The graph above displays the 3rd group of tests after narrowing down the planes to the best ones.



The graph above displays the 2nd group of tests.



The graph above displays the 1st group of tests.

AUTO + TELEOP

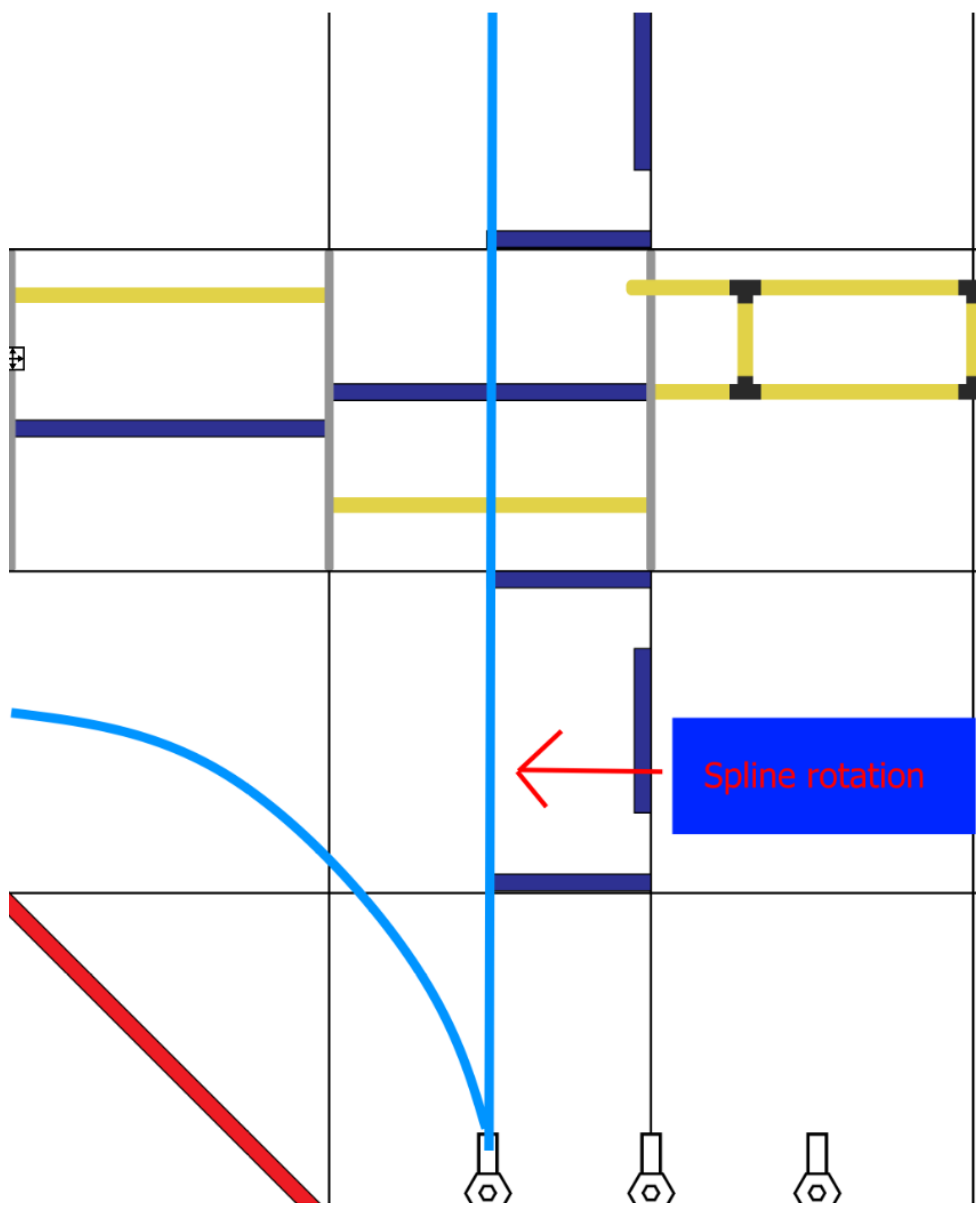
Sensors

- **Webcam**: Mounted on the left, with a 78-degree field of view for AprilTags localization and Easy OpenCV for custom prop detection, crucial in the autonomous stage.
- **Distance Sensors**: Facing forward, left, and right for dynamic trajectory adjustments during autonomous operations to avoid collisions.
- **Dead-Reckoning Wheels**: These enable precise localization using arc length trigonometry, compensating for wheel slippage and floor unevenness, essential for autonomous path-following.

Autonomous Algorithms

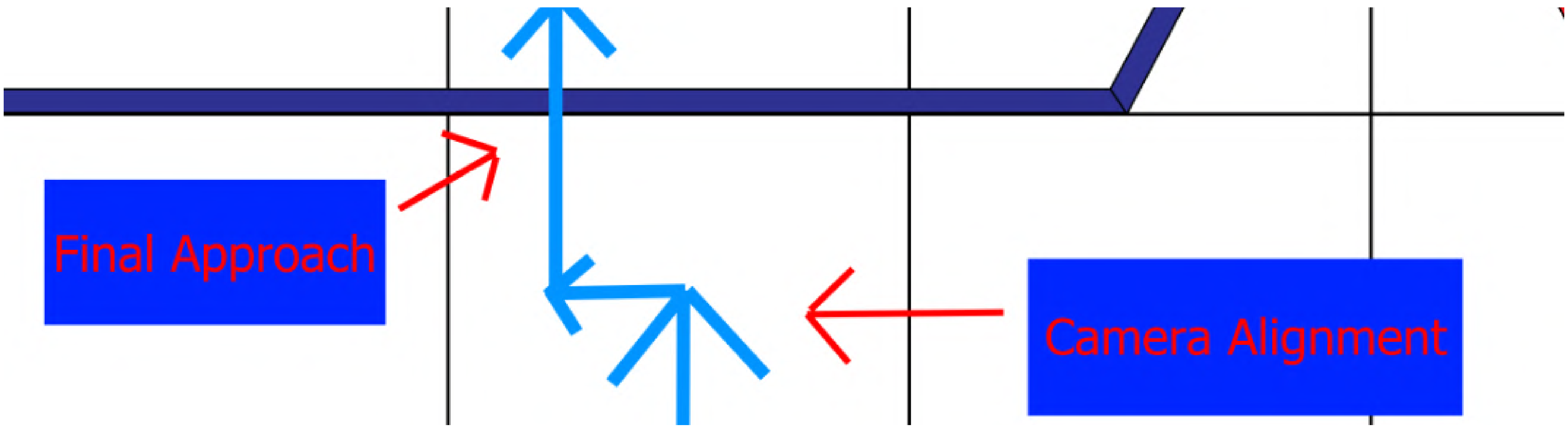
- **Odometry/PID Control:** Our system relies on odometry tracking, utilizing data from three dead-reckoning wheels and motor encoders to maintain the robot's position on the field. Employing PID control, it compares actual position and velocity data with target values. Through fine-tuning the PID parameters—proportional, integral, and derivative—the system predicts and corrects the robot's movements, ensuring it closely follows the target velocity.

- **Road Runner/Trajectory following:** We use the public Road runner library to generate the power function of each of the motors given the path that we pre-programmed for the robot to perform. This path following will also take into account of the live input of the encoders and odometry as mentions above in the last paragraph to alter the power function when the trajectory deviate from the preset.
    - The figure on the right is a diagram of the first portion of the autonomous trajactory, which takes the robot to the the proximity of the backdrop.



AUTO + TELEOP

- **OpenCV randomization detection:** Our camera performs various tasks, including color and shape detection to locate the randomization element on the field. We'll programmed different Road Runner trajectories corresponding to each starting position of the robot but the robot will also live generate three more different final approach path (figure below) based on the randomization by using the vision algorithm explained in the next paragraph.



- **AprilTags/vision alignment**: Even if we have a near ideal motor profile and PID tune, the condition of each field, and the battery voltage, and rolling resistance of the tiles could differ greatly from our practice field. To ensure the versatility of our robot in the unpredictable conditions of the competition, we need a way for the robot to be aware of the environment directly through vision. This years addition of AprilTags into the game made localization of from the vision algorithms much more accurate. After using the road runner algorithm to navigate the robot to an approximate position near the ApirlTags on the Backdrop board. The robot can perform a horizontal fine adjust using the x position of the AprilTags from the camera. We can further use the 6-axis of orientation of 2 or more AprilTags to in turn accurately adjust the localization of the robot. Below shows the testing and tuning process of our camera for detecting AprilTags.