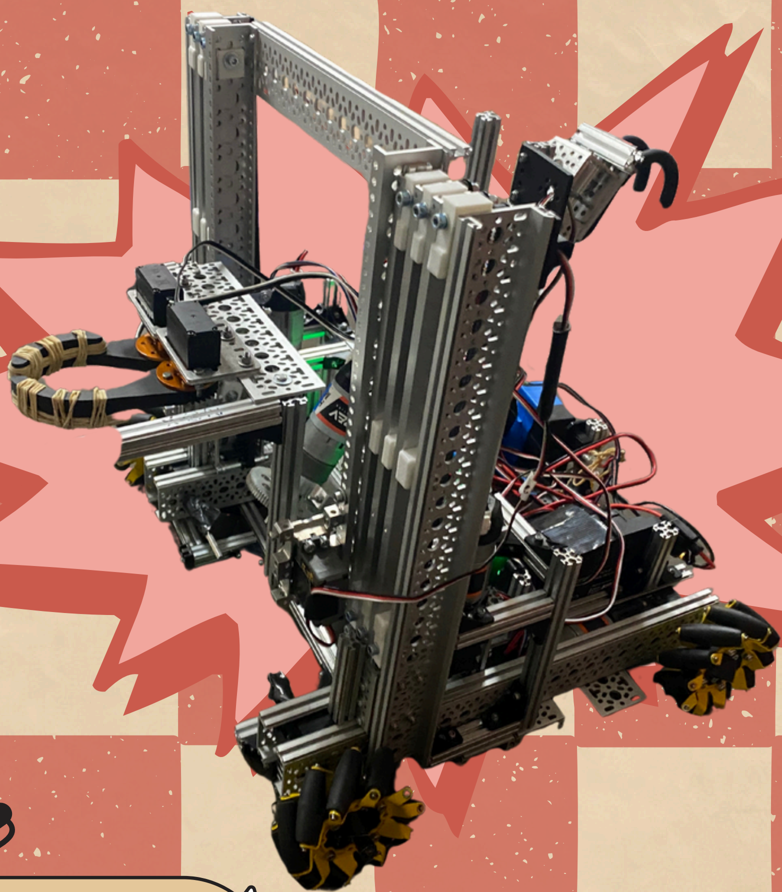
Invicta Ferro Capybaras

15157



2024-2025 SEASON:
INTO THE DEEP

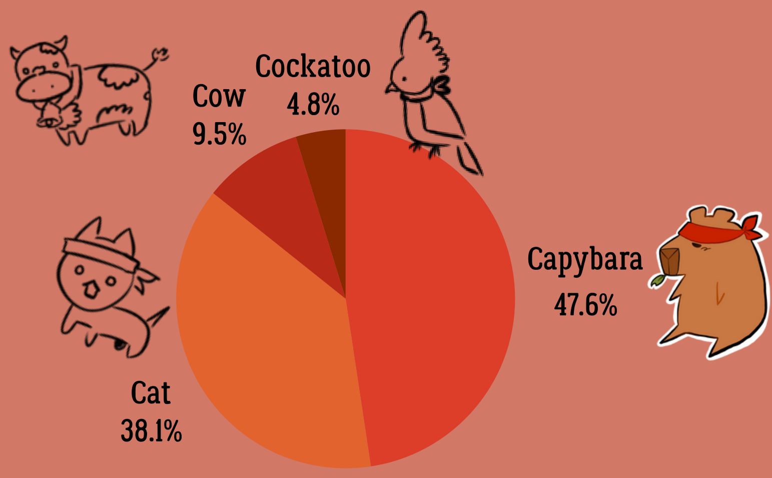
TEAM OVERVIEW

ABOUT US

We are IFC, a team of 15 students at Pasadena High School who are fascinated by every aspect of robotics, from design to fabrication to programming. We make sure to focus on team-building as much as we do on building actual robots. This is our seventh year participating in the FIRST Tech Challenge, and we have had so much fun throughout this season!

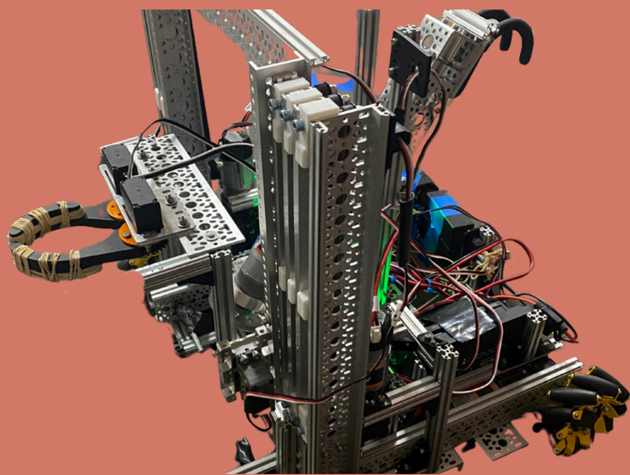
VOTING FOR OUR MASCOT

Our team has been the Invincible Iron Dogs (Invicta Ferro Cannibus) for a while, and this year we decided to rebrand, so we chose several animals that start with a 'C' and voted for our favorite. We ended up choosing Capybaras!



ROBOT OVERVIEW

Our robot uses REV for the chassis and structure; a self-designed belt-driven slide made from MiSUMi, REV, goBilda, and small 3D-printed parts; a 3D-printed claw; and a goBilda lead screw linear actuator for hanging.



"YOU CAN'T SPELL FUN WITHOUT ROBOTICS!"

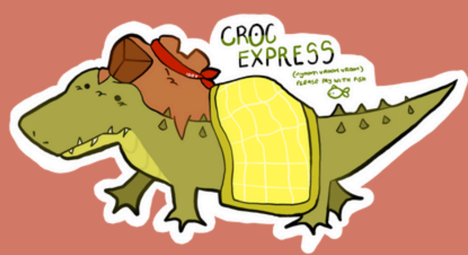
is our motto, and we highlight just that in every meeting and competition: **fun!** Whether that be through taking robot POV videos, team shopping trips, building carnival games with robotics parts, or even ping pong tournaments in the robotics room, we make sure that **everyone on the team has fun** doing robotics. In showcasing this to the rest of our school, we hope to not only preserve the **passion** our team has for robotics, but also **spark more interest for robotics** and STEM in students with less exposure to these fields.

SEASON HIGHLIGHTS

- Finished 6th out of 16 teams in League C2 (big jump from last year's 12th place finish)
- **Highest ascent score in our league**
- Bought new mecanum wheels that made our robot drive very smoothly
- Designed our own belt-driven slides using MiSUMi, REV, and goBilda parts
- **Bounced back after losing a month of school due to the Eaton Fire**

LESSONS LEARNED

- The importance of **time management**
- Having a **vision** can heavily impact the timeline of a project
- **Teamwork** is vital to the design process



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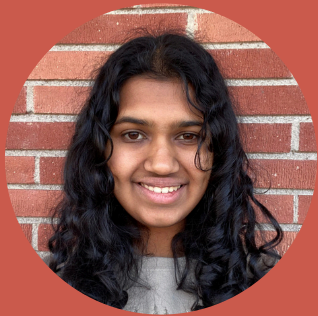
MEET THE TEAM

ZALEA NUNES
President, Programmer Lead



MALLIKA SHESHADRI
VP, Fabrication Lead

MEGAN SINCLAIR
Secretary

JAYDEN CHENG
Treasurer

MARK BARTLE
Ascension Lead

IAN NG
Collector Lead

ISMAEL URBINA
Comic Relief

NATHAN YANG
CAD Lead

KYLIE LIN
Fabrication; Driver

VINCENT VU
Drivetrain Lead

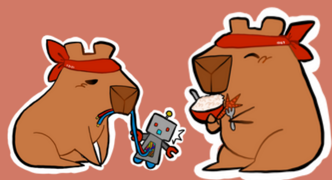
CORY COLLINS-LOPEZ
Collector

KAYLEIGH YUNE
Art

AIDEN VAN HOUTEN
Documentation

MICHAEL VU
Miscellaneous

NOLAN ROMERO
Ascension



"Being on this team is very fun and I love how ***we all get along very well.****"*
-Mallika Sheshadri

"I really like the environment, the energy that the robotics members make, and I also like that ***all the members can agree*** *in harmony in a dictatorship, and the final thing I appreciate about [the team] is that* ***everyone treats each other nicely, like a family.****"*
-Ismael Urbina

"I appreciate that ***I feel like a member of the team*** *and that other members listen to me."*
-Vincent Vu

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OUR PLAN

During the early meetings of this season, we set **long-term goals** to guide the organization of our team, and create a foundation for a successful year.

We inevitably encountered many obstacles, but these goals ultimately helped us grow as a team beyond how we had functioned in previous seasons.

Goal	Action plan	Challenges	Completion status
Fully utilize **CAD and 3D printing** in designing and fabricating the robot	Have members attend Onshape **workshops** and learn from **tutorials**, CAD robot to test, **design** and print custom parts	Members had no experience with OnShape, very little experience with 3D printing; Had technical difficulties with our printer	**Complete** - Several members learned Onshape, designed and printed parts; final collector is 3D printed
Improve outreach and increase networking with other teams/mentors	Reach out to **Honeybee Robotics** about tours and mentors, schedule meetings with Sierra Madre robotics teams, improve social media presence	Conflicting schedules between Sierra Madre teams and our team, no team members adept at posting on social media	**Complete** - Mentored Sierra Madre teams early in the season, are now more active on Instagram, and have mentors from Honeybee
Familiarize **new members** with **all areas of robotics**, ensure everyone can contribute	Host **programming** and **fabricating workshops** before kick-off; Be conscious of **helping new members** contribute every meeting	Very **limited** amount of preseason meeting **time** that can be used for training new members, even more limited during the season	**Complete** - Experienced members taught new members robotics basics before kick-off, new members made significant contributions this season

By recognizing our team's **strengths and weaknesses**, we organize our meetings to take better advantage of opportunities and avoid past problems.

Strengths	Weaknesses
• Team is very close, with good communication between members • Good turnout of new members this season • Very accessible meeting location that allows for flexibility of meeting times • Some financial support from school in addition to savings from fundraising	• Not many members with a lot of experience competing in FTC • Overall smaller team • Lost members who led 3D printing and social media management • Limited access to mentors/people experienced in FTC • Many of our parts are broken or don't fit our plans for improvement

TIMELINE

August — PRESEASON: Hosted workshops, trained new members

September — KICKOFF: Developed a strategy, made a working collector and hanger

October — MEET 0: Our wheels fell off and the lift broke.

November — MEET 1: Bought **new mecanum wheels and lift**! Robot consistently hung specimens

December — MEETS 2 + 3: Implemented **custom slides** and new collector.

January — THE EATON FIRE: The **Eaton fire** devastated our community. Our school **shut down for a month**. Losing access to the robot before ILTs was a major setback for our team.

February — ILT: We bounced back in **2 weeks** to get ready for this competition!

Red: Setbacks
Green: Successes

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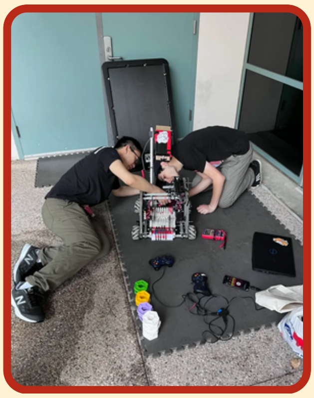
CONNECTING WITH OUR COMMUNITY

2024 PUSD STEMFEST

The Pasadena Unified School District **StemFest** at John Muir High School and the Pasadena City College **Steamposium** were two great events for us to **introduce kids to robotics** and make new **connections**!

2024 PCC STEAMPOSIUM



SIERRA MADRE MIDDLE SCHOOL TEAM

Many of our members are alumni of Sierra Madre Middle School and we have a **close relationship with their teams**. We have visited them to help and guide them, and they've helped us by lending their computer during meets and letting us practice on their field.

HONEYBEE ROBOTICS

- On May 9, 2024, we went on a **tour** of the **Honeybee Robotics** facilities in Pasadena. We saw how our experience can be generalized to a career.
- In August 2024, we **reached out** to Honeybee to ask if any of their **engineers** would like to **mentor us**.
- Lily was and she comes once a week!
- It's great to have someone with real **industry experience** help us improve our bot.

KINGS & QUEENS SCRIMMAGE

We were invited by Kings and Queens to attend a scrimmage hosted at Monrovia High School on January 17th. Unfortunately, because our **school was closed** due to the **Eaton Fire**, we were **unable to access our robot** and we couldn't attend.

TAKEAWAYS

- It's great to **share our knowledge** with younger generations
- Don't be afraid to **reach out** for assistance and **be receptive** to feedback

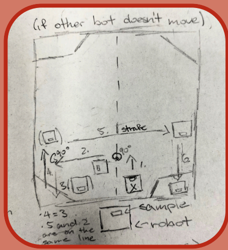
DESIGN PROCESS

Overview:
Our team uses a **goal-oriented** and **iterative** design process that allows us to quickly achieve functionality while still being able to constantly make improvements to different components of our robot.

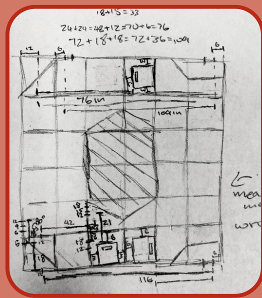
9/10/24

STRATEGIZING

Analyzing the point distribution and our **projected capabilities** for this season, we mapped out a strategy that would give us the most consistently high score. The strategy we chose determined our **goals and priorities** for designing each of our robot's components.



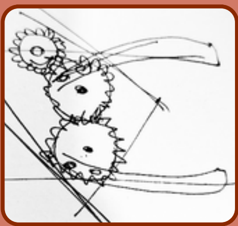
Diagrams of auton strategies

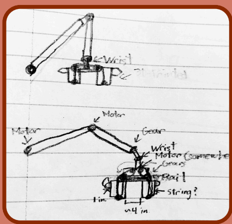


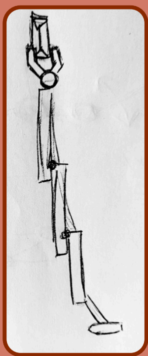
BRAINSTORMING

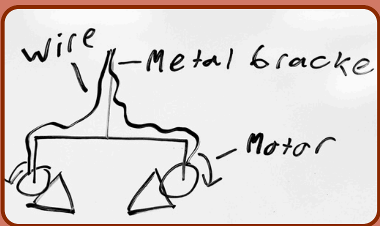
9/13/24

- Decided that our strategy was to hang specimen and reaching level two ascent
- With our mentors, we brainstormed possible methods of collecting specimens, each designed to **address functional goals**.









We ranked our ideas in terms of how well they met our **goals of functionality** with a weight decision matrix.

1-low 5-high Preliminary Ranking

Requirements	Claw	Squeeze	top roller	Side rollers	tripod
robust to orientation	2/5	4	3	5	5
speed	2	3	4	4	2
ease of creating	2	5	5	4	
ease of using	3	3	4	4	

9/19/24

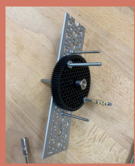
CALCULATIONS

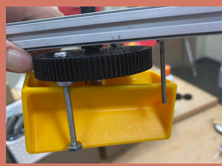
- We made various calculations to optimize the efficiency of each component of our bot. W
- Checked that our materials and motors would be able to withstand the **necessary forces:**
  - pulling the specimen down
  - holding up the robot for ascent.
- We calculated what the **torque exerted by our linear actuator** was, and if that is enough to carry the full weight of our completed robot.

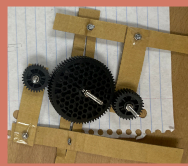
9/17/24

PROTOTYPING

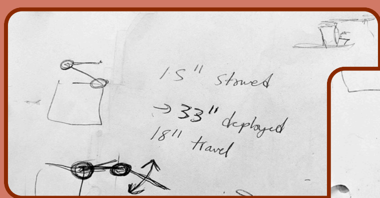
- Split into groups to create prototypes of the **highest-scoring collector** ideas.
- Worked on the **first iterations** of the lift, drivetrain, and hanger.
- We tested our ideas efficiently, and select a final design for the collector.

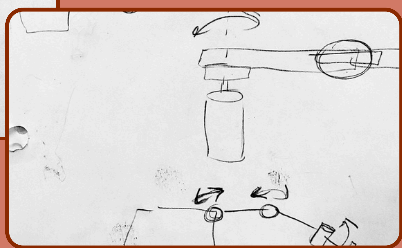






These prototypes allowed us to test the **concepts of motion** in our ideation, such as converting rotational motion to linear motion.





9/24/24

TESTING

We tested each prototype either on the robot or through hooking it up to a battery without any external components. This process allows us to finalize decisions on **design alterations** and on which prototype should be **fully integrated** into the bot.

DESIGN PROCESS

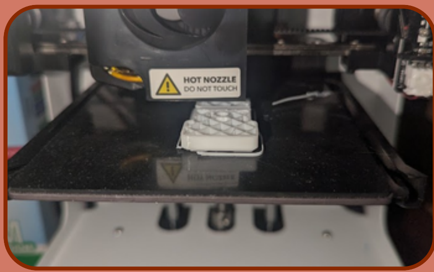
After the initial brainstorming and building, our design process involved **more iteration** to bring us closer to our goals, with **major redesigns** to nearly every component of the robot. The flexibility of completely shifting methods was beneficial to improving our gameplay significantly.

-- Part Two --

10/9/24

CAD AND 3D PRINTING

- Began CAD on OnShape of finalized design of **drivetrain and lift**
- Designed and attempted to print **custom pins** for rotating collector (ran into issues with our 3D printer)
- Use mini printer to **create spacers** and test new design of belt-driven lift

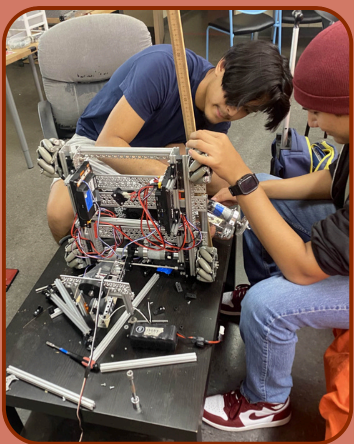


10/9/24

MEET 0 IMPROVEMENTS

Putting our robot into competition for the first time at Meet 0 revealed some **strengths** as well as some **major weaknesses** in our design of various components. We knew from this point what our **reiterations should focus** on, so we:

- Altered our **drivetrain** to prevent wheels from falling off (happened a lot)
- Rethought our design of the **collector** to improve efficiency
- Continued to test and make changes to the **hanger ("web shooter")** to prevent us from hitting the lower bar



11/10/24

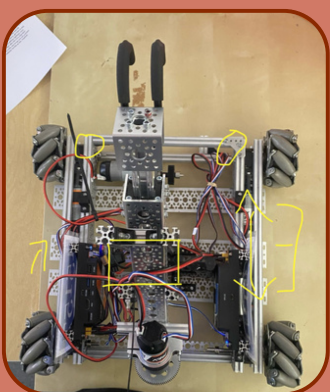
REDESIGN OF COLLECTOR

A major point in our design process was our decision to **pivot completely on our plan for the collector.** Looping back to the **prototyping phase** for this component, we assigned members to:

- Put together and test new prototypes
- Consider how **compatible** different methods would be with **existing components** (such as the lift and collector arm)
- Discuss the **feasibility and efficiency** of implementing the different systems **this late in our season**

11/24 →

MOVING THINGS AROUND ... ALWAYS

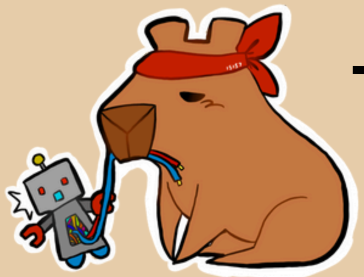


Every change to the robot, especially the new lift, required us to reconfigure the organization of our components, getting **everything to fit** and ensuring the **proper balance for ascent**.

This process will continue through the rest of our season as we **iterate** and **keep improving** our robot!

WHAT WE LEARNED:

- **Don't be afraid to make changes** late in the season if current systems aren't working well
- **Prototype and test**, prototype and test, prototype- make sure you know the best design before rushing into fabrication

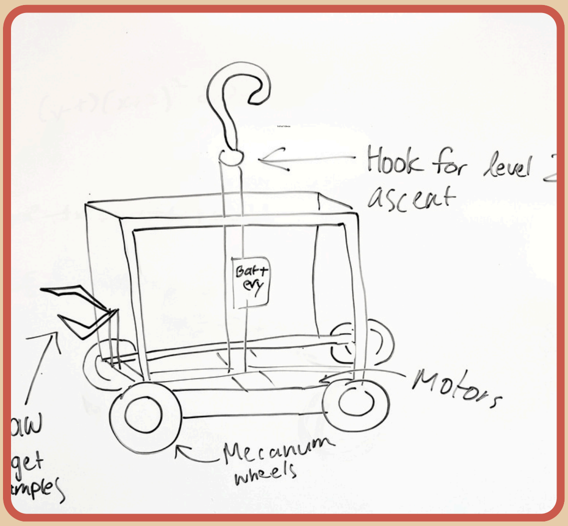


ROBOT CONCEPT

Goals

Our **main focus** in designing the robot was its **adaptability**, as we needed to be able to **iterate components** easily without dramatically setting back the overall **functionality**.

In designing the robot, we wanted to be adept at **scoring specimen on the trusses** while being able to reliably **achieve a level 2 ascent.**



Brainstorming

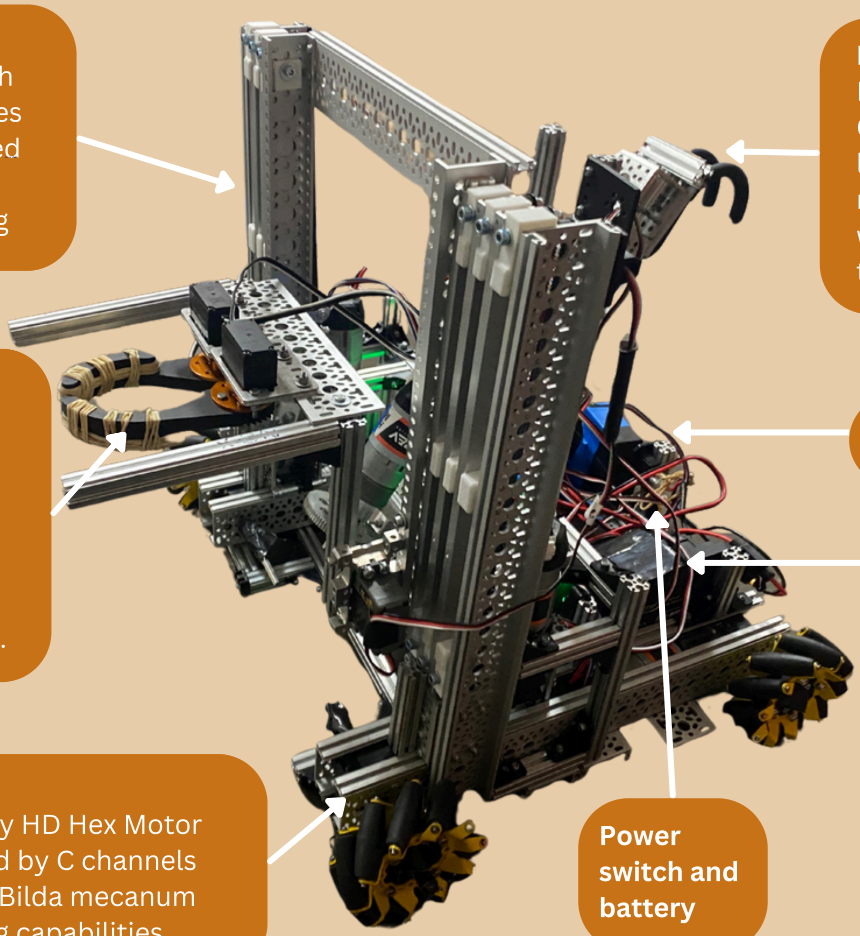
We split into groups to better **focus** on what we wanted to achieve with individual components

- Make a custom claw with triangular 3D printed pieces designed to fit into samples and specimen.
- Make the robot lightweight to hang easily.
- Use a lead screw linear actuator to make the ascension mechanism.
- Get new mecanum wheels for the drivetrain.

Lift
Custom lift built with 2-stage MiSUMi slides and small, 3D-printed spacers. Slides smoothly and strong

Collector
3D-printed claw attached to REV servos. Rubber bands tied on for grip. Can rotate 90 degrees to reach samples on the floor.

Drivetrain
40:1 Ultraplanetary HD Hex Motor drive base encased by C channels combined with GoBilda mecanum wheels with stafing capabilities.



Hanger
For level 2 ascent GoBilda lead screw linear actuator mounted at an angle with a hook attached to the top

Expansion Hub

Control Hub

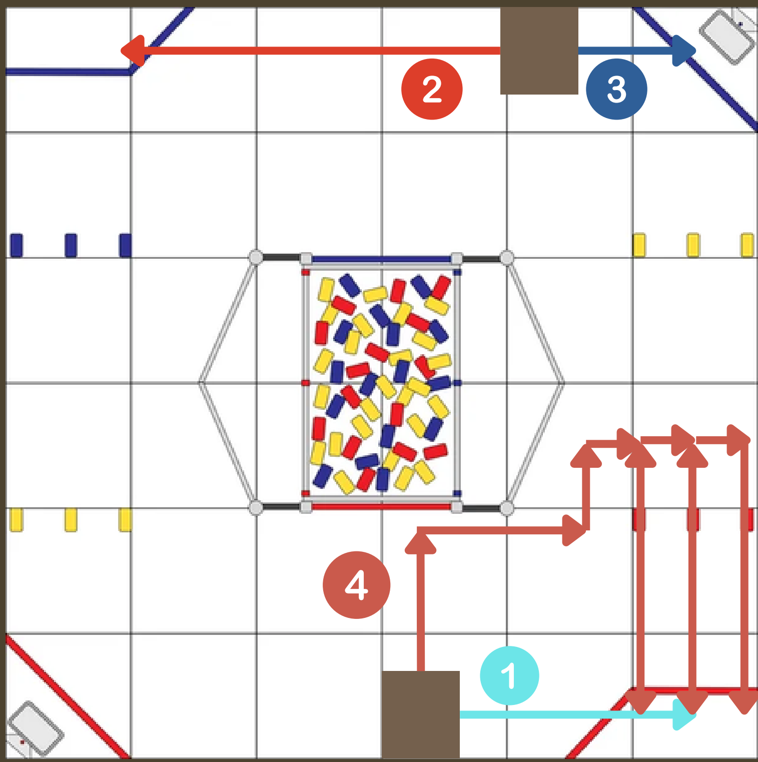
Power switch and battery

PROGRAMMING

AUTONOMOUS

We have four simple autonomous programs.

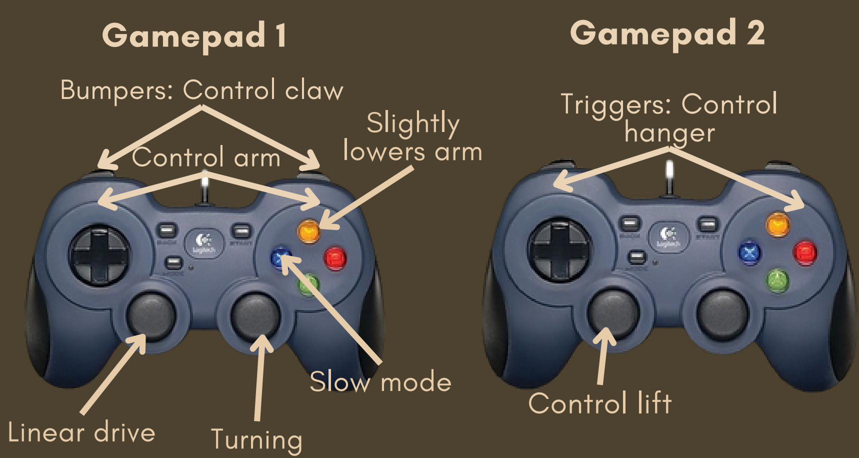
1. **Park in observation zone** (when starting close to observation zone)
2. **Park in observation zone** (when starting close to the net zone): **waits** a few seconds to allow alliance partner's robot to move out of the way
3. **Park in net zone** so preloaded sample is fully in the net zone; **prepares to score sample** in low basket during Tele-Op
4. Push the three alliance-specific **samples into the observation zone** and **park**. Allows all alliance-specific samples outside of submersible to be turned into specimen before Tele-Op begins



STRATEGY

- If alliance partner **scores samples**
  - Autonomous: Run autonomous 4
  - Tele-Op:
    - **Take alliance neutral samples** from other side, if possible, and give to alliance partner
    - **Score 5 specimens** in high chamber
    - If time permits, retrieve sample from submersible
    - Score **level 2 ascent**
- If alliance partner **scores specimens**
  - Autonomous: Run autonomous 2
  - Tele-Op:
    - Score as many **samples in low basket** as possible
    - If time permits, retrieve sample from submersible
    - Score **level 2 ascent**

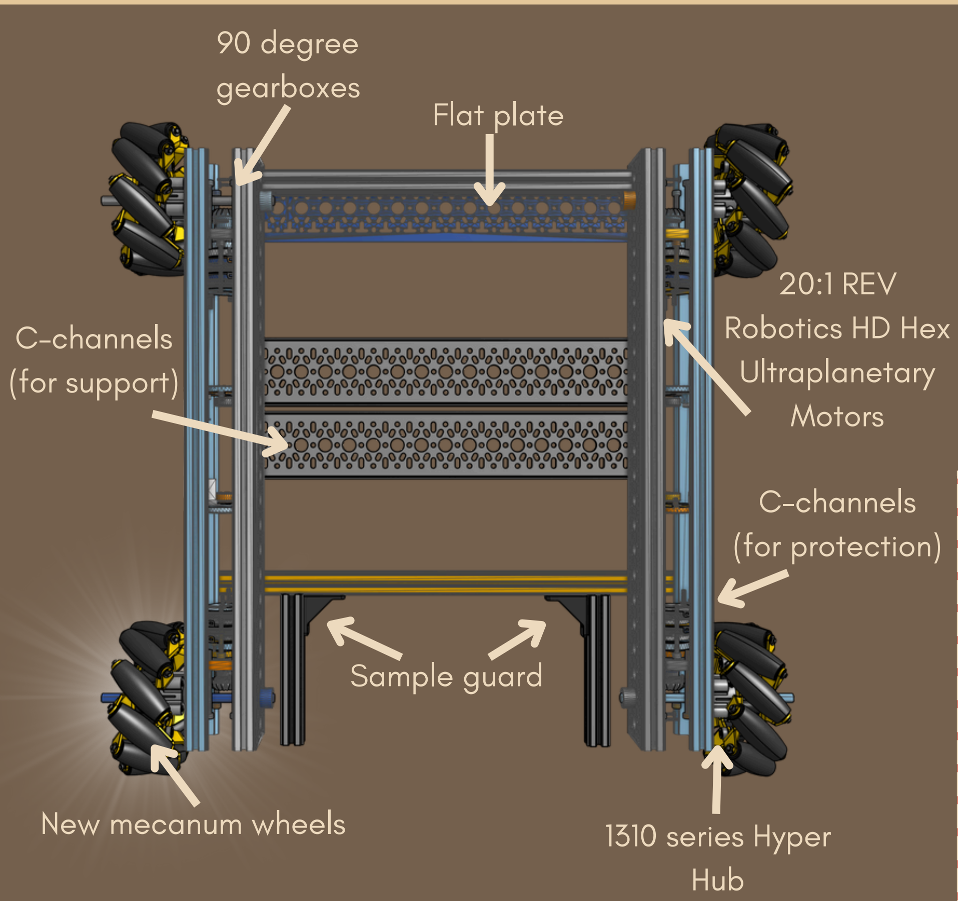
TELE-OP CONTROLS



- The arm has three **set positions** to make **operating** it **easier**: down (to pick up samples from the floor), up, and middle (to help snap the specimen onto the chamber)
- The claw has **preset** open and closed **positions**
- A **slow mode** allows the driver to make **fine adjustments** to robot position easily

DRIVETRAIN

Component Overview: Our goal for the drivetrain this season was to create a reliable chassis that takes up a **minimal amount of space; is modular, reliable, easily fixable/alterable; and, most of all, durable**. To achieve a fast and reliable drivetrain, we utilized GoBilda mecanum wheels (that enable "strafing") driven by 20:1 REV Robotics HD Hex Ultraplanetary Motors with 90 degree gearboxes. These motors, sandwiched between REV "C channels" create a sleek design that protects the motors from harm. To give the drivetrain better structural integrity, we attached two C-channels and a flat plate at the bottom. The front has short extrusions that let the robot push samples around and prevent them from getting stuck under the robot.

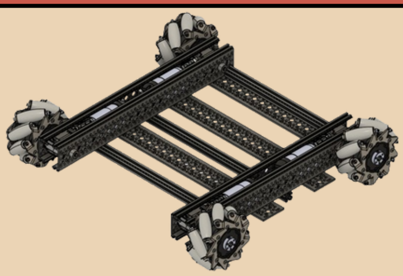
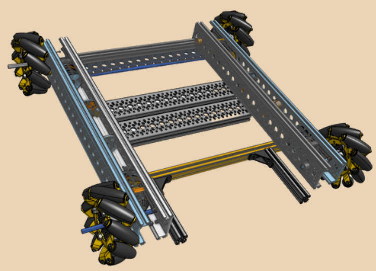


Design Goals:

- Needs to **support** the weight of other components
- Must have **sufficient space** to attach lift and hanger
- Smooth and **accurate driving** controls
- **Light** enough for ascent

Lessons learned:

- In the future, we should try to think of what problems could arise before meets and design preventative measures
- Tape can be very useful in a scramble
- Test more to make sure that the drivetrain will hold up.

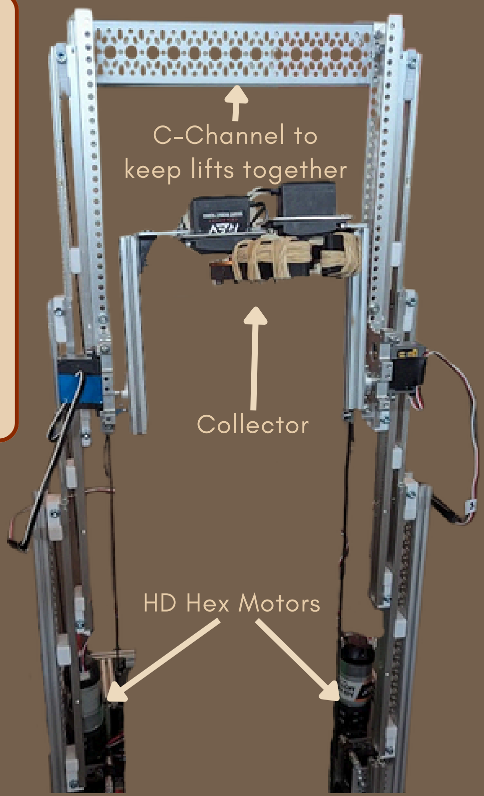
Original Drivetrain	Improved Drivetrain
 • Old mecanum wheels • **Unreliable** shaft collars that often got loose and allowed the wheels to fall off • Flexible flat plates on the bottom could bend, compromising the structural integrity • Game elements could get stuck underneath	 • New mecanum wheels • **Reliable** axle hubs that **securely** clamp axle • Rigid C-channels provide **strong structure** and base for hanger • Added sample pusher and guard to prevent samples from getting stuck underneath

LIFT

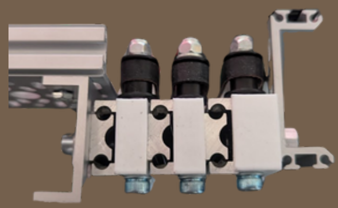
Component Overview: Our vertical lifts are each composed of three two-stage MiSUMi aluminum slides, 3D-printed spacers, and various goBilda and REV parts. Both are actuated by a belt and REV HD Hex Motor with a 20:1 Ultra-Planetary Gearbox. The lifts are attached to the chassis at the front of the robot, one on each side. Each lift has a servo attached that actuates the arm our collector is attached to.

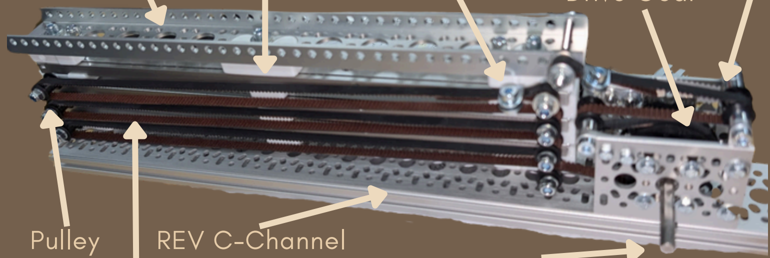
Design Goals

- Move smoothly
- **Consistent and robust** – no sudden failures
- Strong enough to snap specimen onto chamber
- Able to extend at least to high chamber and low basket



Top View of Slides





In previous years we've only used linear slides made from REV extrusions for linear motion, but these always had problems. This year, we bought MiSUMi slides to make our lifts smoother. We initially actuated them with string, however, there were several problems. Taking inspiration from the goBilda Viper Slides, we decided to actuate our slides with a belt instead of string.

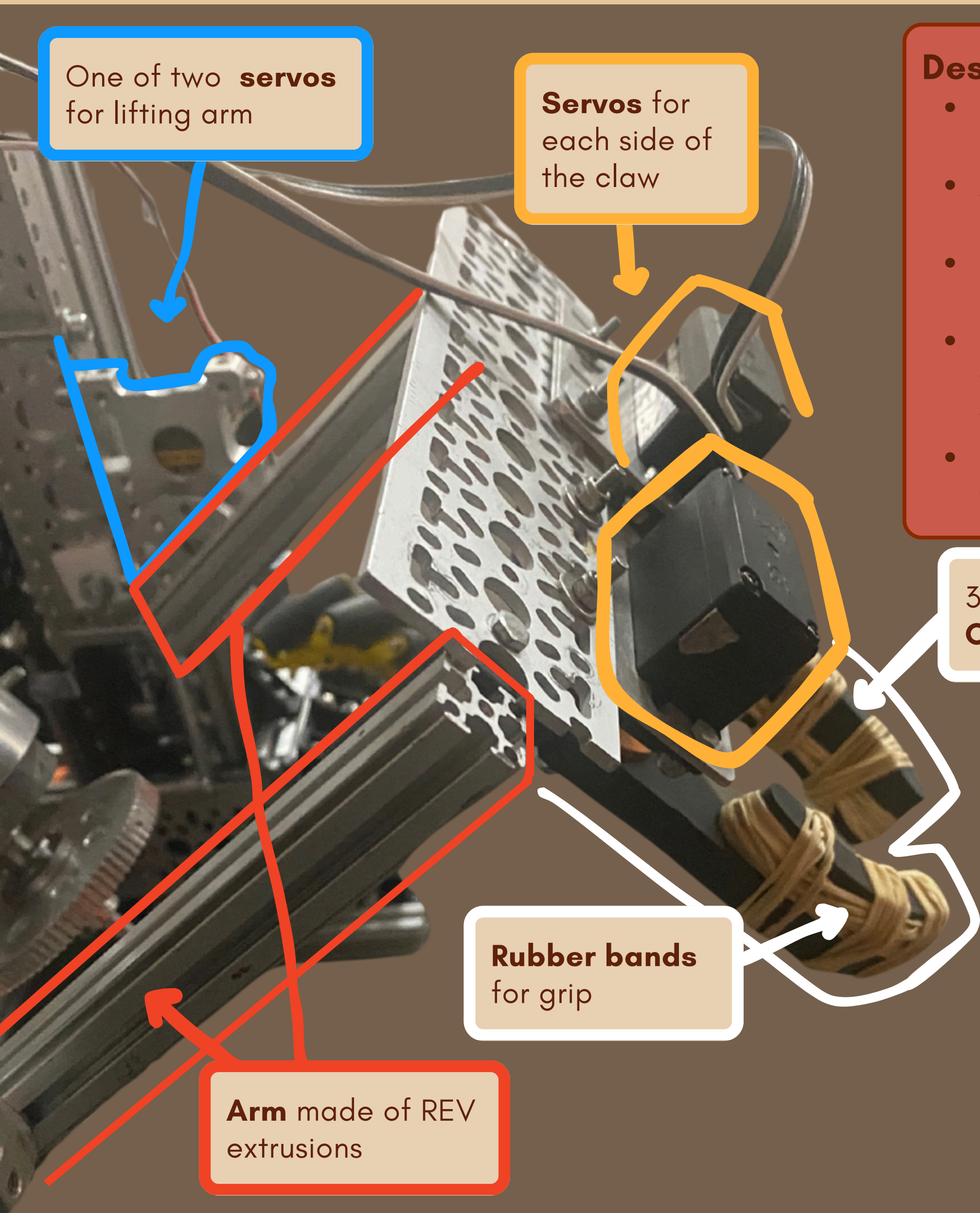
The lift went through a long design process. We initially wanted to use two 3-stage slides, but we realized the 2-stage slides were easier to connect and using 3 of those reached the height we wanted. Our school's 3D-printer wasn't working, so one of our members had to use their tiny personal 3D-printer to print our spacers.

Previous Lift (Oct-Nov 2024)	Current Lift (Dec 2024-Present)

Problems:
• **String-driven**
  ◦ Difficult to keep string tension consistent between both slides
  ◦ Only driven up; relies on gravity to retract so **too weak** to snap specimen onto chamber
  ◦ Not robust – often has sudden mechanical **failures** (end caps popping off, string slipping off of pulleys and/or spool)
• One 3-stage slide: **barely reaches** high chamber; can't reach low basket
	Solved problems of previous design:
	• **Belt-driven**
	  ◦ Belt tension is easy to adjust
	  ◦ Driven up and down; **strong** enough to snap specimen onto chamber
	  ◦ Very **consistent** – no sudden mechanical failures
	• Three 2-stage slides: **Easily reaches** high chamber and low basket

COLLECTOR

Component Overview: Our collector is currently a 3-D printed claw with separate sides each controlled by its own servo. The collector is attached to an "arm"--two extrusions which are controlled by servos that are in turn attached to our vertical lift. The collector can pick up samples from the floor as well as specimens from the wall.



Design Goals

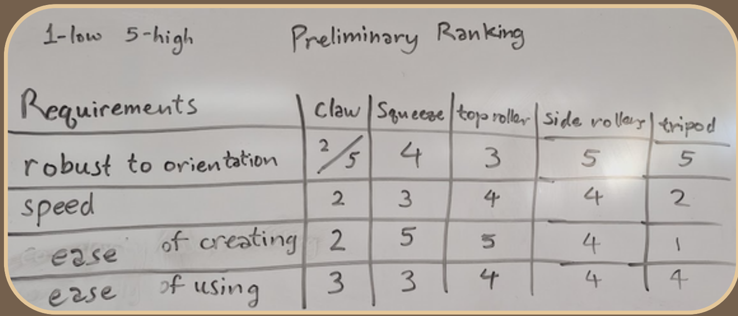
- **Robust** to position and orientation of samples and specimens
- Able to maintain vertical orientation of specimens
- **Durable** enough to snap specimens onto chamber
- Capable of picking samples off the floor and specimens off the wall because of the arm
- **Quick** with **simple controls** to use time efficiently

Previous Collector (Oct-Nov 2024)	Current Collector 1st iteration (Dec 2024)	Final Collector (Dec 2024-Present)

• Two fixed pins and two rotating pins (described on next page)
• **Not** very **strong**
• Required **precise positioning** to pick up sample
• Clip on specimen made it **difficult to pick up** from the floor
   ◦ **Couldn't pick up** specimens from wall
	• **3D-printed claw**
	• Powered by **one servo**
	   ◦ Claw had gear pattern
	Problem:
	• **Claw** often **disengaged**
	• **Couldn't hold specimen securely** enough to snap onto bar
	• **Stress** causing servo brackets to bend
		• Same **3D-printed claw**
		• Each side powered by **individual servo**
		   ◦ **Strong** and **reliable**
		• Each servo connected by two flat servo brackets to **prevent bending**
		• Rubber bands for **extra grip**

COLLECTOR EVOLUTION

We spent the longest time brainstorming our collection mechanism, scoring each design by considering **how to handle the variable orientation of samples, ease of building a design, ease of operating a design, etc.**



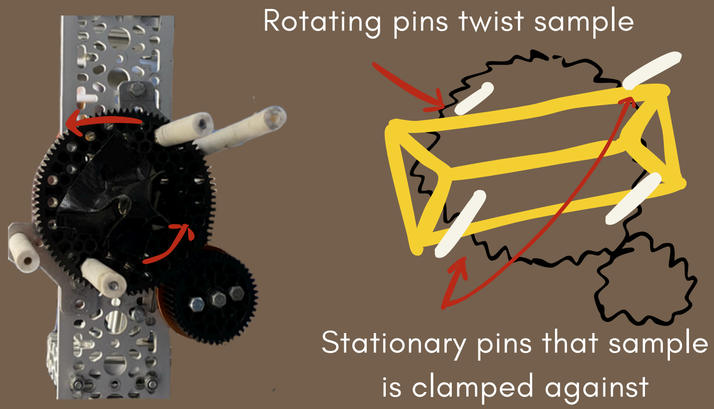
1-low 5-high Preliminary Ranking

Requirements	Claw	Squeeze	top roller	side rollers	tripod
robust to orientation	2/5	4	3	5	5
speed	2	3	4	4	2
ease of creating	2	5	5	4	1
ease of using	3	3	4	4	4

Iteration #1: **Spinny Thing!**

- **Two pins on a gear** actuated by a servo, **two on a flat plate**
- **Lowered over a specimen** while pins are aligned
- **Rotating pins clamp specimen** against stationary pins on plate

This was intended to be the **most robust to orientation**, as the pins just needed to be lowered to rotate the sample to the correct position. We decided this design would be optimal for **both hanging specimen and reaching into the submersible.**



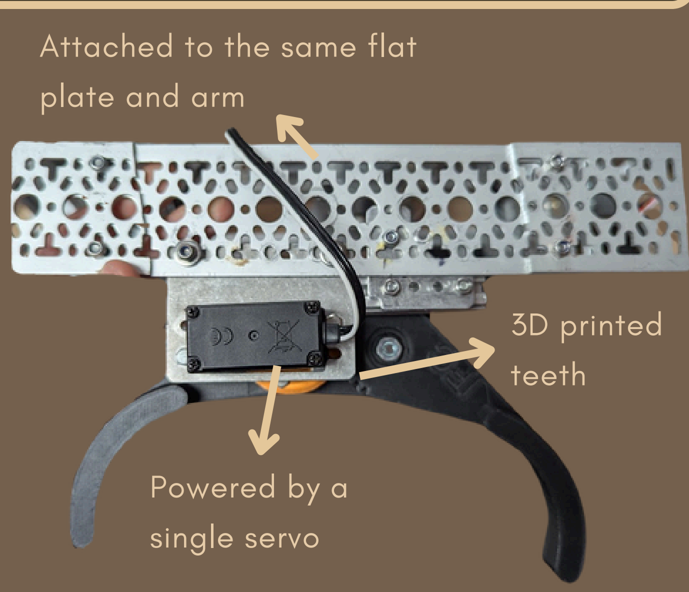
But in practice...

- Much more difficult to position while driving than predicted
- Very inefficient, time consuming

Iteration #2: **Single servo claw!**

We needed something **simple and reliable** to replace our ineffective collector, and we needed it **fast**. We found some **3D-printed claws** originally designed for a different challenge and decided to **repurpose** them, as we've always had a very **limited amount of resources** and find ways to **reuse** parts across seasons.

- Interlocking teeth on each claw
- Thin claws slide into place on sample, taking advantage of triangular shape
- Much easier for the driver to position, especially because we can pick specimen up from wall



But...

- Gear teeth would often **disengage** when hanging specimen
- One side of claw would stop moving

Iteration #3: **Final collector!!**

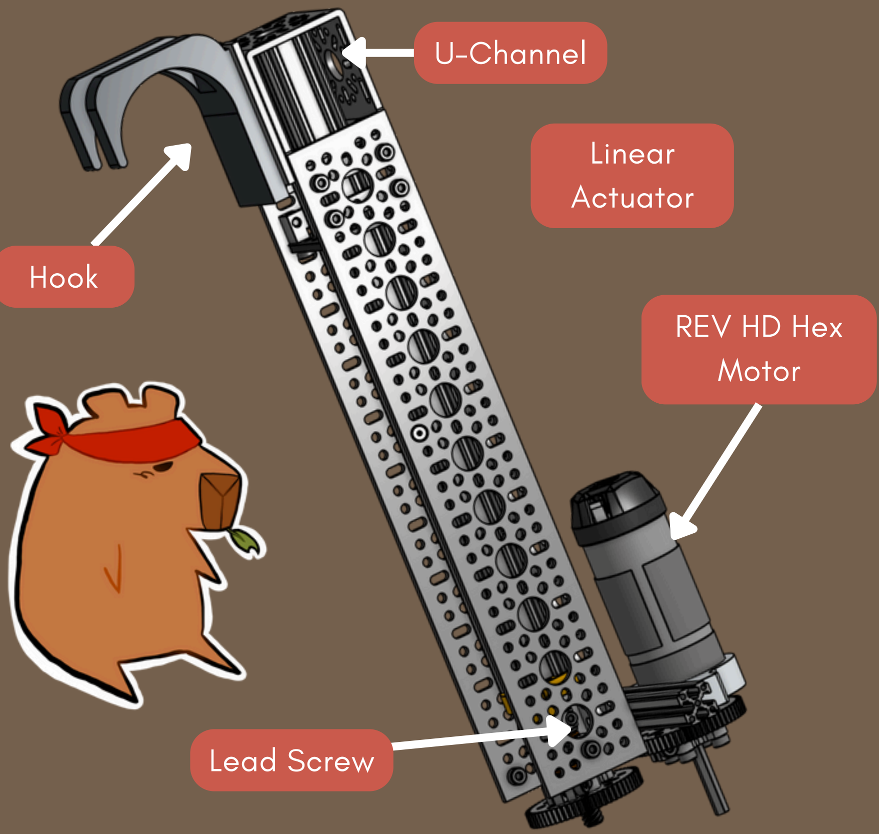
- **Independent servos** for each claw
- Rubber bands to **improve grip**

After careful testing and lots of practice, it has become one of the most reliable parts of our robot.

ASCENSION: THE "WEB SHOOTER"

Overview

To allow our robot to ascend the submersible in the endgame, we have a hook attached to a lead screw linear actuator in the middle of the robot. It is placed at a specific angle to provide **optimal height** and weight distribution while staying within the 18x18 limit. We have nicknamed this mechanism the "**web shooter**".

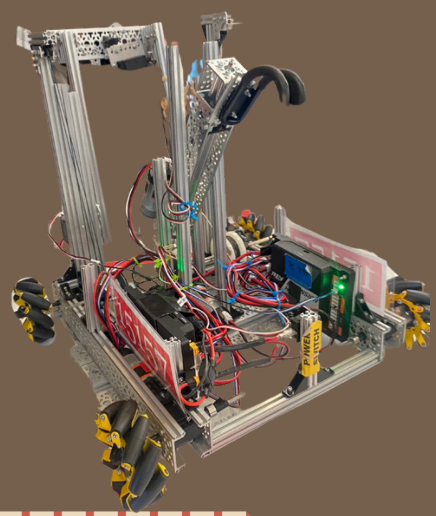


TIMELINE

- Brainstorming ideas that have been used in the past to lift itself. Came up with a design using a lead screw.
- Testing different configurations of attaching the screw to the rest of the robot.
- Adding attachments such as gears motor, and a hook.
- Fixing the web shooter on to the robot and testing the angle and height of the placement.

Design Goals

- Able to reach tall heights
- Lightweight and compact
- Able to lift at least 45 pounds
- Reliable and consistent



Challenges

- To **ensure** the robot would hang without touching the floor we went through many **different angles** and positions on the robot
- To **prevent** the hook from **rotating**, we attached it to a small U-channel with **two points of contact**. The easiest way to line it up made the hook crooked, unfortunately.
- The crooked hook made it likely that one side of the robot would touch the floor, so we straightened the hook, making our ascent much **more consistent**.
- Since the final robot is pretty heavy, we added screws that go all the way through the U-channel the hook is attached to **prevent bending**

Lessons learned:

- Plan the interplay and **balance** of weight between different components of the robot early on
- Best way to **"stress test"** is to do **calculations**

THANK YOU!

We are so proud of everything we've accomplished this season: creating a great robot, **growing** as a team, and **pushing through** the tragedy that was the **Eaton Fire**.

This all would have been far more difficult without the **support** of our leadership, teachers, and parents, to whom we would like to give a sincere **thank you**.

HONEYBEE ROBOTICS

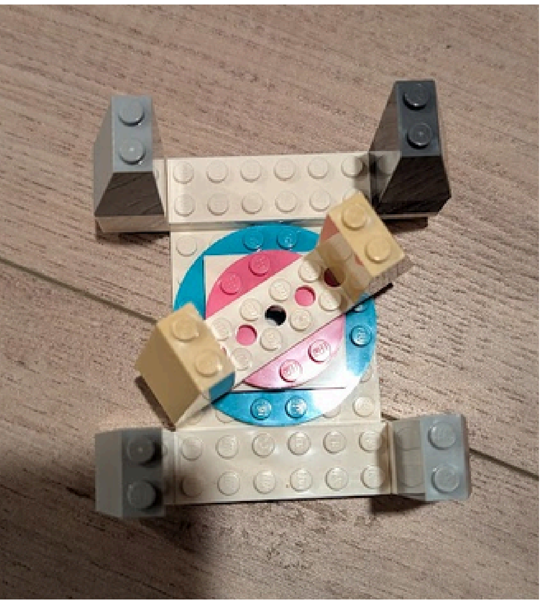
Lily

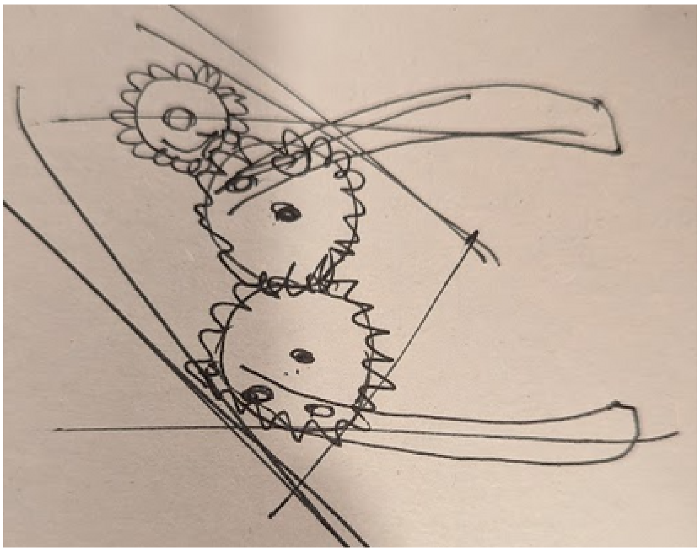
Mr. Marestaing

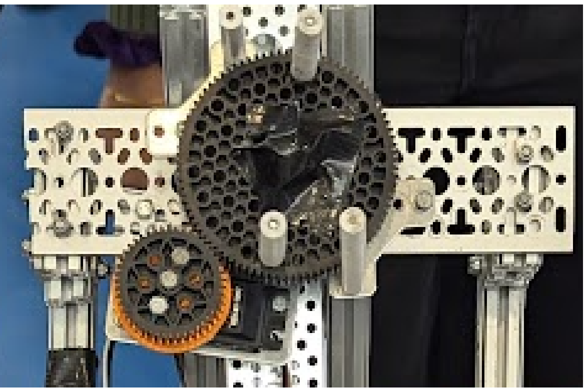
Ms. Orret

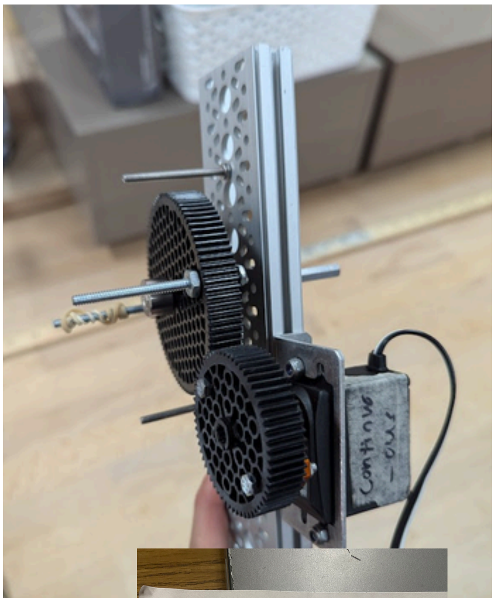
Pasadena EDUCATIONAL FOUNDATION

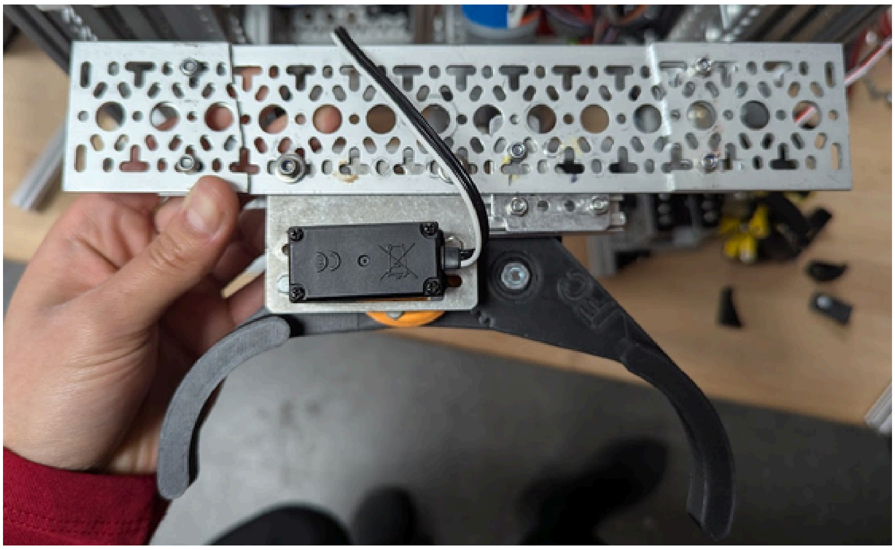
We also want to give a big thank you to our mentors: **Ms. Orret**, **Mr. Marestaing**, **Matthew**, and **Lily**! Thank you to **Team Curiosity** for helping us review our portfolio, and thank you to the **Sierra Madre Middle School Teams** for letting us practice on their field.

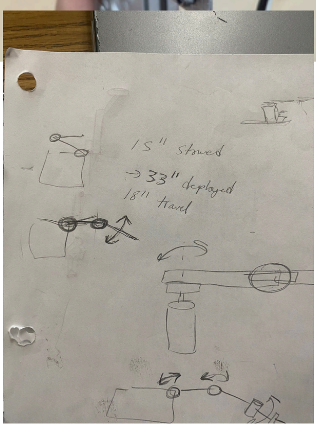


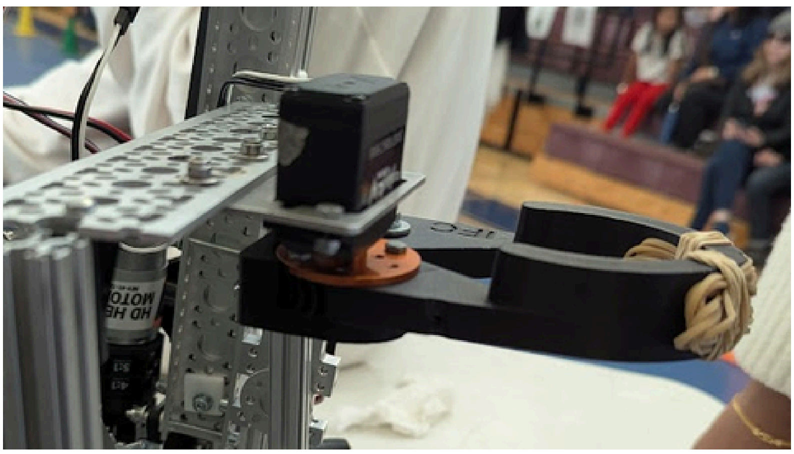




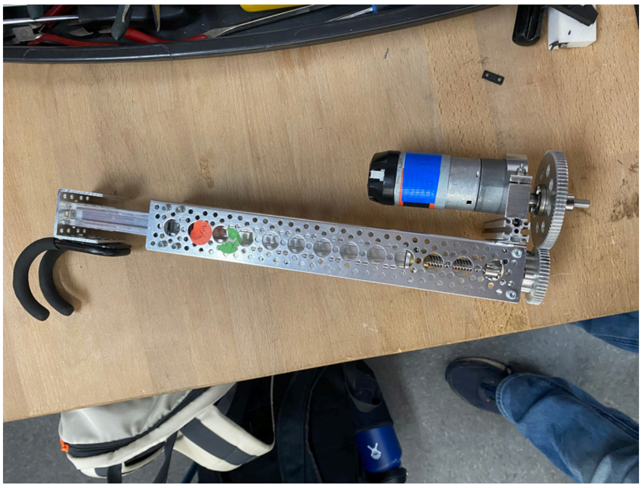
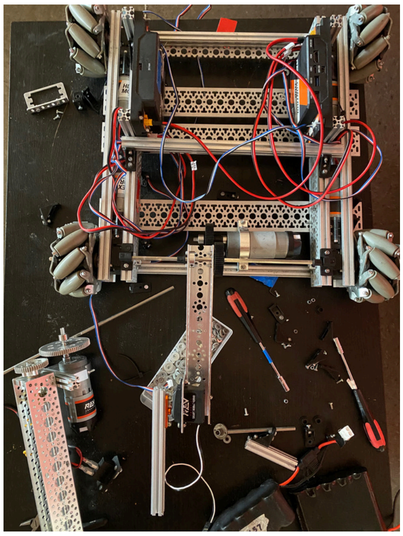
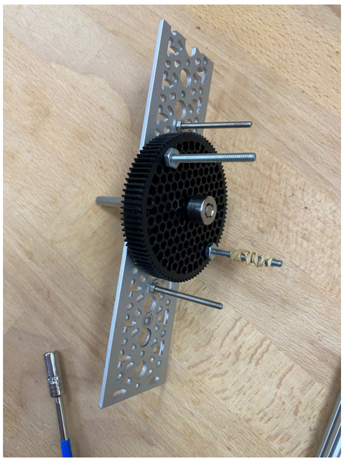
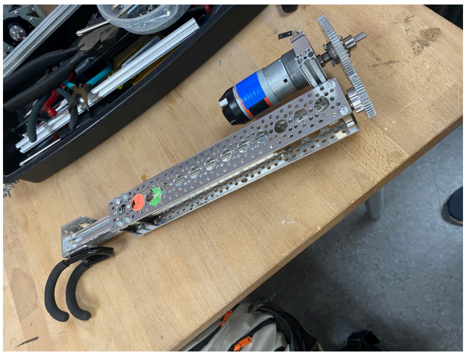
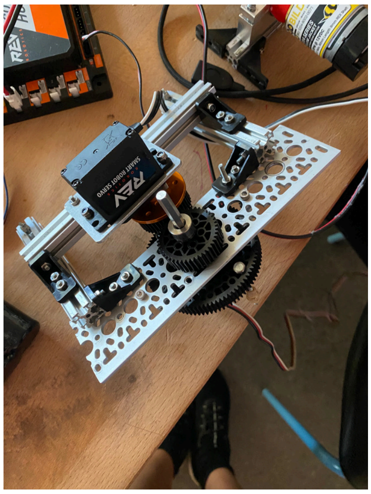
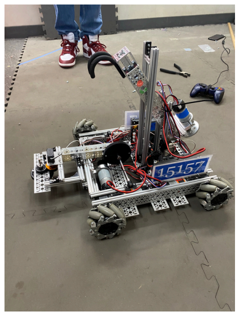
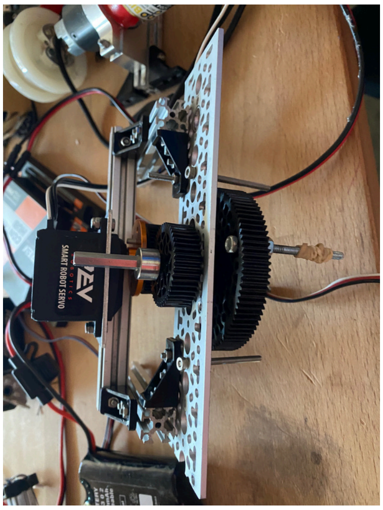
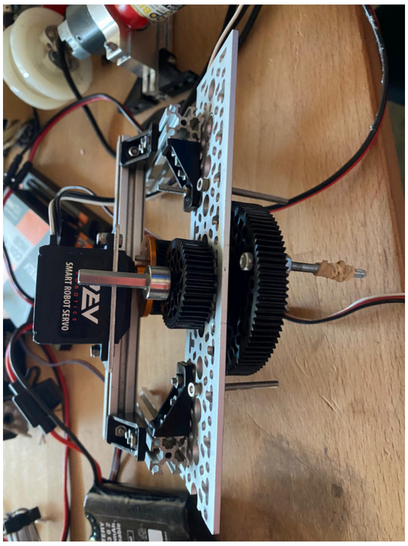








[LINK TO TIMELINE WITH PICTURES](#)









SMART ROBOT SERVO

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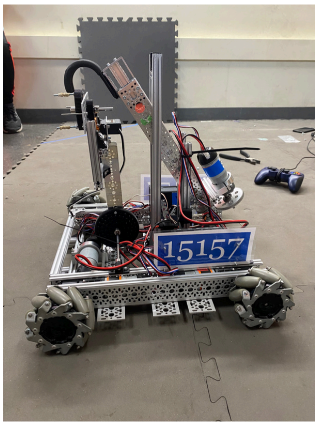
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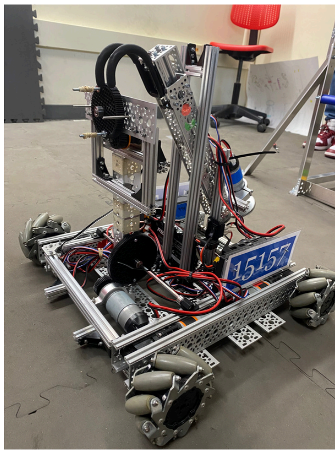
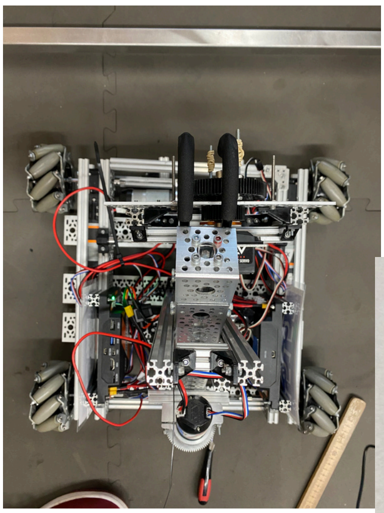
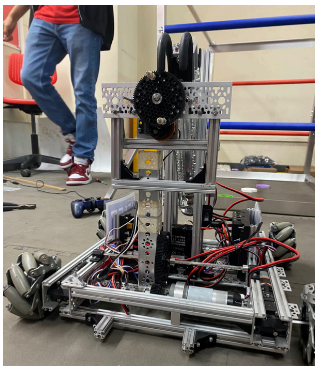

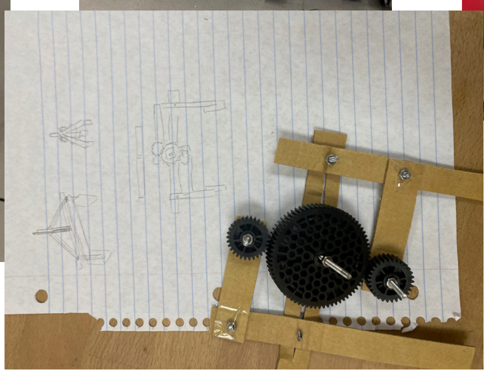


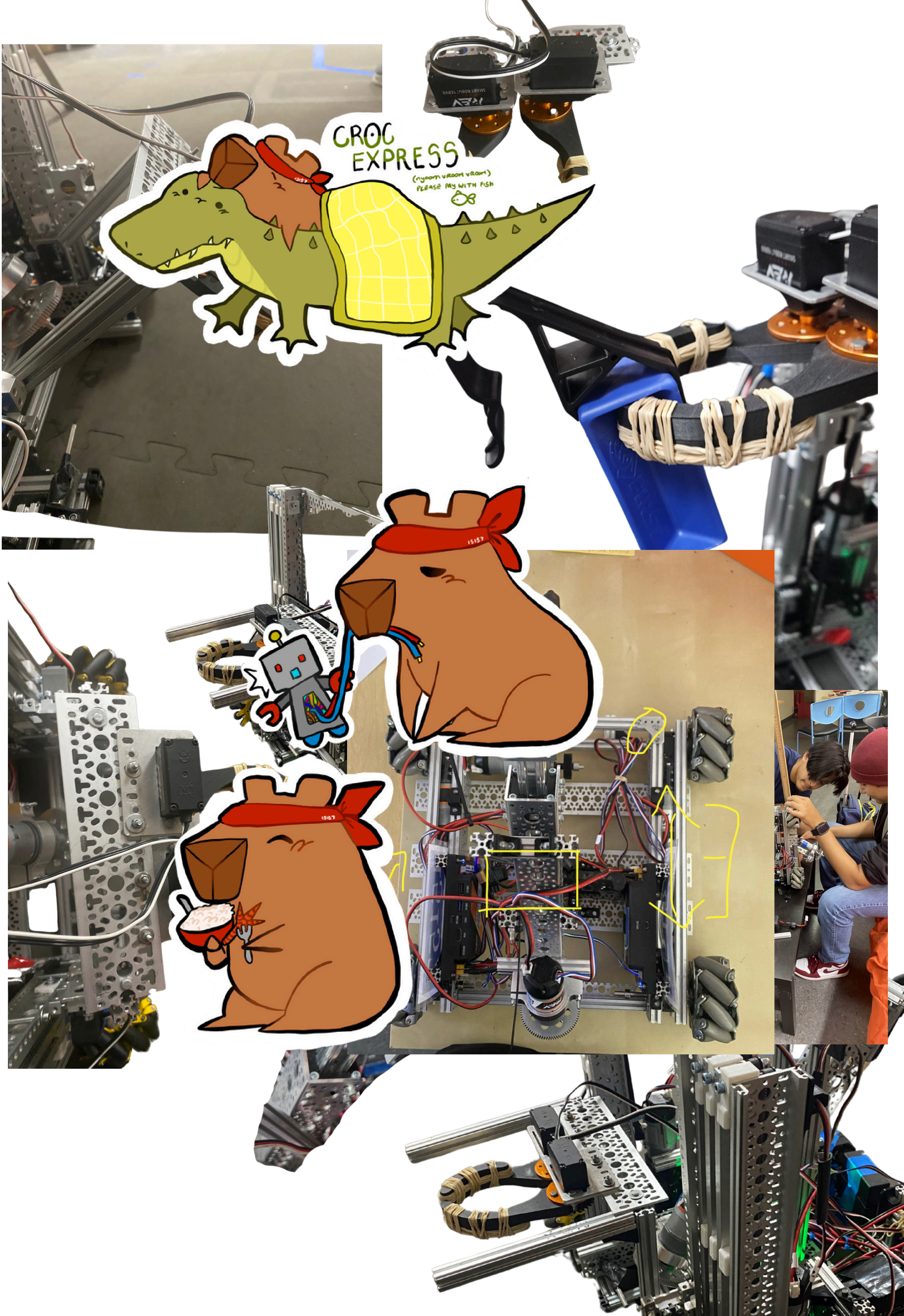
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