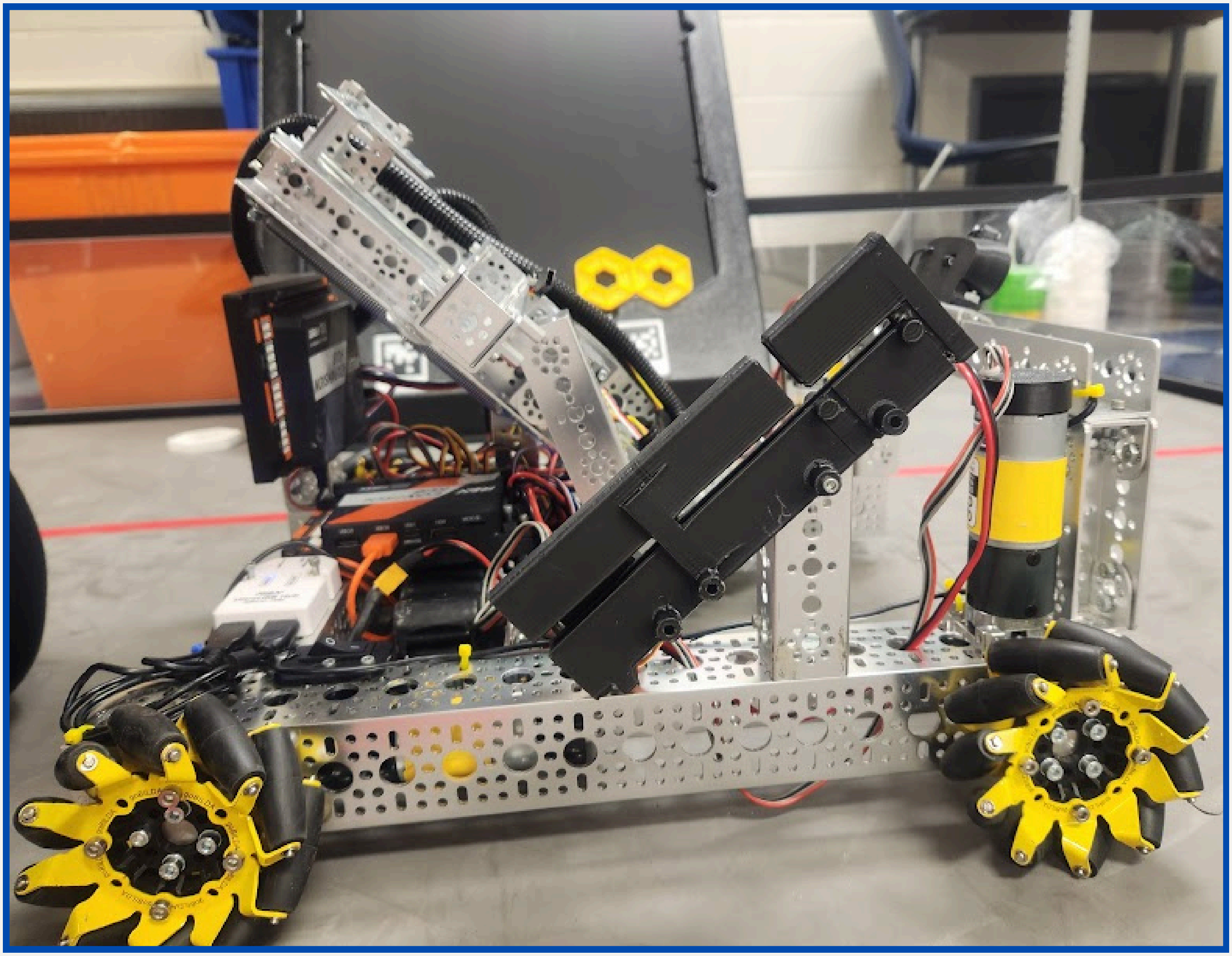
Bolt BusterZ

Paxton-Buckley-Loda Robotics



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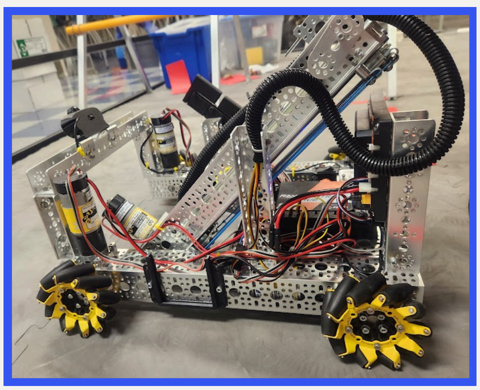
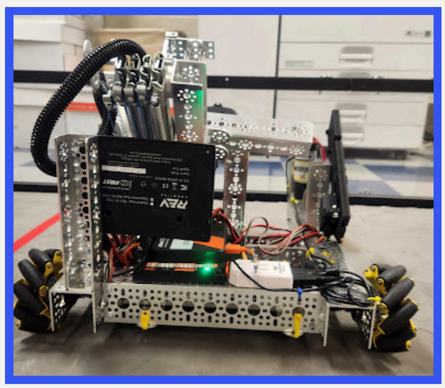
We are Bolt BusterZ. Our team is made up of a diverse group of 9th - 12th graders from Paxton Buckely Loda High School. Our team has been a part of FTC for 5 years.

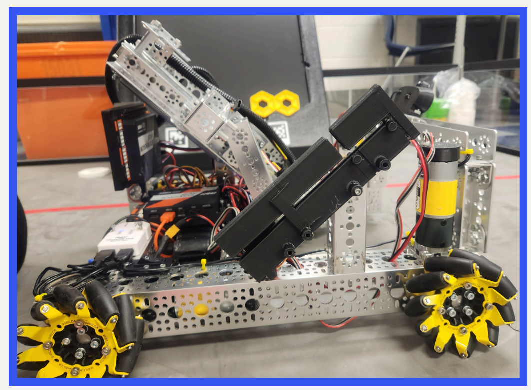
Team Phrase

“Failure is not fatal”

Meaning regardless of the obstacles we face, there’s always a way to move foward.







Overall Goal

Our team’s main goal is to make a positive impact on our community and those we work with. We do this by helping other teams and constantly improving how we strategizing and relate to others. We encourage our fellow peer's ideas and we help each other through our shortcomings. We have spent long hours trying to improve our robot to the best of our ability and represent our community through Gracious Professionalism.

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Meet the Team

Build Team
Arlo, 11th grade
Anna, 11th grade
Elizabeth, 11th grade

Programming
Isaiah, 12th grade
Jazz, 11th grade

Portfolio
Grace, 11th grade
Emily, 11th grade

Design
Zavier, 11th grade
Megan, 9th grade

Outreach
Samantha, 11th grade

Each respective category focusing on different aspects throughout the season

Create a functional and reliable foundation to showcase our ideas for the season

Crucial to having a successful Tele-Op and autonomous program

To fundraise and gather support from our community

Needed to reflect and share our experiences in an ordered manner

Brainstorm new and innovative designs to accomplish our goals

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Our Experts

Design Expert
Mr. Geerdes

Problem: We neeeded to improve our intake and output speed on our attachment.

Expert: After seeing our current attachment, he suggested a intake system with wheels and a strong servo to better pick up the pixels.

Impact: With his advice, we were able to design and 3d print a custom attachment which better suites our needs.

Design Expert
Mrs. Fried

Problem: We were struggling to improve the distance our paper drone was going.
Expert: We spend a practice meeting with Mrs. Fried and allowed us to use the slingshot band for our drone launcher, and an angle measuring device to help us tune our drone launcher as well.Without the band, we would be stuck with the inconsistent rubber bands that we originally tried to use, and knowing the proper angle for launch improved consistency considerably.

Impact: With this new knowledge, we were able to have a working drone launcher.

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Season Goals

Practice Goals	Status
Have more structured and meaningful practices	Completed, we’ve implemented structured drills and deadlines to stay on track
Involve and encourage new members	Completed, we’ve prioritized teaching and supporting new members however we can
Equally divide the work	Completed, we assigned each person a role at the start of the season

Outreach Goal	Status
Reach out to companies to sponsor the team	Completed, we got a sponsor! *The Warehouse at Paxton LLC*

Design Goals	Status
Sketch the ideas for our robot before building them	Completed, we utilized both CAD and sketches to visualize each part before building
Discus and brainstorm with the team before starting	Completed, we had specific meetings to go over ideas and overall suggestions
Create a smaller and lighter robot unlike previous years	Completed, we bought new parts and constructed the robot with those things in mind
Have a mentor give us advice on how to improve upon our design	Completed, Mrs. Fried, a physics and chemistry teacher was happy to help us on how to improve our paper drone launcher

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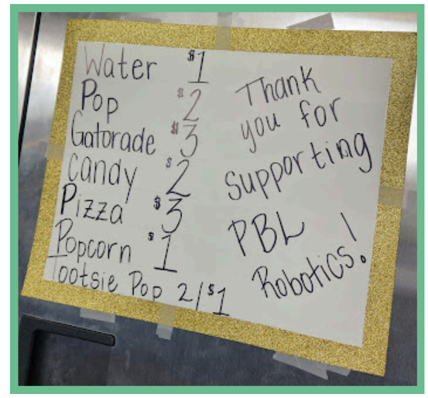
Fundraising



-Budget-

Row Labels	Sum of Income	Sum of Expenses
Fundraising (concession stand)	5890.23	
Sponsor	250	
Donations	500	
GoBilda Parts		-1641.74
Amazon		-154.73
AndyMark		-2184.3
Restocking concession stand		-1334.47
Pitsco		-582.21
Registration		-235
Student Funds		-500
Refunds	295	
Totals	**6935.23**	**802.78**

-Thanks to our Sponsor-
The Warehouse at Paxton LLC

- This year, our team had more income than expenses. This is important to note because this allowed us to purchase a much needed new field. Which is a huge help when making an autonomous program and driving!
- Our team's main source of income would be fundraising at our school's concession stand. It also doubles as a good way to share what we do in robotics

Future Plans

Going into the next season, our main goal is outreach. We want to get more involved in our community and grow our team. As most of our team members are juniors, we are going to focus on recruiting new people and sharing everything we know. We've already started brainstorming different events we'd want to do post-season including:

-Running a booth at our community wide 4th of July celebration

-Hosting and connecting with our lego league team

-Classroom visits at our local elementary school

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Sustainability

Lego League

Recruitment

Outreach

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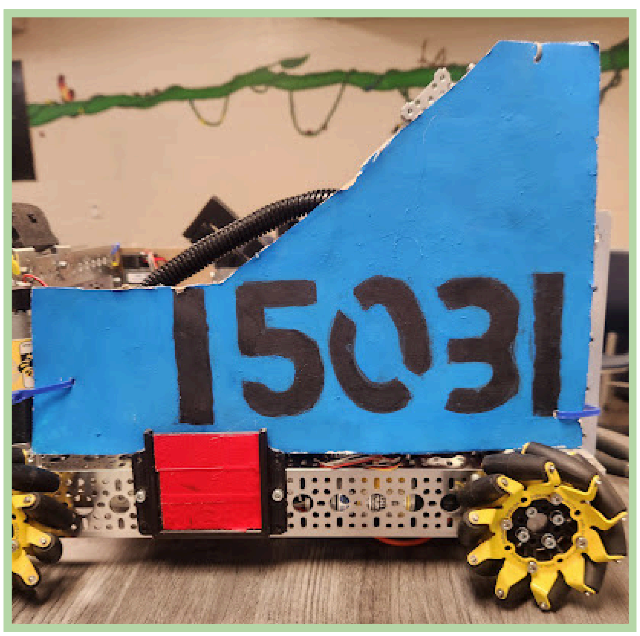
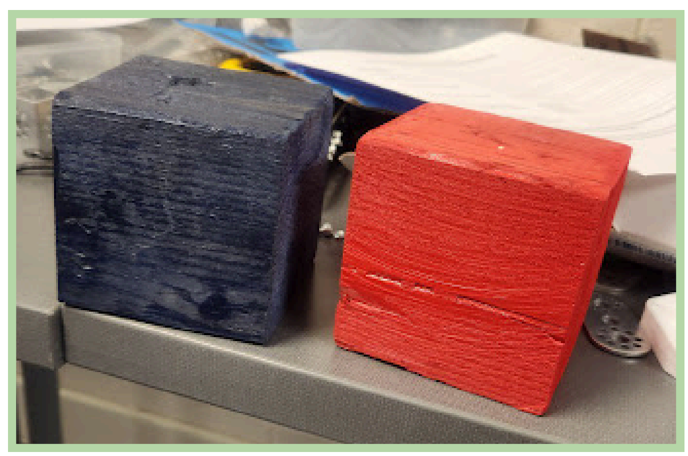
Experts

Our team gains members from our lego league team and through outreach events. We also stay in contact with former graduates and have them be experts.

Number Plate and Team Elements





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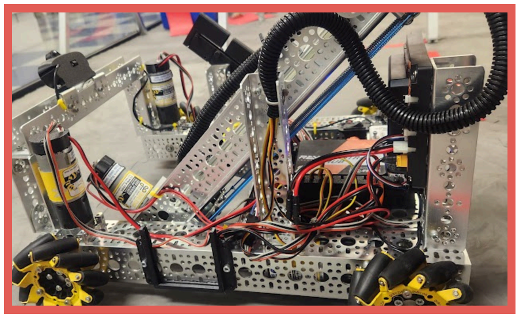
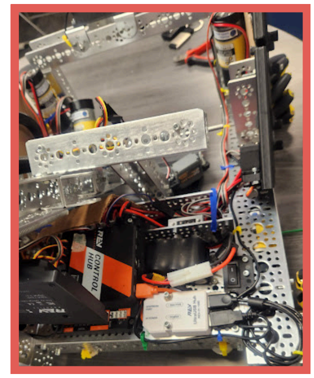
Wire Management

One struggle we find ourselves dealing with every season is wiring, more specifically keeping it out of the way of moving parts.

But this year, we prioritized finding a solution. By trial and error we found that in our case, zip-ties are what works best for us compared to using coiled wires for example.



Before



After

Our Engineering Process

STRATEGY

Explain our thought process and goals for the project

DESIGN

We recreate an outline or sketch of the idea we want to build or improve upon

IMPLEMENT

Shows the physical or installed version of our idea

TEST

Describe the process of testing and observations to see if it's ideal

REVIEW

Describe and reflect over on what we learned and what will be changed in the next attempt

We used this procces on our 3d printed attachments and when designing the chassis

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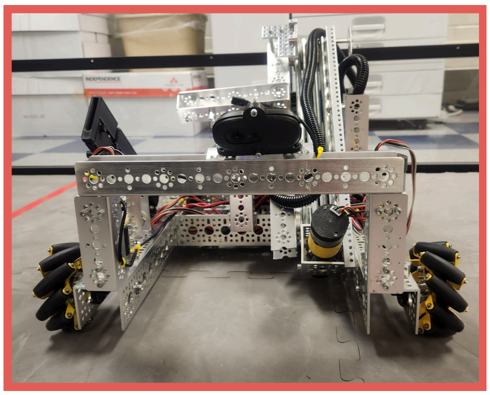
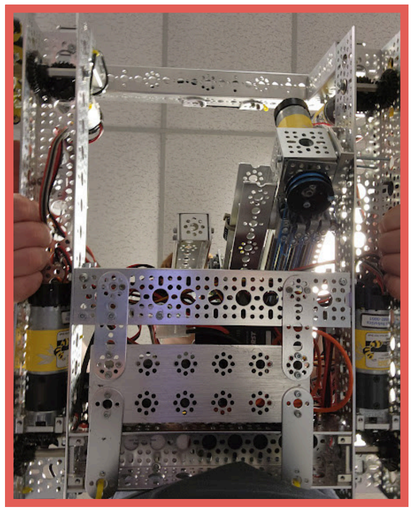
Chassis

When designing our chassis we want to make it smaller, lighter, and faster. Our previous designs have been clunky and slower compared to others in district.



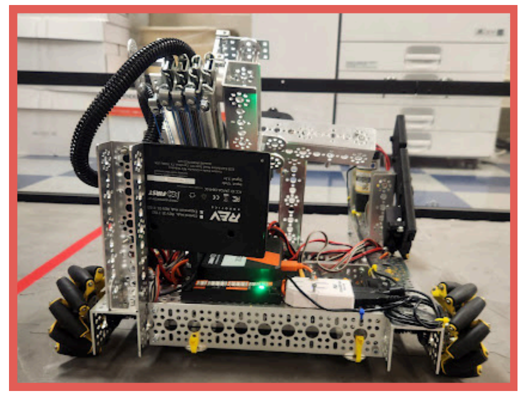
-At the front of the frame, a series of 3 tetrix pieces create a bridge for stability and to situate the camera in an optimal position.

-Plus an additional piece that sticks up on the left side of the rear of the robot for the expansion hub.



-The framework of the chassis is made up of a rectangle, with two cross pieces at the rear of the frame.

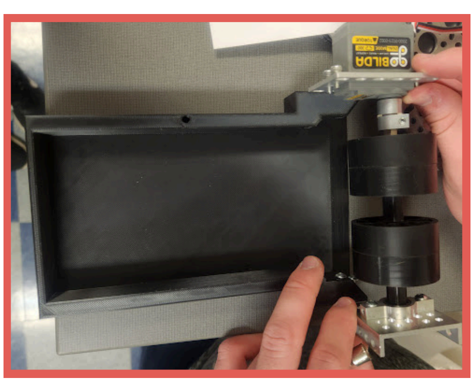
-It has a bottom plate between these 2 pieces to house both the battery and one of the control hubs.



-The front 2 motors are mounted in an upright position so we can work easily on the rest of the chassis. The back 2 are housed inside of the chassis itself.

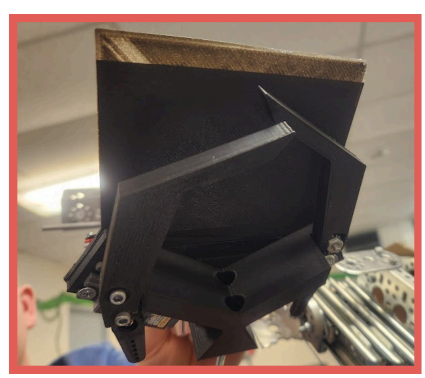
-All 4 motors use two bevel gears to run their mechanum wheels.

Iterations

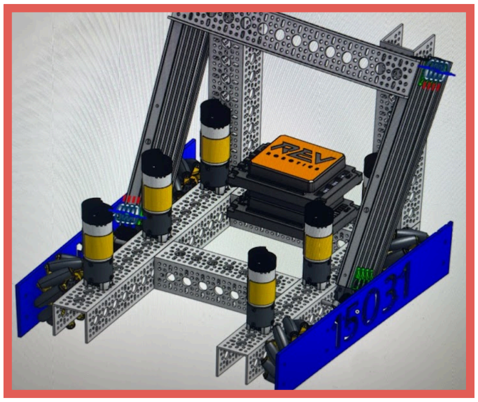


Prototype

From our prototype we've changed the wheel intake system to a claw to more efficiently grab and place pixels

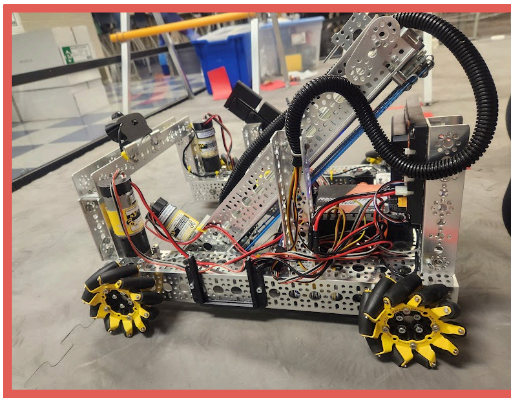


Final Product

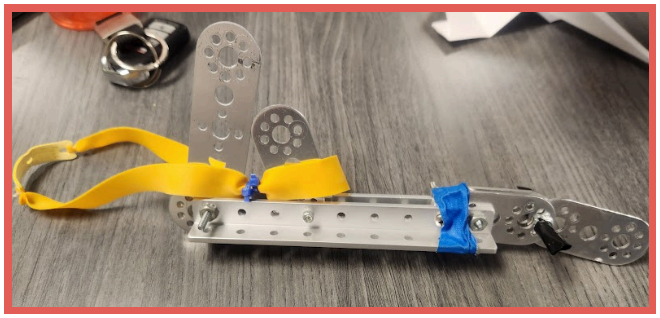


Prototype

From our prototype we've changed the placement of the motors and overall frame to better balance out of robot to prevent it from tripping over

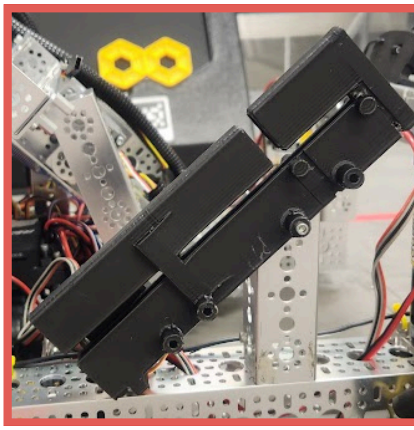


Final Product



Prototype

From our prototype we've took the idea of using a rubber band but designed and 3d printed a custom launcher

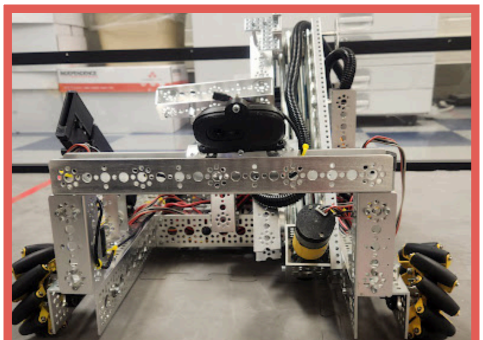


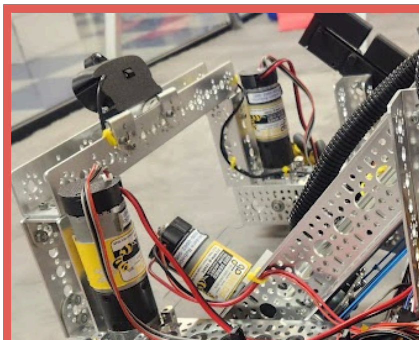
Final Product

Through the use of prototyping, we were able to visually plan out and brainstorm ideas for our robot, which resulted in saving us time during practices.

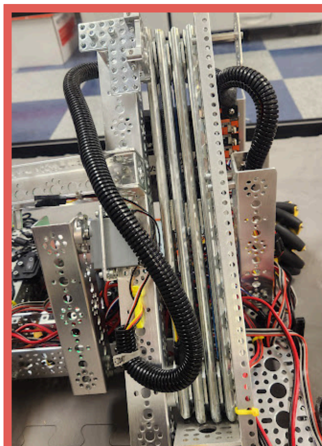
Attachments

These parts were created to improve upon and create designs that we were incapable of doing with the standered parts we already had. CAD allowed us to come up with, test, and configure designs faster and more efficiently while also solving problems that we had.





The camera is used in autonomous for recognizing our game element. The case for our camera is entirely 3d printed allowing us to mount the Logitech camera to the tetrix pieces quickly and easily



Viperslide - linear string-based slide with the spring and motor

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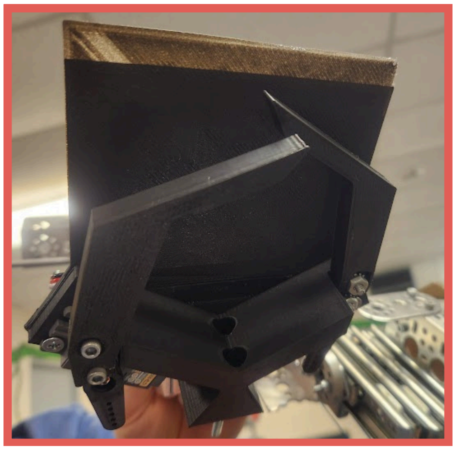
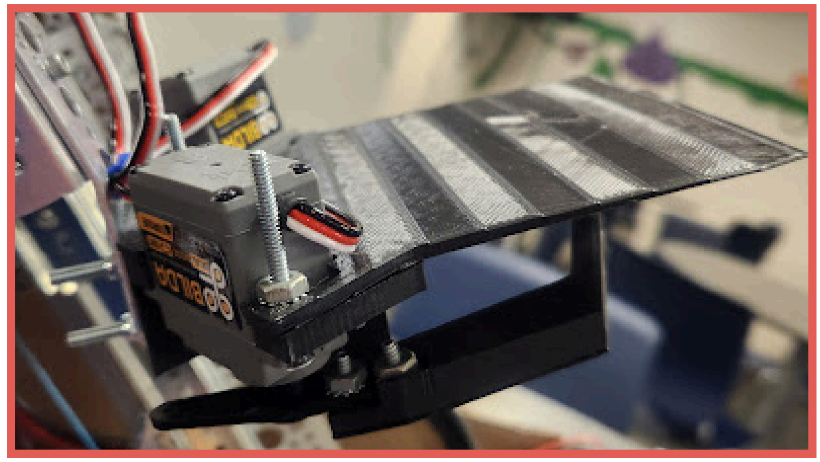
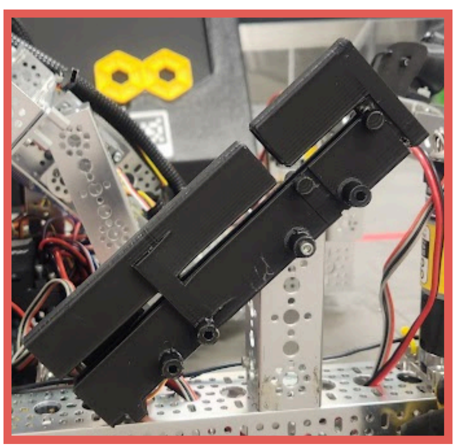


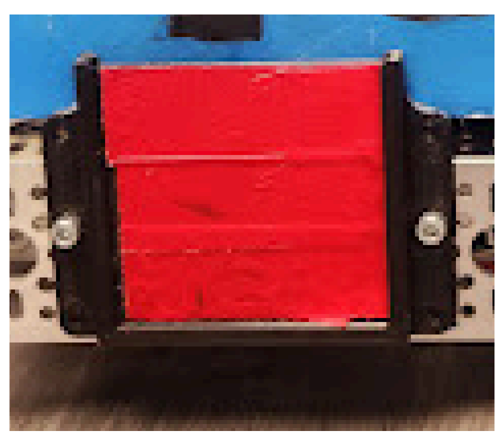


Our intake and output system is made up of two claws stacked ontop of each other and a plate for alignment with the backdrop which is attached to the viper slide. Our claw is mostly 3d printed which allowed us to follow the edges of the pixels for more grip and more consistency with picking them up and putting them down.



Our drone launcher uses a rubber band to launch the preloaded plane. Everything except the servo is 3d printed.

Our alliance markers and holders are 3d printed, the markers themselves have the corresponding color of tape, red on one side and blue on the other, making it easy to switch between matches



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Setbacks/Success

The design we thought would be the last design of the intake/outtake was scrapped after finding a major problem with reliability and ease of use. We were able to section out our chassis so each part runs independently, quickly, and efficiently. It allows us to focus on optimizing the individual functions of the robot so we don't have to limit ourselves in certain areas of play to excel at others and allows us to put our best foot forward.

- Troubles with using a combination of ot tetrix and gobilda.
  - We combined them in the first place because our team used to be all tetrix but saw an advantage to using a gobuilda set to create the chassis and linear slide.
- Using tetrix parts as expendable pieces where we can create specific pieces without worrying about damaging more expensive parts. We used this method for the camera mount, baseplate, and supports for the slide. It's difficult to get going but worth the grueling process.
- Well we now have a different design but it is completely different than what we had anticipated. We had been planning on using rollers to suck the pixels into a box so we could just dump the box when we got to the backboard. But we found that using a double claw design would suit the need to control where the pixels landed better would suit our needs more closely.
- Another challenge was keeping the plane in place during compition, since so many things are going on how do we keep the plane safe while driving. After several trials and some testing, all our versions of the shuttle would get in a bind due to to angle that the rubberband was held onto the launcher, faced with the choice of scrapping the shuttle or rebuilding the launcher we decided to scrap the launcher and work out a different solution.
- The next one was simple a bar that held down the drone while it was waiting for launch. It worked. A final decision was made and after all of the iterations and changes we ended up using a 3d printable design from blue bot builders.

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Special Programming

What special programs do we have that make our robot better?

First and foremost, our programs use PhotonFTC, a powerful tool to make robot commands much more efficient. At a high level, it uses a custom command scheduler to send commands much faster than the SDK does by default, using 100% legal methods. At a low level, it sends multiple commands at once, ignoring the technical option command lock that the SDK has and running new commands before the Robot Controller receives its acknowledge signal, saving around 1 ms per robot command. Since commands run on a loop, that means that the time it takes to run each loop can *half* cause much more accurate localization, and thus path following in autonomous, as well as more accurate slide PIDs.

We also use Bulk Reading, allowing our control hub to read the position of most of its sensors with a single, 3ms command, which means that instead of needing to run 12ms worth of commands to read the encoders for localization.

Most noticeable for most would be our field-centric driving, a method of controlling the robot that offsets its target travel direction by the current robot heading, meaning that no matter what direction the robot is currently facing, pushing the stick forward will always move the robot upfield.

Autonomous

Our autonomous uses Road Runner to provide accurate and fast actions while being easy to set up and program. We use the new Road Runner 1.0, as opposed to the much more widely used RR0.5.6, as it provides an easier and more accurate tuning process, as well as much more powerful features for combining robot actions and drive trajectories.

For team prop detection, we use an open-source vision processor that our programmer developed in part. It works by tuning HSV (Hue, Saturation, Value) ranges for each color of prop, looking for the largest contour of acceptable size (to avoid small things being detected), and looking at where it is in the frame. From there, it can report where the prop is for randomization. Then at that point, we use RR1.0 actions to drive to the spike mark and place the purple pixel, before driving to the backdrop and scoring the yellow pixel, both in the place indicated by the prop randomization state.

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Major Success and Failures

A major problem the programmers dealt with is learning Java and feature creep mid-season. It's been hard having to learn so much in such a short amount of time.

Java programming this year has allowed us to do unprecedented things for our team, including complex mechanisms like our arm, computer vision, or our autonomy in general.

```java
public  double[] calculateOneStickPower(double x, double y, double rx, double botHeading){
    double rotX = x * Math.cos(-botHeading) - y * Math.sin(-botHeading);
    double rotY = x * Math.sin(-botHeading) + y * Math.cos(-botHeading);
    double denominator = Math.max(Math.abs(rotY) + Math.abs(rotX) + Math.abs(rx), 1);
    double flPower = (rotY + rotX + rx) / denominator;
    double blPower = (rotY - rotX + rx) / denominator;
    double frPower = (rotY - rotX - rx) / denominator;
    double brPower = (rotY + rotX - rx) / denominator;
    return new double[] {frPower, brPower, blPower, flPower};
}
```

What makes our robot unique?

They work together due to planning, everything comes down to planning. The intention from the beginning is to make the robot as seamless as possible so each part although they move independently acts as one robot.

Our robot is unique due to its modular design and simple controllability. Since everything is independent almost anyone could understand how each part works. It also allows the drivers to make full use of the functions of the robot if they can easily understand what is happening, why, and how they should respond.

I have put myself in this robot through the hours serpent in trial error, and learning. Neither I nor the robot would be the same if I hadn't come to practices, participated, and worked to achieve what we have achieved.

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Programming

Learning Java

We choose to learn Java, specifically through Android Studio, because it provides much more low-level control of the robot than Blocks or even OnBot Java. Without Android Studio, we wouldn't have had access to powerful tools like Road Runner, Photon, or classes that control the robot in special ways, like custom PIDs.

Reaching out for help

An incrediblely helpful source for advice in regards to programming, was the Global FTC Discord. Huge thanks to teams 4017, 16379, 14712, and 19066 for the massive help that they've provided as we learned so much because of them. We've also spoken to the developer of PhotonFTC, the creator of RoadRunner, and spoken to the creator of and contributed to MucurialFTC and Dairy, all of whom have helped us a lot when using their software. We would not have been able to learn as much as we have as quickly as we did.

Pride in the work we do

We are incredibly proud of the mechanism efficiency that we've been able to achieve. Instead of all mechanisms being manual like in previous seasons, this year's actions are chained and automatically occurring, meaning that the drivers don't have to worry about the arm at all, drivers just must worry about picking up and depositing pixels.

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Game Strategy

Teamwork

Teamwork is incredibly important especially during a match. Being able to work with our allience partner comes in handy when building mosaics and communicating with human players.

Things we discuss with our alliences are:

- Their endgame strategy
- Whether they prefer their human player or is open to using ours
- What to prioritize during tele-op

Scouting Strategy

When scouting, we enjoy talking to other teams to learn their capabilities and what makes them stand out in competition.

Some questions we ask teams:

- How reliable is your robot
- What kind of tasks can your robot preform
- Do you have a functioning autonomous program

By doing this we are able to craft a game plan and maximize our overall capabilities as an allience

Scoring Priorities

Autonomous

Scoring

- Preload the 2 pixels and move them to “backstage”
- Park in the “backstage”

Tele-Op

Scoring

- Complete mosaics and stack pixels as tall as possible
- Push pixels into the “backstage”

Endgame

Scoring

- Continue placing pixels
- Launch our airplane
- Hook our robot and hang off the ground