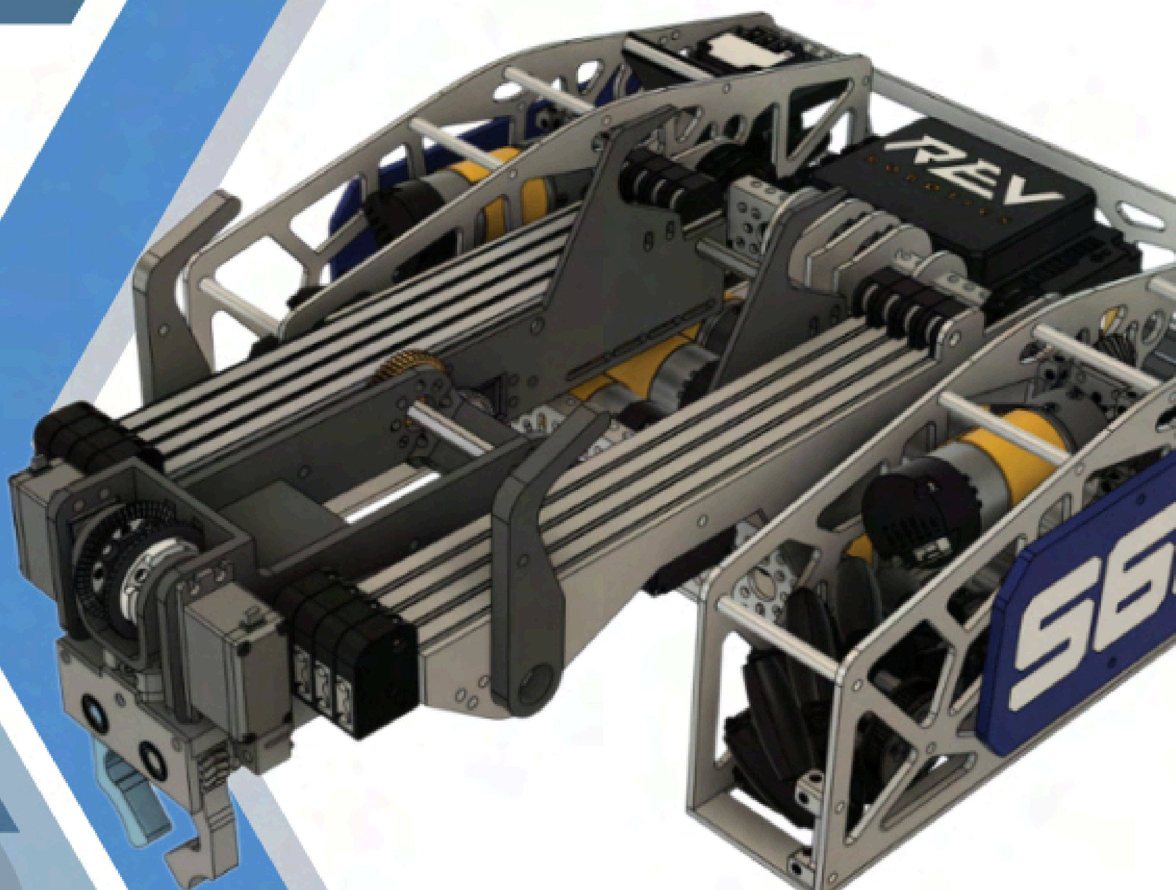
ESTRELLA FOOTHILLS

2024 - 2025

WOLVES ROBOTICS

PRESENTS



CRUSH

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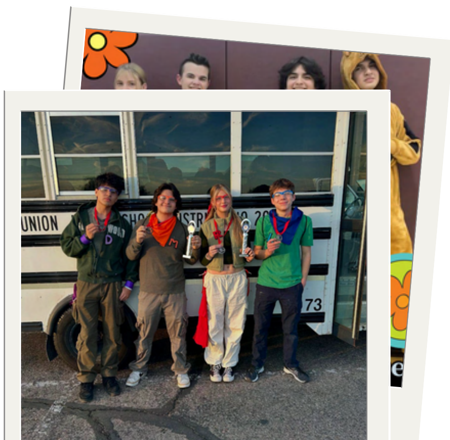
Quick Overview

Who Are We?

We are FTC Team 5661 Wolves Robotics 1 (Wolfpack) located in Goodyear, Arizona. We compete alongside our sister team 7156 Wolves Robotics 2 (Puppack).

We believe that each student, adult, alumni, and teacher will always be able to **improve no matter what**. We strive daily to spread the idea of STEM and refine everyone's skills in our community.



Red Rock Drive Team
Ninja Turtles

What Makes Us Unique

Drive Team Costumes was an idea our team came up with during the CENTERSTAGE season. At each competition our drive team will show up in a new and interesting costume to set us apart from the rest of the teams competing. Some costumes we have done are:

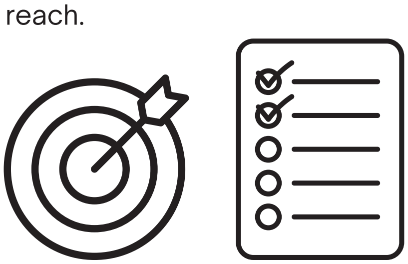
- Men In Black
- Scooby-Doo
- Hawaiian
- Lethal Company

Additionally, our team isn't just an FTC team. Our members get involved in many forms of robotics, such as **combat robotics**, **Hockey Robotics**, **Skills USA robotics** competitions, and so much more!

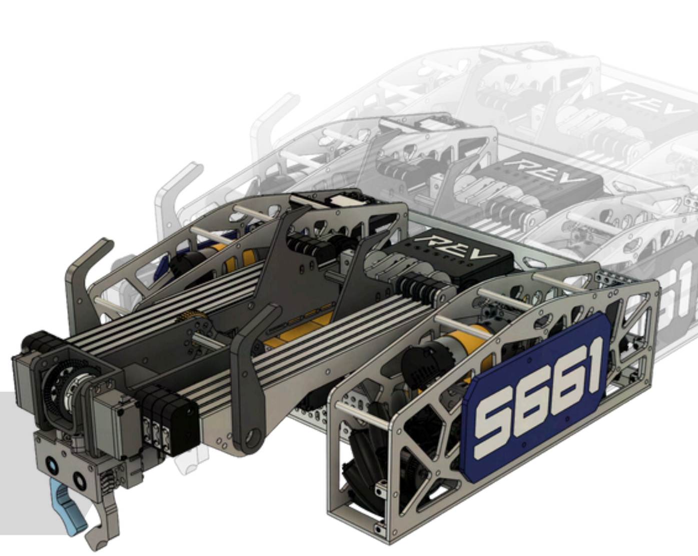
15 Years **50+ Awards** **Thousands Inspired**

Milestone Goals

In the post season of our centerstage year we created milestone goals that will take the duration of the 2024-2025 Into The Deep season to reach.



- Improve and **encourage GP** within our school
- Create a **framework for future rookie teams** to build on
- **Promote inclusivity** to technical and non-technical communities
- Develop **Manufacturing skills**
- Refine **team management**



Meet The Pack

Building Leaders Every Year

Our club has always focused on being **fully student-led**. Our new club management system divides everyone into four different departments, each with a department lead. One team lead will contact the department leads to ensure deadlines are met.

The team lead will also update our CEOs (Coaches) on progress. Each department has sub-categories that build up our team.

Baden A. - Team Lead
- Senior - 4 years in FIRST

Personal Win: Learning to CNC and laser engrave parts

Sam C. - Engineering Lead
- Senior - 5 years in FIRST

Personal Win: Winning our first inspire in years

Carson P. - Chassis
- Junior - 3 years in FIRST

Personal Win: I was able to develop my leadership skills

Declan S. - Subassemblies
- Senior - 3 years in FIRST

Personal Win: More proactive on bot design on CAD

James B. - Software Lead
- Senior - 2 years in FIRST

Personal Win: Developing advanced control systems

Derek L. - Drive Lead
- Senior - 4 years in FIRST

Personal Win: First place alliance at Red Rock

Elijah L. - Driver 2
- Senior - 2 years in FIRST

Personal Win: Improving upon my CAD skills

Deagan M. - Drive Coach
- Senior - 4 years in FIRST

Personal Win: Building the robots subassemblies

Luis V. - Outreach Lead
- Senior - 4 years in FIRST

Personal Win: Designing a well recognized portfolio

Shawn S. - Documentarian
- Junior - 3 years in FIRST

Personal Win: Being able to connect with so many new people

Sustainability

Obtaining Rookies

By participating in school events like **Future Freshman Night** and **Club Rush**, we showcase our club to all students, regardless of their STEM background. This sparks interest and helps us recruit new members.

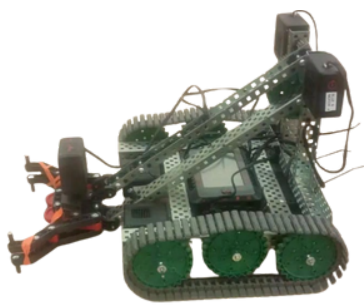
Robotics Class

Due to our team's success in various forms of robotics, our school has decided to offer robotics as a course option following this school year. This class will teach valuable **robotics skills** and foster a steady flow of new club members each year.

Rookie Mentorship Plan

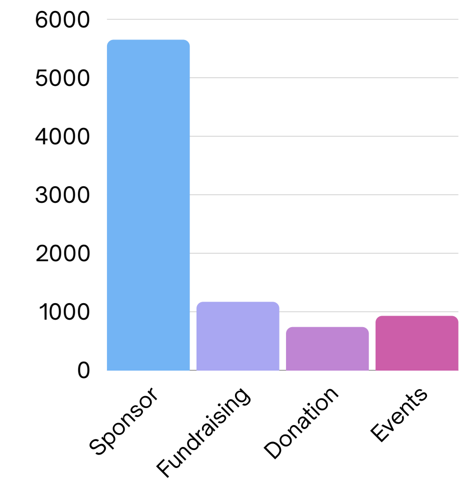
Passing down knowledge is the **best thing** we can do to ensure our club is always prepared for the season. To work towards **our goal** of creating a strong foundation for rookies we put many activities into action.

- To ensure every member gains a solid **understanding of robotics**, we provide VEX robot kits for them to customize and iterate on. This fosters both **technical skills** and the concept of **gracious professionalism** as members compete against one another.



- By utilizing online platforms like **Codeacademy** and **SolidProfessor**, we provide students with opportunities to **learn technical design** and **coding skills**, regardless of their prior experience or skill level.

2024-2025 Funds



Sponsorships

This season, we contacted numerous local companies to secure additional funding. Through a combination of emails, presentations, and direct outreach, we successfully gained the support of **six sponsors**.

Booster Club

Our booster club allows **parents** and **companies** to support our team. Donations are tax-deductible, and funds go directly to us. This allows us to buy parts faster than using the school's PO system.

Instagram: @efhsroboticsboosterclub

Outreach Overview

The Goal of Our Outreach

Our first step when planning out the outreach for the season was to figure out what we wanted our goals to be.

- Provide assistance to as many teams in Arizona FTC involving portfolio, software, CAD development, and much more.
- Connect with professionals in the engineering field and apply their advice to improve our skills and knowledge.
- Inspire youth to get excited about STEM by engaging them in hands-on learning and real-world applications while teaching them important problem-solving and teamwork skills.

What's The Game Plan?

Now that we had our goals in mind we made a plan on how we would achieve them.

1.) We would start creating levels of challenge in our teaching. This would allow those of any STEM background to be engaged.
2.) We need to apply ourselves and actively look for business events to showcase Wolves Robotics.
3.) We would create connections either online or in person with robotics teams.

These are all just a fraction of what we did to get started on this years outreach.

10+ Teams Assisted | **5 Events Hosted** | **200+ Youth Inspired** | **50+ Career Professionals Met**

Valuable Lessons

Through connecting with youth and mentors, we've learned:

- **Clear Communication** – Explaining ideas strengthens teamwork and outreach efforts.
- **Mentorship Sparks Growth** – Learning from professionals enhances our skills and problem-solving abilities.
- **Inspiring Others Fuels Us** – Motivating youth to explore STEM keeps us driven and passionate about our work.

Moving Forward

After connecting with so many people throughout the year we learned a lot. Moving forward we have many ways already in the works to improve.

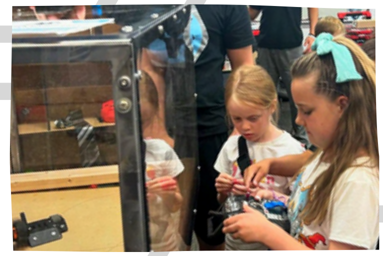
- **Gather Feedback** – Collect input from participants, volunteers, and partners to identify strengths and areas for improvement.
- **Track and Analyze Data** – Monitor outreach participation, engagement, and impact to refine strategies and improve future initiatives.
- **Create an Outreach Calendar** – Plan events, workshops, and initiatives well in advance

Community Connections

Youth in STEM

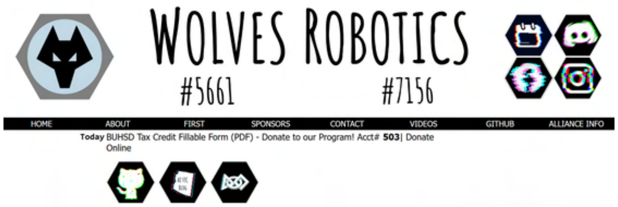
Girl Scouts - 5 Scouts
In our off-season, we had the opportunity to collaborate with Girl Scouts and assist them with **obtaining their Robotics badge**. They built a LEGO Brainstorm robot which we then challenged them to obstacle courses, races, and freight delivery.

Westar STEAM Camp - 80+ Students
We took part in the **Westar Elementary STEAM Camp**, running a robotics section for grades K-6. Students built VEX kits, controlled robots, and learned about the engineering design process. We also 3D printed Harry Potter-themed prizes for the students to fit the camp's theme.



Team Resources

Our website offers a variety of **resources** and documents for teams, including **GitHub**, **CAD files**, **portfolios**, **contact information**, and much more!



Cactus Wren Qualifier

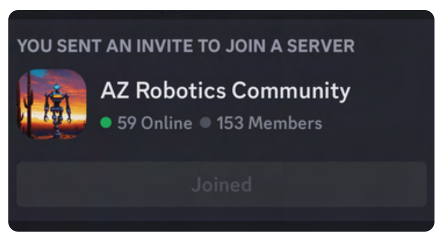
We contacted the PDP and were given the opportunity to **host a robotics competition** on our campus this year. The event took place on January 11th, 2025.

m.e. FIRST Ambassadors

Team 18421, Unscheduled Disassembly, invited us to be M.E. FIRST Ambassadors, **promoting menstrual equity** and providing period products at four competitions this season.

AZ Robotics Discord

Our team is part of a **thriving Discord community** with over 60 teams across Arizona, where we help each other troubleshoot issues, share resources, and offer support to one another



Team Assisting

We strive to **support every student** in FTC by passing down the knowledge we've gained from mentors and personal experience. We have assisted **5 teams** from Arizona by **sharing our cad**, **giving portfolio advice**, and **demonstrating ways to structure a new team**.

Additionally, we know it can be hard to get space for a field test of a robot. We do our best to allow teams to use our lab to test and prepare an autonomous.

Community Connections

Social Media - 780+ followers

Our social media keeps the FIRST community **updated** on where we will be competing during the season. We also document achievements and create fun posts for the FTC community.

Club Involvement

We made it a goal this year to partner with many CTSO and **community clubs** within our school to push the idea that robotics is **EVERYWHERE** in total we worked with 8 different clubs and CTSO chapters

Some Clubs we have worked with:
- SkillsUSA
- FBLA
- Interact
- FCCLA
- Coexist
- HOSA

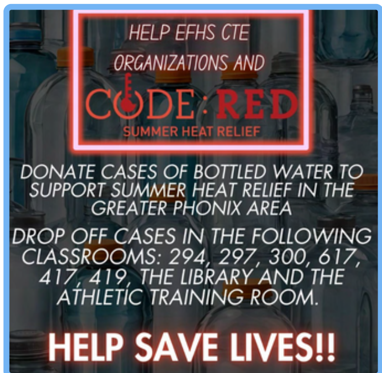
ROBOTICS IS EVERYWHERE

Donation Drives

Partnering with CTE clubs we were able to orchestrate 2 donation drives.

Code RED - EFHS CTE Organizations
Code RED was the **largest school drive we ran** partnering with 6 different CTE chapters to **donate water** for those struggling in the heat.

New Life Center - Skills USA: Engineering
After getting into contact with the New Life Center we created a **donation drive** to help victims of domestic/sexual violence.



St. Mary's Food Bank

Our members alongside interact **helped prepare emergency food boxes** for those in need. Each box created meals for 2 people to eat for a whole month!

Team Mentorship

A look into our Mentors

While we focus on mentoring other teams and students, we recognize the **vital support** and expertise our mentors provide. They are the backbone of skill development, ensuring the growth and continuity of both technical and business knowledge.

Jennifer A.

Booster President

- Helped us through our presentations and solidified our marketing with the booster club

Hunter B.

Design Mentor

- Advised us when deciding on our designs, he also provides building space for us.

Professional Assistance

Our showcasing efforts have intrigued many professionals within the engineering field who had great advice to give.

Northrop Grumman - Christian M.
Gave us important insight on how we should go about planning a project like a robot subsystem

- **Met Through**: Classroom Visit

AXON - Brent H.
He demonstrated ways to market our team as well as giving us insight to making smart financial decisions

- **Met Through**: Community Outreach

ASU Engineering Student
He taught us how to **better utilize** our CNC Equipment

- **Met Through**: Battle Bots Event

NASA - John K.
Showed us the many career opportunities that we can work towards after high school

- **Met Through**: Classroom Presentation

Peer Mentoring

We believe that learning from our peers is one of the **most valuable** ways to **develop skills**. This collaborative approach not only **enhances** our own abilities but also strengthens those we work with, creating a supportive and enriching environment where everyone benefits and grows together. Some teams we have collaborated with were:

21579 - Testing is Optional - AZ

- Introduced us to creative design and building techniques, helping us improve our robot's **efficiency and functionality**.

23395 - Hivemind - TN

- Taught us **effective portfolio design principles** and methods, helping us enhance the presentation and impact of our work.

14179 - Sushi Squad - WA

- Taught us strategies to **enhance the quality of our portfolio** information and improve our approach to judging.

Technical Events

Club Showcases

To **connect with companies and corporations**, we make an effort to participate in various community showcases and events. This involvement allows us to **build relationships** and demonstrate our capabilities to a wider audience. Some events we have participated in were:

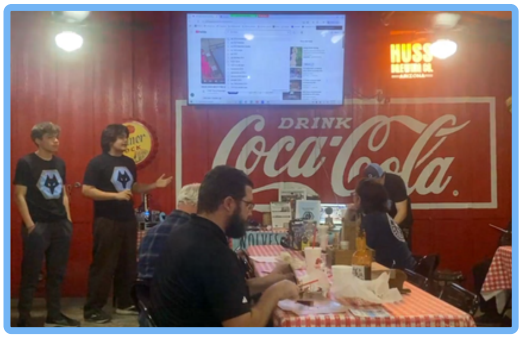
CTE Advisory meeting
With robotics now a program at EFHS, we were invited to the CTE Advisory meeting with teachers and directors from the district. This allowed us to **showcase our work** in the robotics/engineering program.

Chamber of Commerce
Every Wednesday, we make it a point to attend the Chamber of Commerce meeting, where we can **connect with various companies** and showcase our club in hopes of securing sponsorships and funding.

Kiwanis Presentation

Kiwanis is an organization dedicated to inspiring and supporting the younger generation through community service. We had the incredible opportunity to **present our team** to them, and they were ecstatic about the work we do. So much so they were willing to donate to the team and become a sponsor.

Additionally, we are working toward making Wolves Robotics an official "Key Club" and becoming a Kiwanis-affiliated robotics team. This partnership will strengthen our commitment to service, leadership, and innovation in STEM.



Wolves Combat Classic

Our team **hosted a Combat Robotics** event which many students in FTC attended. Using our 3D printers we created trophies for the winners of the event.

Our Makerspace

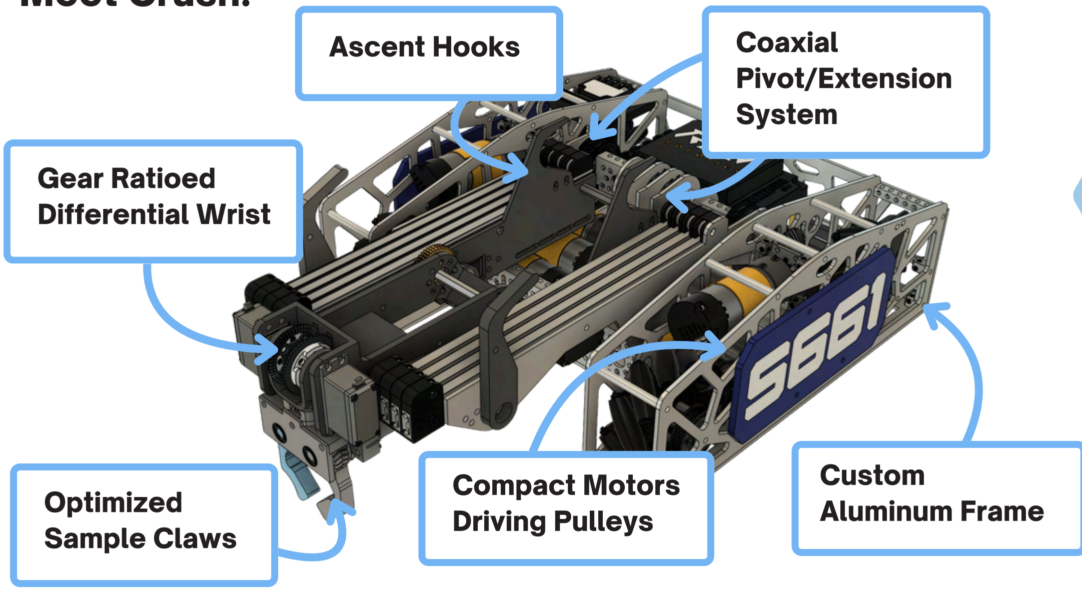
As the representatives of our school's engineering department, we've received funding from the BUHSD district to **establish a dedicated maker space**. This space is equipped with advanced tools like a CNC milling machine, a laser engraver, and other large machines that we actively use. These resources allow us to produce a variety of items, including:

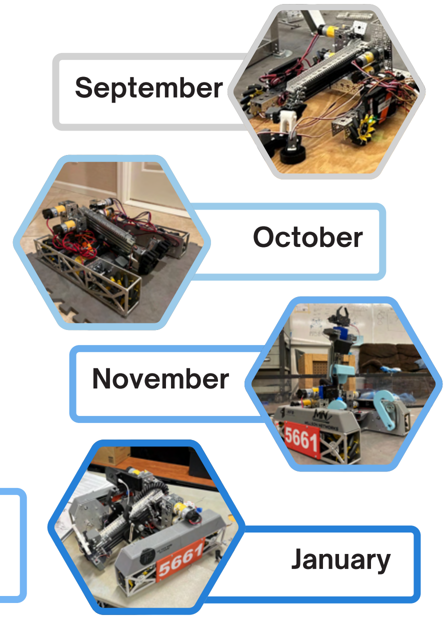
- Parts for teams
- Plaques for the school
- Components for company manufacturing

These capabilities enable us to support both our school and local businesses with high-quality, precision-made products.

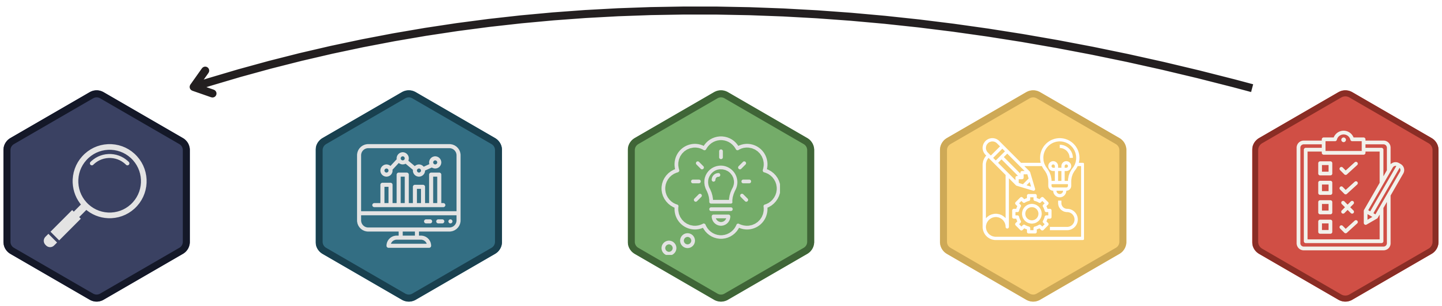
Robot Overview

Meet Crush!





Our Engineering Plan



Identify
This stage of our design process identifies the problem that we are facing

Analyze
This step required us to locate the physical game constraints we would need to work with

Envision
A small but crucial part of our process is to imagine our designs. We begin unrealistic then refine.

Prototype
Through the use of Fusion 360 we are able to assemble our robot online saving time and recourses.

Evaluate
Once we have a working concept, its off to the sub teams to assemble and test designs.

Design Principles

Murphys Law
“Anything that can go wrong will go wrong.” A term we are very familiar with after a few years. Our goal for this year was to make the bot not only **reliable** by design but also **easily repairable**. This means that at every competition we have all the parts to essentially replace anything needed

K.I.S.S.
Keep It Simple Stupid (or **KISS** for short) is a design principle we adopted for the season.
We wanted our robot to be the simplest design possible and **avoid unnecessary complexities**. This will mitigate the points of potential error in the design

Drive Train

SendCutSend

Innovative by Design

Our chassis is designed with efficiency, durability, and reliability in mind utilizing:

- **Compact Motors** – Helps to save space while maintaining a low center of gravity, allowing more stability and speed while compacting the design.
- **Hard Stops** - By implementing physical limits of the arm pitch we save our batteries and motors **improving performance**.
- **Belt-Driven System** – Reduces weight and improves power transfer for smooth and consistent movement.
- **Custom-Manufactured Side Plates** – A combination of parts we machined ourselves and components from SendCutSend, allowing us to refine our design and manufacturing skills.

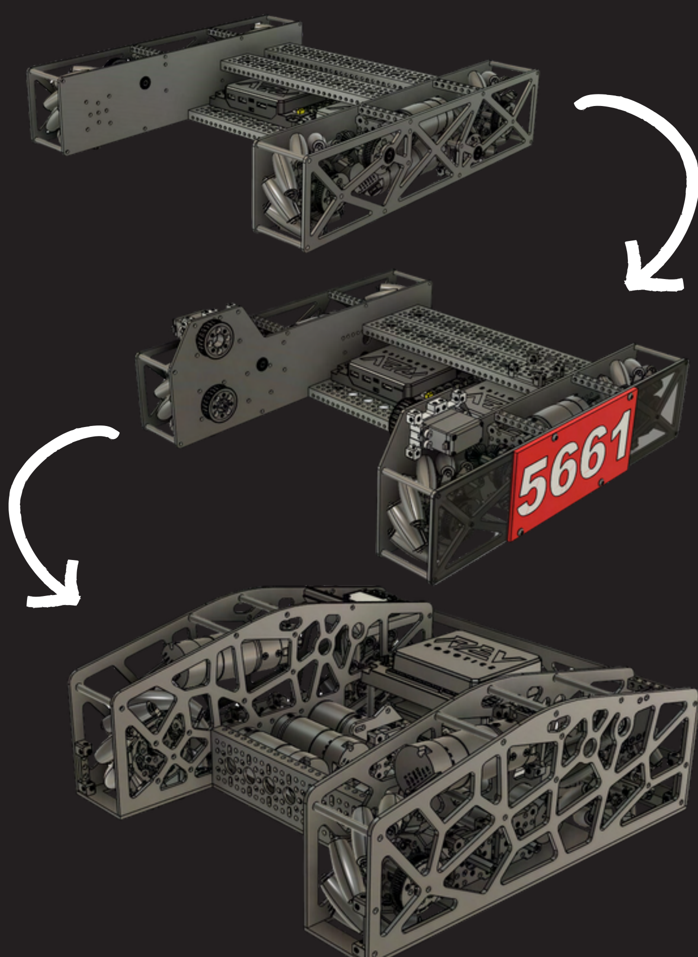
By combining these features, we've built a chassis that is both effective and thoughtfully designed, supporting our team's goals of learning, improving, and developing our technical skills.

Stronger, Lighter, Better

Cutting our aluminum side panels gives us **greater control** over our design and manufacturing process, leading to a **more efficient and well-integrated chassis**. The key benefits include:

- **Precision Fit** – Designing and cutting our panels ensures they integrate perfectly with our chassis, minimizing the need for adjustments.
- **Lightweight and Strong** – Aluminum provides an **excellent balance of durability and weight**, keeping our robot both sturdy and efficient.
- **Design Flexibility** – Custom cutting allows us to optimize the shape, mounting points, and cutouts to fit our exact needs.

By machining some panels ourselves and utilizing SendCutSend for others, we've gained valuable hands-on experience while ensuring high-quality results. This approach helps us refine our designs and improve our fabrication skills.

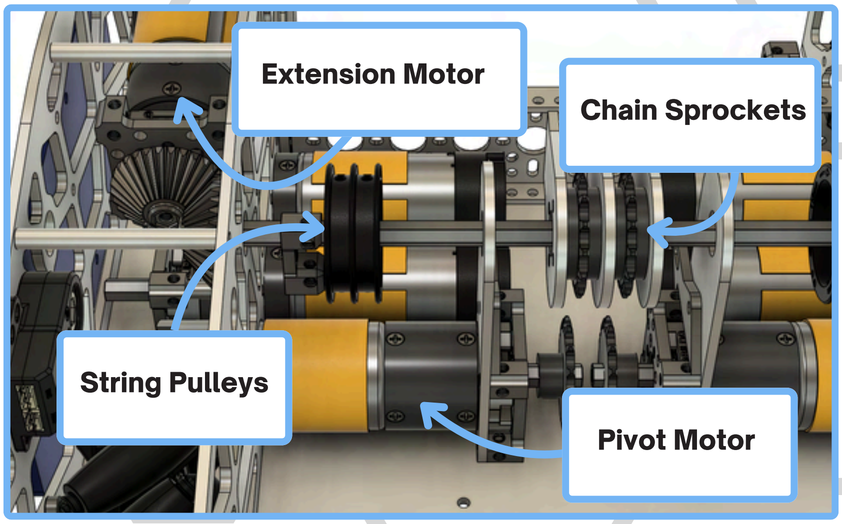


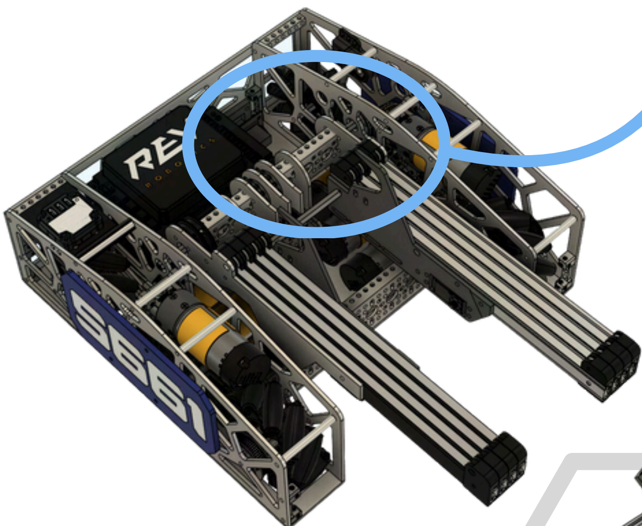
Pivot Slide

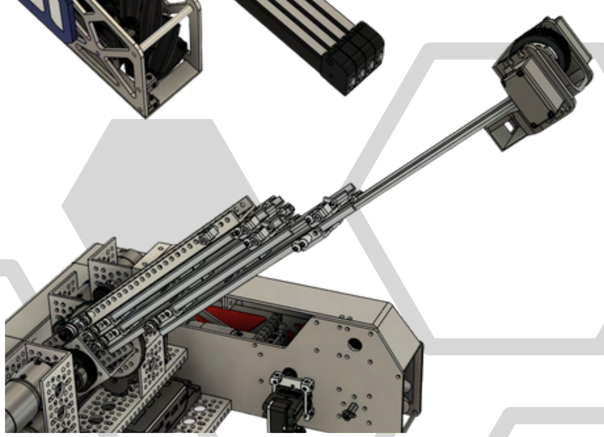
Our Linear Slide

The linear slide is essential to our robot's gameplay this year. It stays compact, keeping us within the sizing box, but once the match begins, it can extend up to four times its initial length.

Our linear slide operates on a coaxial pivot, meaning that both extension and rotation share the same axle. **This design simplifies the mechanism** by allowing reaching and pivoting to occur from a single system, improving efficiency and reducing points of error.







Swapping to dual slides

We made several key upgrades to improve our system's performance and functionality:

- **Dual Misumi Slides**: Upgraded from a single GoBilda ViperSlide for increased rigidity and stability. This also created space for a secondary arm powered by an Axon Max, allowing it to smoothly drop in and out of the submersible.
- **String-Driven Slides**: Switched to string-driven slides, which eliminated slippage (a common issue with belts), **providing more reliable movement.**
- **Simplified Code**: The new design removed the need for a limit switch to confirm slide retraction, streamlining our code.

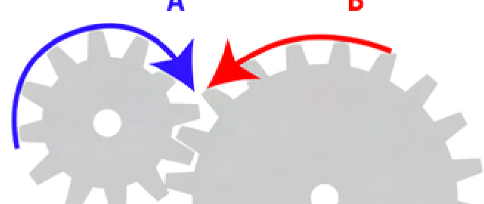
These changes have significantly enhanced the system's stability, reliability, and functionality.

Finding the "Sweet Spot"

By using gear ratios, we identified the ideal pulley size and RPM speed needed for both lifting the robot and ensuring quick sample cycling. **This allowed us to balance the torque required for lifting** with the speed necessary for efficient movement. The right combination of these factors ensures optimal performance for both tasks.

Gear Ratio Example

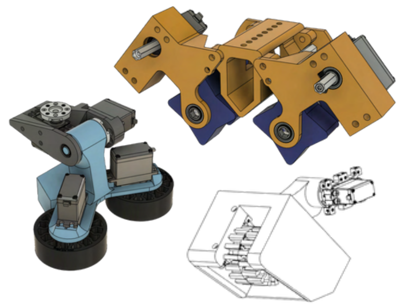
$$RPM_A \times Teeth_A = RPM_B \times Teeth_B$$



Intake Systems

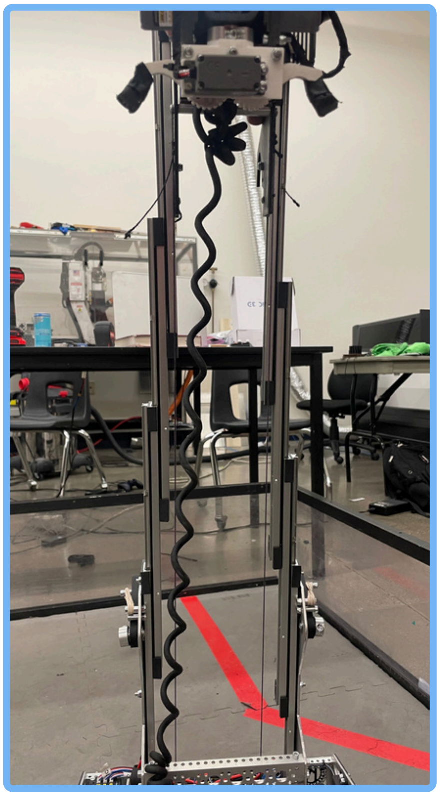
Early Prototyping

Early designs required us to choose between a passive or active intake, each with its own trade-offs. Our decision had to balance simplicity and functionality, ensuring the system remained reliable while effectively handling game elements.

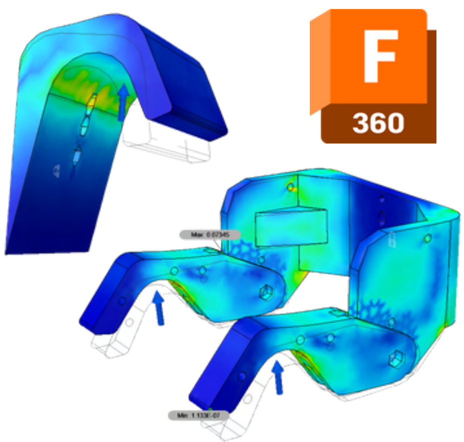


Custom Wiring

We use an Ethernet wire to reduce the number of wires that need to extend with the slides. By custom-wiring the servos at the end effector to the Ethernet port, we can efficiently transmit signals while keeping the wiring compact and manageable.



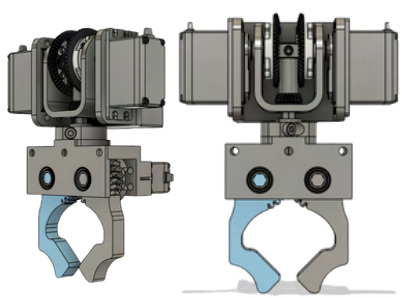
Digital Simulations



Using Fusion 360, we can analyze potential failure points in our parts before physical testing. While online simulations help predict performance, we recognize the risk of inaccurate results. Because of this, we continue to evaluate prototypes in person to ensure reliability and accuracy.

Finalizing Designs

After finalizing our design, we focused on refining the passive intake we chose. Over time, we made small but crucial tweaks, continuously innovating and improving its efficiency and reliability.

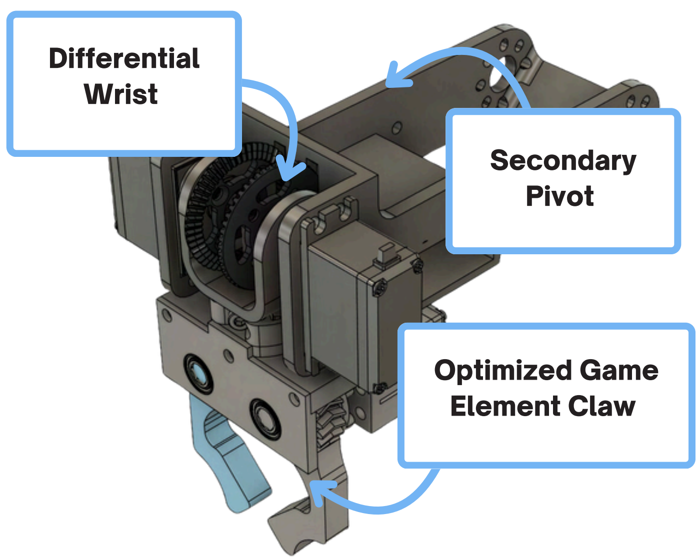


The End Effector

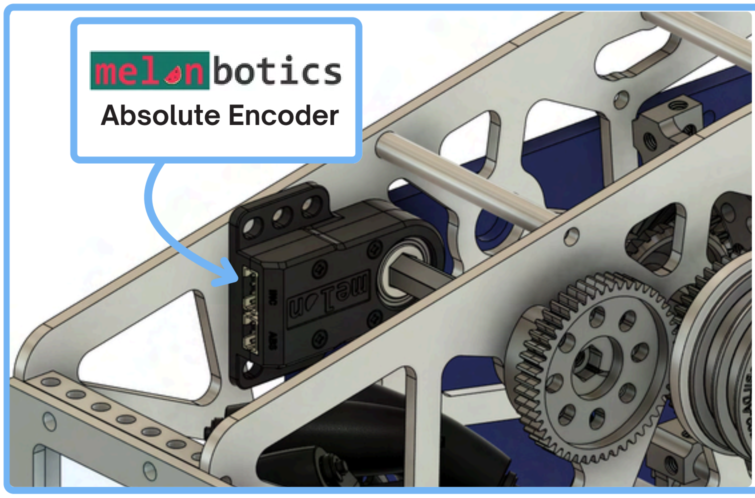
Our scoring mechanism utilizes a multi-axis rotating end effector for greater flexibility.

- **Secondary Arm Pivot** – Mounted on dual slides, this arm allows us to move up and over barriers while providing more degrees of freedom for precise teleop control.
- **"Diffy Claw"** – Inspired by a car differential, the joint adjusts based on servo movement, enabling smooth and controlled motion at a **5:1 gear ratio**.
- **Optimized Grip** – The claw is specifically designed to securely hold the game element for efficient scoring.

These elements work together to create a versatile and effective scoring system



Sensors Overview

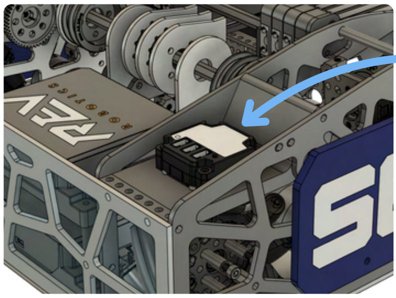


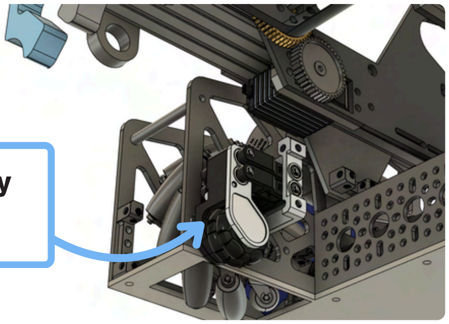
Detecting Slide Pitch

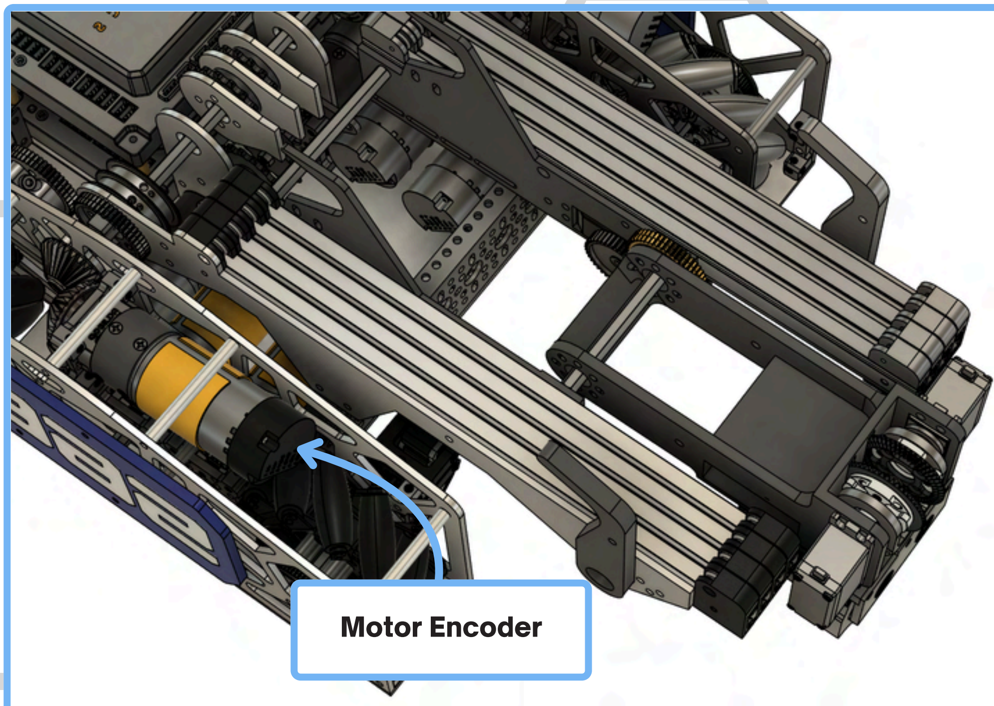
In an effort to mitigate slide pitch inaccuracies, we've opted to use the **Melonbotics absolute encoder**. This encoder detects the rotation of the mounted gear, which is meshed with the slide assembly, at all times even when powered off. This allows the slide pitch to be controlled accurately and removes the need for perfect robot setup every match. Through advanced control systems, this encoder has allowed our arm to be **fast and versatile.**

Calculating Robot Position

In previous seasons we have used odometry pods alongside positioning algorithms found in libraries like Roadrunner to calculate robot position. This season, we have continued to use similar odometry pods alongside the new GoBilda Pinpoint Odometry Computer which calculates robot position thousands of times per second, **providing more accurate and consistent localization** to use alongside our autonomous programs.







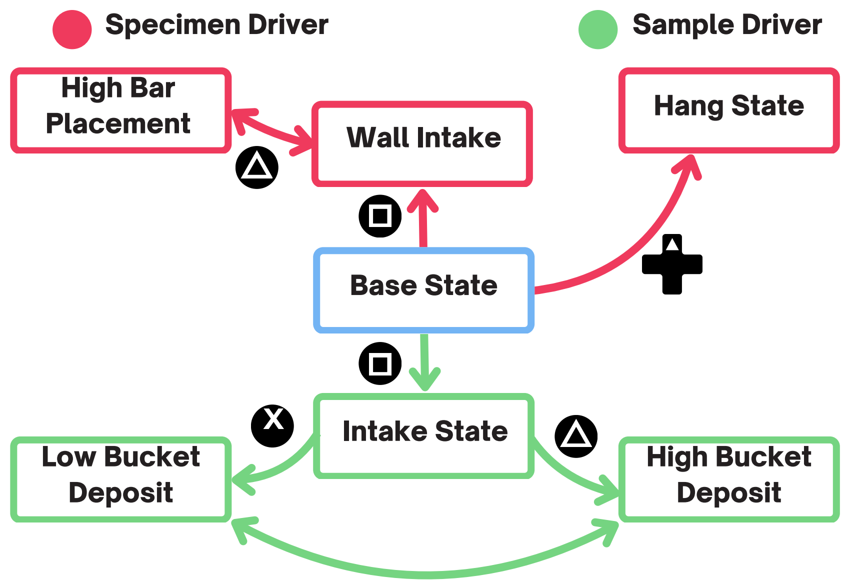
Extension Control

In order to abide by this season's extension limit rules, we're using the **extension motor encoders** to determine slide position. These encoders give us an accurate position of the extension slides which we pass through a PIDF controller to position the intake during autonomous and driver-controlled periods. Both extension motors receive the same power and are mechanically linked so both motors maintain the same position.

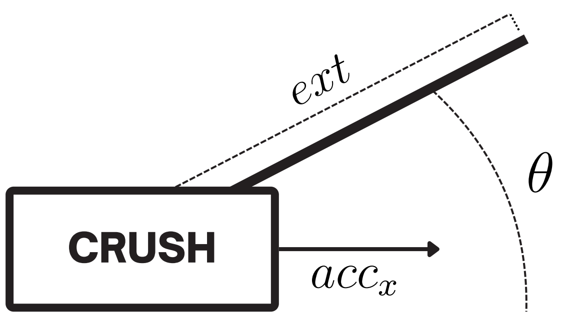
Control Systems

Finite State Machine

This year we've implemented a custom finite state machine for our driver-controlled systems that leverages FTCLib's command-based paradigm. This allows us to easily expand our program by adding more states based on what's required of the bot while maintaining flexibility through defining transitions between states. Each driver has to press one button to transition to a desired state and the underlying control systems will coordinate and manage the subassemblies automatically.



$$kF = kF_g * cos(\theta) + kF_a * sin(\theta) * acc_x * ext$$



$\theta : arm\ pitch \quad acc_x : forward\ acceleration$

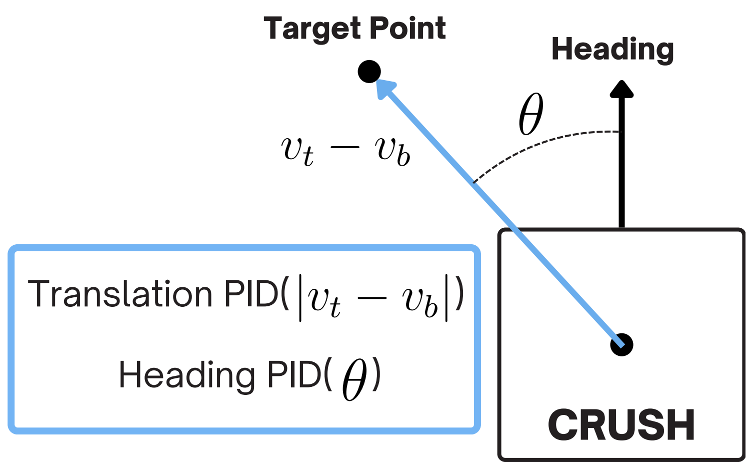
$ext : normalized\ extension$

Motion Control

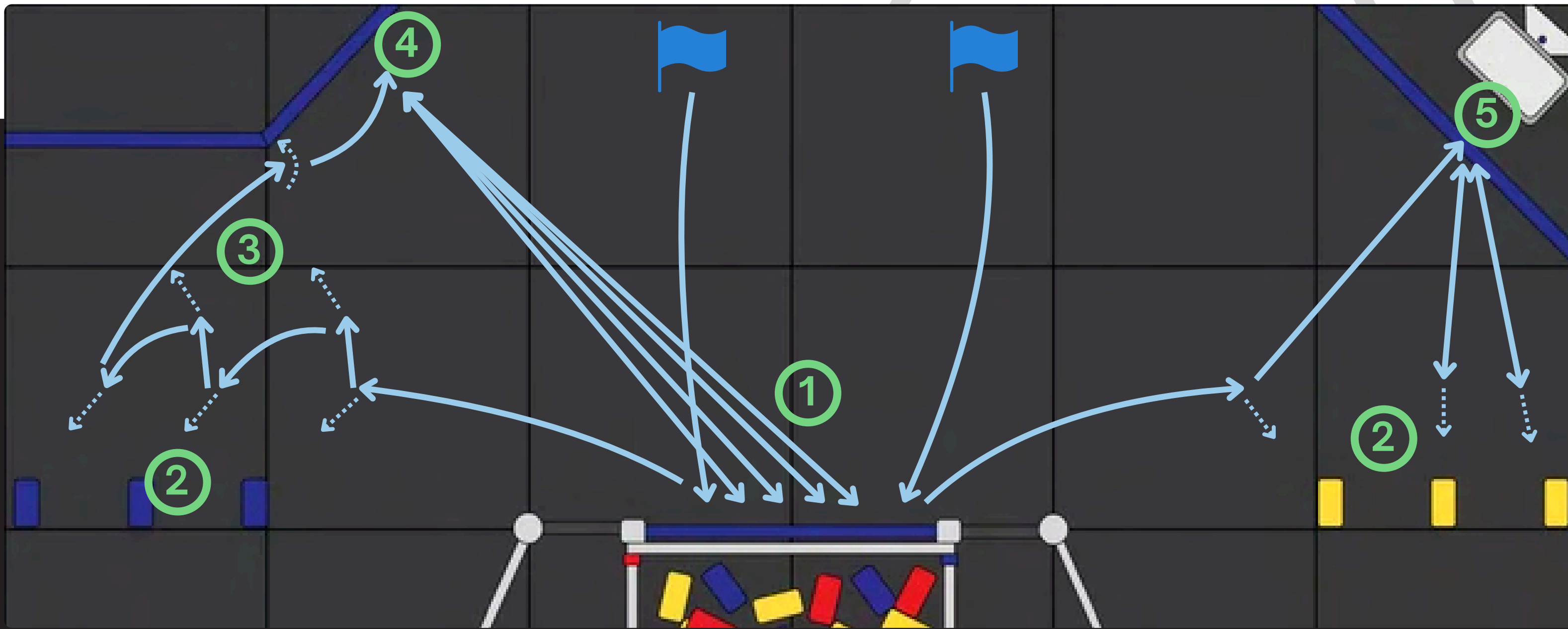
As a result of our design choices, we've had to implement robust motion controls for our pivoting linear slides. We've accomplished this through a few methods. First, we've implemented an advanced PIDF controller for pivoting our slides. This includes the standard kP, kI, and kD terms along with 2 additional feedforward terms. The first counteracts gravity, while the second counteracts arm wobble while extended upwards. Using the sensors covered in the previous page, we can accurately control the arm with this PIDF loop to position it at any angle and extension at any robot speed.

Pathing

In conjunction with our pinpoint localization odometry, we use two forms of pathing: Pedro Pathing and PID to point. We chose Pedro Pathing for its speed and relative accuracy, but for paths that need to be extremely reliable, we developed our own PID to point algorithm. It takes the magnitude of the difference vector between current bot localization and a target position and passes it through a PID controller to drive the bot towards the point. The same is performed for robot heading. The combination of these two systems allows our robot to have a consistent and efficient autonomous.



Robot Autonomous



① Place specimen on high bar
② Intake sample
③ Transfer sample to player
④ Intake specimen from wall
⑤ Place sample in high bucket

Overview

Our autonomous system can complete a 5-specimen route or a 4-sample route.

Purpose: Provides flexibility to adapt to different autonomous strategies.

How It Works:

- The robot places one specimen and hands the other three to the human player for high bar placement.
- Alternatively, it can complete a 1-specimen and 3-sample route for the bucket side.

Benefits: Allows the team to choose the autonomous strategy based on which one our teammate excels at.

Autonomous Pathing

The combination of all systems mentioned previously and the integration of Pedro pathing, an FTC community path following library, allow our robot to score high point autonomous periods alongside our teammates consistently.

Autonomous Aids

With the control systems in place, we've implemented helpful features for our autonomous system, such as slide endpoint position holding. This ensures the slide maintains its endpoint in space, defined as a 2D vector, regardless of the robot's position.

Purpose: Keeps the slide endpoint fixed in space, compensating for errors in Pedro pathing.

How It Works:

- Uses the robot's position and slide extension as inputs.
- Calculates the difference vector between the target point and slide endpoint, then converts it to slide motor PPR for precise extension.

Benefits: Improves sample-taking consistency and accuracy during autonomous.