



# HOT WHEELS

#28659

SPINNING TO WIN



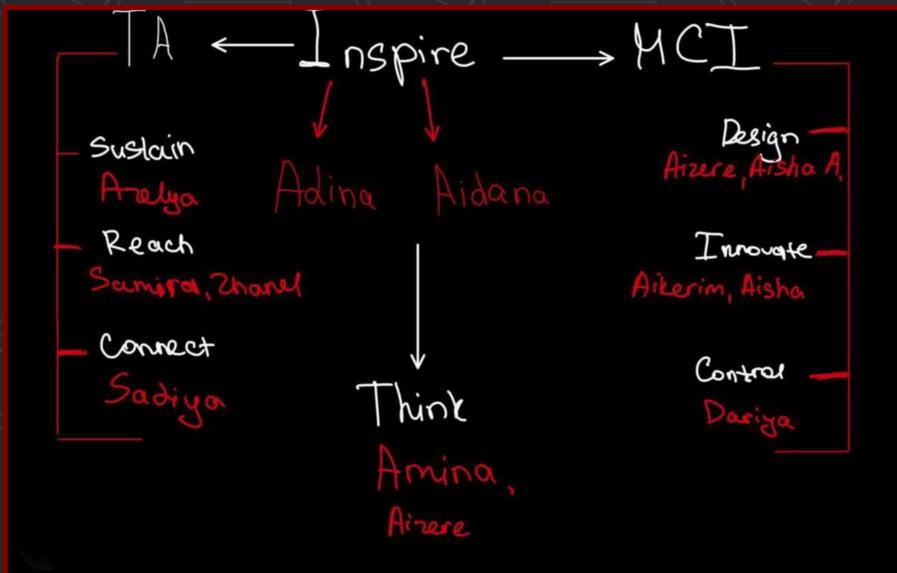


# INTRODUCTION

## WHO ARE WE?

Our team, **Hot Wheels #28659**, was founded in 2024 in Astana, Kazakhstan. We are made up of 12 participants from BIL Astana for gifted girls.

## TEAM MANAGEMENT



At the beginning of the **DECODE** season, we assigned team members to **different award categories** to organize the work and avoid chaos. More complex awards were split into small groups, allowing us to work more efficiently and support each other.



**AIDANA  
CAPTAIN**



**ADINA  
ENGINEER**



**AIZERE  
DRIVER**



**AIKERIM  
ENGINEER**



**AMINA  
ENGINEER**



**AISHA  
CADER**



**AISHA  
CADER**



**DARIYA  
CODER**



**SADIYA  
SMM**



**AZELYA  
OUTREACH**



**ZHANEL  
DESIGNER**



**AYAUZHAN  
CODER**



**SAMIRA  
PLANNER**

## OUR MISSION

Our mission is to **inspire** girls to explore engineering, technology, and teamwork through the **FIRST Tech Challenge**, while developing creativity, problem-solving skills, and confidence for the future.



# GOALS & MENTOR

## OUR GOALS

### Growth

Hot Wheels never stop learning. Continuous improvement is one of our main goals. We spend every opportunity developing both technical and soft skills - from engineering and programming to teamwork and leadership.

### Mentorship

We actively mentor FLL teams, sharing our workflow, experience, and lessons learned. Our goal is to help younger teams grow independently and continue their journey in FTC in the future.

### Empowerment

One of our main focuses is developing STEM education in "Comfort" schools across Kazakhstan. Many schools have robotics kits but lack experience. We introduce them to FIRST, inspire to create teams and guide them through their long journey.

## OUR MENTOR



### MSc in Computer Science

Over the past four years, our mentor *Manchuk Teacher* has played a **key role** in our team's development. She supported us in finding tech details for our robot and helped organize our teamwork during the season. With her guidance, we were able to plan tasks more efficiently, solve problems collaboratively, and stay focused during challenging moments. She also helped us build partnerships and connect with external supporters, strengthening our outreach and growth as a team.

## MENTOR'S IMPACT

- Supported outreach planning
- Helped us find accurate technical details for our robot
- Structured and coordinated our team's workflow
- Supported the development of partnerships and external collaborations

## OUR FUTURE VISION

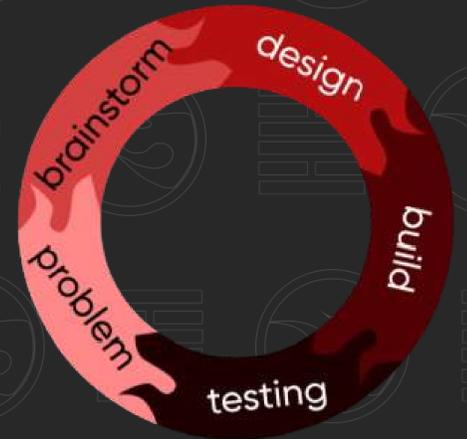
1. Expand STEM opportunities across Kazakhstan
2. Raise awareness of FIRST among deaf and less-informed communities
3. Continue mentoring younger teams

## OUR VALUES

- **Gracious Professionalism** – competing with respect and kindness
- **Teamwork** – every idea matters
- **Innovation** – we search for creative solutions
- **Responsibility** – we commit and deliver



# WE THINK BEYOND THE LIMITS



## WORK PROCESS

Our wheels never stop, so our **robot-building** process is continuous.



## LESSONS LEARNED & DESIGN DECISIONS

During this season, we rebuilt our robot several times after noticing **mistakes**. Here, we explain what issues the robot had, how we identified them, and how we **fixed** them.

### 1. Number of artifacts inside

We decided to build a robot that can hold 3 artifacts, as this increases the robot's efficiency.

### 2. Joystick code

We decided to write code for two joysticks, because one driver wasn't enough to fully control the robot.

### 3. Long-range shooter

We realized that a long-range shooter is much more convenient for games.

### 4. Adding Limelight

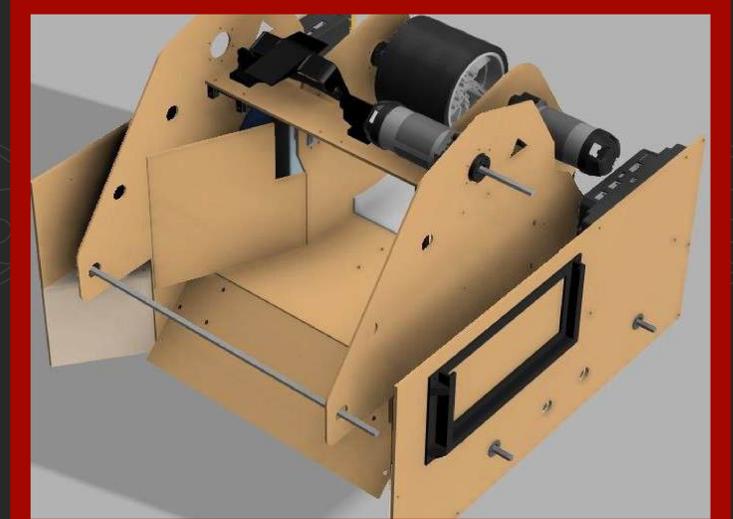
By using a Limelight camera, we improved our autonomous mode and increased our chances of scoring during the autonomous period.

## BEFORE



- holds 2 artifacts inside
- shoots at the nearest launch zone
- code is written for only one joystick
- folding (flexible) platform

## AFTER



- + holds 3 artifacts inside
- + shoots from the furthest launch zone
- + code for two joysticks
- + sturdy platform



# WE THINK BEYOND THE LIMITS

## GOALS AND PROGRESS

To achieve our goals, we write each **goal** separately, list the **actions** we need to take, and set **deadlines**. In this way, we manage to complete everything efficiently and with high quality. Here are a few examples:

Goal	Actions	Deadline	Progress
intake	learned how to use 3D printer, checked its effectiveness in work	25.10.2025	sweeper intake was amazing in work
outtake	calculated the right angle, printed on 3D printer	31.10.2025	At first, the artifacts couldn't get the goal, but we found a solution
"tunnel" for artifacts	selected the most convenient way to outtake from intake	03.11.2025	This improvement made our robot better
middle part	The mechanism was tested and errors were corrected	05.11.2025	robot was improved, and a time-efficient approach was found

HOT WHEELS - FROM GOALS TO  
REAL PROGRESS



# WE BUILD THE CONNECTION

## COLLABORATIONS

Over 11 month, we held **regional** and **international** meetings with **90** teams, both online and offline.

These teams represent countries from around the world, including the **Kazakhstan, USA, Vietnam, Russia, Indonesia, Turkey, India, Brazil, Romania, Malaysia, Mexico, UK, Ukraine, South Africa, Cambodia, Canada, Rhailand, Japan, Thailand, Israel, Palestine, Kyrgyzstan, Canada, and Moldova.**



- **SEA+ community** network (roboticsunited.network), which includes many teams from **12 countries in Southeast Asia.**
- **BIL FTC** community in discord platform
- **Worldwide** meeting with 18 teams, **representing their cultures and countries.**

### Special thanks to the teams that reached out and shared their experience with us:

- Spirit
- Florencia
- Irys
- Sipizero
- Ro2d2team
- Water7
- Bolt.m3
- Altyngear
- Gambit
- xCeption
- Sipinine
- UltraViolet
- BilOrda
- Kawiswara
- Fizmat Robotics
- BilBarbie
- Sana
- Yaku
- Horizon
- Celestial
- Panheya
- Zenith
- Errorda
- Juzztogys
- PomPom
- Qttech
- Antares
- Foxslide
- Sirius
- Tolqyn
- Future Vortex
- SlapSeals
- Mortex
- North Star
- Foxslide
- Ata
- TNT
- xcellence
- Naizagay
- ThunderBolts
- Y-tech
- Broboti
- InternoX
- Celestial
- Juztogys
- 51teams
- Tolqyn



# WE REACH FIRST WITH THE COMMUNITY

## SPREADING FIRST

### BRILLE BOOK FOR PEOPLE WITH IMPAIRMENTS

We wrote a **Braille** book for people with visual impairments to **spread awareness about FIRST and STEM**. In this book, we share personal stories and experiences, showing how FIRST can be accessible and inspiring for **everyone**.

### ENACTUS & DIGITAL ALMATY

**Distributed by FIRST** and encouraged everyone to participate in competitions for Enactus and Digital Almaty accounts.

### ASL & FIRST

We created an Instagram page where we share valuable STEM and robotics content in **American SIGN LANGUAGE**, with a focus on FTC resources and learning materials.

### FAIR

We helped organize a fair on behalf of our team at the BIL Astana school for girls, and raised 100,000 tenge, which we donated entirely to the club **charity of the same school**.

### MINISTRY OF EDUCATION

We explained FIRST and the FIRST Tech Challenge at the Ministry of Education. We also demonstrated the functions of our robot and talked about how **FIRST has influenced us**.

### TELEGRAM BOT

We developed and continuously **updated** a Telegram bot (2025 version) that provides FTC manuals, resources and much more.

### RESEARCH PAPER

We conducted a **qualitative** study on inclusive STEM education, focusing on the role of robotics for students with **disabilities**.

### STEM NEWS

We created an Instagram account that we manage with the Zenith team, where we share **World STEM news** and talk about **FIRST values**.

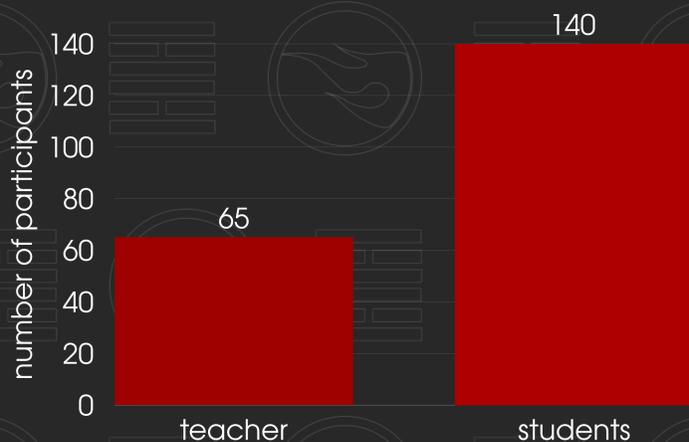
### COMICS FOR KIDS

We created educational comics for children that explain FTC concepts in a simple and engaging way. We **designed in a LEGO style** that visually can explain the concept of the FTC to children.

## PRESENTATION TO SCHOOLS

We held presentations where we told **12 schools (7 "Comfort" schools, 4 regular schools)** about FIRST and gave them all the information about the competition.

In some schools, this has become an impetus to create their own FTC team, and we provide these new teams with it.



In total, we told **65 teachers** and **140 students** about FIRST. List of schools:

- "Comfort" school No. 100
- "Comfort" school No. 101
- "Comfort" school No. 103
- "Comfort" school No. 104
- "Comfort" school No. 105
- "Comfort" school No. 108
- "Comfort" school No. 111
- "Comfort" school No. 110
- School-lyceum No. 56
- School-lyceum No. 59
- School-lyceum No. 79
- School-gymnasium No. 65

## COMMUNITY

We also **contributed** to the **FIRST community** by:

- Created a **Telegram Bot for FTC newbies**
- We launched a **YouTube channel with coding tutorials**
- We held a masterclass on **Figma** and engineering portfolios
- We created the FTC Hub archive website, which contains all the information of interest to FTC participants about this season.

## FORUMS

We have conducted many online and offline **STEM forums**. At each of them, we promoted and talked about FIRST:

- STEM forum in compatibility with ziyatker.nis
- Women in STEM forum with Femunity Aqyl Education
- FTC Masterclass and Forum for Atlas Students
- Essay info session with Aroo Study Centre
- Masterclass from MasterSAT, where we also talked about FIRST
- Debate session with Zhanel Kuatbeova
- Workshop about ECA and IELTS
- Workshop on debates with a MUN specialist



# WE REACH FIRST WITH THE COMMUNITY

## LOCAL FIRST

### Disabilities center visits

We visited a center for children with disabilities, where we spent time together, engaged in activities, and introduced them to FIRST.

### Educational centers

We visited **AIPlus** and planned further events to present and discuss **robotics** as BIL students at the BIL admissions center.

### Ministers and Astana Hub

We held **meetings with the Ministry of Education and Astana Hub**, where we presented our team and FIRST.

### Scrimmage Spectrum

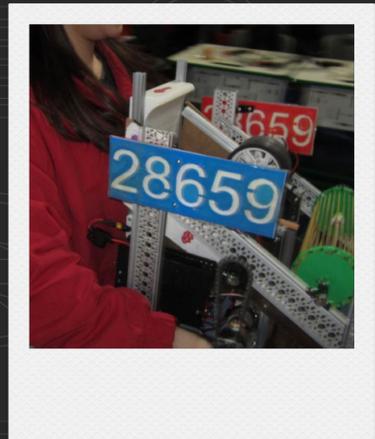
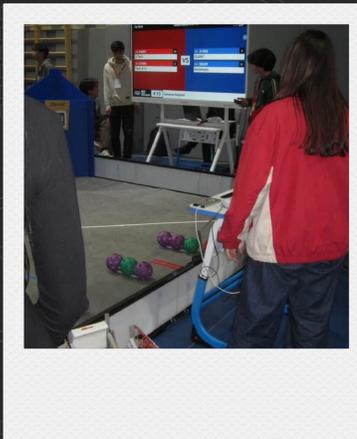
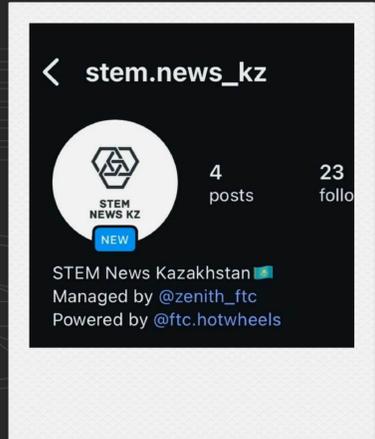
**Co-organizers** of scrimmage in Spectrum from teams such as Florencia, Sea Nomads, Tech Nomdas, Stay Hydrated.

### FLL Conference

We held an open conference for the FLLC and FLLE teams, where **our members served as speakers** and shared their experiences in response to advice. We also invited Tamiris Isataykyzy, a FIRST judge, to this conference.

### Feedback for FLLC teams

We provided feedback on the FLLC teams' presentations, offering **advice** on how to **improve** their presentations.



# over 357

participants reached through meetings, scrimmages, and conferences.

# 30+

FIRST teams involved

# 7+

major events organized, including scrimmage, conference, and feedback sessions

**30+ hours** of mentoring & consultations provided to FLL teams  
**20+ presentations** reviewed with detailed feedback  
**3 new teams** inspired to continue or start participating in FIRST programs.

# #28659

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# WE REACH FIRST WITH THE COMMUNITY

## MENTORSHIP

More than half of our team members have successful experience in **FIRST**. Currently, we provide mentorship to teams in the FLL Challenge and FTC categories.

## FLL CHALLENGE



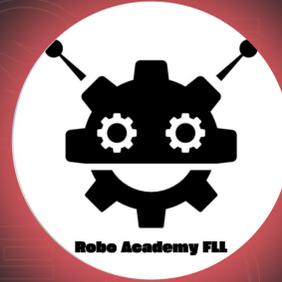
### STAY HYDRATED

• With our support, the Stay Hydrated team won the Robot Performance Award (3rd Place) at the Astana FIRST Off-Season, the Innovation Project Award at the Dubai FIRST Off-Season, and became the Robot Performance Award Winner at the Astana FIRST Regional.



### MOVING ELEVEN

• We helped the new Moving Eleven team, which successfully received the Engineering Excellence Award at the Astana FIRST Regional.



### ROBO ACADEMY 100

• Our support for the Robo Academy 100 team expanded their knowledge in the FLL Challenge category and helped them receive the Engineering Excellence Award and Robot Design Award (3rd Place).



### ERROR404

• We helped new Error404 team to enhance their outreach and collaborated with them at the Karaganda FIRST Regional.

## FEEDBACK FROM TEAMS

“We are very grateful to the Hot Wheels team for their support in outreach activities. With their help, we started organizing workshops and other events that strengthen our portfolio, and we also began working with SMC. We highly appreciate your support and collaboration—thank you once again.” - **Naizagay**

“We would like to express our gratitude to the Hot Wheels team for helping us resolve several issues and for pointing out our mistakes, which we later corrected.” - **Stay Hydrated**

## NEW TEAMS

We also **created** an FTC team at **“Comfort” School No. 100** and **inspired other 3 teams to start their journeys**, and they will begin participating in championships in the near future.

We helped **BRUH and Naizagay** teams create their **engineering notebook**, helped the Zenith team with **outreach** and expanded knowledge about **SMC** for teams such as Qazaq Style Juniors and Mooneye. We inspired to create the **Mooneye** team to make their own stickerpack.



# SUSTAIN FINANCES

With the support of our mentors, our team receives financial support from the **Bilim-Innovation Lyceum foundation** and from the **personal contributions of the team members**.

## FINANCIAL STRUCTURE



## FINANCIAL PLAN

### 1. Presentations and pitches for sponsors

We organize presentations and pitches **to attract financial support** from businesses and community leaders. This is how we found our private sponsors, who helped us a lot.

### 2. Alumni's brand Red lines wheels - 30% of the toys from Hot Wheels Alumni's

**Future:**

Partnerships with **bigger companies with mutual benefit**.

## TEAM/ALUMNI DEVELOPMENT PLAN

**Hot Wheels alumni** account managed by former team members. This platform will allow alumni to stay involved with FIRST, sustain the team and contribute through outreach, even after graduating. **The initiative was inspired by current members.**

The goal of this plan is to **develop each team member's skills** in all key areas of work and discover all directions.

### 1. Training in Basic Skills

**Goal:** To master the basic skills in the team's key areas of work.

- Sharing experience within the team
- Sharing experience with experienced teams

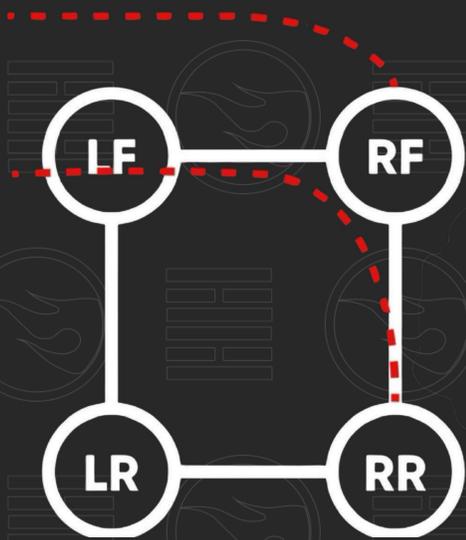
### 2. Active Participation

**Goal:** To involve all team members at every stage of the project.

- Hold meetings to discuss tasks and problems
- Provide help among team members



# WE DO NOT JUST BUILD ROBOTS, WE CREATE NEW SOLUTIONS



We develop code for movement and precise turns. wheel and angle turns.

## SOLUTION

To address this, we implemented a centralized drivetrain architecture. All four motors are mounted near the center of the robot and transmit power to the wheels via chain drives.

Energy consumption depends on the angular velocity and the current drawn by the motor. The energy consumed by each wheel is proportional to the square of its angular velocity:

$$V_x = \frac{r}{4}(\omega_1 + \omega_2 + \omega_3 + \omega_4)$$

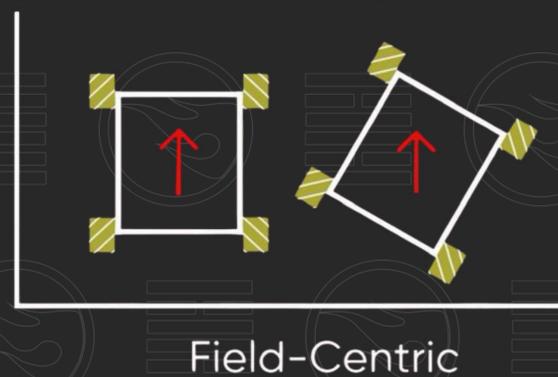
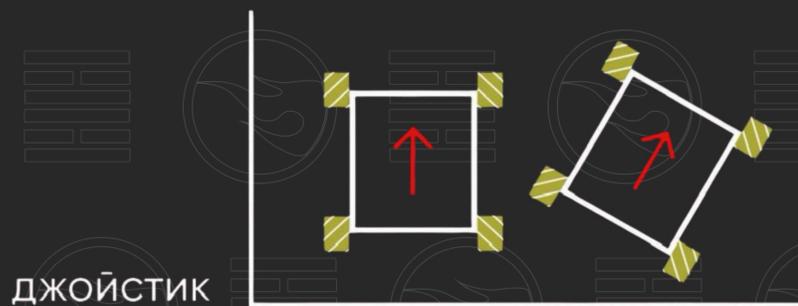
$$V_y = \frac{r}{4}(\omega_1 - \omega_2 - \omega_3 + \omega_4)$$

## PROBLEM-2

Fast motor movements increase the risk of collisions with other robots and on the map, which may waste time and cost points.

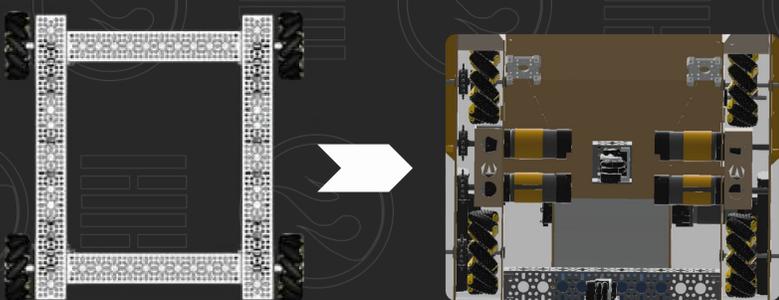
## PROBLEM-1

In the DECODE season, maintaining a low and centered center of mass was critical for stability while rotating. Traditional base increased rotational inertia and limited internal space for mechanisms.



## SOLUTION

For the convenience of the drivers and to save time, we used **field-centric control** with the addition of an **IMU (Inertial Measurement Unit)**. The main goal was to control the robot from the driver's perspective rather than the robot's perspective.





WE DO NOT JUST BUILD ROBOTS,  
WE CREATE NEW SOLUTIONS

### PROBLEM-3

We struggled for a long time to find the right angle and speed for the shooter so that the ball would consistently hit the target. The initial speed of the artifact - and thus its flight trajectory - depends on how fast the outtake wheels spin. To solve this problem, we applied basic physics: calculating angular speed, linear (tangential) speed, and the equations of motion for a projectile thrown at an angle.

1. Angular velocity of the wheel

$$\omega = \frac{2\pi \cdot 1600}{60} \approx 167.6 \text{ rad/s}$$

2. Tangential (linear) velocity of the artifact

$$v = 167.6 \cdot 0.04 \approx 6.70 \text{ m/s}$$

3. Projectile trajectory equation

$$1.00 = 3.10 \tan \theta - \frac{9.8 \cdot (3.10)^2}{2 \cdot (6.70)^2 \cos^2 \theta}$$

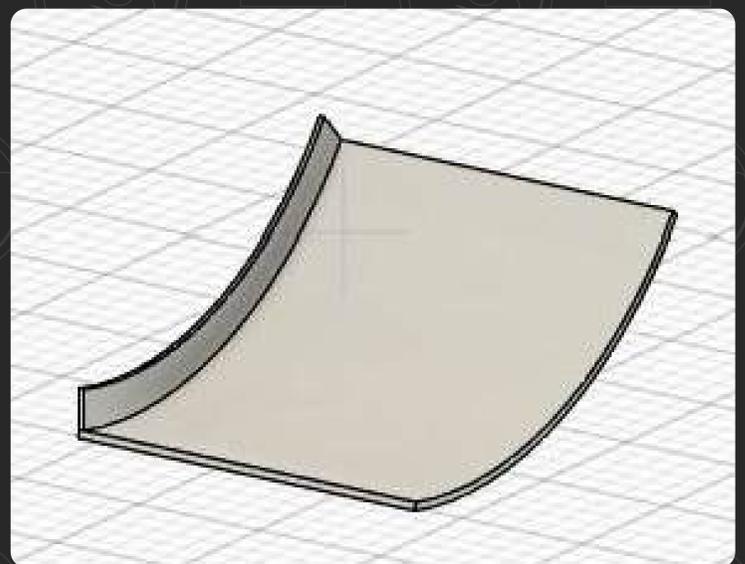
$$\frac{9.8 \cdot 9.61}{2 \cdot 44.89} \approx 1.05$$

4. The equation becomes:

$$1.00 = 3.10 \tan \theta - \frac{1.05}{\cos^2 \theta}$$

5. Final answer is

$$\theta \approx 38^\circ$$



### SOLUTION

With a rev wheel radius of 4 cm rotating at 1600 rpm, the artifact leaves the shooter with an initial speed of approximately 6.7 m/s. To reach a target located 3.10 m horizontally and 1.00 m vertically, the optimal launch angle is about 38°.



# WE DON'T JUST WRITE CODE - WE CREATE INTELLIGENT CONTROL SYSTEMS

## DRIVER'S CONTROLLER



## DRIVER CONVENIENCE

We implemented “reverse the middle part” and “reverse the intake” functions to allow the driver to quickly eject game elements in case of jams or unexpected issues during the match.

**Benefits** of this mechanism:

- + Saves time
- + Maintains scoring pattern
- + Fixes issues via buttons
- + Reduces driver stress

Also, we upgraded our control system from one joystick to two.

The **first driver** controls only mecanum wheels. Since they require precise and constant control, this allows the driver to fully focus on accurate movement.

The **second driver** operates the intake, outtake, and middle mechanism. This separation lets each driver concentrate on their own tasks, reducing overload and improving overall performance during matches.



# ROBOT DESIGN

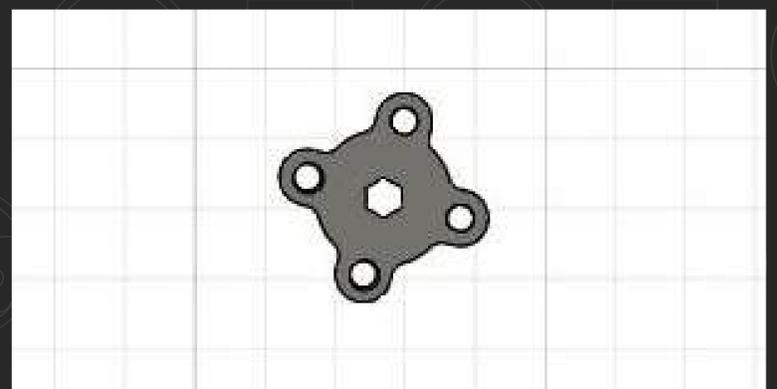
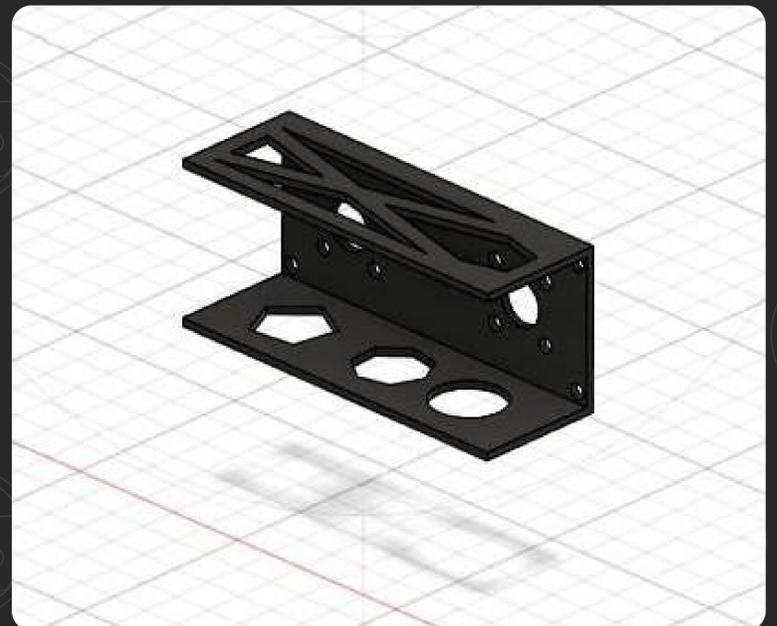
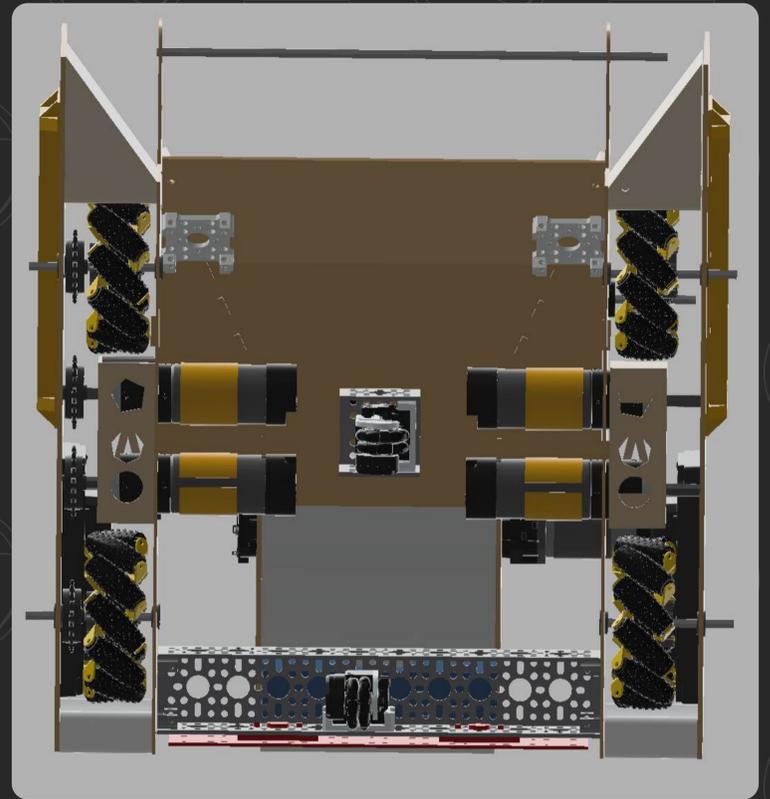
## ROBOT'S BASE

Our robot base is made using wood, with the use of only *one U-channel*. This design choice was made due to limited resources and our goal to explore alternative materials in robot construction.

An additional advantage is that wood is a non-conductive material, which reduced the risk of static electricity and short circuits.

However, wood has limitations such as lower durability and precision compared to metal. To address this, we reinforced high-stress areas and strategically placed the U-channel in a load-bearing position to increase stability.

This solution demonstrates that innovative engineering can be achieved *using simple, non-traditional materials*, aligning with FIRST values of creativity and problem-solving under constraints.



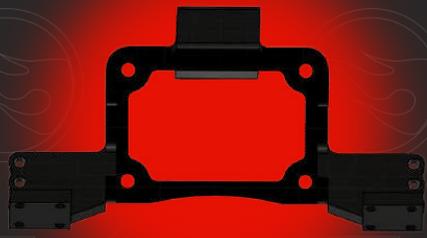
*special printed detail which allows to use hex shafts in mecanum wheels, so we can connect drive chain*



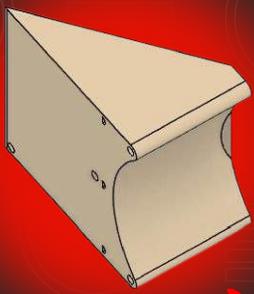


# ROBOT - CAD

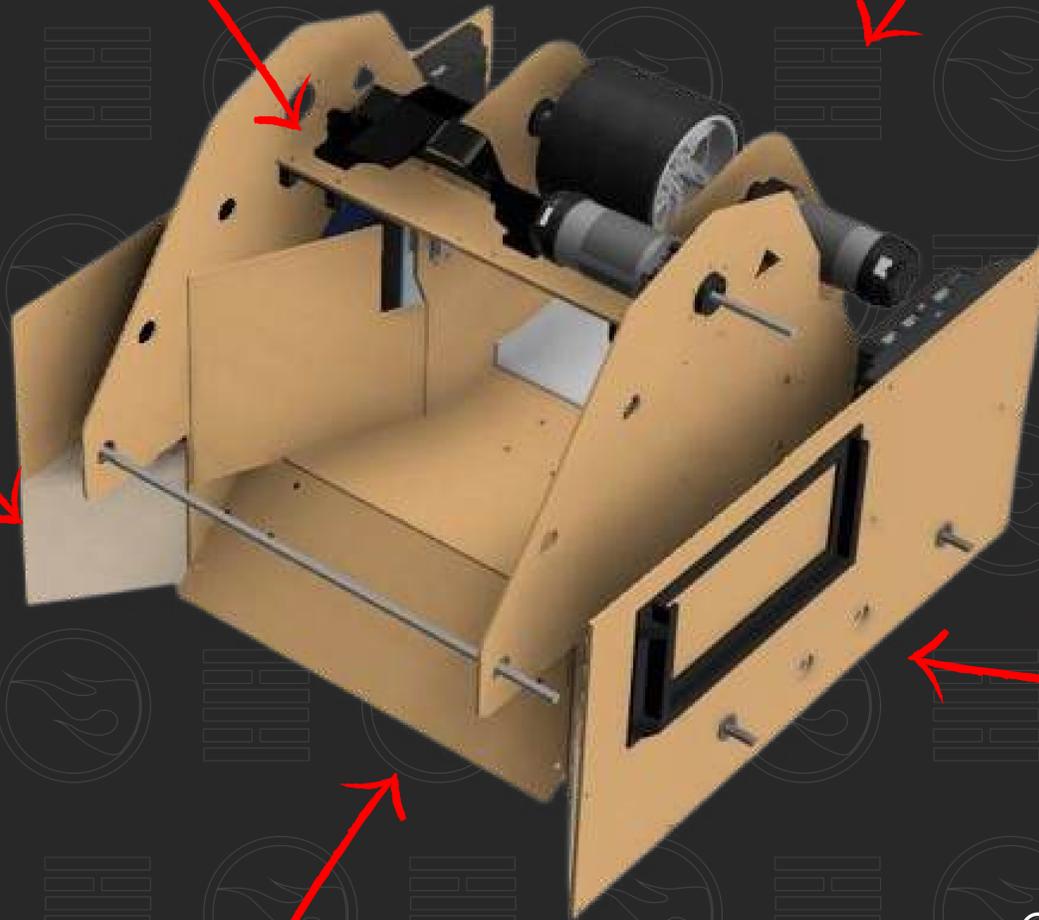
*limelight  
camera  
holder*



*box for gobilda  
motors from the  
mecanum*



*this detail  
allows us to  
take artifacts  
from the long  
range*



*we adapted rev  
gears for rex shafts,  
to use them in  
gobilda motors*

*the beige details is a  
plywood which is  
one of the main  
materials in our  
robot.*

This CAD model shows the final design of our robot. The structure is mainly made of plywood and includes a mecanum drivetrain with goBILDA motors, a Limelight camera holder, and a front intake for efficient object collection. The design focuses on reliability, simplicity, and comfortable control for the drivers.

