ENGINEERDS

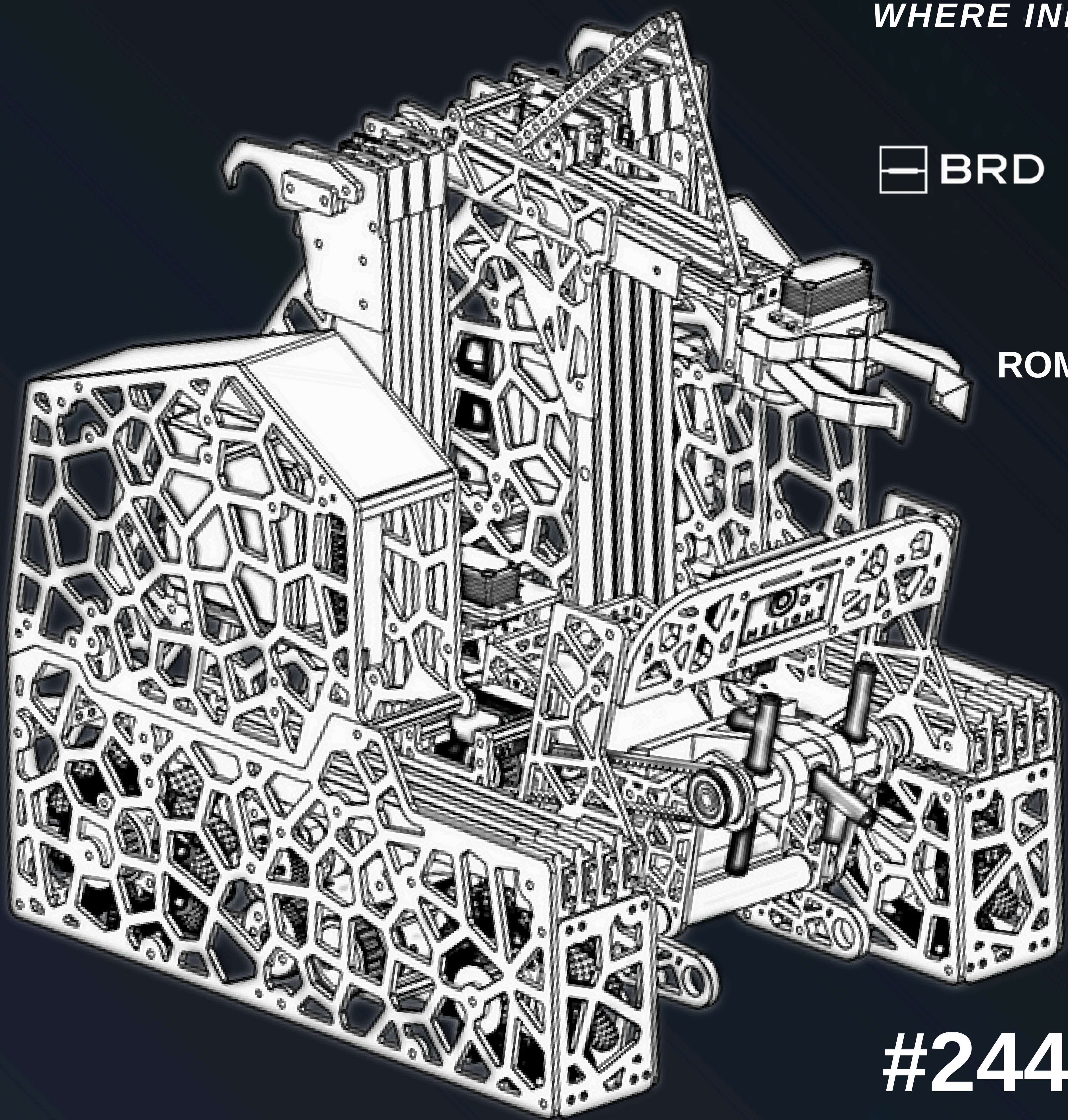
WHERE INNOVATION METEETS COMPETITION

BRD | FIRST TECH CHALLENGE ROMANIA | NAȚIE PRIN EDUCAȚIE | INTO THE DEEP

2024-2025 - SEASON #9

ENGINEERING PORTFOLIO

ROMANIA NATIONAL CHAMPIONSHIP



#24478

@cnrgengineerds

@engineerds_ro190

@engineerds24478

@engineerds

"RADU GRECEANU" NATIONAL COLLEGE

SLATINA, OLT, ROMANIA

MEET OUR TEAM

ENGINEERDS #24478

EngiNeerds #24478, is a FTC team from “Radu Greceanu” National College, in Slatina, Olt county, Romania. The team is composed of **17 members**, from 9th to 12th grade, each bringing a stack of knowledge that helps us become better versions of ourselves each day, collaborating as a team. This is our second year in FIRST Tech Challenge, paving the way for more **STEAM** education. This year, we look forward to not only excelling in competitions, learning from mistakes, and promoting **STEAM** values in our community, but also cultivating a clearer perspective on the vast and ever-evolving world of technology.

LUȚĂ DAVID
Leader,
Hardware Lead
3D Designer
In-Game: Driver

DUMITRESCU ROBERTO
Programming Lead

PRICA RAREȘ
Hardware

UNGUREANU EDUARD
Hardware

VELCEA FLORINA
Marketing & PR

OLANU GABRIEL
Hardware
3D Designer
In-Game: Human Player

POPA ANDREI
Hardware
In-Game: Driver

PÎRVU MIHNEA
Programmer
In-Game: Coach

STANCA ROBERT
3D Designer

DOBRE IZABELA
Marketing & PR

ELISEI BIANCA
Marketing & PR

NEDEIANU OANA
Marketing & PR

RĂUȚĂ ȘTEFAN
Programmer

RAICEA RAREȘ
Hardware

BĂLĂȘOIU LUCA
Programmer

CIUBOTARU ANDREI
Hardware

BĂRBUIA MARIA
Marketing & PR

ALIN DUMBRĂVESCU
Mentor

ANDA DUMBRĂVESCU
Mentor

SUSTAINABILITY

ENGINEERDS #24478

As a team that operates independently, we work hard to fund ourselves through **sponsorships**. We do this by putting our best effort into everything we create and by sharing our passion for **STEM** with our community. Through our dedication, we build **meaningful connections** with sponsors and supporters who believe in our mission.

OUR SPONSORS

PIRELLI · ARTROM · decora DESIGN · AS COMPUTER · Popas Sport · Agrobionics · delta aluminium · SCI GROUP · OVIDIU P. GORAN CABINET DE AVOCAT - ATTORNEY AT LAW · TTWSports club · Total Srl · FARMACIA ADONIS · MARIPOSA · Carmin Popstar Prod · MATRA · WAGRAMER TERMO 2000 · S.C. BEBE TRANS ROM S.R.L. · CONTUR TECH · Pandipo · CAPHYON · vimetco extrusion · mimDragon ADVERTISING

VASILE C I S.R.L. MAXIMGREEN SAT SRL COSULTING S.R.L. MAXIMGREEN SAT S.R.L. ANIL CONSTRUCT S.R.L. NEW ALTERNATIVE AFFAIRS - TOURISM CIUBOTARU N. VASILE - DIRIGINTE DE ȘANTIER

FINANCES

PIRELLI - 5.000 RON
DELTA ALUMINIUM - 2.500 RON
POPAS SPORT - 10.000 RON (hot meals accorded to the team members)
VIMETCO EXTRUSION - 10.000 RON
"OVIDIU P. GORAN" ATTORNEY'S OFFICE - 750 RON
MARIPOSA - 5.000 RON (the equipment for competitions - T-shirts and Hoodies)
MIMDRAGON – 1.000 RON
CARMIN POPSTAR PROD – 25.000 RON
PANDIPO - 650 RON (Pastry food accorded to the team members when going to meets)
AS COMPUTER - 1 laptop
CONTUR TECH - Aluminum plates and components of the robot
ARTROM - 5.000 RON
AGROBIONICS - 25.000 RON

TOTAL: 89.900 RON

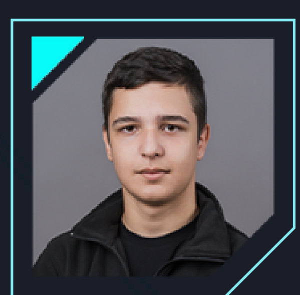
TRAINING NEW MEMBERS

We needed to find a way for them to gain **experience** in building, designing, and programming before officially joining the team as members. Thus, **volunteering** is the first stage of entering a team, in which you **learn**, **adapt**, and **integrate** effectively within the team. This is the stage where you gain experience and knowledge to eventually become a reliable member of the team. Another way to become a volunteer is if you were previously part of the team but can no longer dedicate enough time to actively support it. In this case, more **engaged** volunteers step in to take your place, ensuring the team's **continuity** and **success**.

Căpățână Elena
Featuring in the future in Programming

Nica Elena
Featuring in the future in Marketing & PR

Cîrstina Daniel
Featuring in the future in Hardware



Marinescu Andrei
Featuring in the future in Hardware

Cuje Cosmin
Featuring in the future in Hardware

Cimpoieru Elisabeta
Featured in Marketing & PR

Pîrvu Mihaela
Featuring in the future in Marketing & PR

OUTREACH

Spreading LEGO Robotics

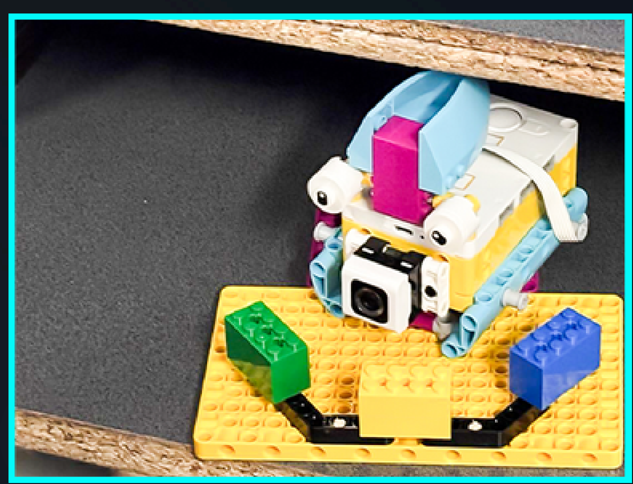
ENGINEERDS #24478

We've grown so much thanks to the **mentorship** and **sponsorship** we've received throughout our time in **FIRST**. Since not every team has the same experience or access to these resources, we use **outreach** to help bridge that gap and share the **opportunities** that have helped us succeed.

LEGO WORKSHOPS FOR CHILDREN

We have made the commitment to support the local community by offering an ongoing, engaging initiative designed for children passionate about **STEM**. Every Sunday, our team convenes in the laboratory, guiding the children as they explore and develop their talents in **mechanics** and **programming**, fostering creativity and problem-solving skills for their future, all while building **LEGO** robots, having **almost 20 meetings** up until now.

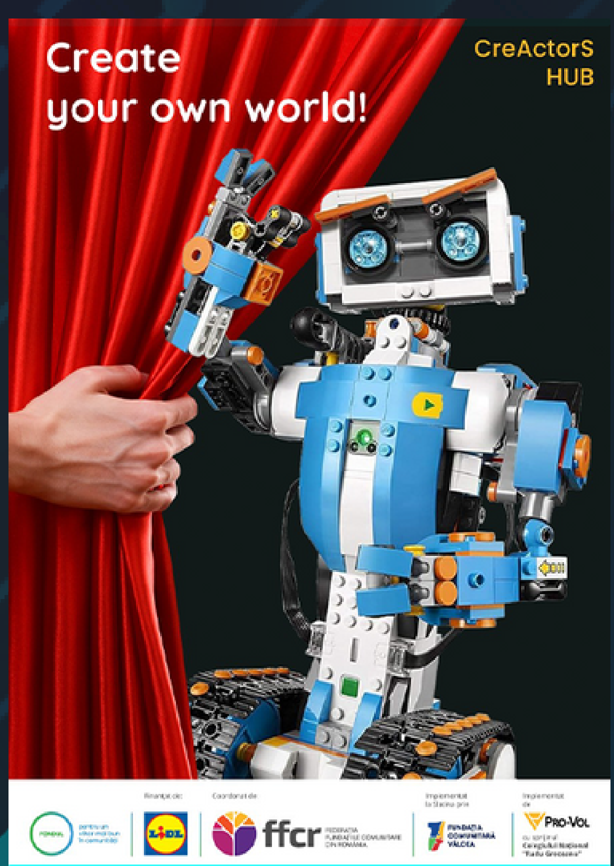




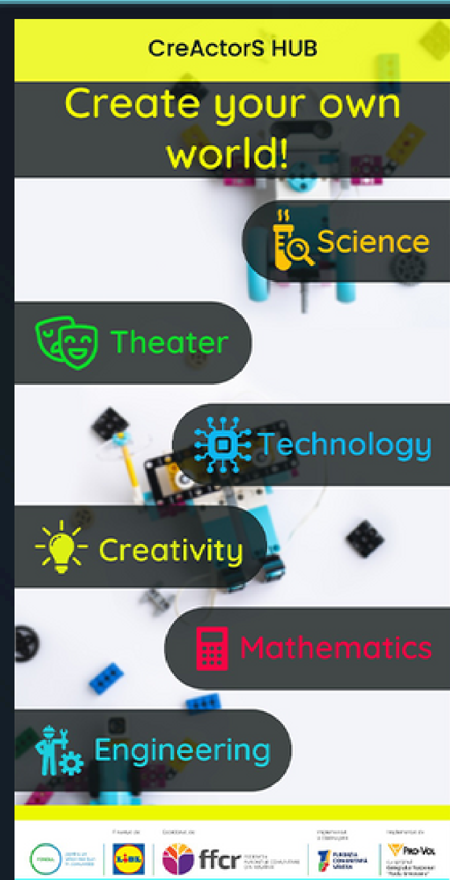

LEGO ROBOTICS EDUCATION IN UNPRIVILEGED AREAS

This project is an educational initiative implemented in partnership with the **Vâlcea Community Foundation** and sponsored by **LIDL.** We aim to organize robotics sessions for children in rural schools in Olt County and to bring **STEM** closer to students through active and hands-on learning sessions. The sessions will be organized at our headquarters, "Radu Greceanu" National College, for children from neighboring localities as well as those from Slatina. Additionally, at the end of the project, each participant will receive a volunteer diploma in recognition of their active involvement, acknowledging their **effort** and **enthusiasm** for learning new things and contributing to the success of this initiative. This is an excellent opportunity to support the educational development of future generations and to **learn** alongside **children**.

"CREACTORS HUB" ACTIVITY



We created an activity for both **robotics** and **theatre-passionate** people, in order to integrate **STEM values** into the arts by using LEGO robots as **actors** in theatrical performances that illustrate traditional stories. By designing and programming robots to play key roles in these plays, we blend **creativity** with **engineering**, encouraging problem-solving and innovation. With LIDL's support, this approach not only makes STEM education more accessible but also highlights how **technology** can preserve and reimagine **cultural heritage** for new generations.



FIRST TECH CHALLENGE ROMANIA | INTO THE DEEP | 2024 SEASON #9 2025 | ORGANIZATOR NAȚIE PRIN EDUCAȚIE | PARTENER FONDATOR BRD GROUPE SOCIETE GENERALE

OUTREACH

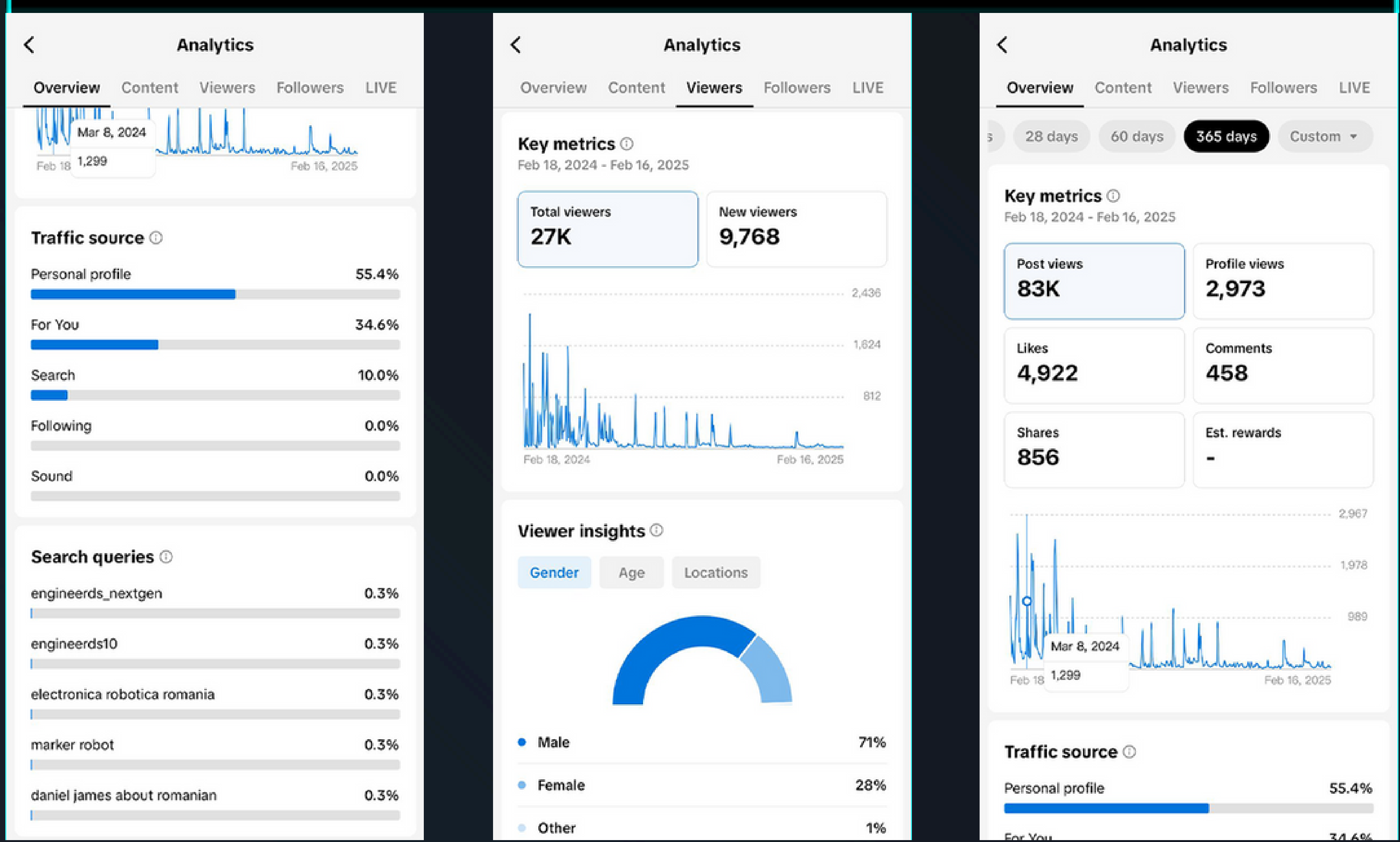
Connecting to the Community

ENGINEERDS #24478

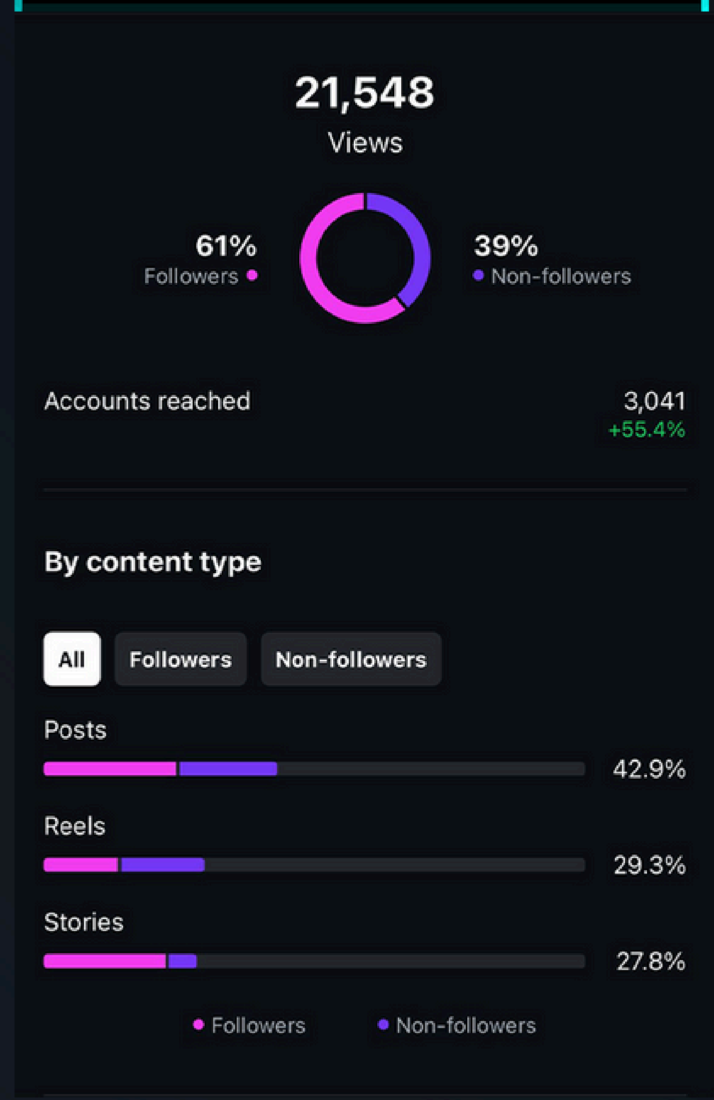
SOCIAL MEDIA

We leverage **social media** as a powerful tool to promote our robotics activities, engage with the community, and inspire the next generation of **STEM** enthusiasts. Through dynamic content, including the use of **memes** and other **comical content** related to First Tech Challenge and its hardships, we showcase our **journey** and **team spirit**. By sharing **educational posts**, **competition highlights**, and **success stories**, we foster **connections** with sponsors, partners, and aspiring young engineers. Our strategic use of platforms like Instagram, Facebook, and TikTok helps us amplify our impact, attract support, and encourage broader participation in robotics and **STEM education**.

TIK TOK STATISTICS



INSTAGRAM STATISTICS



THE "BOTCAST" PODCAST

The podcast took place biweekly alongside the **TechNova #12611** and **Mechanical Paradox #7182** teams in October 2024. It focuses on answering questions and sharing the most valuable **FIRST** experiences we've gained in our year of experience. Through the **Botcast**, we hope to build a community that we can help advance, just as we have done. Moreover, this podcast is an opportunity to collaborate with other teams, where they can ask questions, and connect with the overall **FIRST** community.

FTC DISCORD

Our members have maintained consistent communication with numerous teams on the official **FIRST Tech Challenge Discord server**. Through mutual collaboration, we have successfully built valuable connections with teams such as **AI Citizens**, **Cyllis**, **Tech Nova**, **Mechanical Paradox,** and **Solar Sparks**. We've also started a direct collaboration many people from the FIRST community, where we shared opinions about robot designs, odometry, and the ongoing season.

1382 Messages Since Kickoff

100 Members

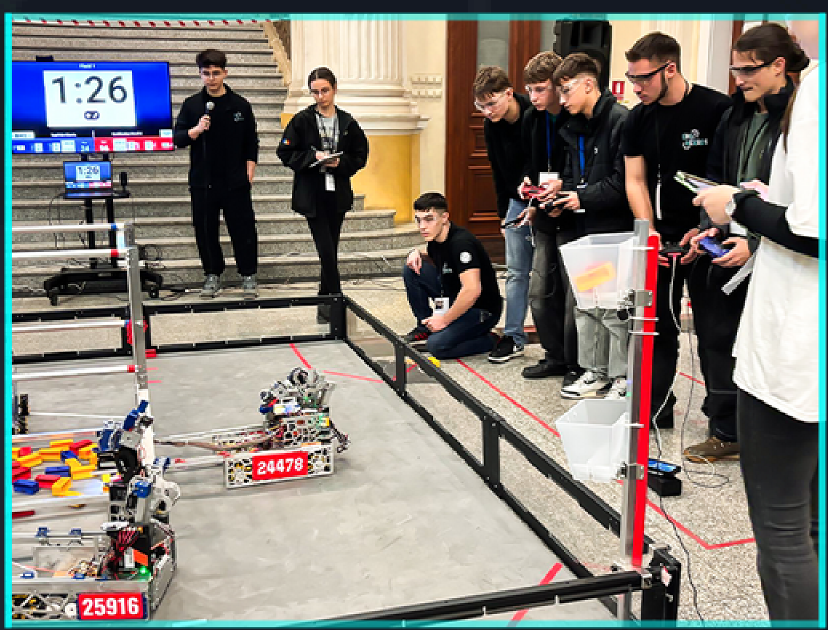
OUTREACH

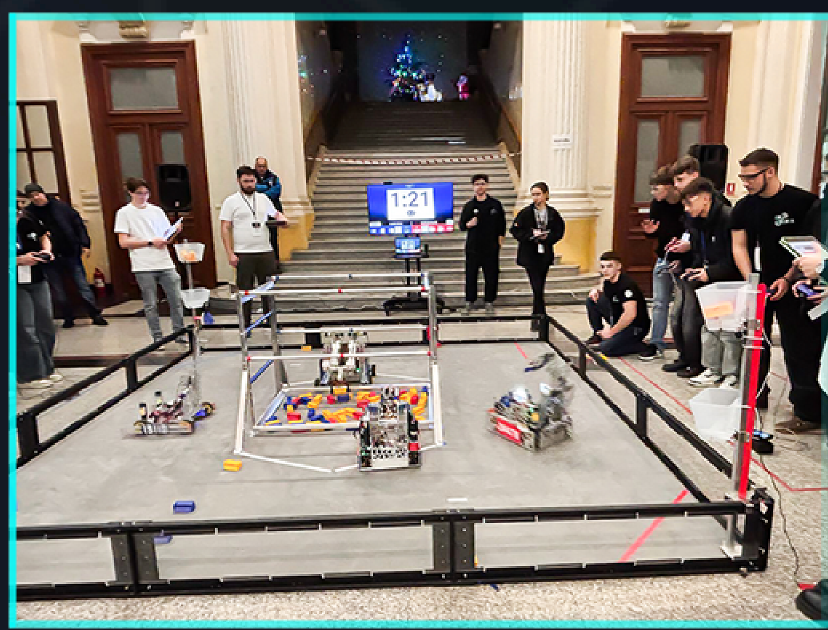
Connecting to the Community

ENGINEERDS #24478

TECHTIDE OLTENIA MEET

We hosted the **TechTide Oltenia Meet** (January 4th to 5th) at the University of Craiova. This event was one of our **goals** for this season, so we are honored to have organized an opportunity to contribute to the **growth** and **development** of the FTC in our region. We collaborated with our trusted partner, **SoftHoarders #12560**, and ensured the event's success.





MENTORING AND ASSISTING - 2 TEAMS

With the knowledge and experience in FIRST gained from our previous season, we proudly volunteered to mentor two rookie teams: **Solar Sparks #25871** and **EngiNeerds NextGen #25916**. Through this mentorship, we provided guidance on robot designs, offered advice on outreach efforts, and were always available to answer any technical questions they encountered. Globally, we've made efforts to help teams located even in **Kazakhstan** with ideas and knowledge.

PARTICIPATING AT "ORA DE EDUCAȚIE" BROADCAST ON OLT TV

We were honored to be invited to this **broadcast** twice, one time before the regionals and the other before the nationals, which features hardworking students, including Olympiad competitors, student council representatives from top high schools, and more. The show's mission is to promote **education**, **innovation**, and **personal growth** by encouraging open discussions about the guests' achievements. We had the opportunity to share our **journey** - how we discovered our passion for **robotics**, how our team was founded, and how it has grown over time. Additionally, we gave insight into how we welcome and support new members, helping them develop their skills and become valuable parts of our team.

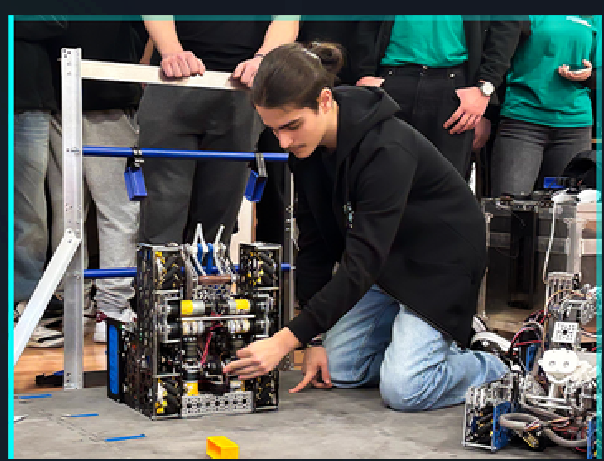
OUTREACH

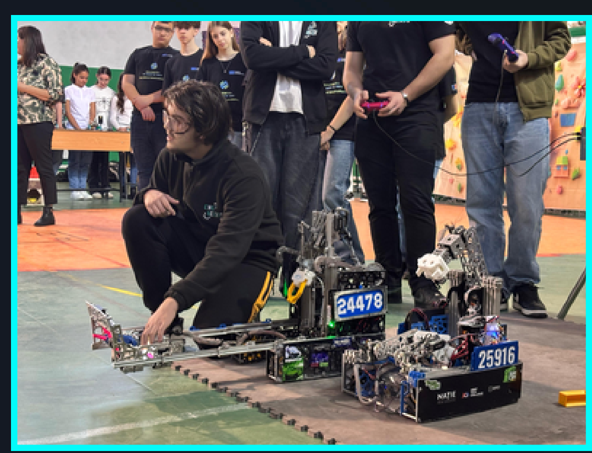
Motivating Students

ENGINEERDS #24478

PROMOTING OUR TEAM TO MIDDLE SCHOOLS

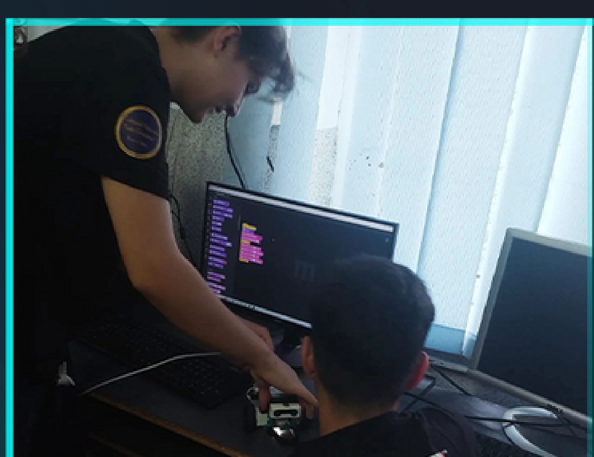
At this time, our robotics team had the opportunity to visit “Eugen Ionescu” and “Constatin Brâncoveanu” Middle Schools from our city, and share our passion for **STEM**.
We introduced the students to our team, explained how we designed and built our robot, and demonstrated its capabilities. It was exciting to see their **enthusiasm** and **curiosity** as they explored the world of robotics. Beyond **inspiring young minds**, this outreach also helps us connect with potential future recruits who might one day become part of our team and continue our mission of innovation!

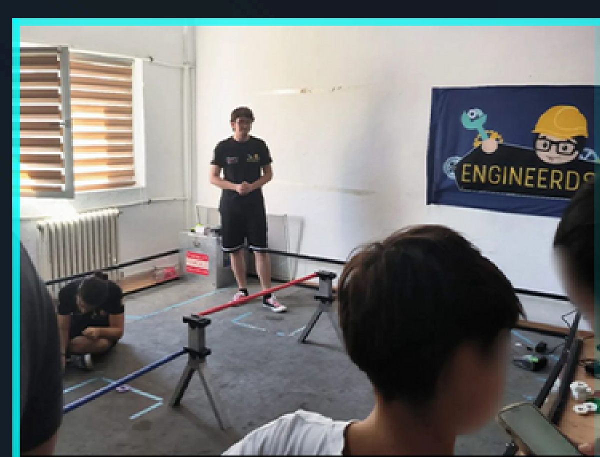




ENGINEERDS’ OPEN GATES ACTIVITY (AUGUST 2024)

Throughout **August 8-14 2024**, we organized an event in which we engaged with **children** of all ages through daily demonstrations of the team’s CENTERSTAGE robot. We actively showcased and communicated the core values promoted by **FIRST** and **STEM**, while aiming to inspire them to pursue careers in **technology** and **innovation**.
This activity was divided into **two parts**. The first one is for **young** children, for ages from 6 to 12, in which they have learned to built and program their own **LEGO robots**, and the second one is from **12 above**, in which our most experienced team members explained the **CENTERSTAGE** robot in great detail, offering a great view of what being an **EngiNeerds member** is like in order to attract new members to join our team.
Through this experience, we have reached over **80 individuals**, two of them now being motivated **rookies** in our team.





THE ROBOT

ENG NEERDS #24478

ROBOT AND DESIGN OVERVIEW

DESIGNING

Design the best solution in 3D. We use OnShape to create most of our designs, but also Autodesk Fusion 360.

STRATEGIZING

Research and brainstorm possible solutions

IDENTIFYING

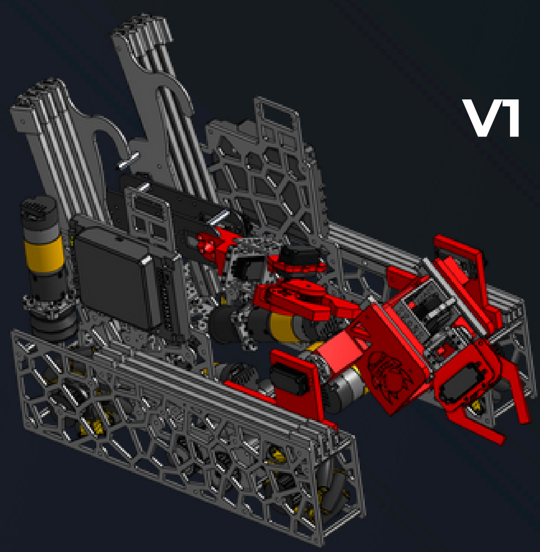
Identify the problem that needs to be solved/the objective

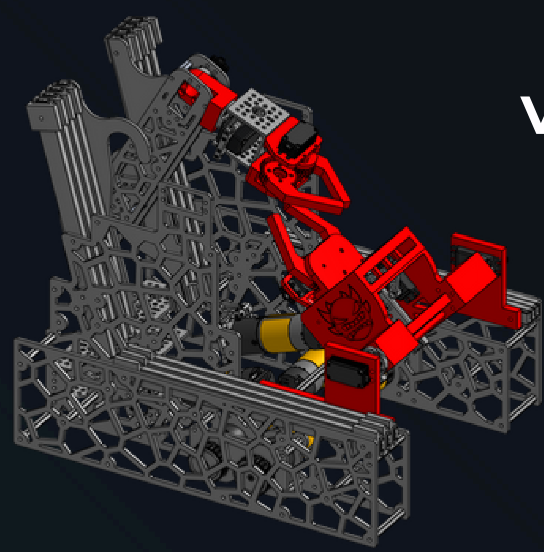
TESTING

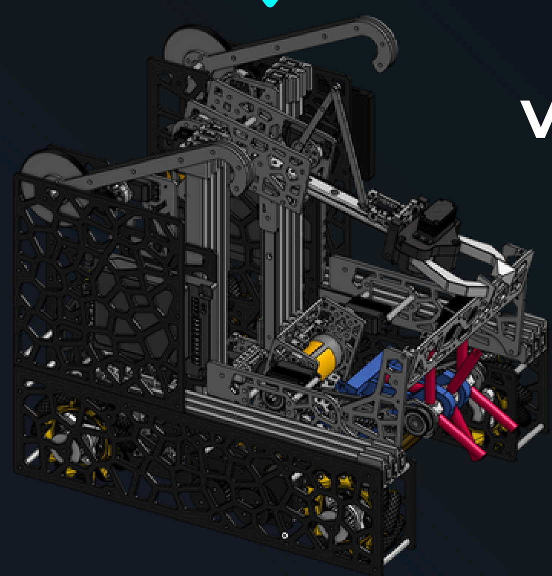
Print the designed parts and test them to see if they work. This is when we identify the main design's problems and ways to improve it

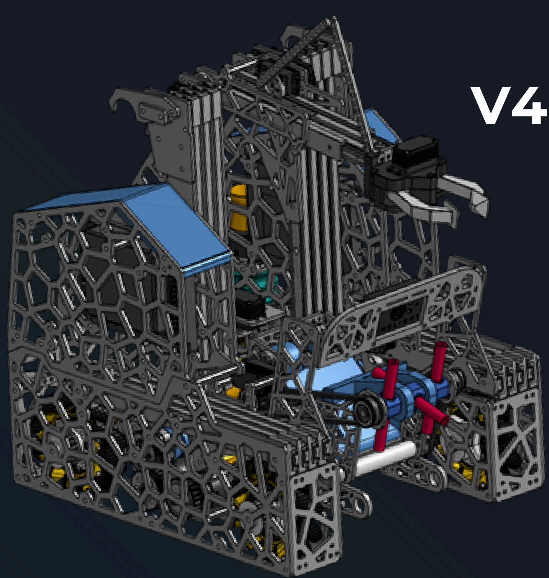
ITERATING

Test and improve the design based on the information gathered by research and testing









REASON FOR COMPLETELY REDESIGNING AND REBUILDING THE ROBOT (V3 - V4)

The reason for completely redesigning and rebuilding the robot is mainly because the past model did not fit the **hanging terms** properly, because of the exterior plates that were designed to be L-shaped, which did not allow the robot to slide over the first bar. We took this challenge as an **opportunity** to improve the robot overall, which is why we made the **chassis smaller**, so that the robot becomes **lighter** and, automatically, **faster**. This change also allowed us to add another pair of **Misumi SAR230 slides** to the **horizontal extension** system in order to increase our reach of **picking samples** from the submersible.

CUSTOM MANUFACTURING

This year, we decided to fully custom-manufacture our robot, utilizing industry-leading platforms like **CONTUR TECH**. By incorporating pocketed aluminum plates on as many structures as possible, we made sure our robot remains both strong and lightweight.

THE ROBOT

ENG NEERDS #24478

ROBOT AND DESIGN OVERVIEW

DESIGNING

Design the best solution in 3D. We use OnShape to create most of our designs, but also Autodesk Fusion 360.

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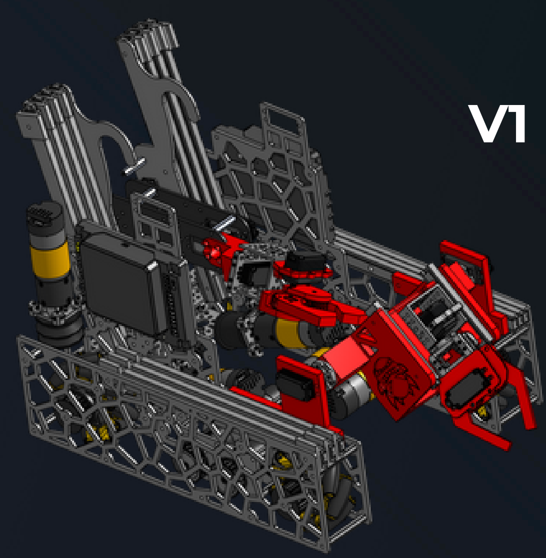
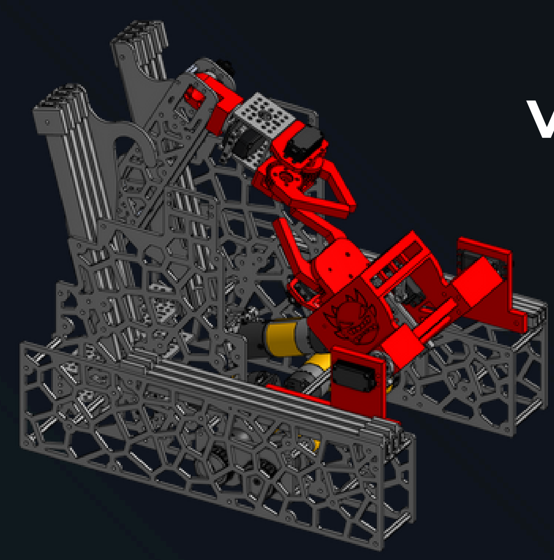
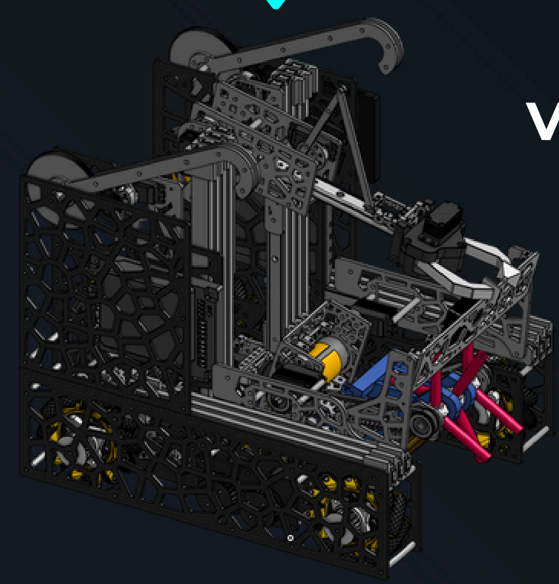
V1



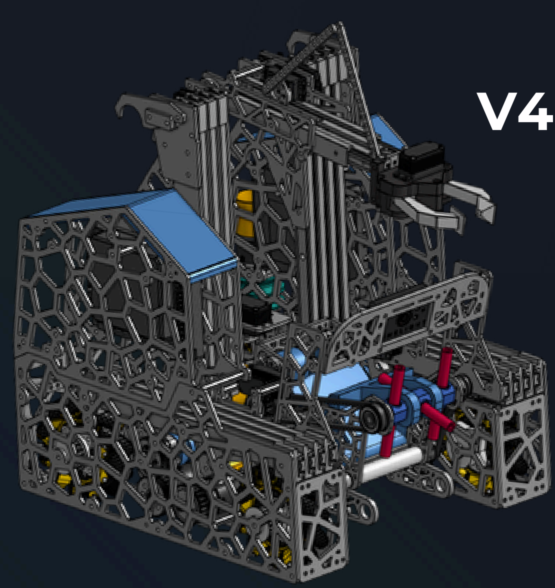
V2



V3



V4



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THE ROBOT

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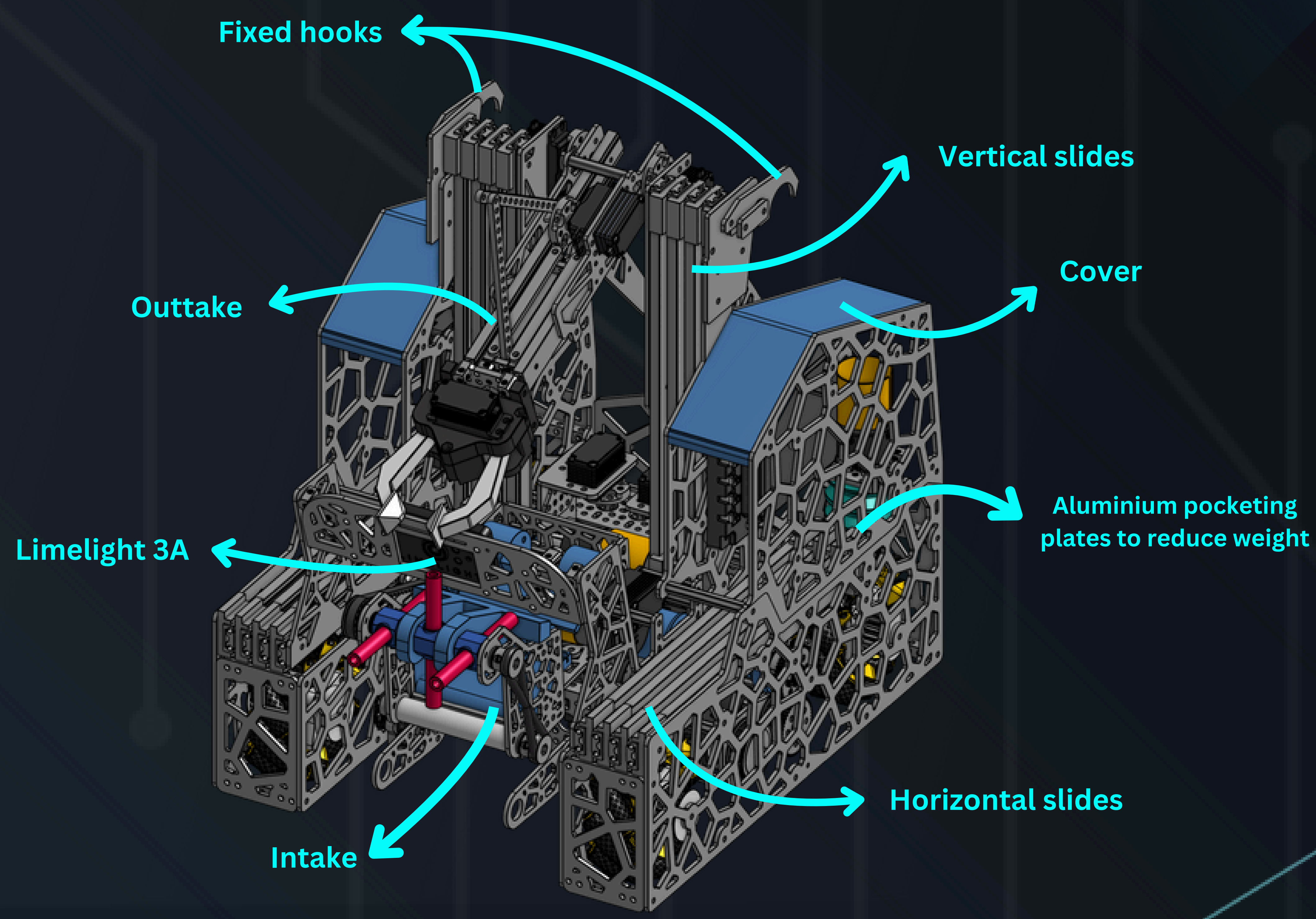
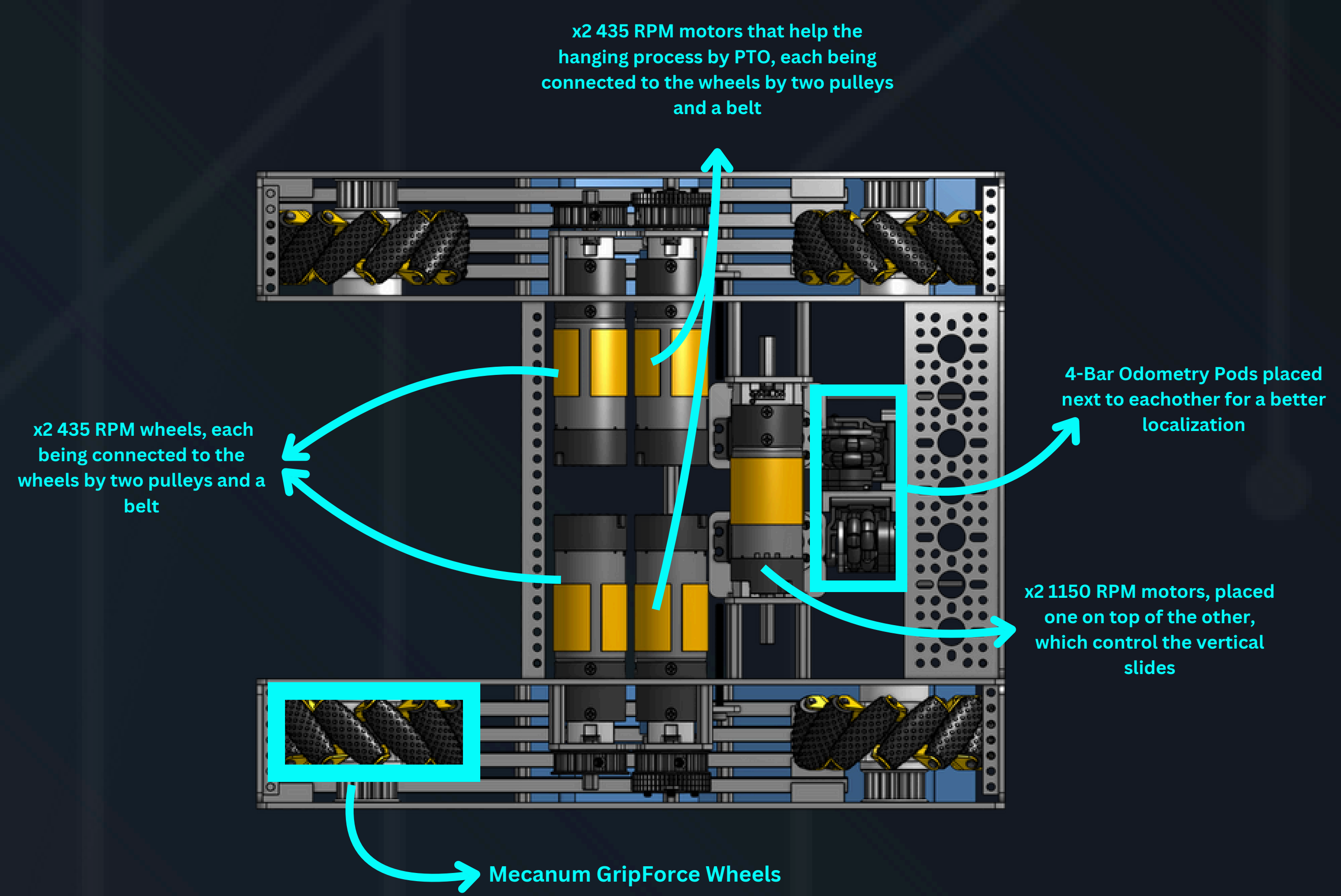
CLOSE-UP OF THE ROBOT



DRIVETRAIN



Manufacturing

The drivetrain is custom-made in OnShape and manufactured with the help of **CONTUR TECH**.

MOVEMENT

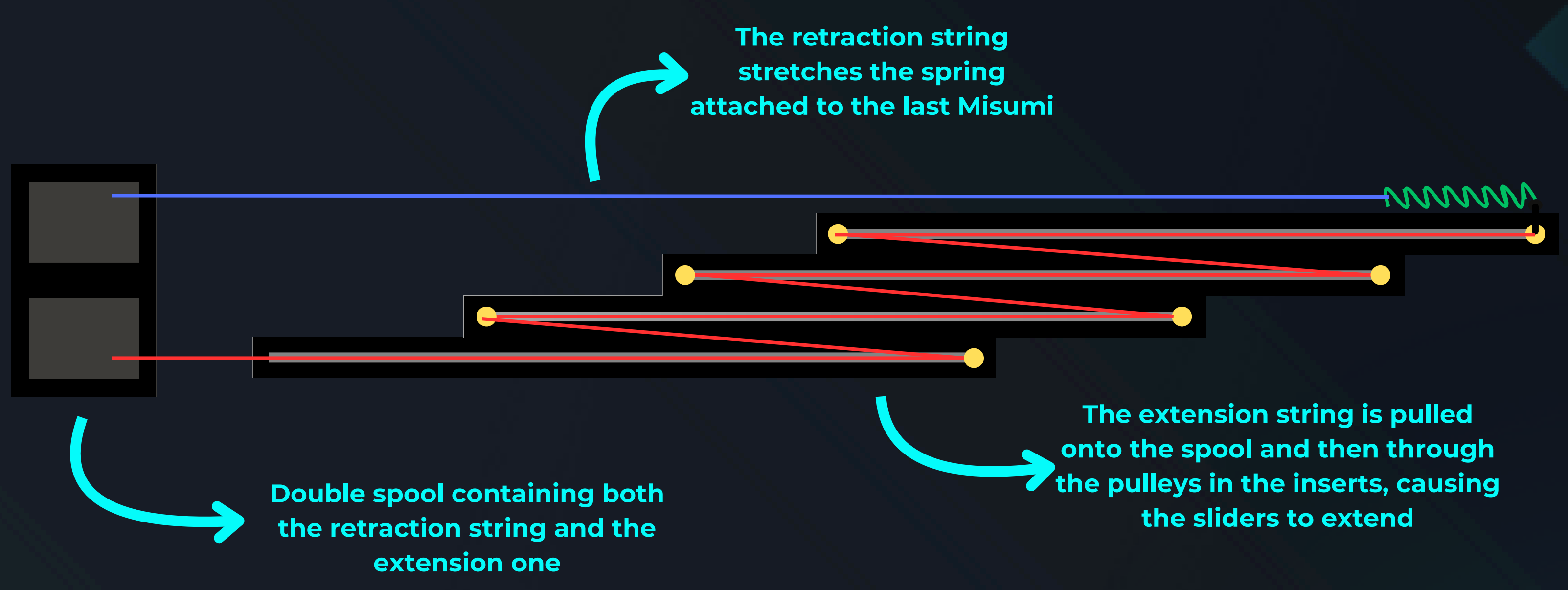
Odometry Pods - We use them to localize the robot on the field, during the Autonomous and Tele-Op periods.
PinPoint Odometry - We have a goBILDA PinPoint placed above the odometry pods for easier tunning.
Mecanum Wheels - We use GripForce Mecanum Wheels from goBILDA in order to trouble our opponents during the game and for better localization in the Autonomous period, as they reduce the slippage Mecanum Wheels usually have.

THE ROBOT

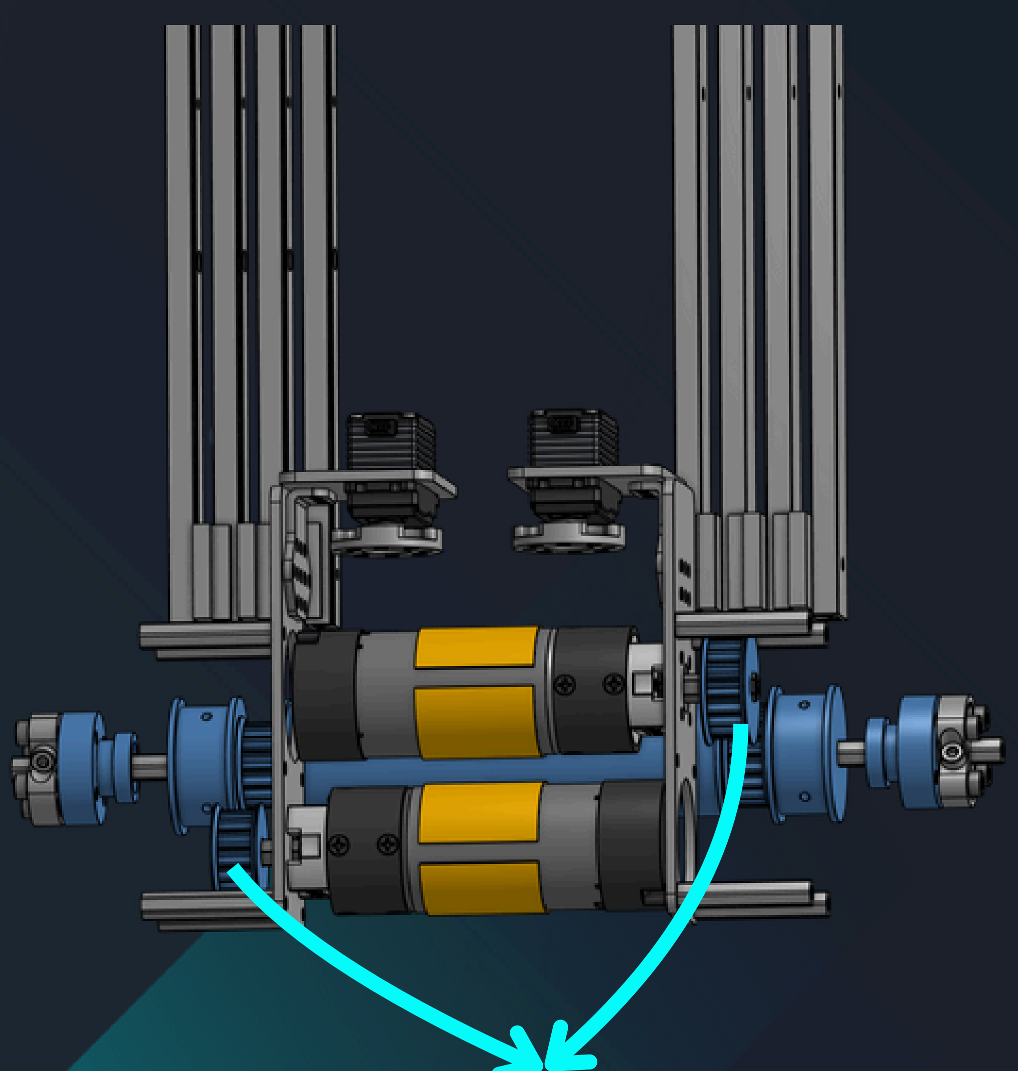
EXTENSION SYSTEMS

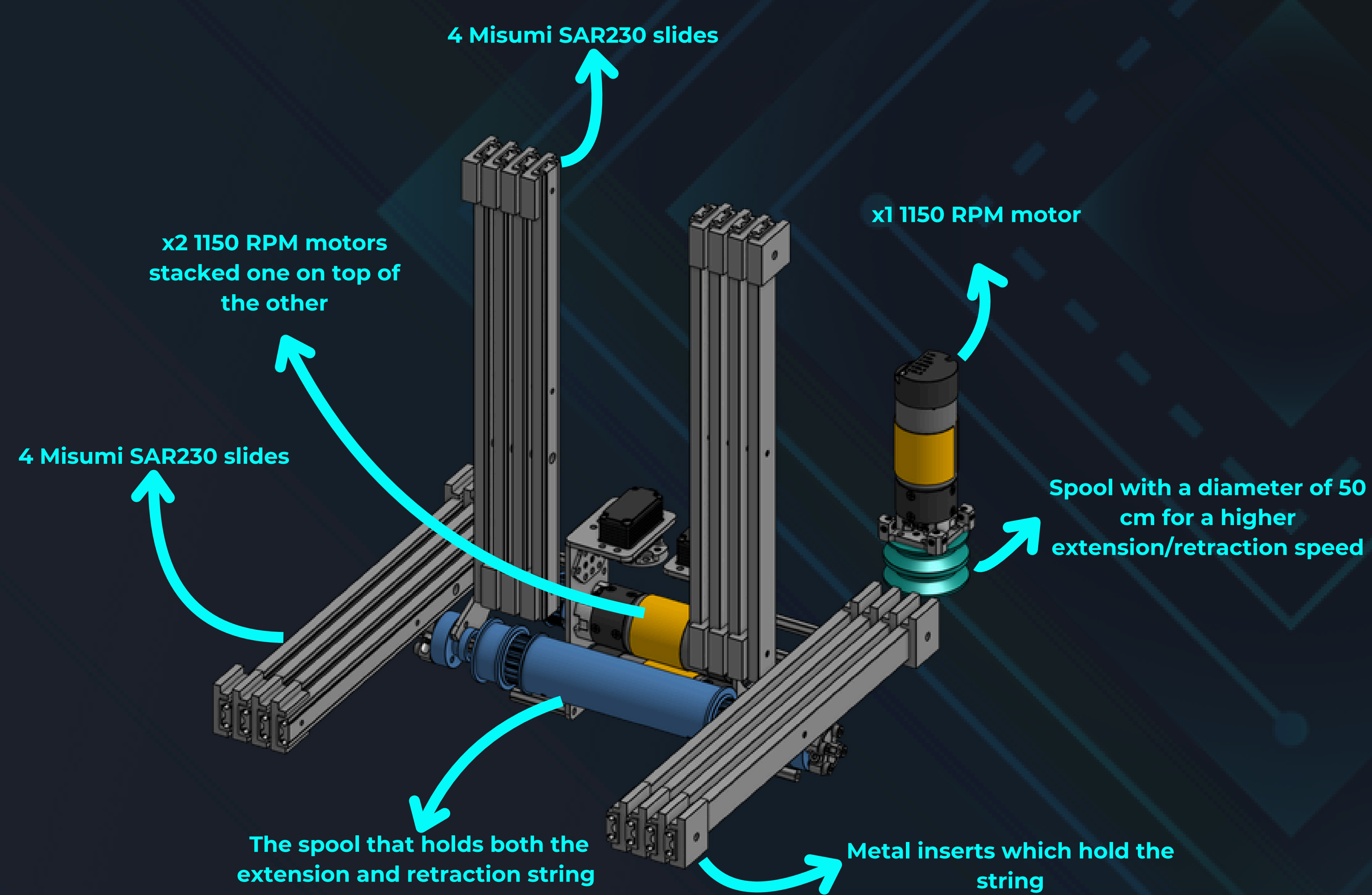
ENG NEERDS #24478

We use **8 Misumi SAR230 slides,** 4 for the horizontal extension and 4 for the vertical one, which are software-limited to stay within the extension limit. The extendo works with the help of two strings: one for **extension** and the other for **retraction.** Retraction happens by spinning the motor in reverse, which allows the tensioned spring to bring the extendo back to its initial position. While the retraction string is tightened, the extension string loosens, and the one on the bearings prevents the string from falling. The sliders extend in the opposite way of the retraction process.



The components of the extension systems:
a) Metal Inserts: To connect the sliders, we use metal inserts, as we noticed that in previous versions with 3D-printed inserts, they would frequently break due to high pressure.
b) Bearings: Inside the inserts, there is a bearing with an attached string, acting as a pulley that enables the extension.
c) String: At first, we used a fishing line that could hold up to 150 kg and had a 1 mm diameter, but it wasn't strong enough, as the pressure caused it to break quite often. To increase the durability, we switched to a stronger string that supports up to 159 kg and has a 0.9 mm diameter.
d) Pulleys: To connect the motors to the sliders, we use pulleys placed at the end of the motors, linked by belts to the spools that operate the vertical sliders.





THE ROBOT

EXTENSION SYSTEMS

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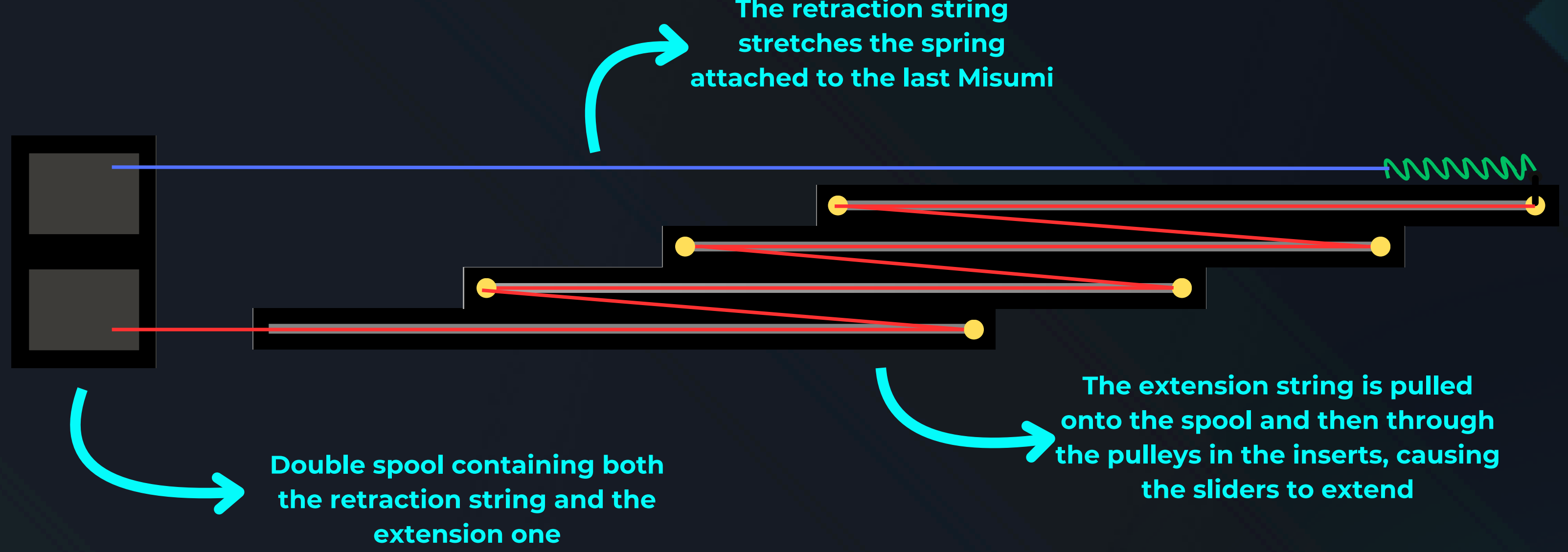

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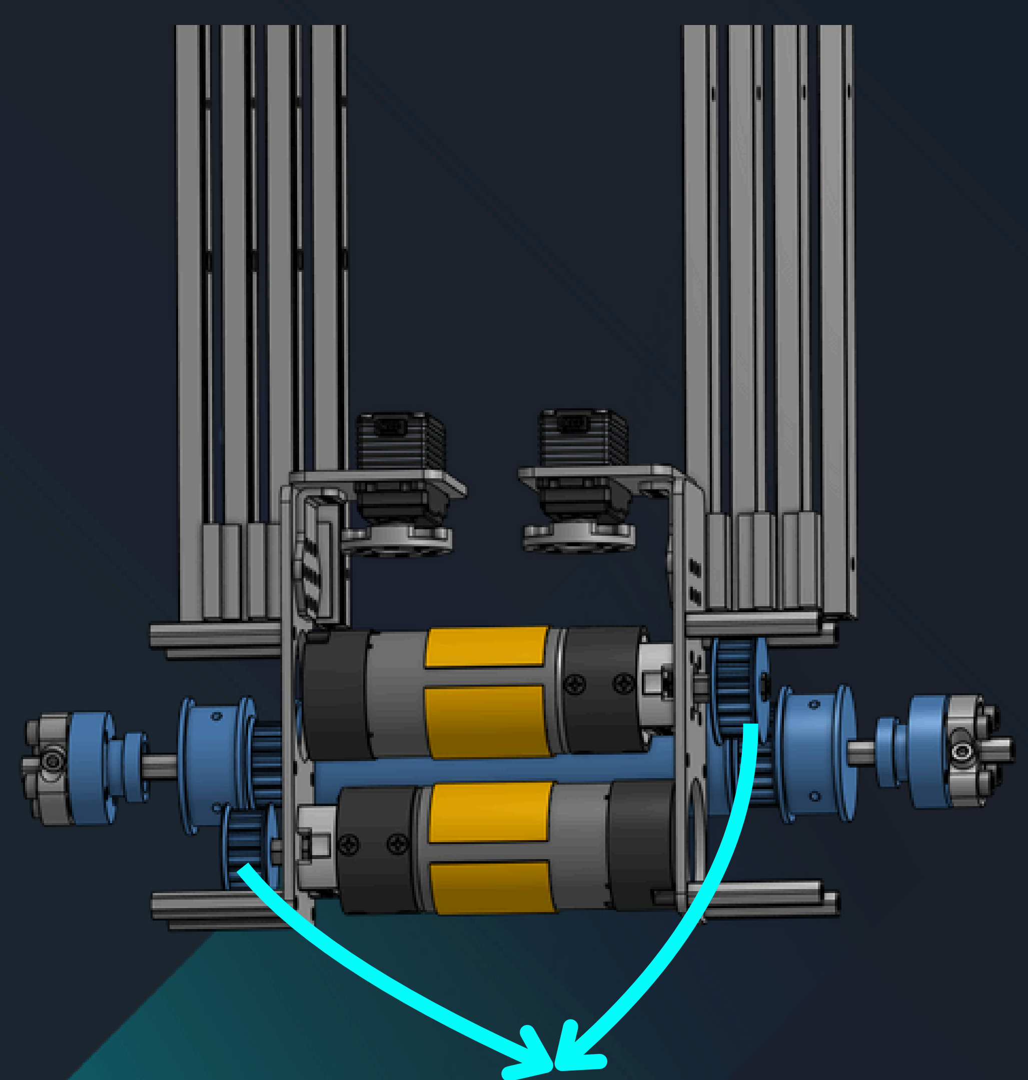
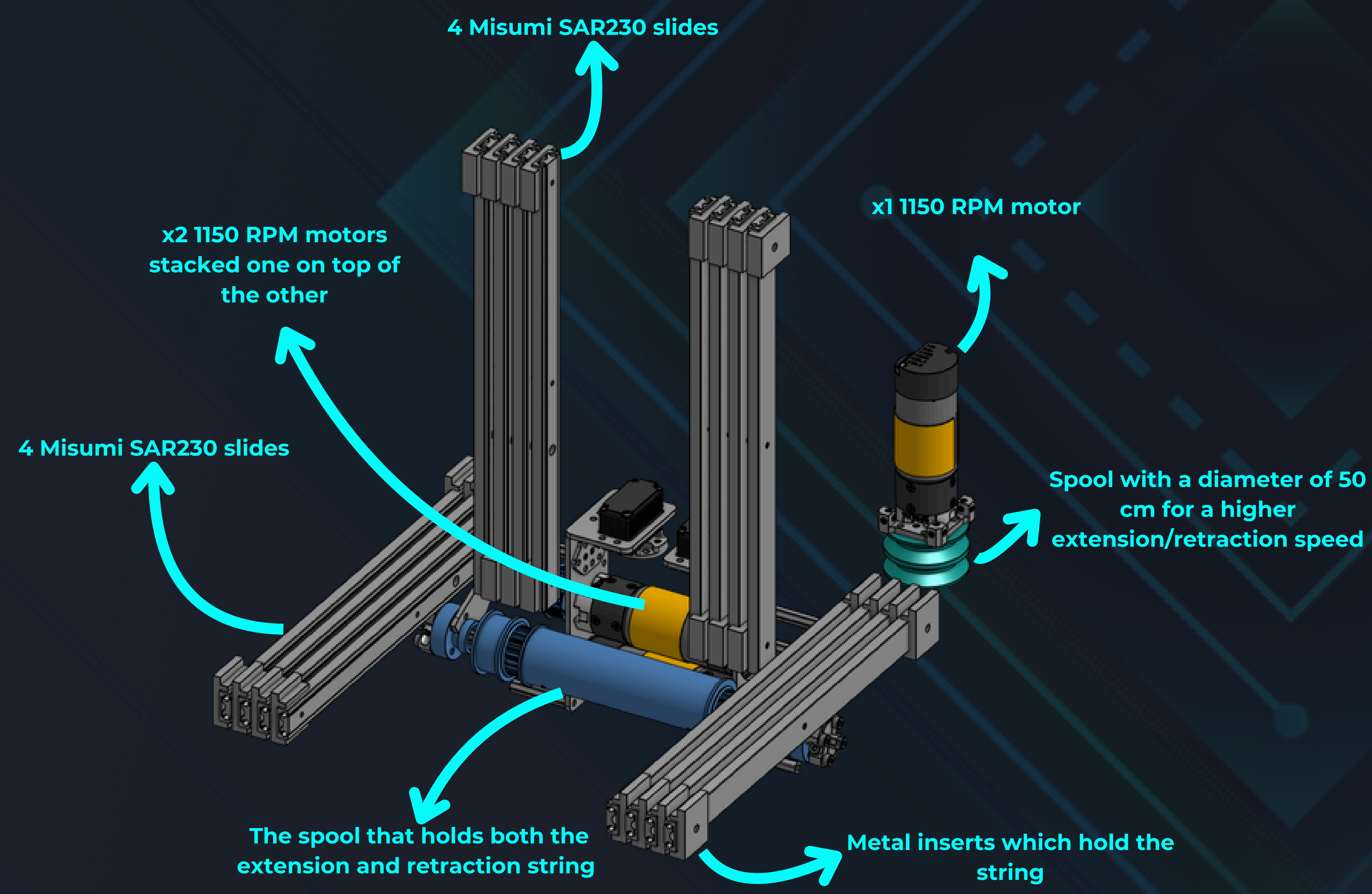
d) Pulleys: To connect the motors to the sliders, we use two pulleys placed at the end of the motor, linked by belts to the spools that operate the vertical sliders.

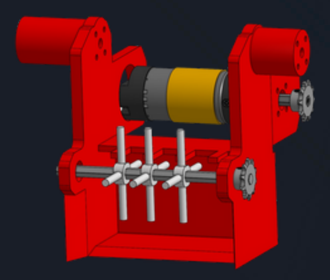




THE ROBOT

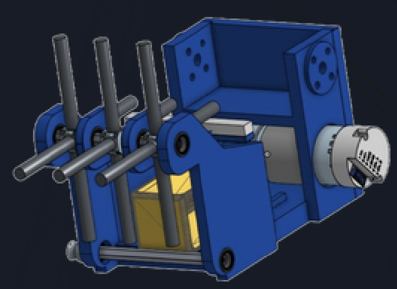
ENGINEERDS #24478

INTAKE

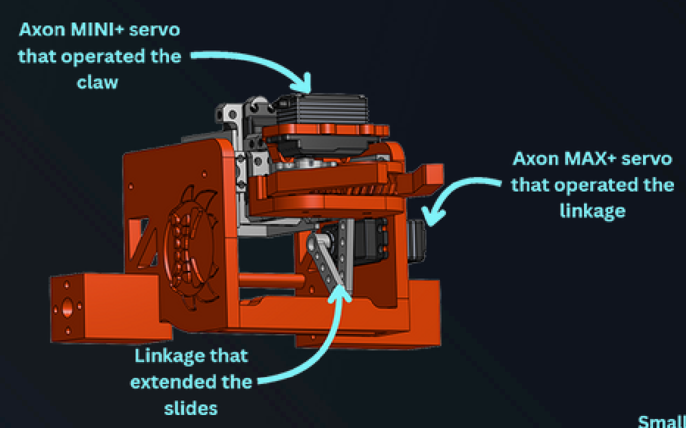


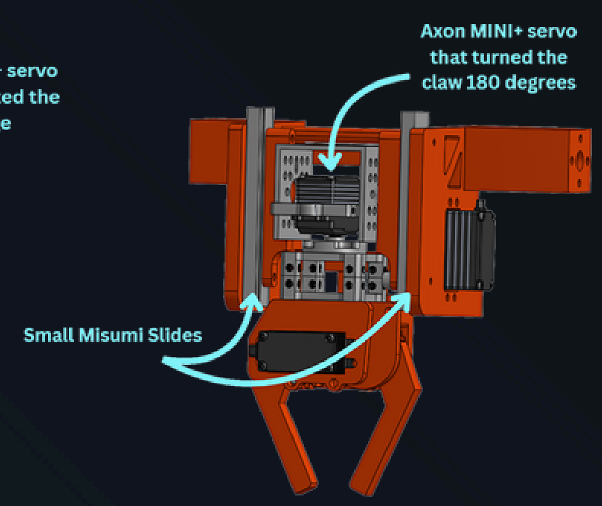
Intake V0 - This is the first prototype of the intake. We noticed that it regularly had issues with **repositioning samples.**

Intake V2 - To make the intake stronger, when we rebuilt the robot we switched to the first model, but smaller to ensure precision and also to reposition the sample vertically. This version worked very well, but the fact that it was **3D-printed** did not ensure durability and was prone to **breaking** under high pressure. So, even though the chance of it breaking was very small, we rebuilt it from **metal**.

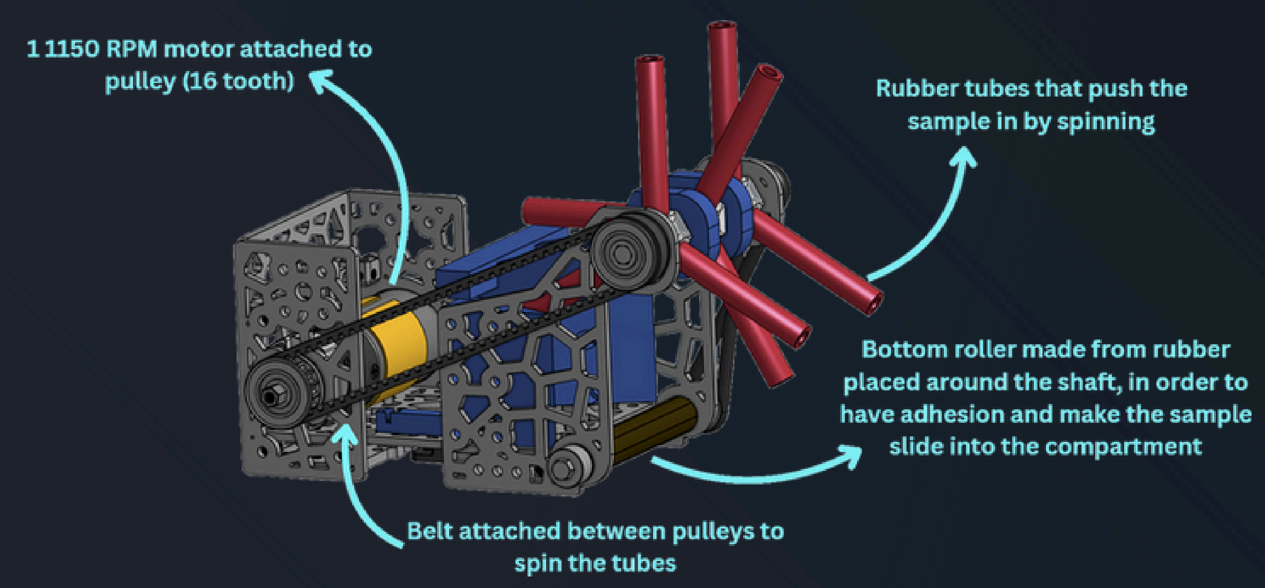


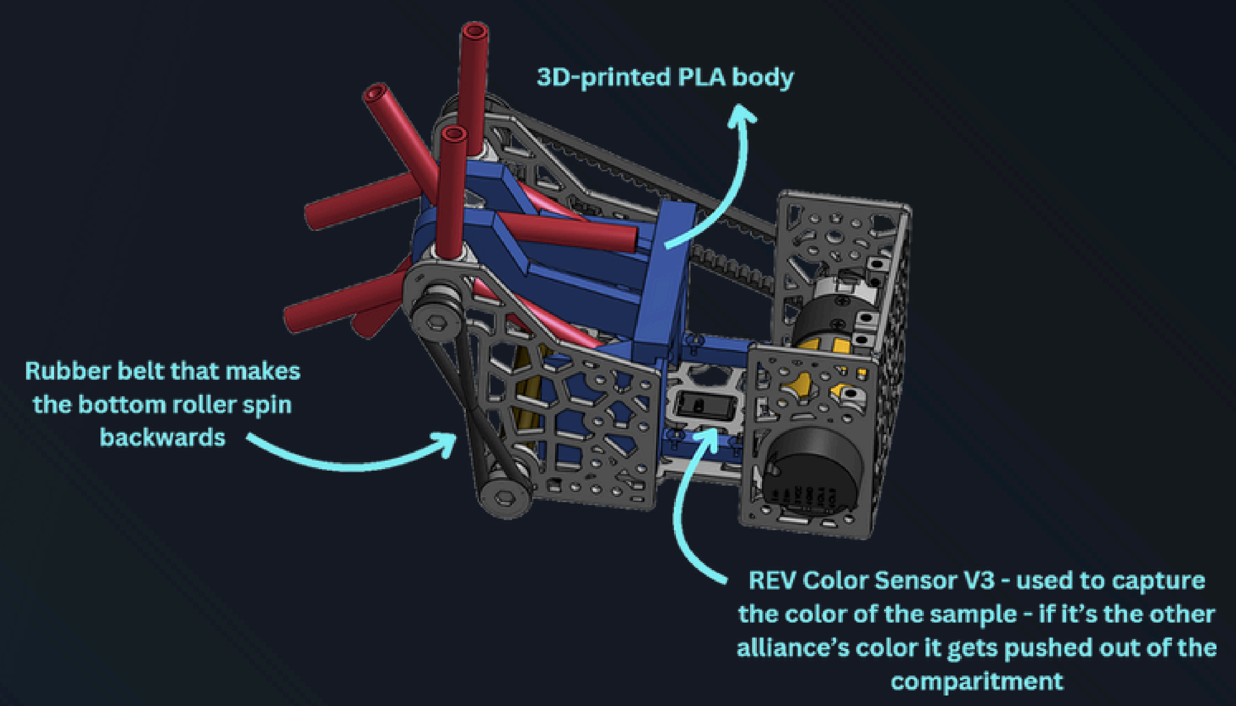
Intake V1 - We switched to a completely different model, with a claw, to ensure stability to the caught sample. This version used an Axon MINI+ servo to spin the claw **180 degrees**, and an Axon MAX+ servo to operate the **linkage** of the small Misumi aluminum slides that held the claw. It also used an Axon MINI+ servo to open and close the claw.



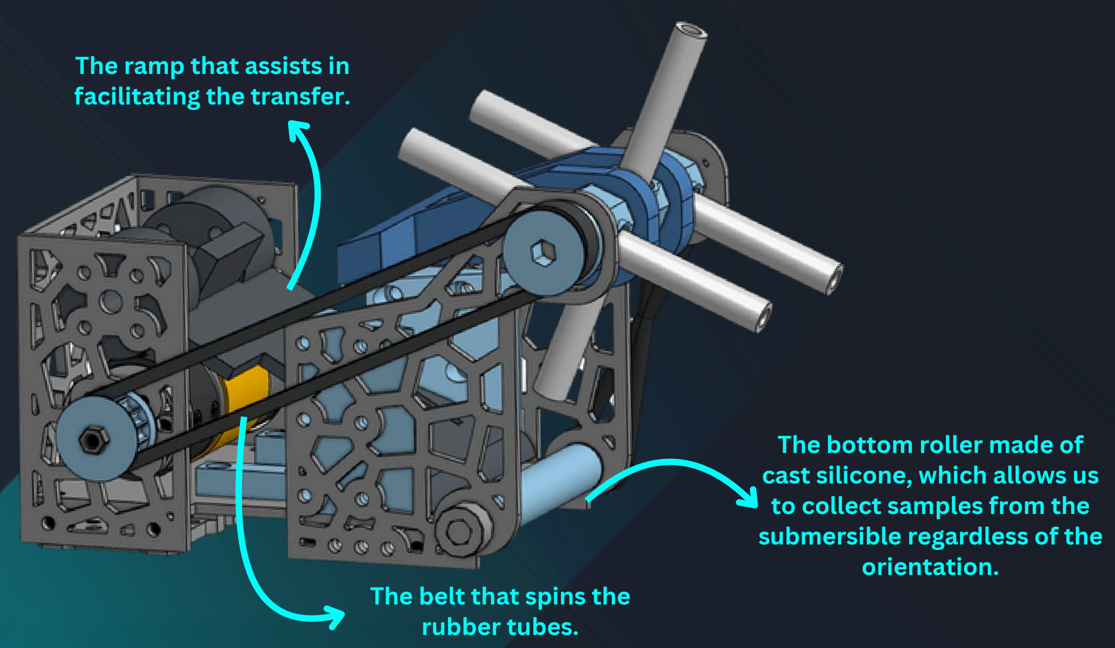


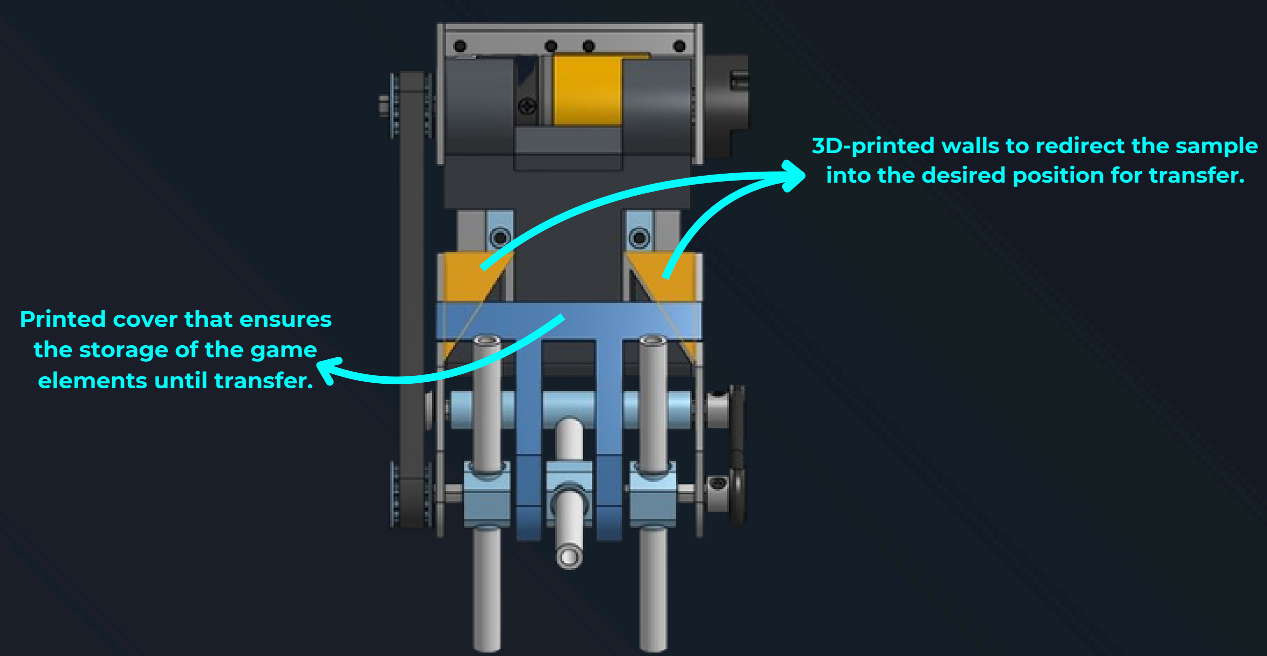
Intake V3 - It works the same as the **third model**, but we switched the 3D-printed model to a **metal** one because it is more **durable**. It used silicone tubes attached to 3D-printed supports and a bottom roller made from rubber placed around the shaft, in order to have **adhesion** and make the sample slide into the compartment.





Intake V4 (the actual model) - This version works almost exactly the same as the previous one, but we added a **3D printed ramp** for the **consistency** of the **transfer**, the other change being in the material used for the bottom roller. This one has been made using **cast silicon** to pick up samples more **efficiently**, because it is more **resistent to friction** than **rubber**.





THE ROBOT

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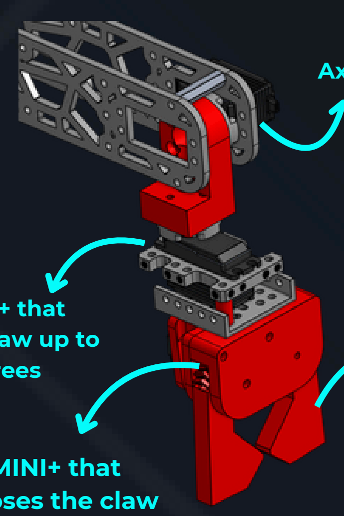
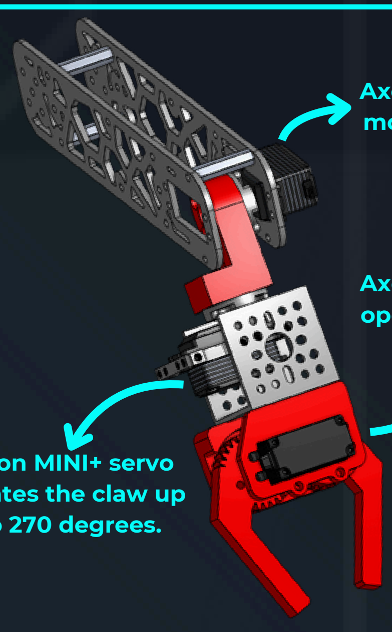
OUTTAKE - V1 TO V4



Outtake V1 - The first prototype of the outtake, which worked very well overall. The claw part used an Axon MINI+ servo to open and close the claw and another Axon MINI+ servo to spin the claw 180 degrees. The reason we changed it is to ensure **efficiency** in the **Autonomous** period.



Outtake V2 - This model was made to be more effective by making the **arm longer** and changing the shape of the **claw fingers** to be **triangle-shaped**, in order to ensure **reliability** in the transfer process. It functioned the same as the first model and functioned very well, but did not fit the third version of the intake. When the robot was rebuilt and we changed the intake, we also had to change the outtake.

Outtake V3 - It is a **simpler** model in comparison to the other two versions, this one not having a servo that spins the claw 180 degrees. We also changed the claw fingers, making them as **slim** as the first prototype, but more **arched**. It was made for the actual intake, so that the transfer of the samples between the intake and the outtake could take place easily.

COMPARISON OUTTAKE V3 - OUTTAKE V4

OUTTAKE V3

1. It used an Axon MAX+ servo to move the claw up and down.

2. It was restricted by its size, but still worked very well.

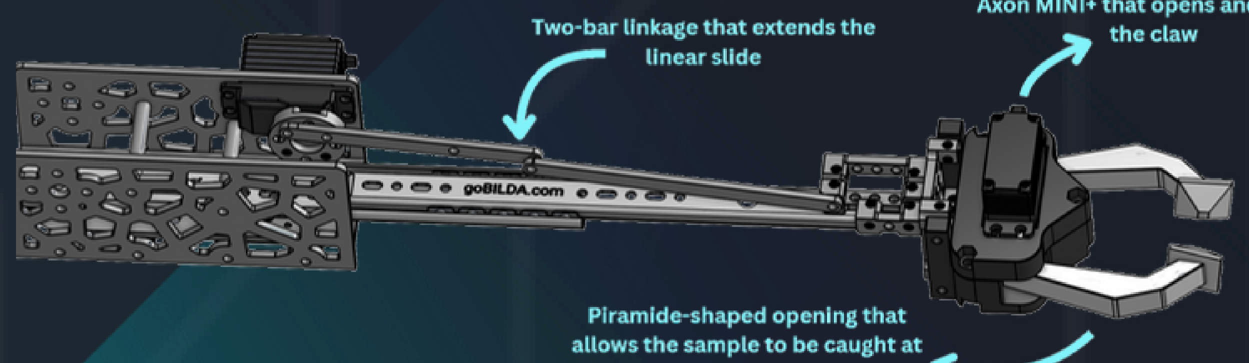
3. The claw fingers were slim and arched, which made the sample to be caught easily, but it had a slim chance of dropping the sample, depending on the angle.

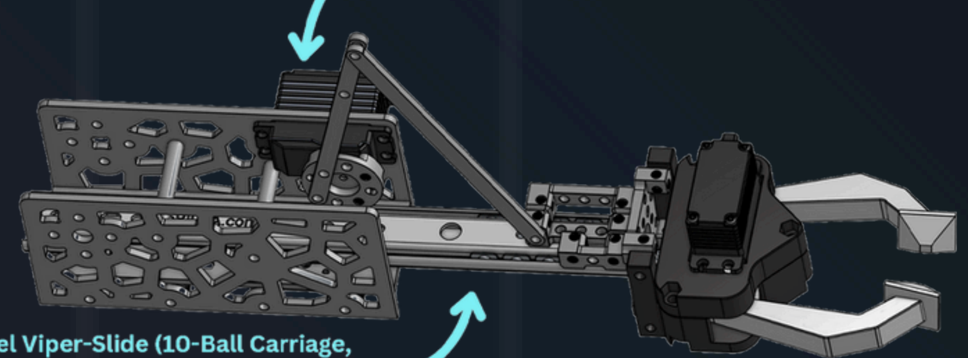
OUTTAKE V4

1. It uses an Axon MAX+ servo to extend the arm.

2. It can extend depending on the task, which makes it more efficient.

3. The claw fingers are slim, the opening being piramide-shaped to ensure that the sample is caught at any angle.





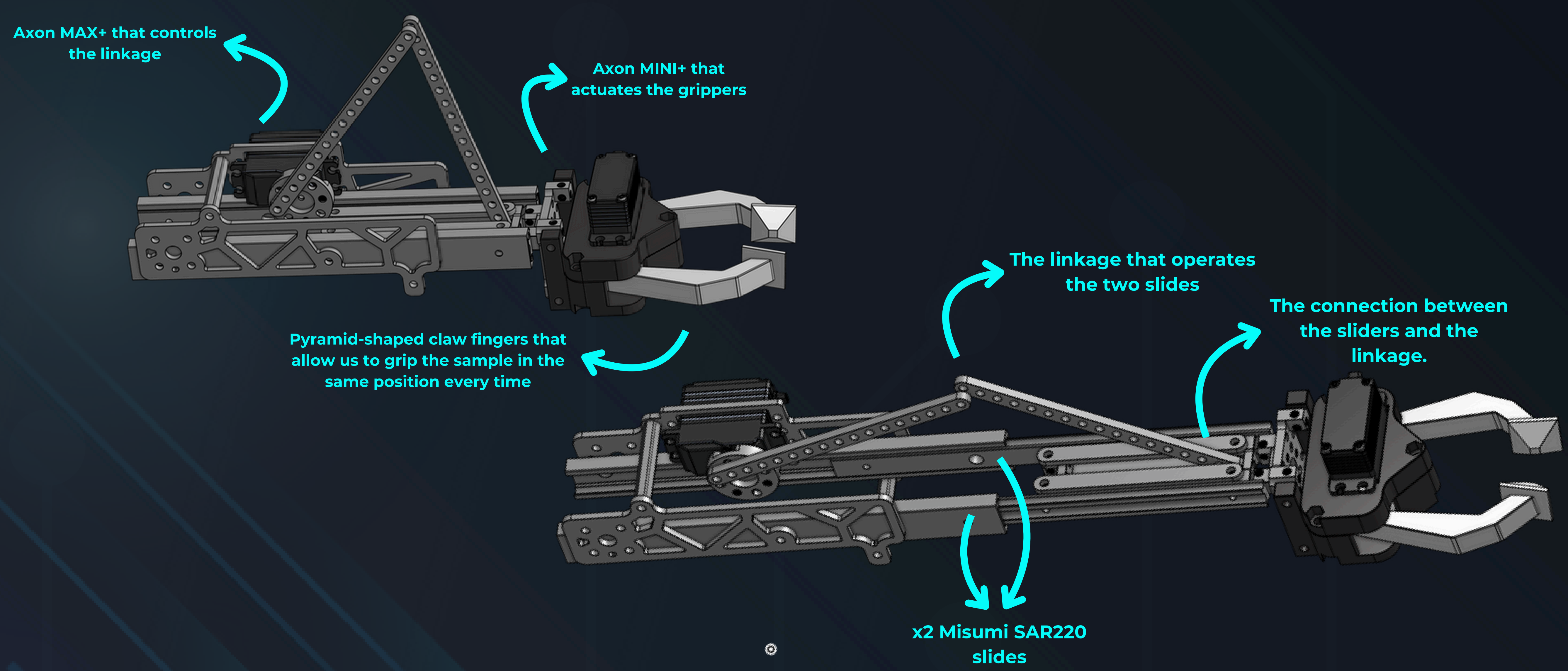
THE ROBOT

OUTTAKE - FINAL VERSION (V5)

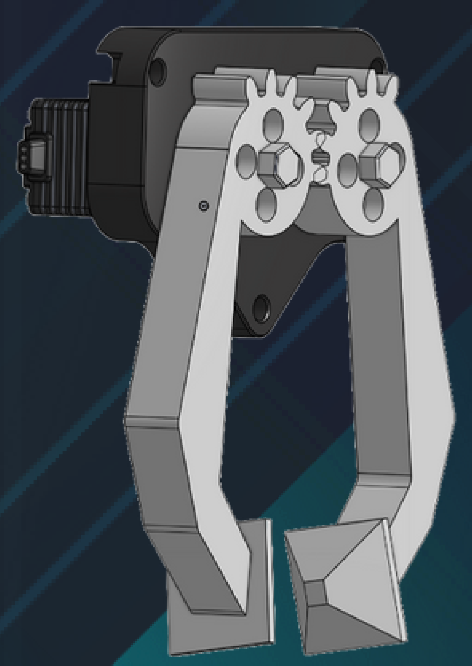
After testing previous versions, we developed a model that addresses all the issues encountered throughout the season.

We mounted **two Misumi SAR220 slides** (from a Viper slide) on **two CNC**-designed and machined **supports**. We chose this type of slides because of their efficiency and their size, the length being shorter than the Viper slide, which allows us to fit within the pre-established dimensions set in the Competition Manual.
Additionally, the Misumi slides move smoother and put less strain on the Axon MAX+ servo that controls them, features that make this type of slides better than the Viper ones.

They are moved using a **linkage-type mechanism**, which is also powered by an Axon MAX+ servo, to allow the robot to hook specimens from **any orientation** and at a greater distance, reducing the need for such high dexterity from the drivers.



CLAW FINGERS MOVING MECHANISM



- We have a set of claws attached through a quad block on the slides.
- They are powered by an Axon MINI+ servo for increased speed.
- The unique design of the claws, featuring a **pyramidal shape** at the tip, ensures that extreme samples are grabbed in the same orientation every time, ultimately improving scoring efficiency.

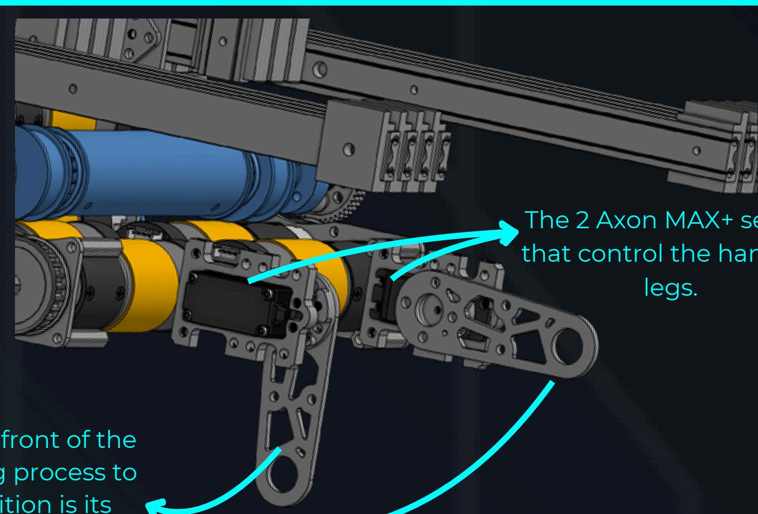
THE ROBOT

HANGING

During the regional stage of the competition, we noticed that teams using a **hanging mechanism** had a significant advantage. However, we struggled to find an optimal solution to properly execute this process. The difference in the number of teeth on the gears was too small, which meant that the Axon MAX+ servos did not have enough power to successfully complete the hooking process.
The hooking mechanism is executed through **multiple mechanisms** that depend on eachother:

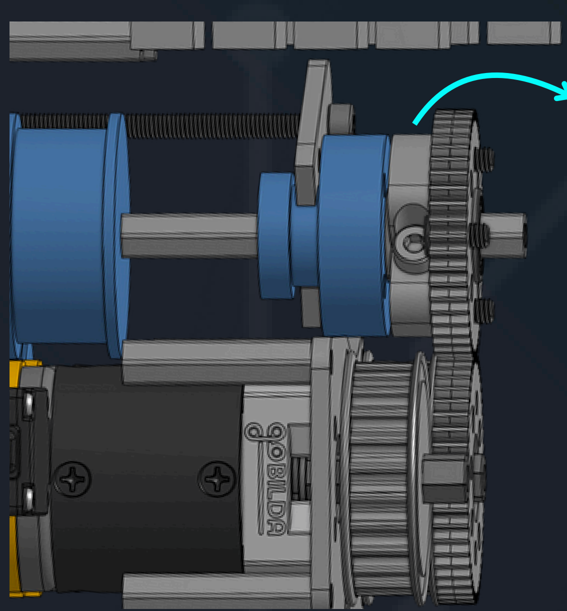
THE HANGING LEGS

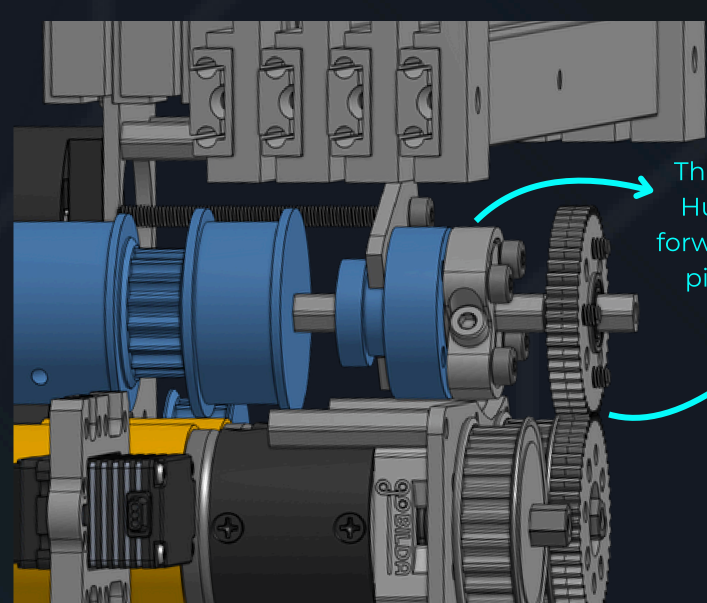
These are powered by **two Axon MAX+ servos**, which are connected to the Servo Hub to provide the necessary force. Their role is to push the robot at a **30-degree angle**, making it easier to complete the hooking process.



THE PTO (POWER TAKE-OFF)

We implemented a system that connects the rear motors to the sliding system. The **PTO** is controlled by 2 Axon MAX+ servos, which maintain a tensioned string. When a button is pressed, the string loosens, and the sonic hub, influenced by this mechanism, is pushed toward the gear connection at the end of the motor.

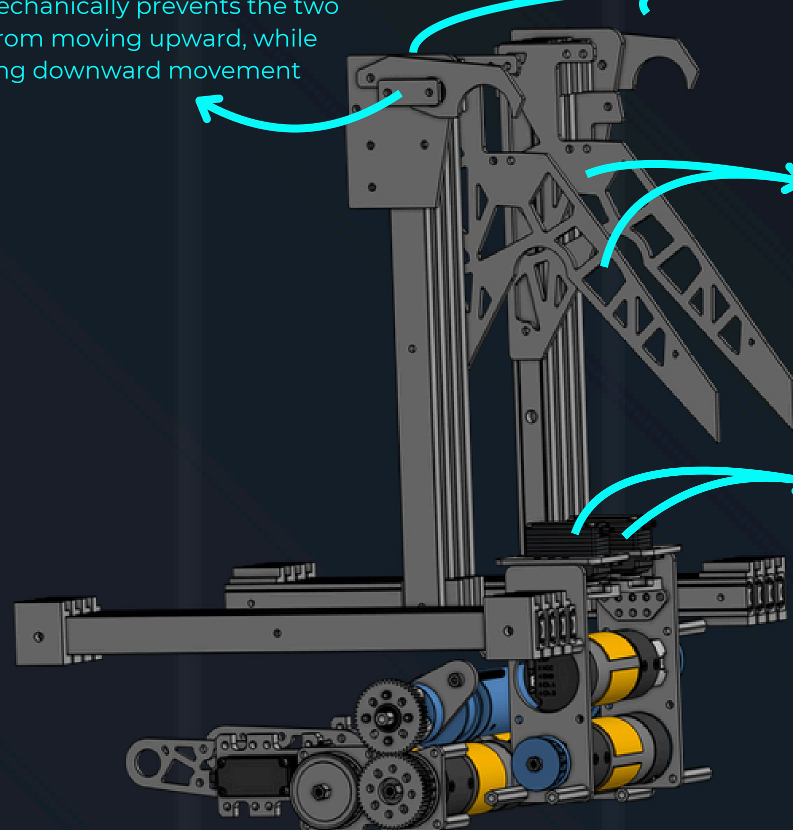




HOOKS

Small Hooks – These are fixed and positioned at the end of the vertical sliders. They can only move downward, allowing them to pass the first bar and release the larger hooks, which will complete the attachment to the second bar.

Large Hooks – Positioned on the last set of vertical sliders, they enable hooking onto the second bar. After the large hooks attach to the first bar, the small hooks take over the support of the robot on the first bar, allowing the large hooks to complete a level 3 hang.



SENSORS & LOCALIZATION

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PIDF CONTROLLERS

- A **PIDF controller (Proportional-Integral-Derivative-Feedforward)** is what is known as a "closed-loop" control system.
- Adjusts the power of our motors based on real-time feedback from previous actions in order to achieve a more precise movement of our slider systems.
- The **proportional** term makes sure a system's current position correctly aligns with its target position;
- The **derivate** term, also known as a dampener, is used in order to prevent overshoot;
- The **integral** term, is used lightly in order to fully prevent any system error;
- The **feedforward** term corrects for system disturbances and other external factors such as gravity.

VOLTAGE SENSOR

The **REV Control Hub's internal voltage sensor** is used in order to boost the accuracy of our TELEOP subsystem functions.

- Automated autonomous program switching based on battery voltage reported by the Control Hub's voltage sensor in order to ensure accurate intaking of SAMPLES and safe placement of a SPECIMENS.

COLOR SENSOR

A **REV Color Sensor V3** is used in order to differentiate between SAMPLE colors and make sure the SAMPLE has correctly been deposited

- Robot automatically ejects a wrong color SAMPLE from the intake
- Checks distance in order to ensure that a SAMPLE is in the deposit when initiating a transfer sequence.

FIELD LOCALIZATION

Robot localizes (tracks its position on the field relative to an arbitrary starting point) using both absolute and relative methods of localization. **Absolute localization** returns a fixed value, whilst **relative localization** acts as a tracker, measuring robot movement continuously. We use a combination of both types of localization in order to ensure accurate tracking during both the AUTONOMOUS and TELE-OP periods.

ODOMETRY PODS

- **Odometry Pods** are dead omnidirectional wheels hooked up to an external encoder that measures the robot's position, in ticks per revolution, on an axis relative to a starting point.
- Two Odometry Pods are used in order to measure robot movement on both the x-axis and y-axis of the field.

PINPOINT COMPUTER

- During AUTONOMOUS, we use the GoBILDA Pinpoint co-processor, alongside 2 GoBILDA 4BAR Odometry Pods.
- The **goBILDA Pinpoint Computer** runs positional calculations independently from the Control Hub, thus ensuring precise localization on the field. The Pinpoint computer runs at approximately 1500hz (1500 calculations per second), compared to around 50hz when processing calculations internally (on the Control Hub)
- Pinpoint also contains what's known as an internal IMU (Inertial Measurement Unit). We use the **IMU's gyroscope function** in order to measure our robot's heading on the field.

LIMELIGHT 3A CAMERA

- A **Limelight Camera** running an HSV Color + Edge Contour detection pipeline (program) is used to detect SAMPLE locations in the field.
- Using **image homography**, the camera accurately tracks the SAMPLE position and angle relative to the robot. Then, by converting the **pixel distance** to **encoder ticks**, we make sure our robot's extension runs to the SAMPLE intaking position determined beforehand.
- The camera is used for **SAMPLE angle re-localization** in concordance with the Pinpoint Computer during the AUTONOMOUS period of the match.
- Besides re-localization, we make use of our **detection model** in order to detect another SAMPLE at the start of AUTONOMOUS & get an additional SPECIMEN on the high chamber.

AUTONOMOUS & TELE-OP

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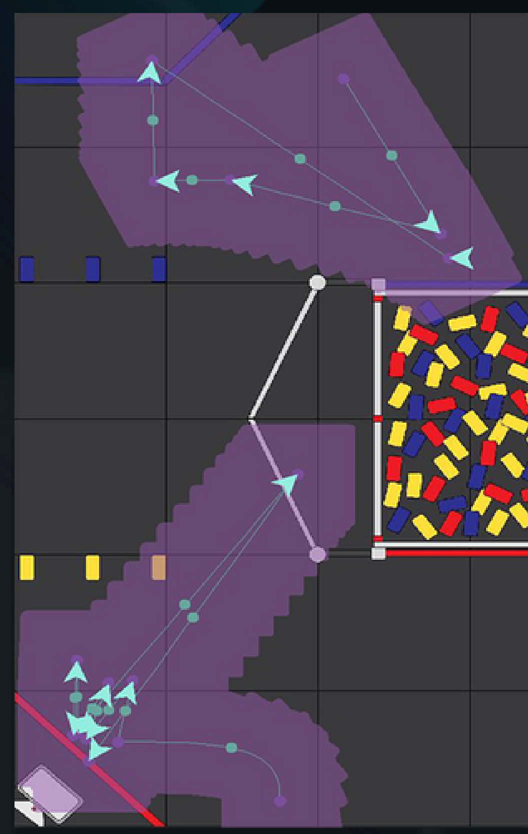

PEDRO PATHING (LM1)

- For our first League Meet, we used **Pedro Pathing**, a robot pathing & following algorithm.
- Pedro Pathing is a **GFX (Guiding Vector Field)** algorithm. It works by generating a set of directional vectors that guide the robot along a predefined path. Thus, it adapts to external disturbances and path deviations caused by aggressive robot contact.
- This path-following algorithm is rather inconsistent though, prioritizing **raw speed** over **robot field accuracy**.

RRPATHGEN

- **RRPathGen** is a Java program that allows us to easily generate paths for Roadrunner. We use it to test our autonomous programs before running them on actual hardware.

ROADRUNNER (LM2+)

- Later, we moved on to **Roadrunner 1.0**, an open-source motion profiler.
- The main advantage of a motion profiler is that it prioritizes **localization accuracy** and **time consistency** over **speed**. Using Roadrunner, we make sure that subsystem actions run at the same time, every time.
- Roadrunner also runs **3 additional drive motor PID control loops** for accurate positional tracking, one for robot heading and two for x and y-axis control. This way, the robot corrects itself throughout the path.
- In order to relocalize on the field using our **camera**, we modified Roadrunner's default follower in such a way that it allows us to automatically change the robot's pose based on output data from our camera.

COMMANDS & SUBSYSTEMS

- Our code architecture is structured around **commands and subsystems**, ensuring a modular approach to robot control.
- In order to structure our code in such way, we use an external java library called **FTCLib**. Using FTCLib is a great way to improve code structure, as the library provides an in-built, easy-to-use command system.
- We define a sequence of commands that allow us to break down complex actions, such as our **transfer**, into reusable tasks. This makes it easier to **improve** or **fix** specific robot actions. without disrupting the rest of our codebase.
- Each controllable part of our robot is separated into its own **subsystem** in order to improve code **organization** and **maintainability**. This ensures a great level of **independence** (if one subsystem has issues, the rest of the robot can remain functional) and allows for parallel execution of multiple actions, therefore improving **efficiency**.

TELEOP ENHANCEMENTS

Automatic Transfer & Ejection

A REV Color Sensor V3 is used in order to automatically eject wrong-colored SAMPLES and initiate the transfer sequence.

SLIDER PIDF DEACTIVATION

Our slider's PIDF controllers automatically deactivate when not used, thus extending our robot's battery life by a substantial amount.

AUTOMATED SPECIMEN CATCHING

We make use of **Roadrunner pathing** during TeleOp in order to fully automate our specimen-catching sequence. Our driver presses a button from anywhere across the field, and the robot automatically moves, detects & catches the specimen in the human player zone.

AI Assistance Acknowledgment:
This portfolio was created and written entirely by the EngiNeerds team. To improve clarity, structure, and wording, AI-based tools such as ChatGPT were used as writing aids. All technical content, design decisions, and engineering solutions were documented, tested and developed by our team members.