

16818

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@hb16818

16818
**HYPE
BIRDS**

Team 16818

Engineering Portfolio

Mexico City | Tlalpan | 2025-2026



FIRST® Championship

hypebirds.com

Who are we?

Hype-Birds was founded **7 years ago** looking for a **community** that focused not only in **robots**, but the **future of our planet**. Our objective is that **each member practices and develops new skills**. For this, we're divided in 6 different areas: **Media Finance, Eco-Birds, TototlKali, Inclusion,** and **Engineering**. Each one is focused on **inspiring a positive impact** in our team members and community.

Season objective

Our main goal this season was to **pull together new members** and push them to develop skills **within FIRST®**. We want to be a point of reference for **rookies** to learn that **inspiring others means more than robots**.

FIRST® philosophy

Within our team, we encourage **Gracious Professionalism**, so that we all work respectfully and always encourage ethical decision-making. At competition, we believe that **Coopertition** is fundamental to make the Mexican region we are a part of grow.

Core Values

Discovery	We follow a student-led philosophy that prioritizes problem-solving through experience and learning from our mistakes
Innovation	As a team we are committed to using technology to find innovative ways to integrate engineering strategies to support environmental causes.
Impact	We look to make a positive impact in our community, from Tlalpan to the rest of the world.
Inclusion	One of our team's areas is entirely dedicated to spread this value as it is essential to us to create a safe space for everyone.
Teamwork	We promote teambuilding activities on a monthly basis to ensure all members get to know each other.
Fun	We ensure that every event we participate, host or volunteer on is filled with dancing, laughter and cheers for everyone.

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Sponsors

Qualcomm

Grants



JABIL



TIMKEN



INTUITIVE Foundation™

Strategic allies

ROBOTIX Fundación



Tecnológico de Monterrey
Escuela de Ingeniería y Ciencias



PrepaTec

SOLATEC
Soluciones Láser y Tecnológicas

Donations



Hyper-Parents

Thanks to everyone who has helped us for making this season's **adventure** possible, we're so grateful to **explore** by your side!

Judged Categories Highlight

KEY

Page; Achievement

Team Attributes (TA)

Every award has an associated **color!**
(and icon)

Sustain 

Connect 

Reach 

3; We establish **team goals since** the beginning of the season.
3; Recruited **43 new rookies** for this season and the next one.
4; Raised **9,500 USD** for the season's expenses and gained **11 sponsors, grants and allies**.
4; Built a **PET recycler** that produces **filament** and a **solar charger** for FTC batteries.

5; Worked with **5 STEAM professionals** to develop team skills in both Tech and Non-Tech fields.
5; We have **6 FIRST® alumni mentors** that span across 3 universities and 5 different majors.
5; Organized the **first Robot-in-30-hours** in **Mexico**, which will take place **next Kick-Off**.

6; Make FIRST® accessible in **LATAM** by collaborating with 10 other teams **across the continent**.
7; Created an **accessible** in-web **scouting tool** for Spanish speakers and rookies members.
7; Provided **1200 menstrual products** to support m.e. FIRST®.
8; Projected to volunteer **4,771 hours** in **15 FIRST® events** this season.

Machinery, Creativity and Innovation (MCI)

Design 

Control 

Innovate 

10-11; Documented all **changes** made during the **season**, the good, the bad and the lessons learned.
11; Evaluate **strengths, threats and risks** of the robot and how to mitigate them.
12-13; **Design** mechanisms with **mathematical** backing.

14; Designed **analyses** to know which **challenges** to prioritize.
15; Implemented a **Kalman Filter** to **correct the robot's pose** mid-match.
15; Programmed autonomous trajectories using **motion-profiling** tools like RoadRunner and **Finite State Machines**.

11; We followed **two engineering philosophies** to arrive at our design.
12; We created the **M.U.R.O.** and the **P.E.R.A.s** to integrate a **defensive design** in the robot.
15; We added **haptic feedback** to achieve better driving, showing drivers the **state of the robot**.

Think Award



3; Each **team member** identified the **main goal** they wanted to achieve this season.
488; Recruited **99 people** into FIRST through **rookie recruitment** (43) and Event's **volunteering** (56).
5; Displays which abilities **we have learned** from each of our mentors and professionals.
11; Adapted our **Engineering Process** into a famous engineering philosophy called **SCRUM**.
12-15; Thoroughly calculated the **viability** of our robot both mechanically and control-wise with **maths** and **cost/benefits** analyses. All calculations were double-checked by **Dr. Nava**.

Season Timeline

April 2025 - May 2026 

Día	Key Events Season Plan
19/04	FIRST Championship INTO THE DEEP
22/05	FIRST Global Classification Event
29/08	Off-Season Hyper-Hurdle
06/09	Kickoff DECODE
22/09	1° Robot Iteration
15/11	2° Robot Iteration
22/11	Cuautitlán Regional
10/01	3° Robot Iteration
17/01	Monterrey Regional
07/02	Mexico Championship
02/05	FIRST Championship DECODE

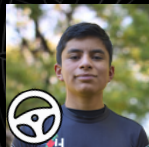
Día	Key Events Impact and Outreach
10/07	Astro-Birds Summer course
29/08	Hyper Hurdle Volunteering
11/10	Science Without Borders
10/11	GetUpTec
22/11	FIRST LATAM Project Launch
29/11	FLL CDMX Volunteering
06/12	FTC CDMX Volunteering
28/12	Global BirdWatch Web Launch
17/01	FLL Cedros Volunteering
25/04	FLL Nationals Volunteering
27/05	FLL Mexico Open Volunteering
23/07	FTC Premier Volunteering

Lessons learned:

After making it to **World's FIRST® Championship** last season, we learned that constant work and passion leads the way to success. 

Future plan:

We strive to keep **growing collectively** so we can **inspire** more people both in and outside of FIRST®. 

 Engineering Inclusion Eco-Birds Media Finances TototlKali Drive Team**ALFONSO - ROOKIE - 1ST YEAR IN FIRST**

I learned to program a robot in Java

- **Role:** Manufacturing & Build Team.
- ✓ **Goal:** Become the Mechanics captain.

**ISAAC - ROOKIE - 1ST YEAR IN FIRST**

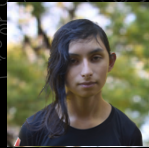
I learned to negotiate alliances with teams

- **Role:** Strategy & Scouting Lead.
- ✓ **Goal:** Develop improvements on Birdwatch.

**BRUNO - JUNIOR - 2ND YEAR IN FIRST**

I learned to use Roadrunner in autonomous

- **Role:** Autonomous & Controls Specialist.
- ✓ **Goal:** Become the Programming captain.

**SARA - JUNIOR - 2ND YEAR IN FIRST**

I learned to build a tank chassis

- **Role:** Manufacturing & Build Team.
- ✓ **Goal:** Train future rookies on engineering.

**AMANDA - SENIOR - 9TH YEAR IN FIRST**

I learned to lead a 50 people team

- **Role:** Team vice-president.
- ✓ **Goal:** Lead growth through strong teamwork.

**IAN - JUNIOR - 8TH YEAR IN FIRST**

I learned to validate the robot under pressure

- **Role:** Manufacturing. Build & Quality Analysis.
- ✓ **Goal:** Build reliable and tested mechanisms.

**CONS - ROOKIE - 1ST YEAR IN FIRST**

I learned to combine robotics with ecology

- **Role:** Eco-Innovation Lead. Scouting.
- ✓ **Goal:** Scale impactful green innovation.

**REGINA - ROOKIE - 1ST YEAR IN FIRST**

I learned to coordinate social projects

- **Role:** Outreach and Impact Lead.
- ✓ **Goal:** Develop eco-STEM experiences.

**DANY - ROOKIE - 1ST YEAR IN FIRST**

I learned to use financial statements

- **Role:** Finances. Interview. Scouting.
- ✓ **Goal:** Obtain a sponsorship for EcoBirds.

**MADDIE - ROOKIE - 1ST YEAR IN FIRST**

Learned to support emerging LATAM teams

- **Role:** LATAM Outreach & Coordination.
- ✓ **Goal:** Growth and sustain for LATAM teams.

**ALANIE - ROOKIE - 1ST YEAR IN FIRST**

I learned to document an event

- **Role:** Communications & Documentation.
- ✓ **Goal:** Strengthen clear team communication.

**LEO - JUNIOR - 2ND YEAR IN FIRST**

I learned to turn designs into performance

- **Role:** CAD Lead. Manufacturing & Build Team.
- ✓ **Goal:** Develop consistent robot execution.

**OSCAR - JUNIOR - 2ND YEAR IN FIRST**

I learned the importance of Inclusion

- **Role:** Team President. Inclusion Lead.
- ✓ **Goal:** Equity, belonging, and empowerment.

**MIKE - ROOKIE - 1ST YEAR ON FIRST**

I learned CNC while guiding kids

- **Role:** Manufacturing & Youth STEM Mentor.
- ✓ **Goal:** Inspire young learners through STEM.

**JOSUÉ - ROOKIE - 1ST YEAR IN FIRST**

I learned to perform under pressure

- **Role:** Diversity and equity Lead. Scouting.
- ✓ **Goal:** Grow analytical skills for strategy.

**PAOLA - SENIOR - 2ND YEAR ON FIRST**

I learned to establish goals and times

- **Role:** Electronics & Energy Systems Lead.
- ✓ **Goal:** Ensure an energy efficient robot.

Team sustainability plans

**By season**

Together we determined the specific **goals for the season.**

**By competition**

We updated our **portfolio and interview** with what we learned from judges and other teams.

**Monthly**

The board **reviews** the **progress** of social and robotics projects. Opportunity areas are **discussed.**

**Weekly**

Area meetings to provide **continuous follow-up** on each project.

**Day to day**

Work is done on **iterations** of the robot and projects are carried out.

Lessons learned:

Having clear goals and documenting them allows us to be aware of how and when they are achieved.

Future plans:

Facilitate communication between areas through a shared Notion.

Sustaining the team 16818

Rookies

At the beginning of each semester we go around our school, **presenting in classrooms, information sessions** and participating in **school fairs**.

- For this season and the next one, we had more than **80 interested people**, of whom 43 joined the team.



FIRST® Alumni

With over **65% of our team** graduating at the end of last season, we have the support of new mentors and supporters from a variety of fields! Currently:

- 11 studying **Engineering** Majors.
- 3 studying **Arts and Humanities** Majors.
- 1 studying **Business** Major.



Lessons learned:

The shortage of members at the start of the season motivated us to focus on supporting rookies, as we understood their importance in the sustainability of the team.

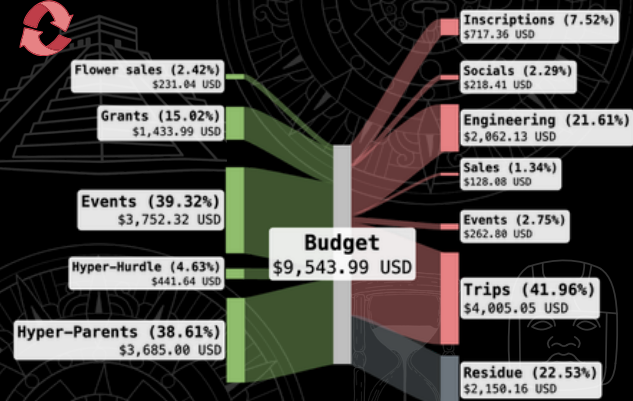
Future plan:

Incorporate rookies into the planning of events such as sales, so that they not only participate, but also suggest new ideas.

Finance and sustainability

This season our main sources of income were:

- Hardship and Intuitive Foundation Grant:** financial support from 5 companies for **1,600 USD**, used for the team's registration fees and electronics.
- Gene Haas Foundation Grant:** financial support for **2,000 USD**, used to pay the 75% of our **Championship enrollment fee**.
- Qualcomm:** financial support for **500 USD**, and the donation of 5 of their brand-new **RubikPi boards**.
- Get Up Tec:** we organized a student event at Six Flags Mexico that raised **3,796.88 USD** and was attended by 7,000 people. The funds supported our 2 regional events and **75% of the robot's materials**.
- Solotec:** a strategic partner for fast and free **MDF cuttings** for prototyping.



Team profit and expense diagram (August 2025 - March 2026)

- To replenish our cash, we organize bimonthly flower sales at our school, collaborating with **local suppliers** to optimize profits.

Lessons learned: The trip to the 2025 FIRST® Championship was not budgeted, which left us without sufficient funds to attend the Mexico Premier Event. This season, we effectively anticipated expenses by area and prioritized planned savings, creating a more sustainable and strategic financial model.

Lessons learned: Connecting with rookies in the field through business and personal finance training in partnership with a student finance group.

Future plan: To find a menstrual product sponsor for our participation in the m.e. FIRST® program.

Saving money by recycling

At Hype-Birds we value **sustainability in robotics**; that's why seek to **raise awareness** about its importance within the **FIRST® teams and our community**.

- We **converted 200 PET bottles** into **4 kg of PET filament** to print some prototypes of the robot, saving us approximately 90 USD across the building season.
- We **collaborated with Sustainable Development Engineering students** and their director, **Rubén Ahumada**, to **create solar chargers** for the robot's **batteries** that extended their lifespan and save us 15 USD per unit. It will be of **open source** for the entire FIRST® Community.

Future plan: Learn collectively with other teams by sharing our successes and failures.



Lessons learned:

Ecology combined with engineering allows us to create solutions and inventions that support our community.

Connecting with STEAM

The **Professionals** who shared their **experience** in the **industry**

B.A. Rodrigo Huerta, Professional, Teacher @ PrepaTec



- He has continuously aided the team and aims to become a team mentor next year.
- Taught us to maintain a consistent image on both our Engineering Portfolio and Interview.

Dr. Iyari Nava, Profesional, Researcher @ ITESM

- As a Ph.D. in Mechatronics, he did two visits to our workshop to see the robot, show us potential issues and ways on which we could improve mechanisms.

Dr. Crescencio García, Professional, Department Chair @ ITESM

- Gave us a Master Class on PID Control applications at a high school level.
- Led a VEX Robotics team in the past, and shared this experience with us.

Eng. Blanca Gomez, Professional, Project Manager @ Celeritech

- Taught us industrial techniques like SCRUM to work efficiently in our projects.
- Worked alongside us to create a season roadmap, prioritizing milestones for each month.

Dr. Rubén Ahumada, Profesional, Undergrad Coordinator @ ITESM

- Has guided us with biweekly meetings to develop a solar charger for our batteries.
- After meeting us, he became an FTC judge at our hosted Regional Event.

Our **coaches**, who together add up to **17 years** in FIRST®

Ma. Victor Gómez, Coach, Undergrad Coordinator @ ITESM

- Has been coaching FRC and FTC teams for 11 years, and as a robotics teacher and engineer, he helps us with the robot by applying what he knows has worked in the past.

Emilio Rangel, Coach, Robotics Engineer @ ITESM



- Team founder. He knows the team like the palm of his hand! He helps us with outreach projects, volunteering initiatives, and the robot.

Our day-to-day **alumni mentors**, present in **every meeting** and **project**.

Ramses Pérez, Mentor, Industrial Engineer at ITESM



- He mentors social media, the team's image, and taught us to manage our website.

Bernardo Guillén, Mentor, Comp Science @ St. Leo Univ.



- Leads Birdwatch, oversees the scouting team, and trains members.

Naty Hernández, Mentor, Sustainability Engineer @ ITESM



- Helps coordinate the EcoBirds projects and manages the portfolio.

Juan Álvarez, Mentor, Lic. Global Business @ ITESM



- Uses his theater experience to tell a story during the interview. Compass Award Submission.

Ximena Herrera, Mentor, Mechatronics Engineer @ ITAM



- Delivered 8 CAD training sessions for rookies this year.

Jorlen Moreno, Mentor, Robotics Engineer @ ITESM



- Leads the programming team, giving advice on algorithms for the robot.

Sergio García, Mentor, Mechatronics Engineer @ ITESM



- Uses his engineering and alumni experience to aid with EcoBirds and outreach projects.

Lessons learned: Not limiting our mentors to just former team members lets us find new points of view that enrich the team. Additionally, connecting with our school makes it so that more people get involved.

Finding new mentors

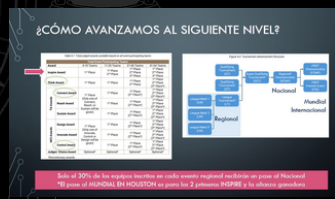
In addition to encouraging mentors to stay in the team even after they graduate, we have started to reach out for new mentors in the **STEAM community**. Examples for this are some of the professionals mentioned above, such as **Rodrigo Huerta** and **Blanca**, who will be our **coach** and **mentor** respectively starting **next season**.

Early training for rookies

Historically, the team has struggled to train the rookies recruited in **April**, in order to combat this, we organized the **first Robot-in-30-hours** event in Mexico alongside teams **21704**, **27976** and **31983**, which will serve as a first approach for our rookies in August 2026.



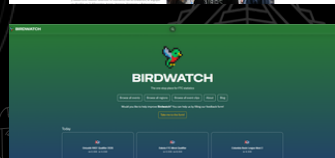
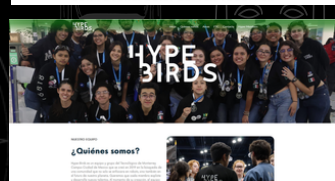
Dr. Crescencio



Dr. Nava



Dr. Rubén



Juan



Lessons Learned: Working with other teams allows for bigger initiatives. Also, it helps us all to grow as a team!

Reaching the Latin American Community

What is FIRST® LATAM?

When we went to FIRST® Championship 2025, we met members from **Team Imagineers 21539**, a team from **Venezuela** that shared their experience with us, as well as the struggles they faced in order to qualify. At the time, they had no regional competitions in their country and needed to **travel all the way to Italy**. This made us realize the **limited access that Latin American teams have** and motivated us to promote their presence through this initiative.

According to our **Birdwatch** data:

- **5 out of the 103** FTC regions are in Latin American.
- **11 out of the 338** FTC teams at Worlds are from Latin American.

Our 5 step Roadmap

Ambassadors

- Have at least 1 ambassador team per country.
- This allows us to contextualize ourselves with the issues in each country.

Establish projects

- Develop a work plan for the following quarter.
- We establish goals that meet SMART requirements.

Document and share

- Put down all findings into a blogpost in our website for other regions to follow.
- Get feedback from both ambassadors and other teams.

1

2

3

4

5

Focus groups

- We get in touch with ambassadors to find common issues.
- Make a list of priorities for projects and assign deadlines.

Continuos feedback

- We have monthly meetings with all ambassadors to share advancements and work on next steps.

North Star en Español | Recursos

Un centro de recursos guía para la próxima generación de innovación y competencia en FTC.

Traducido por 16818 HYPE-BIRDS (Translated by Hype Birds 16818)

Main initiatives

It is important for us to achieve the **widest reach possible**, and we have found that Latin American teams' main difficulties lie in the matter of **infrastructural and language-based barriers**. In pursuit of leveling playing field for FTC in LATAM, we developed the following initiatives:

- **Translating resources from team Curiosity 11770** from English to both Spanish and Portuguese to improve their accessibility. At the moment, we have **translated five documents** that teach new teams how to **build a robot**, as well as a how to **plan outreach** projects and get funding. We plan on reaching out to all LATAM PDPs to **share the documents with the next season's rookie teams**.
- **Developing an open source solar charger for FTC batteries**, which allows teams to charge their batteries even when national electric grids fail for long-term periods. The resources for teams to build their own chargers are **available in our website**. We prioritized **scalability and affordability**.
- **We developed an affordable FTC Game Field**, along its list of materials and manuals for teams to **build their own with accessible materials and for a price under \$250 USD**. Additionally, we encourage our ambassadors to donate 3 of these perimeters every season.

Current ambassadors and direction (FLL, FTC, FRC)

Each country gets assigned a coordinator, which encourages team members to develop leadership skills

VENEZUELA

21539, 21565

Focus on making **competitions accessible** for the region.

COLOMBIA

Team Jarvis

Building the **infrastructure** for the program in **FLL**.

MEXICO

9280, 9301, 28254, 23639

Building the **infrastructure** for the program in **FRC**.

BRAZIL

28778

Creating communication channels that go **beyond language**.

ARGENTINA

34143

Make the **community's** coding and building documentation **accessible** for rookie regions.

UNITED STATES

11770

Guidance from teams with similar initiatives in the past. (Curiosity's North Star project)

Lessons learned: Such a large-scale initiative taught us that being consistent and resilient with our work yields the results we seek.

Accessible and universal scouting: Birdwatch

Birdwatch is an application that we designed with the support of our programming mentor, **Bernardo**, inspired by The Blue Alliance (FRC Scouting site). It introduces an **innovative way to scout**:

- No other scouting platform that is **built for Spanish speakers**, making it both appealing and accessible for Latin American teams, where scouting as a concept is not as developed as in other countries.
- As it is a web page, it can be **accessed with any device at any moment without need for an account**.
- **Does a complete breakdown** of each robot in any given match or event from any region in the form of **detailed statistics and diagrams generated in real time** to ease the task of scouting.
- **Stands apart from other platforms** like FTCScout with features like predicting matches and playoffs results as well as the use of graphics and diagrams to showcase performance.
- Best of all, it is completely free and available world-wide!

It has shown incredible results!

- **Up to April, we have registered around 7,000 visits**, most of them coming from **Mexico, Romania and New York**.
- **This season, we managed to streamline the program to handle real-time data from up to 1,480 events**.

Future plans:

We want to continue translating Birdwatch as well as having a tool to compare regions.

Lessons learned:

Connecting programming with scouting demonstrates that it is useful for much more than just moving the robot.



Try it out right now!



TototKali: STEM for children

We **inspire children** to discover the world of STEAM through courses and hands-on activities. Our mission is to bring science and technology to **new generations** and introduce them to **FIRST®**. We adapted **NASA's AstroCamp** program and created **Astro-Birds**, impacting **25 children** over the summer.

Additionally, we have invested over **105 total hours** as **mentors** for the robotics team Revolution Bots (**FLL**) from the Technical Secondary School 183 in Jaltepec, State of Mexico, covering mechanics, programming, projects, and interviews. With their hard work and our support, they won the **Rising All-Star award** at their Regional.



#FIRST®LikeAGirl

We are proud to be **ambassadors for the 3rd year in a row**. Our goal is to invite **more girls** into the world of STEAM with events like the picnic at our Off-Season **Hyper Hurdle**, or the monthly posts we do in our Instagram, centering women in STEM as well as activities organized during competitions! With these posts, we reach **56k monthly viewers**, over 50% of which are women!



m.e. FIRST®

We provide free menstrual hygiene products at competitions as well as in our workshop, this promotes the visibility and well-being of menstruating people in the FIRST® community.

We provided products at 10 official competitions:
1 Off-Season, 5 regional, 2 national, and 2 international.
In total, we were able to offer approximately 1,200 free menstrual products.

Lessons learned:

Inspiring girls and women in STEAM goes beyond a social media post.

Future plans:

Connect with women in STEAM to give talks at our school.



Science Without Borders

We like introducing new people to the world of FIRST®, so we offered a **basic Arduino programming** course to more than **40 participants** from **Casa Frida**, a shelter for LGBTQ+ people who have been victims of violence. This way, **technology becomes more accessible** for everyone regardless of their context.

Hyper Hurdle 2025¹

We organize a yearly off-season competition to **encourage rookie members to participate** and give them a pre-season **introduction to FIRST®**. This year:

- We focused on reaching out to rookie teams, which resulted on **71% of the youth members attending** being **rookies** from teams all across Mexico.
- We implemented **changes to the challenge** so that teams would have the opportunity to **experiment with mechanisms inspired by past seasons**. In this case, throwable tennis ball-sized "artifacts" called debris.
- **We covered the registration fee for team 31609, who won our award for the most Graciously Professional team.**

Lessons learned:

The importance of giving rookies the opportunity to gain experience before the season.

Future plans

We plan to approach the Mexico Premier 2026 committee to plan the event together, given our experience.

FIRST Volunteering

One of our priorities is to **give back** to the FIRST® community which has given us so much, so volunteering is essential for our team. To expand this impact, we invited people **unfamiliar with FIRST®** to volunteer, allowing us to introduce new STEM professionals into the competition. In addition to the Hyper Hurdle 2025, we hosted and supported over 12 events:

Mexico City FLL & FTC Regionals²: We hosted and ran **2 events** at our campus, which combined received **59 teams** and had **83 volunteers** from our community. As part of an initiative to increase FIRST® awareness, **15%** of these volunteers (12)⁶ were approaching FIRST® **for the first time**.

FLL PDP Strategic Alliance: Additionally, we became **strategic allies** with Mexico's **FLL Program Delivery Partner (PDP)**: RobotiX's Foundation, which allowed us to serve as **key volunteers** and staff in several FLL events:

- We constituted **+60% of volunteers** in other **2 Regional Events³**. And invited 14 professionals⁷ from companies like **Oracle** and **Zebra** to volunteer as judges at said events.
- Additionally, we **supported other 5 Regional Events⁴** by arranging and building medals, trophies and other logistical materials.

Mexico Championship FLL CDMX³: This event gathered **over 60 teams** from public institutions from **20 states** in Mexico. The team helped volunteering for **all queuer and referee positions**.

Mexico International Open FLL⁵: Will take place at the **end of May**, and as part of our alliance with Mexico's PDP, they will **sponsor all travel fees** for 25 team members to serve as **key volunteers** at the event in the state of **Guadalajara**.

Mexico Premier Event FTC⁵: **Over 15 members have applied** to help organize and volunteer as queuers, referees and judges at the event. Additionally, we have committed to invite other 15 members from our community⁸ to know FIRST® for the first time.

In total, the team alongside 56 members from our community are projected to do around 4,771 hours of volunteering in FIRST® events by the end of the season.

Event	Volunteers		Total Hours
	Team	Community	
Hyper Hurdle 2025 ¹	27	5	546
Ran & Hosted Events ²	71	12 ⁶	1,224
Ran Only Events ³	25	14 ⁷	936
Supported Events ⁴	15	0	150
Intenational Events ⁵	40	15 ⁸	~1,375*
Hyper Hurdle 2026	~20	~10	~540*

* projected

Lessons learned:

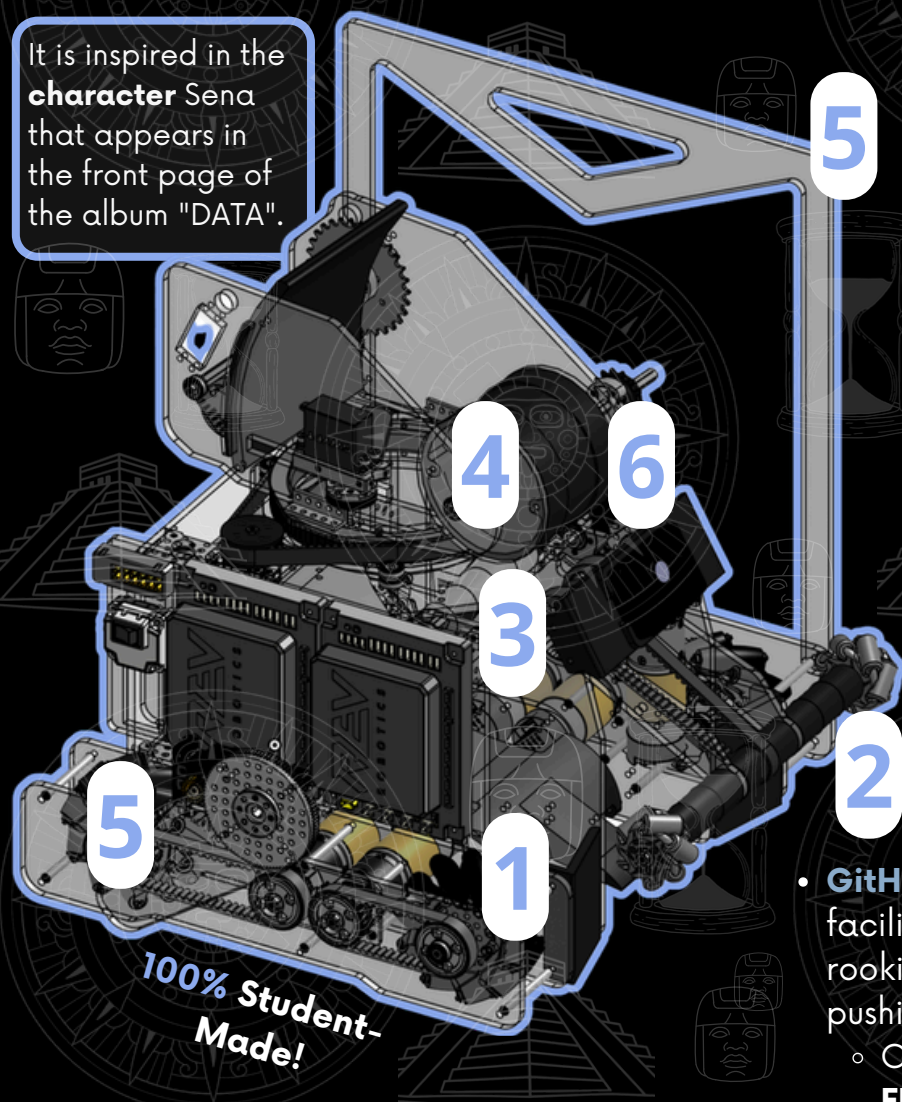
Organizing a lot of people can make our **individual efforts** result in a **collective success**.



Robot Engineering ⚙️

Hype-Birds is proud to present **SENA**: our most efficient, innovate and elegant robot to this day

It is inspired in the **character** Sena that appears in the front page of the album "DATA".



What sets us apart:

1. Completely **personalized** chassis made of polycarbonate.
2. Intake **inspired** from Australia's Finalist Alliance Captain, **team 14380**
3. Transfer of the game elements into our **270° turret** for constant shooting.
4. Shooter inspired **by former World Champions**.
5. **Passive Defense** elements and strategy (**P.E.R.A** and **M.U.R.O**).
6. **500g flywheel** to lose less power between shots and save battery.

Documentation and Collaborative Work ⚙️

- **Shared development log:** A OneDrive unit so that all of the team members learned about the engineering process.
- **GitHub Repository:** A historic file that facilitates the iteration logs so that the rookies have an opportunity to innovate, pushing them to create and collaborate.
 - Our repository is **publicly shared** so that **FIRST® Mexico** and **LATAM** communities can benefit from these.

Commitment with Design Standards ⚙️

This season, our top priority was to follow a thorough design process and build a robot focused on **functionality**, **strategy**, and **efficiency**. Using engineering methodologies such as **SCRUM** and **MoSCoW**, we ensured every part of SENA was intentionally designed and carefully built.

We've reflected this work throughout this document, but we invite you to **visit our pit** to see the real thing.

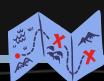
Fast-Working Techniques ⚙️

As a team we have **3 key strategies** that helps us prototype and iterate as fast as possible. Said strategies align with our **design standards**:

1. Every iteration has to have a **CAD** before machining to reduce waste.
2. Every part is first cut in **MDF** to ensure it works.
3. The **router CNC**'s main priority is to develop prototypes.

Lessons learned: A methodology that prioritizes order and priorities allows to develop the robot quickly and with a clear plan for development.

Future plans: We want to use versioning tools in CAD and conduct a workshop on best practices for GitHub, such as knowing when to commit.



The Evolution of SEVA in the Season 16818

Changes made

Kickoff → Cuautitlán Regional

- + We added a **variable angle** to not depend on the velocity of the motor when shooting.
- + We added the **M.U.R.O** to have a passive defense element.
- ↑ We increased the velocity of the **shooter's motor** from 435 RPM to 1150 RPM.
- We changed to 6mm polycarbonate for **mechanisms** with higher stress like the shooter or the turret.
- We changed the design of the **ramp**: made it completely solid to ensure the artifacts didn't jam.

Analysis of the changes

What worked:

- We got to the shooting velocity **faster**.
- **None** of the artifacts got **jammed** in the ramp during the regional.

Needs improvement:

- The variable angle causes the balls to **bounce off** the goal.

■ Secs. to get to max. velocity ■ % of artifacts bounced



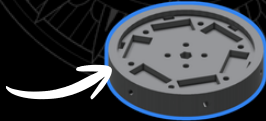
Lesson learned:

- Passive defense is more useful than active. Velocity is a priority.

Cuautitlán Reg. → Monterrey Reg.

- + We added the P.E.R.A.s to **stabilize the robot** when shooting and save **space** when we park.
- + We added a **flywheel** to decrease power lost to every shot, this was useful for a more reliable Auto.

Slots for weights!



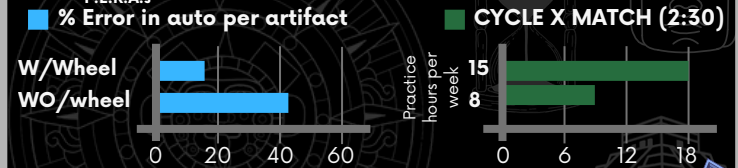
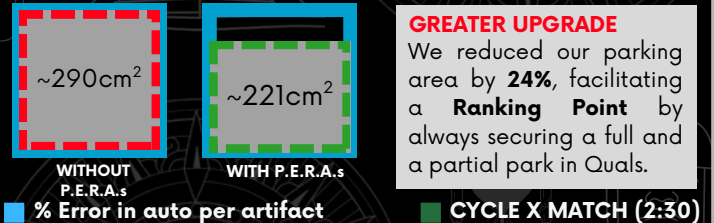
- + We added a **physical limit** to prevent artifacts from escaping through the shooter while we gather them.
- + We added a dead sprocket to the trigger chain to prevent power loss due to vibration.
- + We added a **Servo Hub** so that the servos have 6A, increasing their torque and usability.
- ↑ We increased the rotation range of the **turret** to 180°.
- We changed the **shooter wheel** to a harder one.
- We remade the **turret** increasing its thickness and changing the position of the servos.
- We removed the **variable angle**, since the balls hit it with more force and caused them to bounce off the goal.

What worked:

- The robot's vibrations lowered.
- Using a **hard tire** allows us to easily vary the compression of the shooter.
- The **autonomous** is more reliable because it doesn't lose as much power.

Needs improvement:

- When we shot an artifact sometimes the physical stop caused them to shoot with rotation, which modified the trajectory of the first artifact.



Lessons learned:

- Practice is as important as the robot's development.
- We must prioritize **strategies** that earn Ranking Points.

Monterrey Reg. → Mx. Championship

- + We added a teflon tape covering in the **turret** to expedite the artifacts movement.
- + We improved the **intake** design by moving the collection wheels 10 mm further on.
- We changed the **ramp** to make it closer to the ground.

We observed that a **big bottleneck** was our drivetrain's **low speed**, therefore:

- Our **wheel's rollers** are now made from 30A rubber, which makes them faster due to them adhering to the ground.
- We changed the **chassis motors** from 312 RPM to 435 RPM.

What worked:

- The chassis **velocity** increased drastically.
- The artifacts tend to **jam** less inside of the robot.

Needs improvement:

- The rubber rollers **wear** out much faster, will change them after Worlds.



Lesson learned:

- The baseline for the performance of a robot is the chassis.

Mx. Championship → FIRST® Championship 1st Month

- ↓ We further decreased the **dimensions of the chassis** to maximize our intake length on the front of the robot.
- ↑ Increased the **range of the turret** to 270° by using belts, bearing blocks and custom pulleys.
- + We implemented **TPU indexing blocks** for better intaking and **shock absorption** for contact with field walls.
- We eliminated the **use of servos for outtaking**, to decrease complexity and enhance outtaking cadence.

What worked:

- The **cadence** of our shooter **improved** drastically.
- Our new turret helps drivers to **do less movements**.

Needs improvement:

- The backlash of the turret may cause it to break after extensive wear



Lesson learned:

- We found out how does the shooting speed affect mid-match.

August - November

November - January

January-February

February

March

Mx. Championship → FIRST® Championship 2nd Month

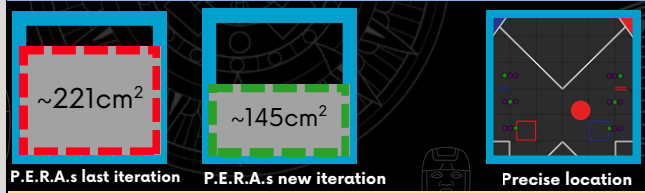
- ↑ Increased the **length of the intake** along the front of the robot.
- + Implemented custom **rubber wheels** and **indexing wheels** for the intake.
- Our **P.E.R.A mechanism** was modified to occupy less than half of the space required for parking.
- Our **vision system** was modified to be static to increase simplicity.
- + Implementation of **Kalman Filters**.
- + Implementation of **April Tag tracking alongside encoder reads** for position correction.
- + We added copper tape in the **shooter's hood**.
- 👑 **SENA's Assembly for Worlds**

What worked:

- **Kalman Filters** with our **Limelight** ensure precision when analyzing the robot's position, so we **no longer rely on dead reckoning** estimation.
- We can now align with the goal without the Limelight having to see it.
- P.E.R.A mechanism allow our alliance to partially park faster than in our past version, and in some cases result in two full parks.

Needs improvement:

- When we intake a lot of artifacts, the wheels tend to jam and bottleneck.



Lesson learned:

- We found that using the auto align allows us to do faster cycles.

Engineering process

MuSCoW

To manage **priorities** for the robot, allowing us to have the best possible robot at any given time in the season.

	Details
Must	• Score 3 artifacts per cycle. • Do a quick and partial lift in the base of the chassis for the endgame.
Should	• Shoot the 3 artifacts smoothly. • Machine the robot with polycarbonate.
Could	• Shuffle the order of artifacts in the robot. • Directly intake artifacts from the human player.
Won't	• Make a lift that raises the whole robot.

Lessons learned:

Planning and **iterating** each part of the robot lets us achieve the **best possible result**. The usage of popular philosophies gives us a great frame of reference

This season, we used **two** main engineering philosophies:

SCRUM

To divide a big task into smaller ones, taking advantage of iteration and additive working.

PLAN

Product backlog

List all **necessary capabilities**.
Rank by importance, dependency and impact.

Sprint planning

Define **2 week** sprints. Each one includes a **testable increment**. Tasks get assigned to subteams.

BUILD

Daily standup

15 minute meets. What is finished? What is next? Any bottlenecks?

The sprint

Subteams work in **parallel**. Everything **must run**, even if just roughly.

REVIEW

Sprint review and tests

Test again for **measurable criteria**. In numbers, how good is everything working?

Sprint retrospective

Reflect on the process. What problems did the team face **independent** to the robot?

ADAPT

Final Sprint

Full robot assembly, stress tests and a LOT of driver practice.
No features, just polishing.

Backlog re-prioritization

Update our Engineering Notebook. Any low-priority tasks get **cut** if time is tight.

Risk management

Level	Risk	Contingency plan
High	The robot is made from polycarbonate, an insulator, which carries more static and may cause the robot to disconnect	The robot has a physical earth connected to small metal plates, we also rub it with chlorine wipes to neutralize the static by ionization.
Medium	One of the custom machined plates breaks in the middle of the regional.	Before hand we machine some replacements for the plates that experiment the most stress , such as the turret and the chassis.
Medium	The shooter cables entangle which can lead to them to disconnect	Group up the cables in a mesh and give them extra range as a breath room
Low	The LED panels that indicate the shooter's speed disconnect or malfunction	Drivers can also know the state of the shooter in the Driver Hub's telemetry!

Sena's SWOT

Strengths:

Completely **custom**, allowing it to be iterated quickly. Defense-focused mechanisms like P.E.R.A. and M.U.R.O.

Opportunities:

Use the robot's position to **automatically move to park**, making the park faster and more reliable.

Weaknesses:

Being custom, a lot of pieces need **replacements**, also, since the shooter is always spinning, the battery dies fast.

Threats:

The electronic is cumbersome in some parts, for example, the turret **might disconnect** if spun quickly.

Chassis design

May not be the flashiest component, but it's the **foundation** upon which **Sena** is built: **resistant, precise, and fast**.

Why polycarbonate?

Impact-resistance: being 7 times more resistant than wood according to Izod's tests. (700 J/m vs 100 J/m).

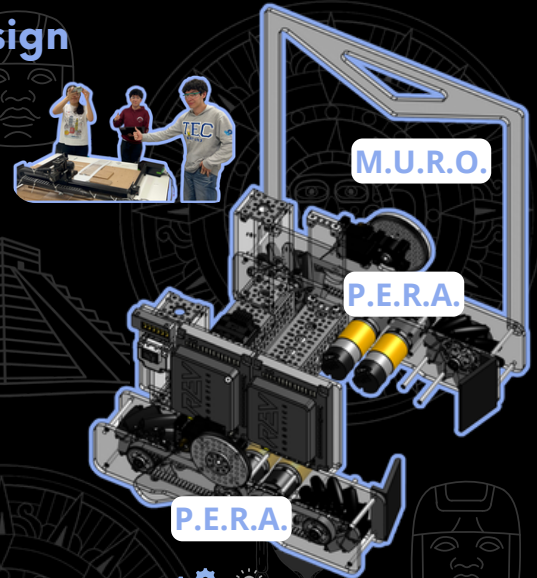
In addition to this it is way **cheaper** and **easier** to machine than other alternatives such as aluminium. As well as being **easier to ship** due to weight.

Collaborative CAD design

We used **Onshape** because it helps us work **remotely** and **collaboratively**. It is regarded as the flagship CAD software in the FTC community, having a lot of support online.

CAM manufacturing

We **manufactured** 85% of the robot's structure using a **Computer Numerical Control (CNC)** router, applying **CAM** tools taught to us by our mentors.



Defensive Design

SENA integrates two **defensive sub-assemblies**:

- **P.E.R.A.** is an active system with servos that deploys one plaque, that the robot uses as an **anchor** to the ground, it helps **reduce our area** when parks during the **endgame**, as the wheels stoped being the contact point.
- **M.U.R.O.** is a set of polycarbonate plaques designed to **passively obstruct cameras** and **artifacts** from opponents. As well as a way to **counter-weight** the robot's electronics.

Structural Load Analysis

The way we calculated if the servos of the **P.E.R.A.** were capable of lifting the robot was by using its maximum endurance. We used 2 Swyft Servos with a torque of **33kgcm** with a ratio of **5:1**, while accounting for the **10cm** between the servos and the floor, therefore:

$$\text{Supported Weight} = 2 \cdot \frac{\tau i}{d} = \frac{2 \cdot 33 \text{ kg} \cdot \text{cm} \cdot 5}{10 \text{ cm}} = 33 \text{ kg}$$

Where:
 τ = torque
 i = relation
 d = distance

This is for the **stall current**, in reality it could endure **80%** in most cases (**26kg**), way above the 10kg that Sena weighs. We also wanted to know if the polycarbonate would endure and wouldn't bend under pressure, for this, we used the **Euler's critical load** formula.

$$I = \frac{\text{width} \cdot \text{thickness}^3}{12} = \frac{0.04 \cdot (0.006)^3}{12} = 7.2 \times 10^{-4} \text{ m}^4$$

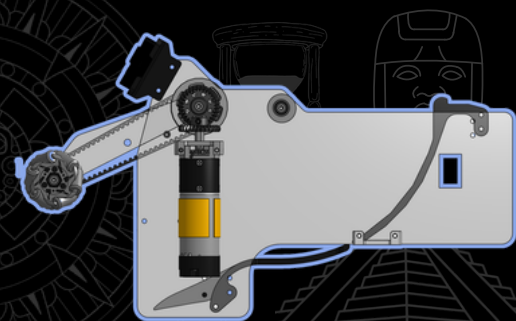
$$F_{\text{critical}} = \frac{\pi^2 \cdot E \cdot I}{(K \cdot L)^2} = \frac{\pi^2 \cdot 2.3 \times 10^9 \cdot 7.2 \times 10^{-4}}{(0.7 \cdot 0.12)^2} = 234 \text{ N}$$

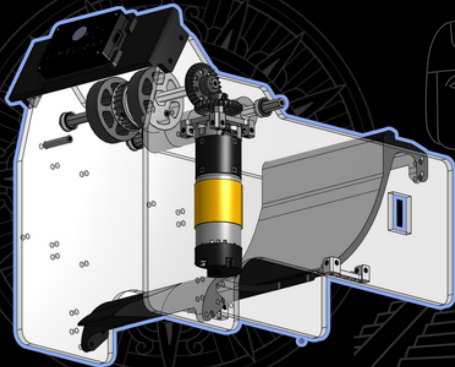
Where:
 I = second moment of area
 E = Young's module for polycarbonate
 K = effective factor of lenght
 L = lenght of the P.E.R.A

234N is equivalent to around **24kg**, hence it should hold Sena's 10kg **without the P.E.R.A.'s polycarbonate bending at all**.

Intake to shooter

The **intake** is the system in charge of collecting the artifacts through **ten custom rubber wheels (four indexing wheels and 2 star shaped wheels)** that rotate and index them up to the **transfer** system. It is powered by a **435 RPM** motor and a 2:3 pulley ratio, it was designed to use only one motor to connect the intake and transfer, minimizing complexity, and optimizing battery and power consumption.



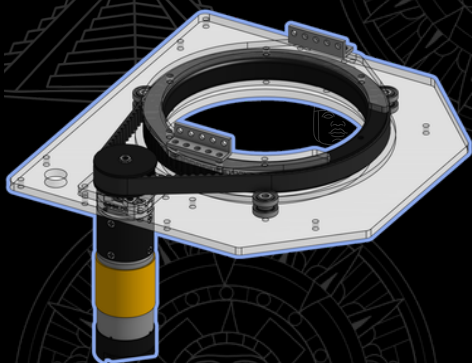
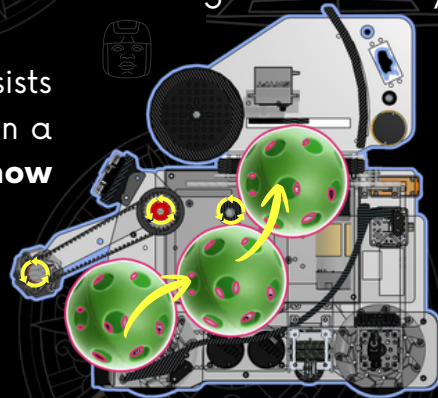


The **transfer** is the system in charge of taking the artifacts **from the intake to the shooter**. The **ramp** was designed using **Bezier Curves** going through the inside of the robot. It allows us to progressively increase the **gradient** without sacrificing **smoothness**. The wheels were positioned so that an artifact is **always** in contact with **at least one soft wheel**. We do not rely on servos to push the artifacts to increase our shooting rate and only use one motor.

To test the efficiency of this mechanisms **we made up a test**, it consists of gathering a cluster of artifacts next to a wall, then driving Sena in a straight line towards them and crashing. Afterwards we write down **how many artifacts were collected** before the robot hit the wall.

- In **82.5%**, **3 artifacts** entered.
- In **12.5%**, **2 artifacts** entered.
- In **5.0%**, **1 artifact** entered.
- In **0%**, **no artifact** entered.

Sena gathers an average of **2.775 artifacts** out of 3 when it crashes. This shows the intake is very effective!



The **turret** is the piece the shooter rests upon. We used 3 bearing blocks, 2 pulleys and a belt so the shooter moves smoothly. The turret is driven by a motor of **312 RPM** that rotates the entire structure of the shooter between **-135° and 135°**, allowing us to **align** the shooter without moving the chassis. By using a 96 teeth and 24 teeth (2.5:1 ratio) HTD 5MM pulley we ensure a precise movement.

Outtake design ⚙️

The **outtake** functions by pressing the artifacts between a fixed surface and a pair of turning **hard wheels**, these wheels are driven by a **1150 RPM** engine with a ratio of **1:3.4**.

To **maintain its velocity** between shots, we integrated a **flywheel** that was recommended by **Dr. Nava**. The weight of this flywheel is 0.5kg and was printed on 3D and filled with clay. This way we reduced the **manufacturing complexity**.

Flywheel ⚙️💡

A **flywheel** allows an object to lose less angular velocity when transferring energy to another object.

This happens since energy is defined as:

$$KE_{rot} = \frac{1}{2} I \omega^2$$

Where:
 I = inertia
 ω = angular velocity

When an artifact is shot:

$$\Delta E_{flywheel} = \Delta E_{artifact}$$

We express the change of angular velocity as:

$$\Delta E_{flywheel} = \frac{1}{2} \omega_1^2 - \frac{1}{2} \omega_2^2$$

$$\frac{1}{2} I (\omega_1^2 - \omega_2^2) = \Delta E_{artifact}$$

Solving for the final angular velocity ω_2 :

$$\omega_1^2 - \omega_2^2 = 2 \frac{\Delta E_{artifact}}{I} \rightarrow \omega_2^2 = \omega_1^2 - 2 \frac{\Delta E_{artifact}}{I}$$

$$\omega_2 = \sqrt{\omega_1^2 - 2 \frac{\Delta E_{artifact}}{I}}$$

$$\therefore I_{large} \rightarrow \Delta \omega_{small} \wedge I_{small} \rightarrow \Delta \omega_{large}$$

Taking into account that the weight of the wheels are **300gr** and the flywheel's is **500gr**, we found that the moment of inertia is: $I = \frac{1}{2} m r^2$

$$I_{wheels} = \frac{1}{2} 0.3 \cdot 0.048^2 = 3.456 \times 10^{-4} \text{ kgm}^2$$

$$I_{flywheel} = \frac{1}{2} 0.5 \cdot 0.050^2 = 6.25 \times 10^{-4} \text{ kgm}^2$$

64% of our inertia comes from the **flywheel!**

Future plans:

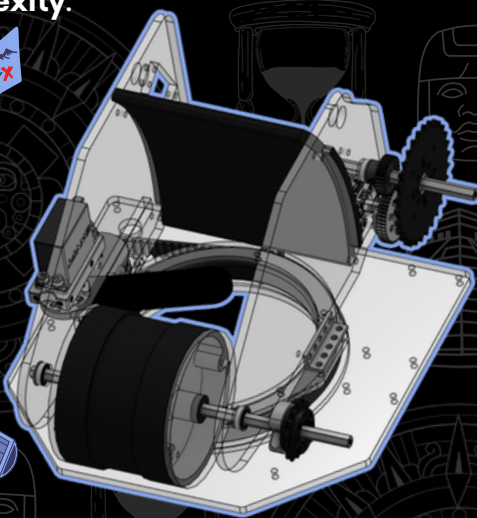
Balance the flywheel, as it is made out of compressed clay and causes the shooter **vibrate** a little.

Lessons learned:

It is really important to find ways in that the **game elements** affects the least possible the **dynamic** of the robot.

Lessons learned:

An efficient shooting outperforms the sorting of artifacts. This way we also don't rely on the artifacts bouncing off the goal.

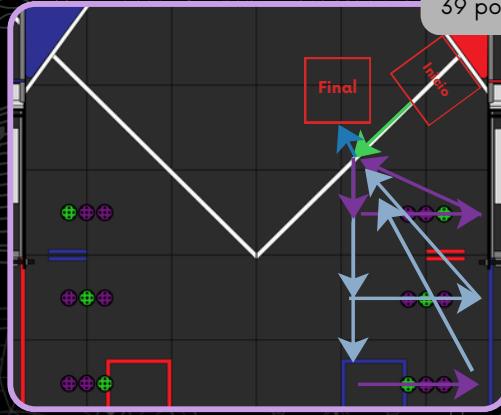


Match Strategy

1 6 8 18

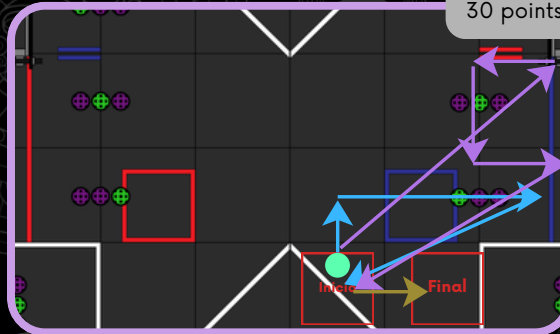
Near Autonomous

Total: 39 points



Far Autonomous

Total: 30 points



1 +9pt
We start from the **near launching zone**, then go backwards and **shoot 3 artifacts**.

2 +9pt
We **collect** the **next line** of **artifacts** and **shoot** them.

There is a variable to this autonomous, where the lever goes down if we fill the goal channel twice with our alliance.

3 +18pt
We collect and shoot the **next 2 lines**.

4 +3pt
Lastly, our autonomous **ends outside** the launching zone for the **Leave** points.

1 +9pt
We start from the **far launching zone**, the robot **advances** a little, points to the goal and shoots.

2 +9pt
Then, we go for the **next artifact line** and **go back** to the launching zone to **shoot**.

3 +9pt
We **open the gate** and afterwards we **gather more artifacts** which are then shot.

4 +3pt
Lastly, we **go out of the launching zone** to claim the **Leave** points

TeleOperated

Total: 194 points

Due to the robot's speed, we can cycle and **shoot near**; our strategy is to **collect** the **scattered artifacts** throughout the field and shoot them near the goal. If there are no artifacts we cycle to the **Loading Zone**. Practice shows we do an average of **16 cycles** of 3 artifacts. Additionally, between cycles, we try to defend by moving the opponents robots while they're shooting to **divert their shoots**.

Endgame

Total: 15 points

To finish our match, we position ourselves in our Base Zone, and with the help of our P.E.R.A system, we **reduce** our total occupied space and leave enough room so our alliance can easily enter a **partial park**.

Max. Final Total: 248 points

Lessons learned:

This **cost/benefit** analysis allows us to adapt to the match **strategy**.

Cost/Benefits in Control

Components	Cost	Benefit
Near autonomous	Due to more trajectories , it is more prone to fail due to external factors	Assures a higher score without draining our battery
Far autonomous	Due to the shooter needing more energy , it consumes way more battery	It is useful for situation where our ally only has a near autonomous
Road Runner	Being a motion-profiling trajectory system, the robot can not go at full speed , it needs breathing room in case it falls behind	Since the trajectory is unrelated to the robot's position, it is more reliable than a solely PID trajectory follower
Limelight	Higher energy consumption during the match	Allows the robot to know the position of the goal at all times
State machine	Drivers have less control over the robot	All actions are precise and safe

16818 Control in Programming

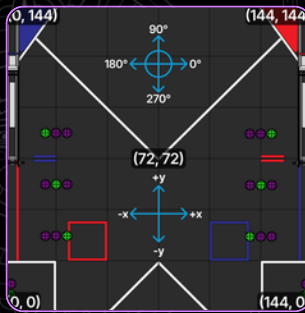
Auto with RoadRunner



We used the **RoadRunner** library for auto programming, which takes the **odometry pod's** readings to follow a set **movement profile**. Using **PIDF** (feedback and feedforward control) in the chassis to follow a "precompiled" point through a trajectory. This makes our autonomous very **consistent**, however, **it can't go at maximum velocity** since it needs leeway to catch up in case it falls behind, reducing the amount of maximum cycles we can do.

Localization with Sensors

The robot uses **2 high-definition encoders** to locate itself in the field. For this we used **2 odometry pods** that move due to the friction with the floor as the robot moves. This way we can **transform the reading of the sensors to inches in the X and Y axes**. To complete the pose, we determine the **robot's heading** using an **external 9-axis IMU sensor**, which provides more **accurate data compared** to the integrated IMU in the **Control Hub**.

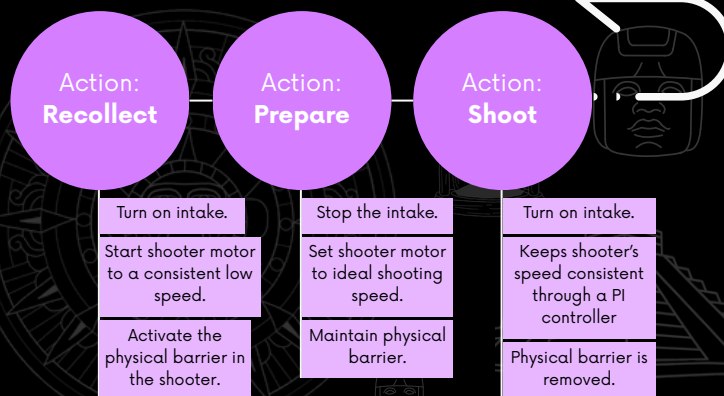


Asynchronous Commands

With these, the robot can aim, shoot and move at the same time. We implemented **Command Based programming**, a programming paradigm that allows us to execute commands or actions **asynchronously**, this is achieved by using libraries such as **FTCLib** and **RoadRunner** that are in charge of assigning a **Control Hub** thread to each task to allow for **parallelism**.

State machine

Allows the robot to do a given **set of actions** without needing human interaction. Either collecting artifacts or shooting them, everything in the touch of **a button**, simplifying driving and following a similar progress to **a flow chart**.



Limelight & Kalman Filter

Since the Limelight is no longer fixed to the turret, we decided that implementing a **Kalman Filter** would be the optimal solution to keep a **precise localization** of the **Goal relative** to the **robot**. The purpose of this algorithm is to correct the robot's pose from noisy or incomplete measurements, like the encoders that add errors over time.

As such:

$$K_k = P_{k|k-1} H_k^T (H_k P_{k|k-1} H_k^T + R_k)^{-1}$$

Where:

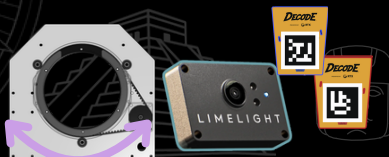
K_k = KalmanGain(Correction)

$P_{k|k-1}$ = UncertaintyPrediction

H_k = MapMeasure

H_k^T = DebugCorrection

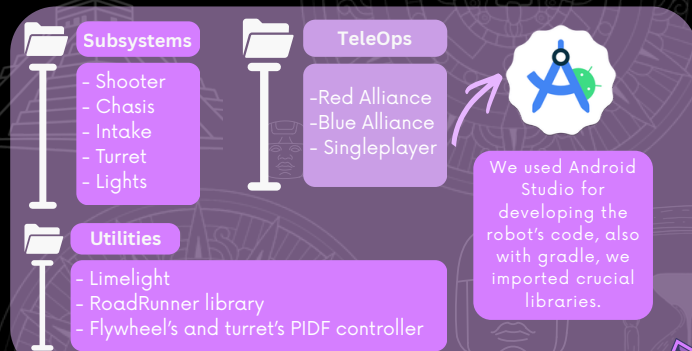
R_k = SensorNoise



We use the **predicted uncertainty**, the **sensor model**, and the measurement noise to **balance** both **sources** of information and obtain a **precise** measurement.

$K_k = \frac{\text{uncertainty of the prediction projected into measurement space}}{\text{total uncertainty (prediction + measurement)}}$

Code diagram



Future plan:

Develop a neural network that allows the robot to tell apart green/purple artifacts

Lessons learned:

Control is not just about the autonomous period, it helps with efficiency throughout the match.

Haptic-Feedback



In order to indicate to the drivers that the necessary rotations have been reached at the shooter, there are **rear LED lights that flash green**, also **the controller** of the second driver **vibrates** to indicate it is ready to **shoot**. However, this same data is sent through telemetry for the Drive Coach to double-check in the Driver Station

Drive Team: Innovating with practice



#3	brendan
#4	14n.4
#5	superspy_eli
#6	sabruzu

Strategies implemented:

- Previous to the assembly of the robot, we **practiced** in the simulator xRC, reaching **ranks 4 and 6** in the **global leaderboard**.
- Routine of **10 practice hours** a **week** to **improve** robot **cycles**.
- Defence** simulation using the **Starter Bot** made by our **rookies** during **practice**.

Acknowledgements

We want to take this space to firstly **thank our mentors** who with great **dedication and care**, founded this team that we now get to call **family**. They **motivate and inspire** us to keep going despite the many challenges we face. We are truly grateful for the **legacy they share** with us and for the opportunity to learn from their experience.

We also want to thank our coaches **for believing in us and for never letting go**. We are always glad to have them on the team; their support has been essential in helping us achieve our goals this season. Thank you **for being there** every step of the way.

We are certain that **Hype-Birds** wouldn't be what it is without the **commitment and dedication** of every single person who is or has ever been a part of this team. **We get to grow thanks to everyone's effort**.

For all this and more, **thank you!** We want you to know that we will **treasure every single moment** that we have lived together and that every one of your stories told will always be part of **Hype-Birds' identity**. We are happy that you have been a **part of it**.

Together we fly higher!

With love,
The members of this 2025-2026 season.

Hype-Birds 16818