2025-2026 SEASON

ROBO
AS

DECODE

RO_009

#19082

ROBOAS Reach

OUR TEAM:

60 members
- 2 alumni
  - *Lazăr Daria*: Optimization & Peer Mentorship
  - *Meșa Vlad*: Prototyping Peer Mentorship
- 5 mentors
- 15 active contributors
  - Programming Department
    - *Griga Victor*: Math for Turret
    - *Colojoară Alexandru*: Custom Pathing
    - *Stoica Teodora*: Subsystem Logic + TeleOp/Auto Integration
  - Engineering Department
    - *Alexandru Rareș*: Lead Robot builder & CADist
    - *Baraboiu Oliver*: Assembly & Maintenance
    - *Blaj Alexandru*: Assembly & Maintenance
    - *Călugăru Amalia*: Assembly & Maintenance
    - *Dacian Tudor*: Assembly & Maintenance
    - *Ene Maria*: Assembly & Maintenance
    - *Nagoe Ana*: Assembly & Maintenance
    - *Varvara Radu*: Design & Prototyping
  - Marketing & PR Department
    - *Bădără Rianna*: Graphic Design for Posts & Videos
    - *Ciobanu Otilia*: Taking & Editing Photos
    - *Huminic Anastasia*: Posting on Social Networks + Financial Manager
    - *Săndulescu Lizica*: Team Documentation + Graphic Design for Stickers
- 32 trainees

TEAM PERFORMANCE:

- **2026** ***1st Prize Innovate Award* – Nationals**
- **2026** ***1st Prize Innovate Award* – Regionals**
- **2025** **Premier Event *Qualification* - Netherlands, Eindhoven**
- **2025** **4th place finish at Premier Event**
- **2025** ***1st Prize Innovate Award* – Premier Event**
- **2025** ***1st Prize Innovate Award* – Nationals**
- **2025** ***1st Prize Innovate Award* – Regionals**

RECRUITMENT PROCESS:

Application requirements: Filling out the application form, followed by an online interview with leads and mentors to assess motivation and work style. The questions focused on reaction in specific situations. The process ended with a face-to-face meeting to introduce the team and responsibilities.

Members recuitment: **July Recruitment** ▶ Open to all students in our school, not only high school students, but also middle school students ▶ Summer period = more available time for training ▶ Practical tasks + continuous mentoring ▶ Faster and smoother integration of new members

October Recruitment ▶ Open to all 9th grade students ▶ Team presentations held throughout the school ▶ Robotics spider displayed in the main hall for increasing visibility and student interest

Result: 44 new members joined the team

Mentors recuitment: One of the team's major goals this season was to strengthen the mentoring area, especially after a competitive year in which outreach activities were few and fragmented. In addition, after recruiting members, we saw that more than half of them applied for the enterprise area. In this context, recruiting Anna-Maria Nedelea as a mentor on the enterprise side was an essential step. She quickly noticed a gap in the team structure — the lack of a person dedicated to coordinating promotional initiatives, partnerships and events — and chose to actively get involved to fill it.
Through her constant involvement, the team managed to develop its enterprise skills and regain confidence in its ability to create impact outside the lab.

EDUCATIONAL OUTREACH TEAM EVENTS:

The First League Meet hosted in Brașov - 31.01.2026

Carpathian Robotics League Meet: The event organized by RoboAS together with teams V.V. Robots, CyberLIS76 and AICitizens marked the first Carpathian Robotics League Meet hosted in Brașov. Over 200 participants and 13 teams took part in the competition. For our team it was the first experience as organizers, which is why we wanted to collaborate with other teams and learn from them. Students from our school also participated in the event, curious to discover the atmosphere of such a meet.

Engineering Meets the Future - 10.11.2025 & 11.11.2025 & 12.11.2025

Demo Metal: The RoboAS team participated in a technology and innovation fair where major automation companies were present. We had our own booth, through which we presented the robot and the results obtained in the previous competition season to a large audience. The team demonstrated the robot's operation to a large audience and actively promoted the FTC educational program, explaining the structure of the competition, the benefits for students and the impact on technical and personal development.

First Steps in Robotics in the Mall - 1.06.2026

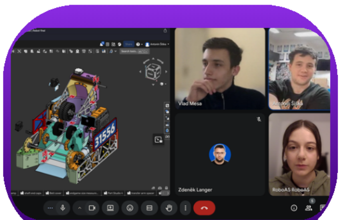
Activity in AFI Mall: On the occasion of Children's Day, we organized an event in the Mall where the children had the opportunity to control a robot. The presence in AFI Mall brought the team in front of hundreds of families, strengthening the visibility of our projects and opening discussions with parents, teachers and maybe, someday, future team members. The event contributed to increasing interest in science and technology among children and parents

ROBOAS Reach

Hands-On Programming & Engineering - 22.10.2025

Programming and engineering workshop: RoboAS organized, within the framework of the "Alternative School" program, a workshop for 9th grade students, dedicated to programming and applied engineering. For an efficient experience, the participants were divided into two groups: one started with programming, exploring the logic of algorithms and the transformation of commands into actions, and the other with engineering, discovering the mechanical components of the robot. At the end, the groups swapped to go through both activities.

Mentorship Across Borders - 16.12.2025



Our Mentorship Session- International FTC Support: Our team held a support meeting with Team #31556 HobbyRobot from Prague, Czech Republic, who are at the beginning of their FTC journey. We shared advice from our own experience about programming, robot design, game strategy, and portfolio organization. We also talked honestly about mistakes we've made and what we would improve if we could start over, hoping to make their path through FTC a bit smoother.

Technology with Empathy - 23.10.2025

Outreach activity at the Children's Hospital, Brașov– FTC Robotics Demonstration: The initiative aimed to bring science closer to the little ones and transform an ordinary hospital day into one full of curiosity, smiles and inspiration. The demonstration was adapted so that every child could safely interact with technology. The hospitalized children were enthusiastic and delighted to discover the world of robotics. For many of them, it was the first direct encounter with the world of robotics, and for us, it was a confirmation that technological education can bring joy even in delicate contexts.

Science and Robots for All - 26.09.2025

Researchers' Night - Event organized by Transilvania University Brașov: With over 1000 participants, the event contributed to creating direct communication between the team and the community. Children had the opportunity to interact with the robot, discovering its precise movements and complex functionality. Team members passionately explained the mechanical concepts and subsystems used in the FTC competitions, explaining technical notions in a way that everyone can understand. Through open dialogue with the public, especially young people, the team managed to arouse curiosity for the world of robotics and encourage STEM vocations.

Flying towards the technical future - 16.06.2025

Paper Aeroplanes: Paper Aeroplanes is a major annual event we organize in a large park with Kronbot team and local volunteers to both fundraise for Brașov's robotics teams and promote FIRST and STEM in our city. The paper airplane competition draws kids of all ages, creating the perfect opportunity to showcase our robots and run practice matches, sparking curiosity and inspiring the next generation of programmers and engineers.

Strong Tradition - 28.10.2025 & 29.10.2025 & 30.10.2025

ȘagunaFEST: Our college celebrated 175 years of excellence with a four-day event. Among the defining moments was the participation of the robotics team, one of the school's outstanding performances. We set up a classroom with our booth, the field and the robot, offering captivating demonstrations. Hundreds of children, parents and special guests – the president and vice-president of the Romanian Academy, the city mayor, the school inspector, writers, journalists and graduates – crossed our threshold.

FTC Near Children - 07.11.2025

First Steps towards STEM: Eighth grade students from Sânpetru visited our school to discover the opportunities of performance education before a decisive moment: choosing a high school. The RoboAS team introduced them to the laboratory, the FTC competitions and the experience of being part of a robotics team. The visit was interactive, with students even testing out how to pilot the robot. Many of them started considering STEM-oriented high schools, inspired by the possibilities offered.

Exploring FTC Together - 4.10.2025 & 15.10.2025

Presenting FTC: RoboAS organized two meetings with all the students in our school to present the team's work and the projects we are working on. The goal was to inspire them and give them the chance to join, if they are curious or passionate about robotics. At the end of the presentation we had a dedicated time for questions, so that it was an interactive meeting.

Technical Inspiration for Students - 10.10./2025 & 11.10.2025

STEM dissemination at the middle school: The team organized a series of meetings with five middle school classes, where we also presented our plan for the next competitive season: forming a team of younger students, who can join right now to get acquainted with FTC. During these sessions, we disseminated information about our work, STEM vocations, and the responsibilities of each department, giving the students a clear picture of the opportunities they can explore in robotics.

ROBOAS Connect

DEVELOPPMENT OF TEAM MEMBER SKILLS-PLAN:

After the recruitment period in early July, the team took advantage of the free time from the holidays and helped the new members to integrate:

- To reach ***Entry-level***: By the beginning of September, we helped the new members to familiarize themselves with the **FIRST values**. In this regard, we distributed some materials and offered them the opportunity to come to the BTC competition to see how it is conducted.
- To reach ***Mid-level***: On September 9, we had a **meeting with the whole team**: we organized our activity for the following weeks. The new members of the engineering department worked in parallel and under the guidance of the old members: they assembled the goBILDA set
- To reach ***Senior-level***: Until January, the new team members can **develop their skills** by collaborating with last season's members, alumni, and mentors. The previous team assigned tasks in TeamGantt, and after completing them, new members uploaded images for review. The experienced members then offered feedback, helping newcomers track their progress and understand what to improve.
- To reach ***Leadership Strategic level***: On February 7th, 2026, several members of the RoboAS team took part in a **Design Thinking Workshop led by a certified coach**. We spent the day sharing ideas, working in teams, and, most importantly, learning how to communicate more effectively, both with one another and with the team's stakeholders, whether they are teammates, parents, companies, or mentors.

To ***communicate professionally in the Online Environment***: On March 5, 2026, several members of the RoboAS team took part in a **Social Media Workshop led by a certified coach**, where we learned how to promote ourselves more effectively, the importance of consistent posting, and the professional way to highlight sponsors. We discussed unitary branding, visual storytelling, content planning

EXAMPLES OF SKILLS & WHAT WE USE TO DEVELOP THEM:

- Marketing & PR department:
  - Grafic Design-Figma and Canva software
  - Content planning -TeamGantt software
  - External communication-emails, press releases
- Programming department:
  - Code testing & simulation-Java software
- Engineering department:
  - CAD design-Fusion 360 software
  - Mechanical assembly-goBILDA set

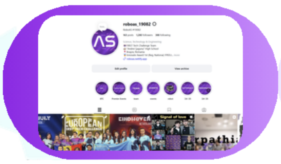
OBJECTIVES FOR SKILL DEVELOPMENT:

- **Fast and efficient integration into the team**: new members are guided to understand the structure, rhythm and values of the team, so that they can actively contribute from the first weeks.
- **Team continuity**: new members are trained to reach the level of experienced ones, and subsequently to pass on knowledge, ensuring sustainability for future generations.
- **Training a competent person**: developing skills applicable in everyday life, transforming the experience in the team into a basis for the development of a solid career.

MEDIA VISIBILITY AND PROMOTION:

We have constant appearances in **the local press in Brașov**, in publications such as BizBrașov or Bună Ziua Brașov, where our projects and events are presented. An important example is the article about the Carpathian League Meet, the competition we organized in Brașov, the first event of this type ever hosted in the city, marking a significant moment for our community.

To raise awareness about FIRST and STEM, our team's three leaders were invited to speak on a **local radio program in Brașov**. They shared insights about the competition, the impact of robotics on youth development, and how FIRST inspires innovation and teamwork. After the FPEEU, we were invited back for a second appearance, continuing our mission to represent FIRST and expand its presence in Romania.



We use the **YouTube, Instagram, Facebook, Linkedin and TikTok platforms** to document the important moments, transmit the team's energy and reach as many people as possible. We also thank the sponsors and partners who support us and make each experience possible.

Team #19109 RaSky invited us to participate in filming **a podcast**, following the league meet we organized and attended. In the discussion, we addressed the experience of coordinating such an event, the successes of last season and the important moments from the European Premier Event. The podcast featured the leaders of each department, offering different perspectives on the team's activity.

ROBOAS Connect

DEVELOPPMENT CONNECTIONS WITH STEAM COMMUNITY-EVENTS:

NVENT VISIT

Strengthening ties with industry sponsor: nVent

15 YEARS OF FORD BRAȘOV

Presenting our team at a business event organized by Ford

DEMO METAL

Our stand at a technology and innovation fair where large companies in the automation field come

SIEMENS VISIT

Strengthening ties with industry sponsor: Siemens

PREPARING FOR THE FIFTH EDITION OF THE PAPER AIRPLANES EVENT - 13.06.2026

The event organized with the Kronbot team and supported by "Round Table" association will take place on June 13. This year, we aimed to organize a bigger event and promote it in advance. The event has a charitable purpose of raising funds for the city's two robotics teams.

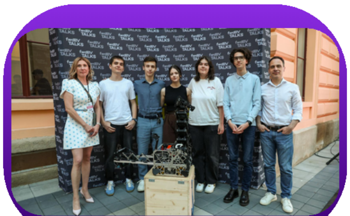
In addition to the paper airplane contest, this year we prepared:

- **artistic moments**: we invited artists from Brasov to sing
- **workshop** to build robots that will be able to follow a route with color sensors
- **raffle** with prizes such as a paragliding flight, a bicycle and Lego sets

To promote the event, besides posting on social media:

- we went to **Radio Brașov** to have a discussion
- we had a **stand at "Brașov Marathon"** (one of the largest and most appreciated mountain running events in Romania - 28, 29 May) where we had the chance to invite all the marathon competitors to come to "Paper Airplanes".

CONNECTING WITH BUSINESS - 22.06.2025



fwdBV Talks: fwdBV Talks is the event through which the Forward Brașov business magazine brings together leaders of the local economic community twice a year, in partnership with Transilvania University of Brașov. RoboAS was present, having the opportunity to show how alternative education takes shape in FIRST Tech Challenge competitions and how high school students develop advanced technical projects and essential skills for the future. The discussions highlighted the impact of these programs on the training of young people. For the business environment in Brașov, the event was an opportunity to connect with the generation that shapes the future, a generation prepared with solid skills and a mature technological vision.

PROFESSIONAL RECOGNITION:

ASOCIAȚIA GENERALĂ A INGINERILOR DIN ROMÂNIA

Premiul Special AGIR 2024

Secțiunea Ingineria construcțiilor de mașini

Se acordă realizatorului

Echipa de Robotică a Colegiului Național „Andrei Șaguna" din Brașov

Mentor Radu Meșa

pentru lucrarea

ROBOTUL DE COMPEȚIE ROBOAS 19082

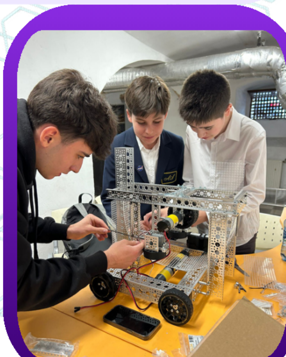
12 septembrie 2025

Președinte, Mihai MIHĂIȚĂ

In 2025, our team received the **AGIR Special Award, granted by the General Association of Engineers of Romania** — one of the oldest engineering organizations in the country, founded in 1918. The distinction was given for the robot from the last competition season in the Machine Construction Engineering section. This appreciation highlights the progress of the members of the engineering department and contributed to the team's interaction with specialists in the field of engineering.

FUTURE PLANS:

An important goal for **the development of the club is to form TWO DISTINCT TEAMS** starting with the next competitive season: one made up of students aged 13–15, and the other of students aged 15–18. In this regard, we have also opened the club to middle school students, so that they can become, next year, the core of the 13–15 team. The decision to allow **middle school students to join the team** is intended to prepare them in advance and give them the opportunity to understand what FTC means. Early exposure to team activities helps them become familiar with the processes, so they become much better prepared active members and capable of achieving superior results. They come to the lab in order to learn from those with experience and come to competitions to understand what participation in FTC entails.

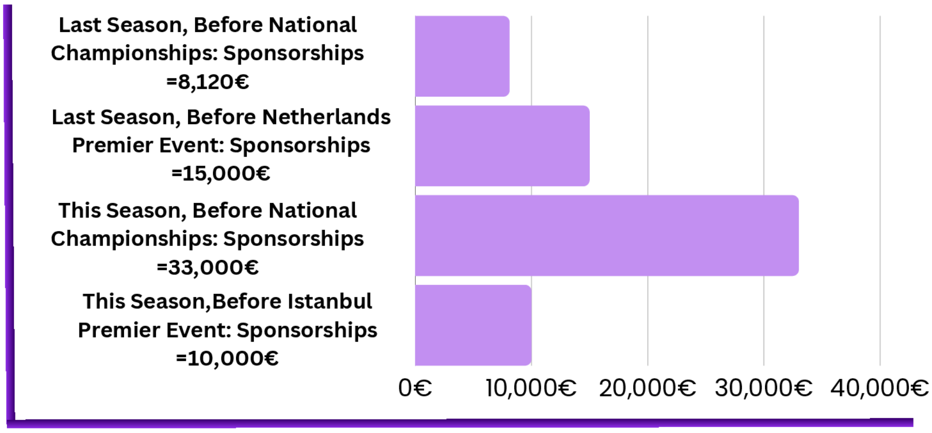


ROBOAS Sustain

FINANCIAL SUSTAINABILITY PLAN:

Sponsorship strategy:

- *Followed up* with companies via email
- Presented team, learned about companies and *proposed partnerships* at events where there were companies.
- We *visited the headquarters* of several companies and had *direct discussions* with their representatives to obtain sponsorships and strengthen strategic partnerships **(nVent visit, Siemens visit, "Masa Rotundă" association visit, "Apa Brasov" Company visit, Autoliv visit)**



- We *invited our sponsors to participate in the Carpathian Robotics League Meet organized by our team and the National Championship* to discover the atmosphere of FIRST competitions and how their support contributes to the team's performance.

SPONSORS & PARTNERS:

They directly contributed to the team's financial stability, supporting us in several essential objectives for the season. Through the sponsorships provided, we were able to cover important costs such as:

- purchasing parts and components for the robot, necessary for both construction and technical iterations during the season;
- purchasing promotional materials that help us represent the team and FIRST in a professional way;
- purchasing a starter kit for new members, facilitating their rapid integration into technical activities;
- improving the internal infrastructure through furniture, tools and other logistical resources;

LESSONS LEARNED:

This year, our team focused on improving our financial strategy to fully cover the costs of building a high-performance robot and to support the work with new members (purchasing a goBILDA starter kit for new members). Due to our performance last season, and by demonstrating that we are a hardworking and results-oriented team, we were able to obtain more sponsors. Thus, we learned that building solid and lasting relationships with our sponsors is vital for sustainable funding.

RAISING MONEY IN A SHORT TIME:

In the past two years, our robotics team has faced this challenge twice: in 2025, when we qualified for the Premier Event in the Netherlands, and in 2026, when we qualified for the Premier Event in Istanbul. We responded quickly, implementing a donation system on our website and promoting the campaign across all our social platforms. In parallel, we organized community events – such as the "First Steps in Robotics" activity in AFI Mall on June 1, 2026 – to showcase our work to the public and mobilize local support.

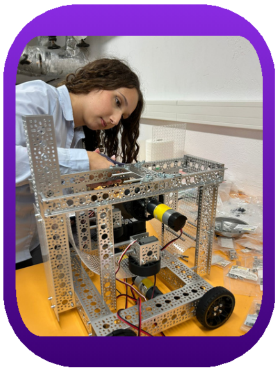
RELOCATION OF THE ROBOTICS LABORATORY:

The robotics lab has been relocated to a more spacious space, optimized for technical and collaborative activities. The new lab is equipped with **five completely new work tables**, configured so that **over 20 students can work simultaneously**, in parallel, without interference. The structure of the space allows new members to quickly join the workflow, benefiting directly from the support and expertise of experienced colleagues. This efficient organization supports hands-on learning, continuous collaboration and the development of technical skills. In addition, the lab offers dedicated areas for assembly, testing and storage, creating a well-structured environment. The relocation represents an important step in the evolution of the team and in the consolidation of its activities.

ROBOAS Sustain

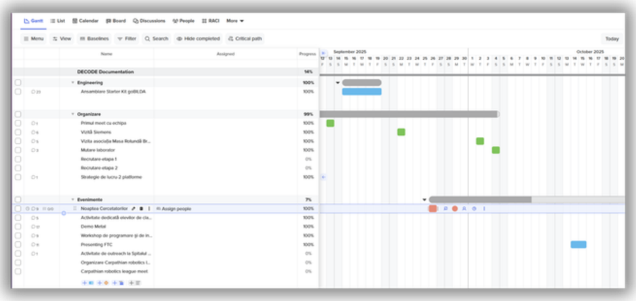
TASKS FOR NEW MEMBERS:

The rapid integration of new team members is based on their direct involvement in practical activities, guided step by step by experienced colleagues. This process accelerates learning, strengthens trust and collaboration. Each department has a clear role in this transition, offering concrete and relevant tasks for their development.



- Engineering Department — the new members assembled the goBILDA starter kit purchased especially for them, learning the basic mechanical structure of a robot and how to use the tools, under the supervision of experienced members.
- Programming Department — the new members tested code sequences directly on the starter kit, understanding the connection between software and hardware.
- Marketing & PR Department — the new members designed promotional materials and posts, respecting the requirements set by NATIE

ORGANIZATION OF WORK ACTIVITIES:



Managing an FTC team efficiently while building a robot is no easy task. To stay organized, we used **TeamGantt, a professional project management tool that generously offered us a free subscription of 500 EUR.** The platform allows for planning, scheduling, and tracking tasks in a visual way, and each member has direct access to active projects.

In TeamGantt, **we write down each task and assign clear responsibilities** to the people who need to complete them. This organization helps us to always know who is working on what and avoid overlaps or delays. For each completed task, the responsible members add a short summary of the work carried out and can upload relevant photos. This process not only provides a complete **picture of the progress**, but also helps us enormously when **drafting the official team documentation**, having already centralized information. Another important advantage of the platform is the possibility of **setting clear deadlines** for each task. TeamGantt gives us an overview of the entire season, but also detailed monitoring of each member, contributing to efficient coordination.
By using this tool, RoboAS was able to optimize its way of working, organize its activities in a professional way, and create a coherent workflow.

MANAGING TIME CONSTRAINTS:

Two identical platforms

Programming and engineering advance simultaneously

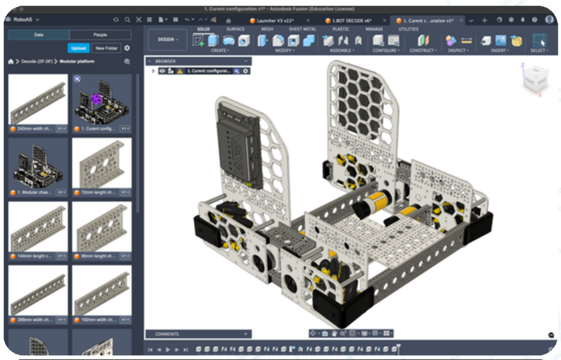
Validated mechanisms → replicated on the programming platform

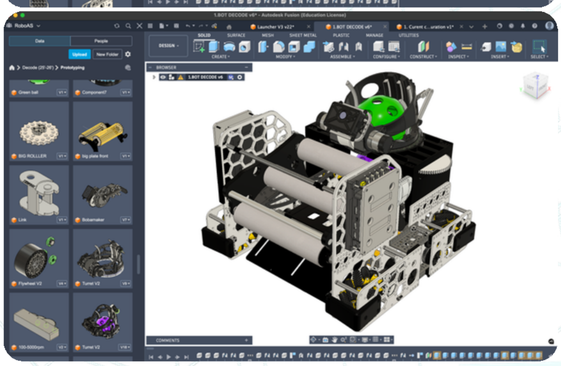
Rapid code testing on real assemblies

Reduced dead time + constant pace of progress

More stable, more tested, more competitive robot

RoboAS has optimized time efficiency by running programming and engineering activities in parallel. We use **two identical work platforms**, each with a clear role in the development of the robot: one for programming, the other for mechanical engineering. At the beginning of the season, programmers can develop trajectories and code, while engineering builds the physical mechanisms. After validating a mechanism, it is replicated and mounted on the programming platform, so that the software can be tested directly on a working assembly.





ROBOAS Innovate

ROBOT OVERVIEW:

- Tunnel-style double intake
- Locking mecanum drivetrain
- Smart transfer assembly
- Easy-to-maintain
- Double park capability

LEGOLAS:

Serviceability System

Two rear-mounted hinges allow the top plate — holding the sorter and turret — to pivot open for rapid access. This reduces repair time while preserving structural alignment.

Chassis

A rigid chassis built from interlocking plates and reinforced standoffs provides high torsional strength while remaining lightweight. The modular architecture ensures durability under defense and rapid maintenance between matches.

Double-Sided Intake

A pivoting pedal enables artefact intake from both the front and back without reorienting the robot, reducing cycle time. Conveyor belts then guide the artefact smoothly toward the launcher path.

Mecanum Locking Mechanism

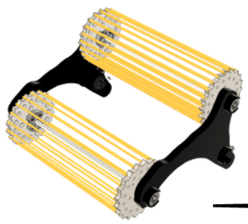
A servo-actuated string system deploys a 3D-printed locking element into the mecanum rollers, converting the drivetrain into temporary tank drive. This increases pushing power and defensive stability when needed.

Feed System

Spring-loaded pedal centers and regulate the artefact inside the robot before feeding it into the launcher. This ensures consistent alignment and reliable shot preparation.

Iterations

1st version of intake



unreliable and easily damaged

2nd version of intake

the pivot system had issues

3rd version of intake

problems with retrieving adjacent artifacts

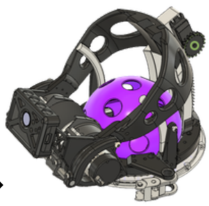
4th version of intake

reliable and fast

1st version of turret

unreliable and not fast enough

2nd version of turret

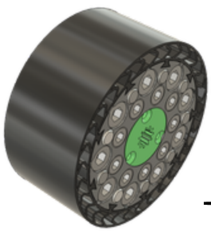


the frictions were too high and not precise enough

3rd version of turret

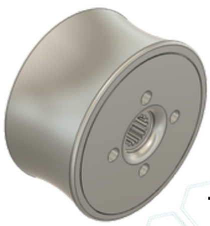
built for artifact variability and speed

1st version of fly wheel



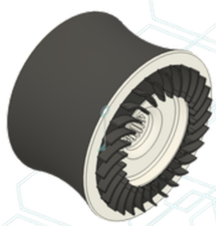
high friction due to the shape of the artifacts

2nd version of fly wheel



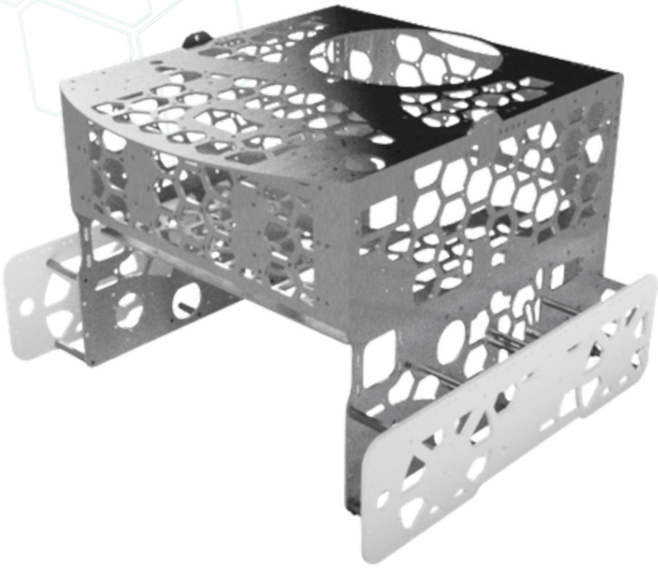
not concave enough and too light

3rd version of fly wheel



the concavity, cooling system, pivot system and weight give us precision and speed for each artifact

The Chassis



Our robot is built on a rigid, competition-optimized chassis weighing approximately 3 kg. The structure uses interlocking aluminum plates combined with reinforced mounting points to create a torsion-resistant frame.

To maximize durability during high-contact matches, we integrated:

- Structural interlocking plates for load distribution
- Reinforced joints to reduce flex under defense
- Standardized standoffs for modularity and serviceability

This hybrid plate-and-standoff architecture ensures:

- High structural rigidity
- Fast maintenance and part replacement
- Consistent drivetrain alignment

Locking mecanum - mechanism

While mecanum wheels provide excellent omnidirectional mobility, they are inherently weaker in defensive pushing situations due to the free-spinning rollers. During high-level matches, this makes the robot easier to push and reduces defensive capability.

We engineered a mechanical locking system that transforms our mecanum drivetrain into a temporary tank drive.

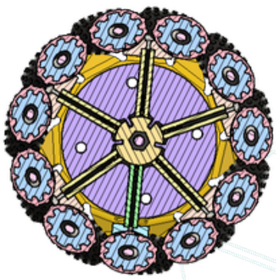
Strategic Advantages

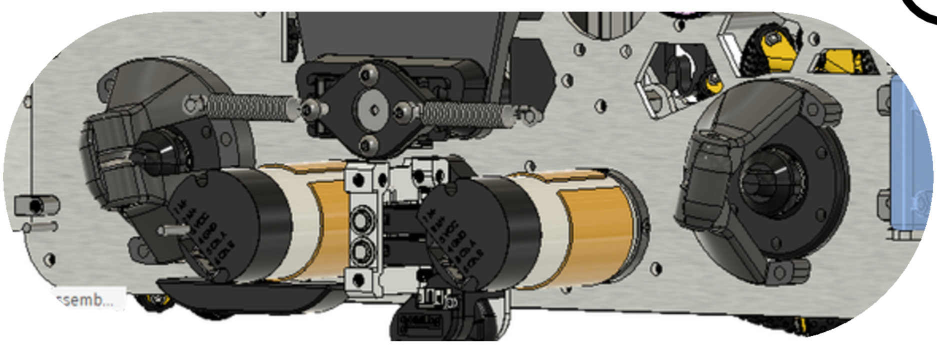
- Increased pushing power during defense
- Reduced lateral sliding when being pushed
- Improved stability during precision scoring
- Ability to switch dynamically between agility and traction

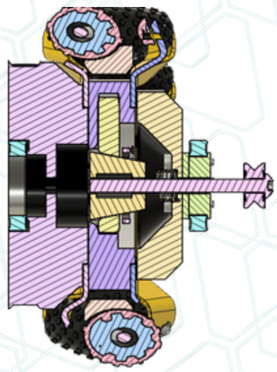
How It Works

- A servo motor actuates the system.
- The servo pulls a tensioned string linkage.
- The string drives a custom 3D-printed locking element.
- The locking element is pushed into the mecanum rollers.
- Once engaged, the rollers can no longer rotate freely.
- The wheel effectively behaves like a traction wheel.

When disengaged, the system retracts, restoring full omnidirectional capability.





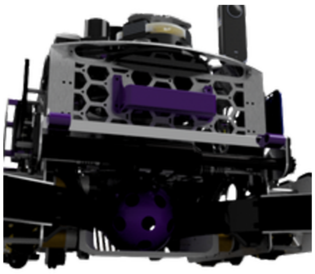


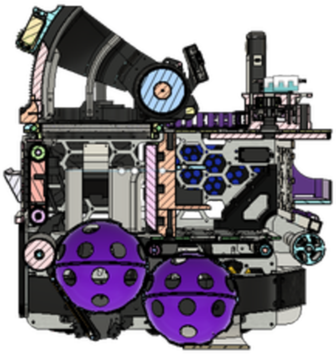
Dual-Direction Intake System

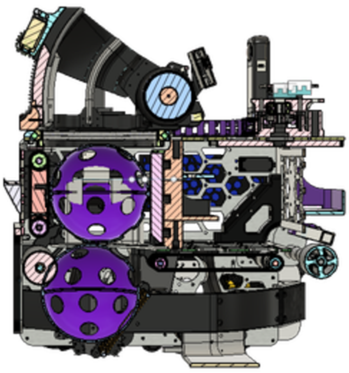
To maximize cycle speed and reduce repositioning time, we designed a double-sided intake system capable of collecting game elements from both the front and the back of the robot without turning.

This allows us to:

- Collect artefacts while retreating or advancing
- Reduce dead time caused by drivetrain reorientation
- Maintain continuous gameplay flow







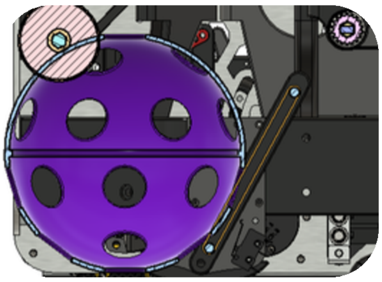
Pivoting Pedal Mechanism

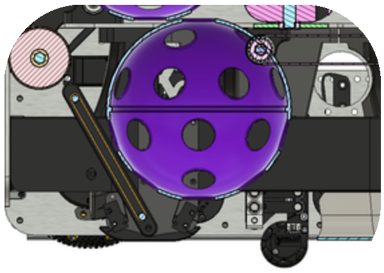
At the core of the intake is a pivoting pedal assembly that automatically adapts to the direction of intake.

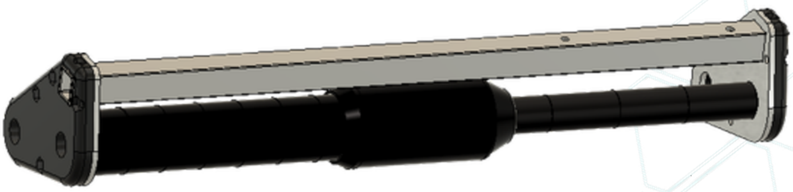
Operating Principle

- When intaking from the front, the pedal pivots backward, allowing the artefact to enter the system.
- When intaking from the rear, the pedal pivots forward, performing the same function in reverse.
- The pedal acts as a passive directional gate, ensuring smooth entry from either side.

This bidirectional geometry allows a single mechanism to function symmetrically, reducing weight and mechanical complexity.







Once the artefact enters the intake:

- A system of conveyor belts transports the artefact inward.
- The belts maintain constant contact with the game element.
- The artefact is guided toward the launcher path with controlled compression.

The conveyor system provides:

- Consistent artefact velocity
- Reduced jamming probability
- Controlled feeding into the scoring mechanism

The intake roller features a variable-diameter geometry designed to efficiently handle multiple game pieces in sequence. The largest diameter section engages the first game piece, generating the highest surface speed and pulling force. As additional game pieces enter the intake, the medium-diameter section controls the second piece, while the smallest diameter section accommodates the third. This creates a natural spacing between game pieces, preventing jams

ROBOAS Innovate

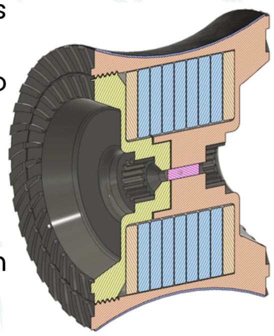
Turret Assembly

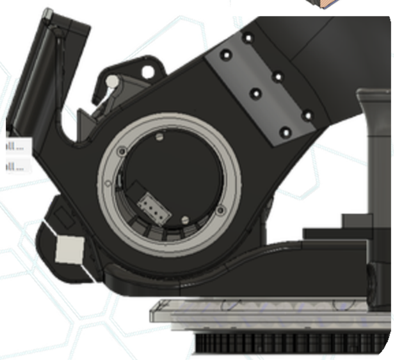
Our robot features **a fully 3D-printed turret** assembly designed for lightweight construction and geometric precision.

Custom 3D-printed flywheel

The flywheel is 3D printed with a special concave shape matching the artefact radius.
The goal is to maintain high contact area for maximum grip **without deforming the artefact** as this creates unwanted variations in launch velocity.
It is built with 9 embedded steel washers into the main body achieving a mass of **612g.**
The high mass provides:

- Increased rotational inertia
- Reduced RPM drop during firing
- More consistent exit velocity between consecutive shooting sequences





Dynamic Tolerance Compensation Mechanism

Game elements are not perfectly spherical. Variations in shape and surface irregularities can cause:

- Inconsistent compression
- Uneven pressure distribution
- Energy loss due to micro-gaps between artefact and backplate

Solution

We implemented a spring-loaded flywheel compliance system.

- The flywheel assembly can translate slightly when an artefact enters the shooter.
- A calibrated spring applies constant normal force.
- The mechanism automatically adjusts to artefact irregularities.

This ensures:

- Constant pressure on every shot
- Uniform contact with the backplate
- Minimal energy loss due to inconsistent compression
- Reduced shot-to-shot velocity variation

Instead of forcing the artefact into a rigid geometry, the system adapts dynamically.

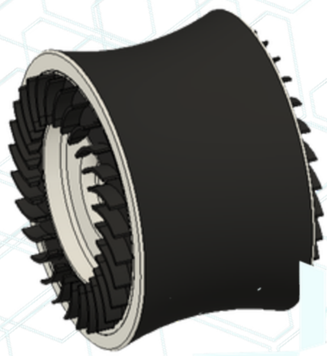
Active Motor Cooling System

When the flywheel spins at high RPM:

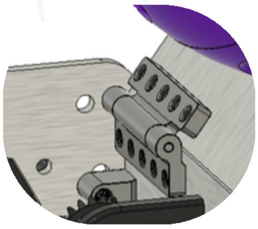
- The rotating mass induces **localized airflow.**
- A slight pressure differential (micro-vacuum effect) is created inside the turret housing.
- Air is drawn across the motor surfaces.

This embedded cooling system:

- Reduces heat buildup
- Increases motor efficiency **during extended shooting cycles**
- Improves thermal consistency



Hinged Upper Assembly



The top plate, which supports both:

- the sorting mechanism, and
- the turret assembly,

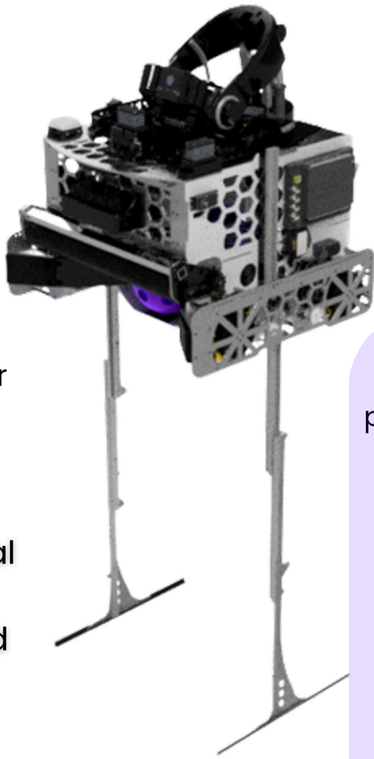
is integrated into this hinged system.

How It Works

- The top plate is secured with a small number of accessible screws.
- When maintenance is required, these screws are removed.
- The hinged mechanism allows the entire upper assembly to pivot upward.
- Internal components become immediately accessible.

This transforms the robot into an “open-book” configuration for servicing.

Power Take-Off (PTO)

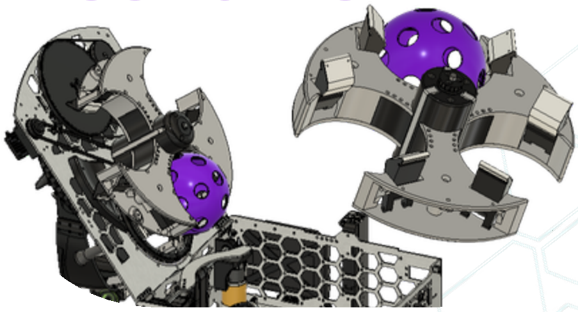


To maximize motor utilization and reduce overall system weight, we implemented a Power Take-Off (PTO) mechanism that redirects drivetrain power to actuate our endgame extension system.

This allows us to:

- Avoid dedicating additional motors
- Reduce electrical load and wiring complexity
- Increase mechanical efficiency

Sorting mechanism



After extensive testing, we decided to remove both the sorting mechanism and the double-park system. The sorting mechanism increased cycle times and could not guarantee perfect separation of game pieces, making it less effective than simply scoring quickly. The double-park concept was also abandoned because it introduced additional complexity and risk for a relatively small reward. Instead, we adopted a fixed storage slot and added multiple limit switches to provide reliable game-piece detection and eliminate issues caused by occasional proximity sensor misreadings. This resulted in a simpler, faster, and more reliable robot.

Tele-Op

One Mind, One Machine - A single driver commands the robot

This season, we adopted a single-driver software architecture to peak operational speed and improve coordination on the field. In order to maximize scoring potential, the robot remains intuitive and easy to control due to well-structured button mapping and logical flow. Throughout the match, we reduce the workload on the driver through automated sequences. In addition, we implemented advanced control systems to ensure smooth, precise mechanism movement, along with complementary fail-safes to maintain reliability.

Using **Command-Based Programming**, we developed automated robot actions for the Intake and Outtake mechanisms, as well as for the transfer between them. With this design pattern, the robot executes groups of commands completely independently, without requiring multiple driver inputs, making it very easy to operate.

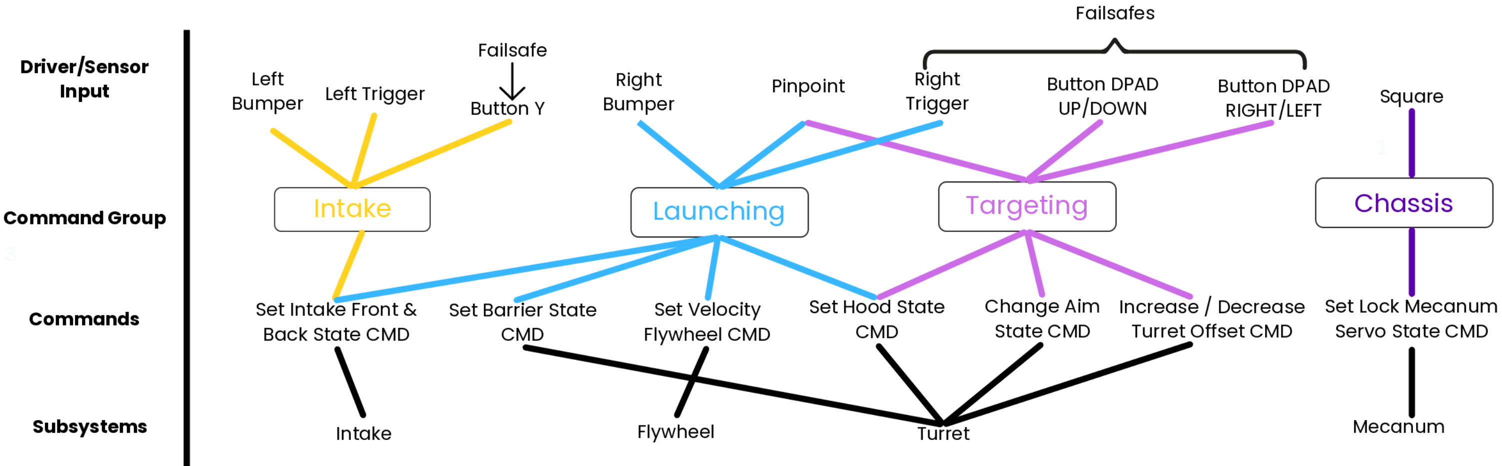
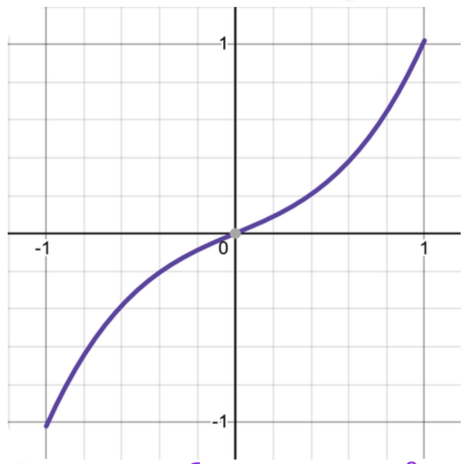


Diagram – Brief explanation of how we implemented Command-Based programming on our robot

Non-linear Power Adjustement



To achieve smoother, more precise control of the Chassis mechanism, its speed is adjusted using the following cubic polynomial function:

$$f(x) = (x^3 + 0.7x) \times 0.6 \quad \text{where } x \text{ represents the joystick input}$$

Unlike a linear control approach, where motor power is directly proportional to joystick input, this function improves precision by creating a smoother transition between low and high speeds. Small joystick movements correspond to finer, more controlled adjustments, while higher speeds are only reached with more significant joystick input.

The Art of Automation

Highlighting the most important driving features

Sensor-Fused Targeting

The robot can shoot from any position on the field by calculating the target angle for the turret every loop, using Pinpoint or Limelight correction.

Automated Launching

Getting the flywheel to the target velocity and the transfer from intake to launcher happens on the press of a button for ease and speed of use.

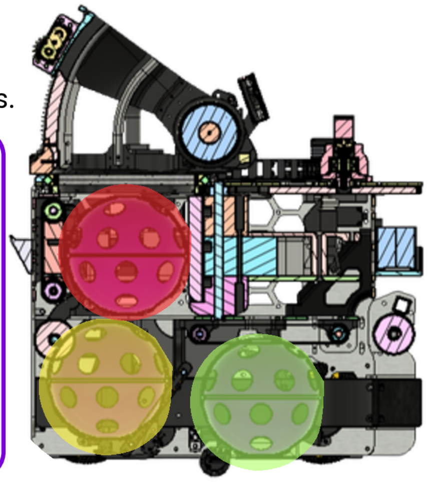
Kinematic Hood Positioning

Our Distance-Based Hood Adjustment uses real-time distance calculations with Pinpoint data to map the robot's coordinates to a precise servo pitch ratio. This continuous kinematic adjustment transforms every position on the field into a viable scoring location, so the driver can maintain focus on high-speed maneuvering.

ROBOAS Control

The Art of Automation

Secure On Contact - Automating The Double Intake



Due to our robot size, in order to eliminate the risk of controlling more than three artefacts, we developed an autonomous monitoring system that overrides manual input when needed based on real-time **sensor** and **limit switches** reads.

We use a triple sensor array to check if the three artefacts have reached the placement needed before launching, mapped across three primary zones:

- Zone 1 (Lower Entry): Limit switches below the horizontal belts detect the presence of the final artefact when intaking from the front.
- Zone 2 (Mid-Transition): Vertical limit switches verify when an element is properly seated on the pivoting pedal, and whether it was acquired from the front or back of the robot.
- Zone 3 (Upper Chamber): Proximity and color sensors detect the presence and hue of the highest-placed artefact before it reaches the launcher.

When the zone count reaches three (all artefacts are in place), the system automatically initiates a brief reverse sequence to account for intake intertia and eject any excess fourth artefact, and shuts down the intake motors.

To keep the driver informed, the LED on the top of the robot turns Blue once the robot is at capacity, signaling to immediately move to an outtake position.

Improving Loop Times

Hardware Caching & Bulk Reading

Communicating with hardware is expensive for the CPU. We reduced this overhead through:

- **Manual Bulk Reads**: Instead of querying hardware one by one, we read all Hub pins together at the start of each loop.
- **Signal Throttling**: We implemented **caching** that only sends new power or position commands to motors if the target value has actually changed.

On-Demand Sensor Processing

Sensors are only active when they are needed.

Tasks such as color and proximity sensing, are only executed while the driver is actively intaking.

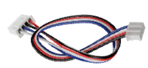
When the robot is simply driving or aiming, these resources are reallocated to the drive train and turret, for maximum **smoothness** and **precision** at all times.

Sensors Used:

Odometry Wheels - Calculate the X and Y Positions of the robot

IMU - Track the heading of the robot

REV Through Bore Encoder - Accurately track the angle of the turret



Motor Encoder - Read the velocity of the flywheel

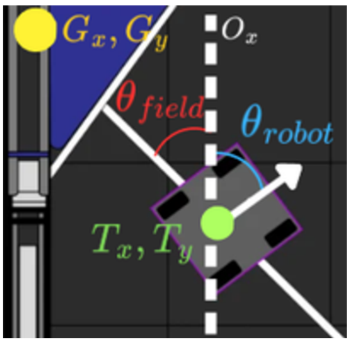
Camera - Fiducial ID detection

Limit Switches - Check whether or not artefacts have reached shooting position

Color Sensor - Failsafe the Proximity Sensor

Proximity Sensor - Check if an artefact has reached the first shooting position and decide whether to sort or not

Programming The Shot



1 The Turret

The Turret subsystem synthesizes field positioning and vision data to ensure the launcher remains physically locked onto the goal, regardless of chassis movement or orientation. Below is the explanation for the **main Aim Mode** of our turret, based on **Pinpoint** odometry.

For maximum precision, we transform **Robot coordinates** to **Turret coordinates** by decomposing the distance between their centers based on θ_{robot} as follows:

$$T_x = R_x - distance \times cos(\theta_{robot}) \; and \; T_y = R_y + distance \times sin(\theta_{robot})$$

This image demonstrates the automated coordinate transformation used to resolve the turret's target heading:

- Field-Centric Goal Angle: The robot uses its Pinpoint odometry to calculate the angle between its current (Tx, Ty) coordinates and the goal's fixed position (Gx, Gy). This is determined using the inverse tangent of the coordinate delta: $\theta_{field} = \operatorname{atan2}(G_y - R_y, G_x - R_x)$
- Chassis Heading Correction: To determine the local turret angle, we must account for the Robot Heading θ_{robot} provided by the IMU. The relative target angle is normalized to ensure the turret takes the shortest path:

$$\theta_{target} = \text{normalize}(\theta_{field} + \theta_{robot}) + \text{driverOffset}$$

For **shoot on the move on the turret,** in order to find the angle at which the turret has to aim, we can think of θ_{target} and the distance to the target as a vector. We will also be working with the robot's velocity vector. The lead corrected aim vector will be: $\vec{A} = \vec{V_{robot}} - \vec{D}$. The aiming angle will be the angle of vector A. We detail the equations behind this predictive algorithm in the Team Notebook.

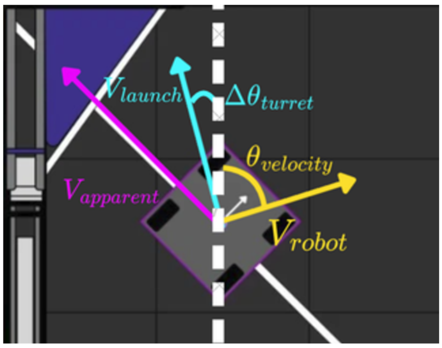


Diagram illustrating velocities we account for in the Shoot On The Move algorithm.

To expand this model, the system calculates a **virtual distance**, the length of vector A, which accounts for the **flight path distortion** caused by robot movement. The flywheel and hood loop uses $|A|$ to dynamically adjust motor velocity and counteract changes in forward momentum.
However, testing revealed a **mechanical impossibility**: our launcher's high rotational inertia requires extreme torque ($\tau = I\alpha$) to change motor speeds within a 120 ms chassis maneuver. This latency caused severe transient velocity deficits. Consequently, we **bypassed flywheel and hood Shoot On The Move adjustments,** leaving our rapid-response turret to isolate and correct angular drift instantly.

To maximize scoring speed and minimize mechanical wear, the turret never rotates more than 180° to reach a target. By applying **Angle Normalization**, the system continuously calculates the difference between the current orientation and the goal, snapping the target to the mathematically **shortest route**. It also ensures the target is always in range **[-90°, 360°]** required by mechanical constraints.

Once the turret's target angle is obtained, we use a **PID + kS Controller**. Maintaining a continuous lock during high-acceleration maneuvers requires a controller capable of instantaneous correction. We started with a PID Controller, but after testing we discovered it was not adjusting to finer changes in target angle, so we added a kS constant to compensate for static friction. The coefficients ***kP, kI, kD*** and ***kS*** adjust themselves automatically based on the current angle of the turret and the size of the error. This allows us to have aggressive values for large movements and gentler values for fine-tuning.

$$\text{Output} = k_P(\theta_{\text{err}}) + K_i \cdot \int \theta_{error} + k_D \frac{d}{dt}(\theta_{\text{err}}) + k_S \cdot \operatorname{sgn}(\theta_{error})$$

2 The Flywheel

The Flywheel subsystem is engineered to deliver high-accuracy launches by maintaining precise rotational speeds regardless of the robot's position on the field. By combining a closed-loop control system with dynamic data mapping, we ensure every shot follows a predictable and repeatable trajectory.

While a standard physics-based projectile motion equation can estimate **required exit velocity**, we chose an **Interpolated Lookup Table (InterpLUT)** for our implementation, because it provides a near-instantaneous result through simple linear scaling and it allows us to modify specific distances that might be inconsistent due to field layout or carpet friction, without affecting the rest of the curve.

The InterpLUT calculates the target velocity V_{target} by finding the **two closest pre-calibrated distance points** (d1, d2) and their corresponding velocities (V1, V2): $V_{\text{target}} = V_1 + (d - d_1) \cdot \dfrac{V_2 - V_1}{d_2 - d_1}$

The flywheel is regulated via a Velocity-Closed-Loop model designed for rapid recovery. We use a velocity constant *kV* to calculate the base Electromotive Force (EMF) required for a target RPM. This predictive power handles 90% of the workload, leaving the PID terms to manage disturbances such as an artefact being launched, returning our flywheel to the target velocity within milliseconds.

$$\text{Output} = k_P(V_{\text{err}}) + k_S \cdot \operatorname{sgn}(V_{\text{target}}) + k_V V_{\text{target}}$$

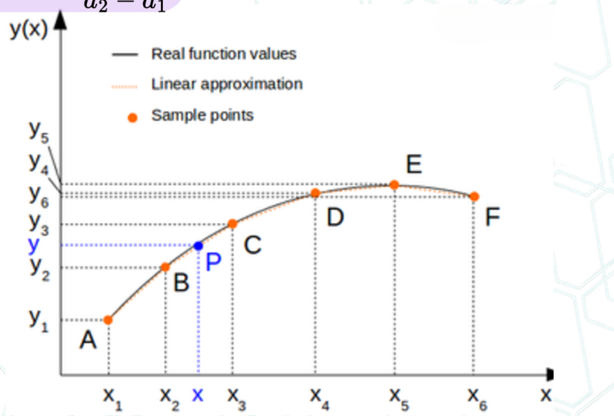
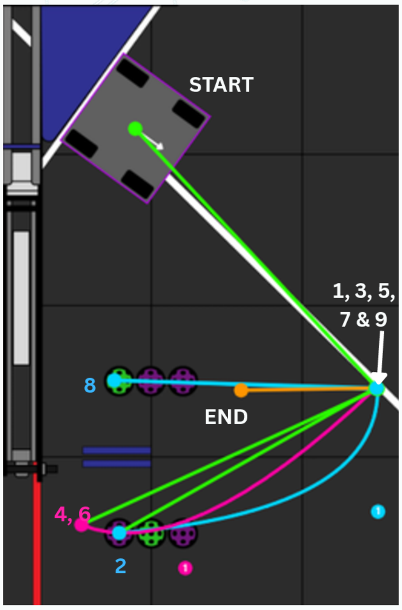


Diagram illustrating how InterpLUT works where X: distance and Y: velocity

Image Source: x-engineer.org

Autonomous

Strategy

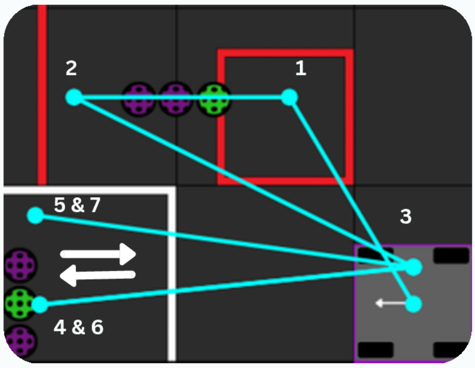


Near zone autonomies diagram

Our strategy in order to match our autonomies with the highest number of alliances possible was to maximize the number of artefacts without interfering with our alliance's half of the field. As such, our autonomous routine from the near zone **opens the gate 2 times**, for both our own scoring and the alliance's. After launching the preload and the two closest spikes of artefacts, we score **15 artefacts** in total

- → **paths to Outtake Point**
- → **paths for intaking rows of artefacts**
- → **paths for intaking from gate opening**
- → **path to Leave Point**

However, from the far zone, since our flywheel and turret allow us to be precise and fast, we run **four cycles** after launching preload and a row of artefacts, thus scoring 9 artefacts without a gate opening, or **18 artefacts** if our alliance opens the gate.



Far zone autonomous diagram

Why Pedro Pathing?

This year, given our time constraints and the need for a highly performant and consistent autonomous program, we chose Pedro Pathing, which stood out due to its Bézier curve generation, which enables smoother, faster, and more efficient trajectories than other methods. Unlike many pathing libraries, such as Road Runner, which rely on purely kinematic models and spline-based trajectory planning, Pedro Pathing optimizes for real-time corrections and fluid motion, making it a superior choice for our robot.

Failure Is Not An Option... But We Planned For It Anyway – Our Most Interesting Failsafes

Tele-Op

1. ***Field Resetting of the Turret -*** If large errors in targeting appear after autonomous to tele-op routine angle transfer or Pinpoint malfunction, driving the robot just above the gate (for near zone) or in the Observation Zone (for far zone) and pressing DPAD_UP or DPAD_DOWN respectively, will reset the Pinpoint and the targeting implicitly, recalibrating the turret for perfect aim.
2. ***Setting Maximum Velocity for Far Zone Launching*** - To compensate for Pinpoint distance errors that might return wrong velocities, the driver has the possibility to hold Right Trigger and set the velocity and hood to maximum, for a more reliable shot.
3. ***Driver Offset*** - In the event of small errors in targeting, the driver can micro-adjust the target angle, by adding or decreasing a certain number of degrees in order to center the turret. This is also used later in the match, after longer distances have been traveled.
4. ***Switch Aim Mode*** - If mechanical issues stop the turret from turning the full 450 degrees or the angle of the turret is offset too much to be corrected by the driver with the third fail-safe, instead of just resetting the turret using the second fail-safe, the driver also has a button that changes the aim mode from Pinpoint to Limelight, who detects the offset of the Fiducial IDs from the center of the Field Of View and then calculates the target angle, instead of relying on our own trigonometry.
5. ***Ejecting Artefacts*** - To prevent game elements blockages in the front intake, pressing button Y powers the motors in the other direction in order to "spit" the artefacts out, so the driver can reattempt intaking.

Autonomous

1. ***Trajectory skip*** - If intaking a row of artefacts during autonomous routines takes more than 2.5 seconds because the robot gets stuck, the robot corrects from the current position to outtake in order to continue along the trajectory.
2. ***Automated Intaking Sequence*** - In order to shorten intaking time as much as possible, we use the automatization from tele-op. When we read the limit switches and proximity/color sensors and they all return true values, it means the robot already has three artefacts and it can continue to the next path before reaching the exact end of the current intaking line.