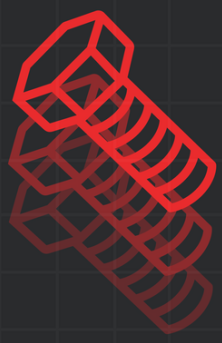


Bolt M3

Engineering Portfolio

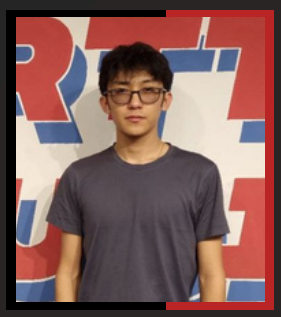
#22801
FTC 2023

Meet The Team

Meet the FTC Bolt.m3 #22801 Team from Almaty, Kazakhstan, based in the National Physics and Mathematics School. We are a group that consists of 15 bright teenagers who are passionate about robotics. Last year, we were not satisfied with the outcome, hence, we worked hard all year to prepare for the competition and strive to show high-quality work.

Our mentors

Aidos
Robotics Teacher
Experienced in WRO and FTC, FRC, FLL.



Dauren
Intern from Satpayev Unversity

Organized FIRST competitions.

Gracious Professionalism

It is the act of treating everyone with love and respect. Gracious professionalism creates a pleasant and healthy work environment.

Mission Statement

To put robotics in Kazakhstan to a high level. To grow as a team and to grow individually. To maximize our impact and give back to FIRST. To solve global problems. To enjoy the process and have fun.

MOTIVATE

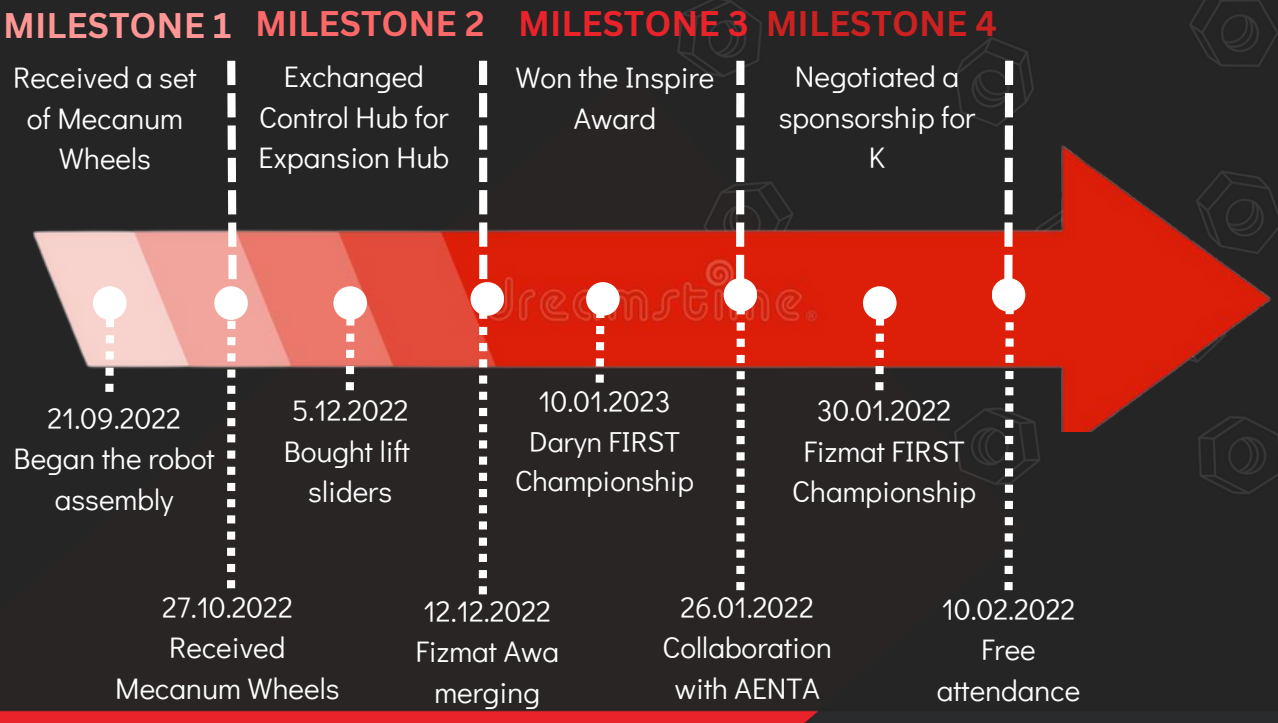
Team Organizational Structure

Bolt.m3 team is divided into five main divisions. Each teammate can belong to multiple or all divisions: Mechanical, Software, Handbook, Business, and Drivers Division.

Mechanical Division	Software Division	Handbook Division	Drivers Division	Business Division
Builders: Alibi, Van, Kadylbek, Ashim	Programmers: Tair, Dinmukhammed	Handbooks: Shapagat, Andrey	Drivers: Ashim, Tair	SMM Manager: Zhanel
Calculations: Zaki, Ashim	Website software: Vlad	Awards: Andrey	Human Player: Alibi	Contacting: Andrey, Tair, Shapagat
CAD/ Sketch: Alibi, Zaki	Strategy: Kadylbek			Mobilography: Zhanel

Sustainability & Fundraising Goals:

- Connections with the FTC teams from around the world.
- Entice visitors to our Translated REV Documentation.
- Engage with STEM and non-STEM communities.
- Spend 500+ hours of outreach.
- Attract people from non-STEM community.
- Make connections for future seasons.
- Maintain team sustainability.
- Fundraise 10.000$



How we reached our goals in brief

Our team actively sought new connections and fundraising opportunities to support the team. We also had occasional meetings with FTC teams worldwide. During these meetings, we distributed our REV documentation translation and shared helpful advice with other teams. Moreover, one of the vital factors in expanding FIRST in Kazakhstan was connecting with STEM and non-STEM communities in our area.

A few examples of our outreach this season:

- As it is highly prioritized for our team to spread FIRST in Kazakhstan, we seek to give back to FIRST any chance we get and bond with teams worldwide.

Meeting with #15083 team

We helped the Antagonists team, sharing our cultures, and playing chess.

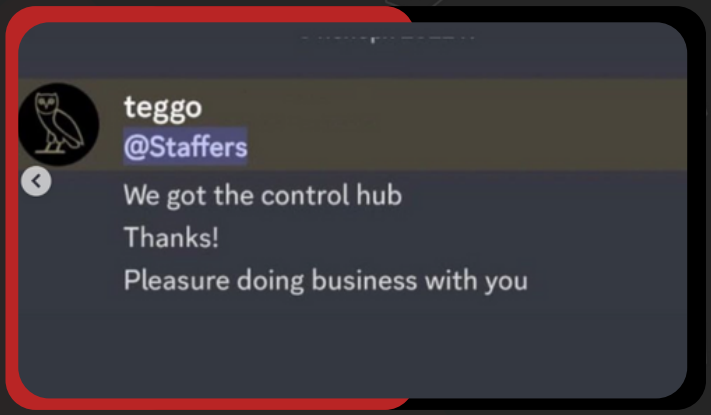
FIZMAT Championship Organization

We organized FTC and FLL Competitions in our school.

Menter team Zertte #22949

We mentored a rookie team and helped them program and train their robot.

Exchange with NMHS Robotics #5628



We negotiated an exchange of our Control Hub to a new Expansion Hub

- Inclusive Outreach. We have learned that many talented children with the strongest desire to grow and develop in STEM need more opportunities. Therefore, we aim to make FIRST competitions accessible to everyone, regardless of their social status.

Teaching Robotics in Almaty Orphanage №1

Introducing children to STEAM and Robotics fields.

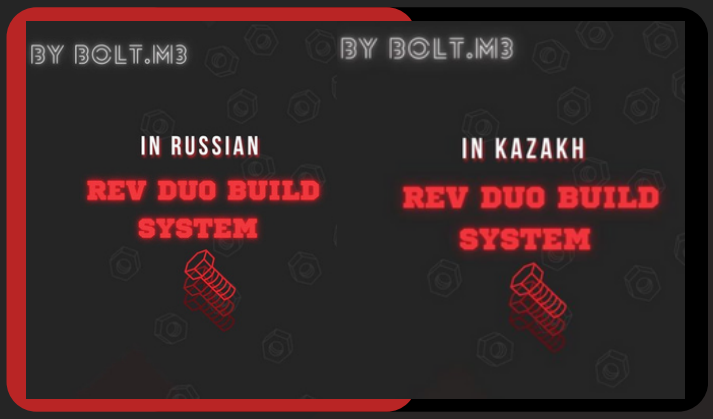
ZhanUya Orphanage

Actively interacting with minority communities

To find out more about our interactions with orphanages read NB: p. 40-41

- As a group of people driven by anything STEM-related, we try to embody FIRST principles and spread knowledge about them everywhere we go. That is why we did a couple of memorable things which surely impacted the popularization of FIRST in Kazakhstan.

REV Documentation Translation



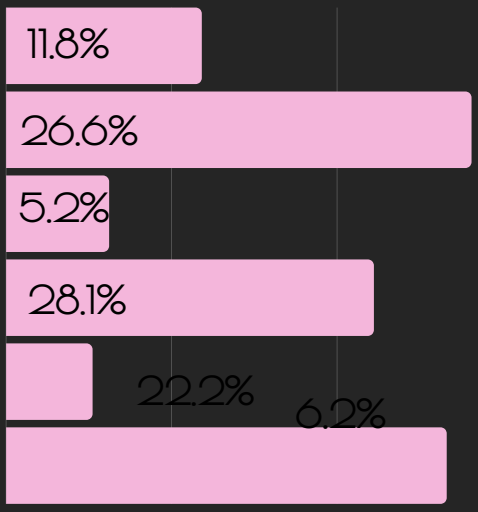
We have translated the official REV Documentation into the Kazakh and Russian languages.

Akpetit Military School

This is us presenting FIRST Competitions to the armed forces of Kazakhstan.

To see all outreach activities, visit the NB on pages 13-57

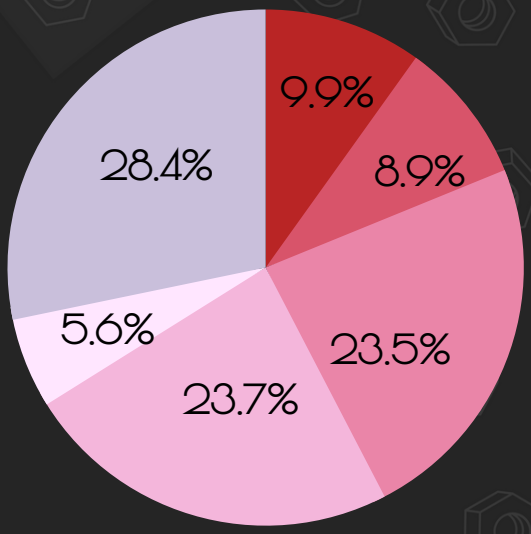
Total Outreach Hours: 677 hours *Read more in the NB: p. 57*



- Presentations
- Social Medias Outreach
- Meetings with teams
- Translation
- Volunteering
- Helping teams/Mentoring

Goal: 500 hours

Total People Impacted: ~2124 p.

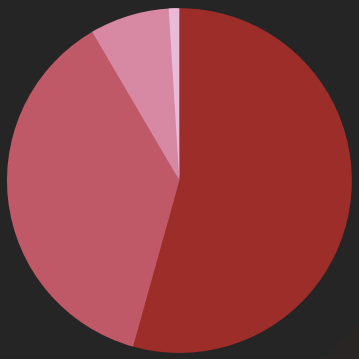


- Presentations
- Social Medias Outreach
- Meetings with teams
- Translation
- Volunteering
- Helping teams/Mentoring

Sustainability

Since most members will be graduating this year, we tried to maximize the team's number of first-year students and seniors. Therefore, we invited all those interested in FIRST and started teaching them the basics of robotics. Our team has ten interns who are gaining experience for the upcoming seasons. We also increased our qualifications within the team by taking courses based on our roles.

Team fundraising *Read more in the NB: p. 143 - 144*



- Sponsors (54.3%)
- Hackathons (37.2%)
- Courses (7.4%)
- Own contribution(1.1%)

All in all we raised: 1.611.700 tenge.

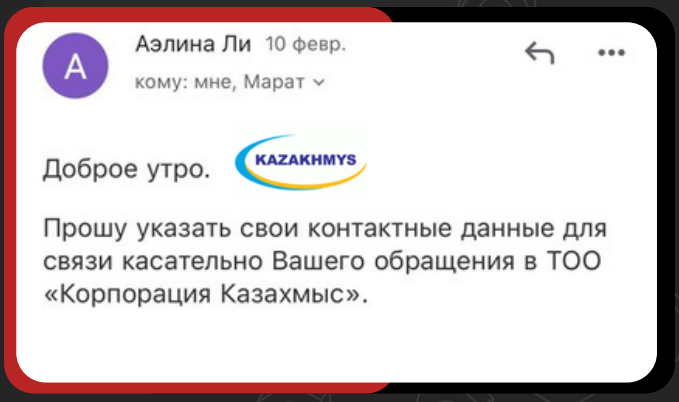
Another thing is covering the team's expenses. Initially, our team members tried earning money by using their knowledge to make a profit. That is how we raised 600K, then spent on accommodation.

- Corporate connections outreach. This outreach is a valuable part of team sustainability and development. With the help of recently made connections, we gathered half a million KZT from huge corporations, therefore covering the team finances.

GCS Study

The business division during a meeting with our biggest sponsors.

Kazakhmys



A huge local corporation has agreed to sponsor us if qualified to the World's

CONNECT

Connections are a very important part of our work. When making connections we seek to narrow the gap between STEM and non-STEM and bring people closer to maths and other exact sciences.

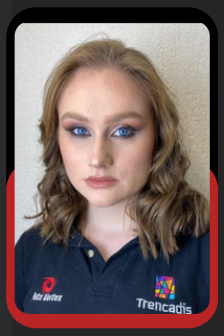
Our Sponsors

Teams Plan: Goals and steps for the development

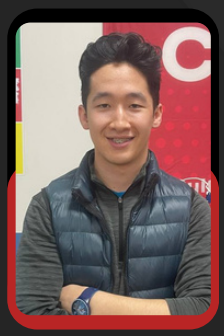
Engineering Division	Programming Division	Handbook Engineering Division	Social Media. Division
Goal: Create an authentic, simple, and well-functioning robot which could be easily fixed anytime. Strategy: Take CAD lessons to model the robot, measure, estimate, and calculate before building, and review engineering tips from MIT and Stanford for creative ideas and efficient assembly.	Goal: Write a driver-friendly autonomous code that can score maximum points. Strategy: Contacting mentors, searching the web, taking programming courses	Goal: Create the most informative and well-structured notebook and portfolio worthy of the Inspire Award. Strategy: Asking mentors to proofread, contacting Inspire Award winners, and following their example.	Goal: Run an active Bolt.m3 social media account. Strategy: Boost posts, contact celebrities, and make deals with famous companies.

More in the NB p. 10 - 12; p. 134 - 142.

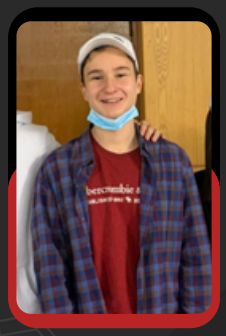
People we connected with during this season:



- Sofia
- Mentor from Russia
- Referee
- Helped with Handbooks.



- Kazhymukhan
- Former host of FIRST Competitions
- Helped the notebook and robot assembly

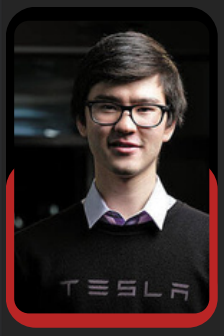


- Sultan
- Fizmat graduate
- Purdue University
- Helped in engineering calculations.

- Baurzhan
- PhD in IoT
- Past robotics teacher
- Helped in autonomous part.

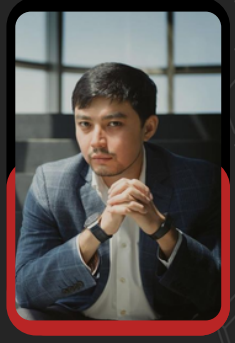
- Sardar
- Fizmat Graduate
- Purdue University
- Helped in the theoretical part.

- Eldos
- Physics teacher
- Helped in engineering calculations.



- Sanzhar
- SpaceX, Hyperloop
- Battery Engineer
- Provided feedback

- Berik
- Entrepreneur
- Founder of FIZMAT Endowment Fund
- Sponsors the lab



- Olzhas
- Fizmat Graduate
- Got more knowledge about FIRST Competitions

Timelines and Scheduling:

Some members have free attendance at school, meaning that they are freed from classes and can spend all day in the lab.

BOLT M3 TEAM PLAN

Monday	*Tuesday*	*Wednesday*	*Thursday*	*Friday*	*Saturday*
Meeting in the laboratory; (9 am - 9p m) **Meeting** with some of the mentors or professionalss; 9 pm: Each member sends a reflection from day.	Meeting in the laboratory; (9 am - 9 pm) Going to outreach activities if planned 9 pm: Each member sends a reflection from day	Meeting in the laboratory; (9 am - 9 pm) Going to outreach activities if planned 9 pm: Each member sends a review from day	Meeting in the laboratory; (9 am - 9 pm) Discord Team Meetings 9 pm: Each member sends a review from day	Meeting in the laboratory; (9 am - 9 pm) Going to outreach activities if planned 9 pm: Each member sends a review from day	Taking ***Courses*** in the free time (engineering/ CAD/programming) Meeting in the laboratory 9 pm: Each member sends a review from day

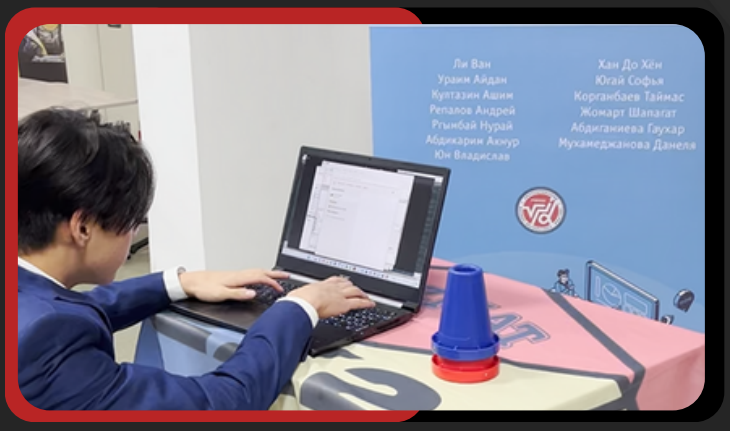
Those who are freed from school have strict working hours from 9 am to 7 pm. During this time they organize tours through the lab, meet up with professors, do outreach activities, and more importantly, assemble the robot.

More in the NB: p. 134 - 142

More in the NB: p. 19 - p. 56

Few Examples of our outreach to STEM communties.

FIZMAT Forum

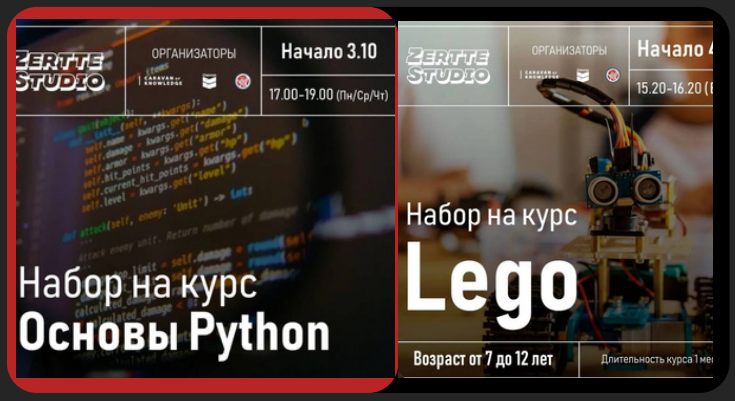


A lot of professors, programmers, and Fizmat graduates came to the Forum where we connected with STEM Community.

KazEngineering Company

Introducing KazEngineering employees to FIRST and robotics in Kazakhstan.

Training courses in Zertte Studio



Our members have conducted robotics-related classes to educate the growing generation

Media Outreach

Bolt M3
FTC TEAM #22801

We have reached 700+ followers on our Social Media, where we post FIRST information and our outreach activities. Also, it is a great resource for finding new connections. all of our connections help us meet our goals and develop our team members

To conclude, we made connections with individuals in the engineering, science, and technology communities. We also actively engaged with the engineering community to help them understand FIRST, the FIRST Tech Challenge, and the team itself.

Five-Step Process Structure

We follow a five-step process when building our robot to achieve efficiency, simplicity, and aesthetics.

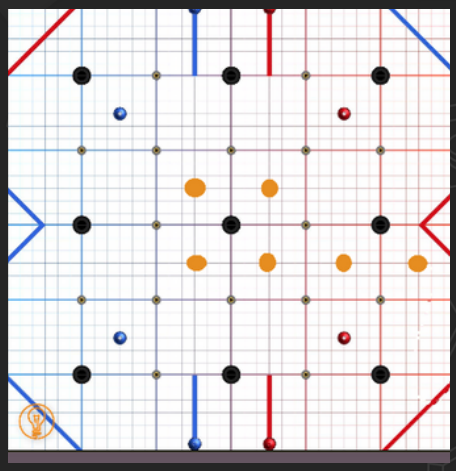
Brainstorm → Research → Prototype → Test → Improve

Game Strategy

More in the NB: p. 148 - 151

Since our main objective is cycling, we are planning to score cones while standing in one place for the first minute of the game. After that, if the opponents try to block us, we will fill other junctions, and then we will come back at the last minute, override the different junctions, and do a circuit.

Game path



To do this, we need our robot to score cones on the junction quickly, move around the field in all directions and achieve maximum efficiency claw.

Design Features:

- Extending intake, which is able to take cones from a distance;
- The Lift System is located at a 60-degree angle, decreasing the weight force exerted on the base;
- Wooden Walls to showcase our sponsors and team number;
- LED strip ;
- 3D-Printed Basket to move the cones through the lift system;
- Customized Intake for a firm grip on the cones;
- Corrugated Tubing to prevent the wire from the environment.

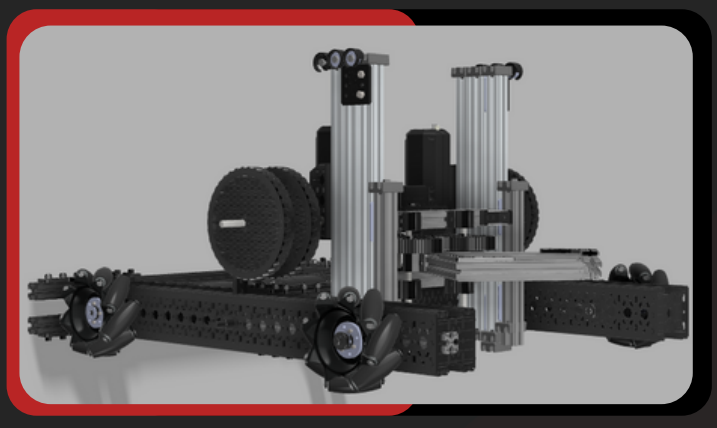
NB: p. 58 - p. 132

Robot's Performance Proposal	Design Proposal
The robot has to place cones quickly.	Use the chained lift, as it has no friction problems like string and moves quickly due to the usage of sprockets and telescopic sliders.
The robot has to move around the field fast and in all directions.	Use mecanum wheels, so robot can move in in multiple orientations.
The robot has to take cones from all locations.	Use horizontal telescopic sliders, so it does not matter if there is a cone in the junction or if something is in the way.
The robot has to easily grab cones with a claw.	Use loofah foam for a better grip

Brainstorming

We have two prototypes of our robot. First, it is a robot with a linear lift mechanism, and second (our final version robot) is a cycle bot. You can see the CAD for the first robot and the second prototype design, the initial CAD from Fusion 360.

CAD №1

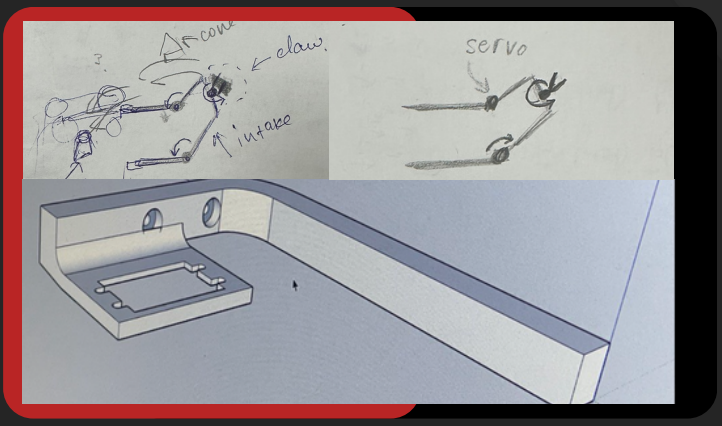


In the process, we understood the non-efficiency of this method because of the low friction between the string and pulley.

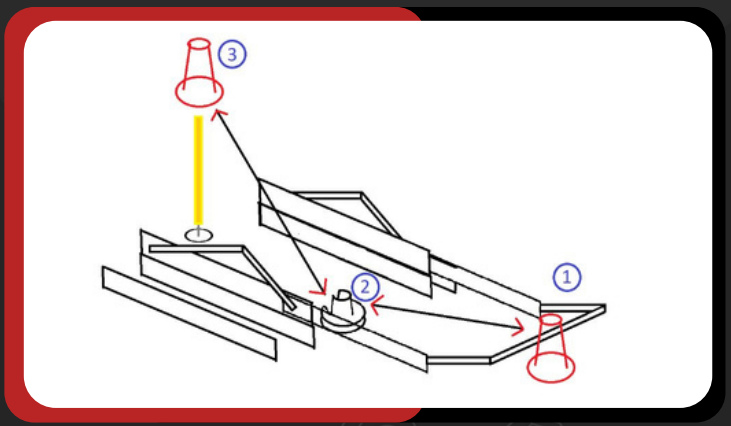
The Initial CAD №2

Specifically, here represented our CAD idea, and on the next page, you can see the full sketches for Intake and Lift Claw.

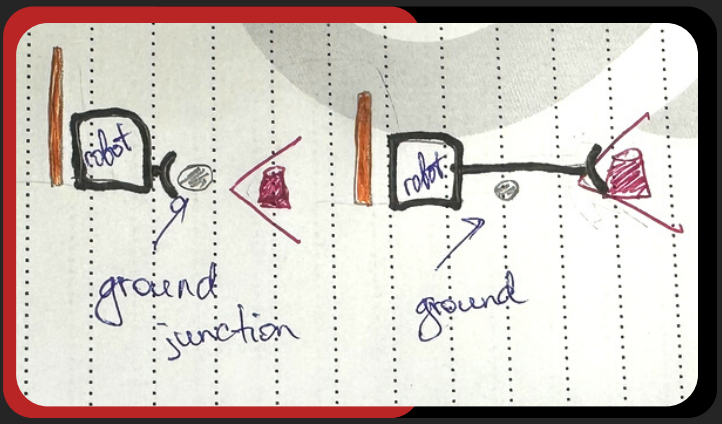
Sketches for the 2nd Verison of Robot



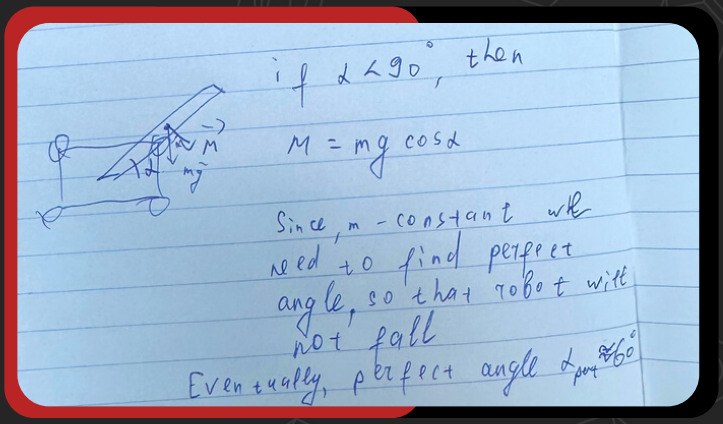
Modelling a rotating intake



Thinking of a new cycle mechanism



Coming up with a counter-strategy in case a cone is placed on the ground junction.



Calculations made by Sat who estimated that the bigger the angle, the less weight.

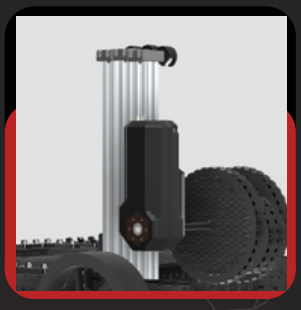
Problems and Solutions

1. Chain Lift Mechanism

Based on our past experience with string lifts, strings can easily break, have bigger friction, and are unstable. Therefore, we switched to a chain lift construction.

Our goal was to have a linear slide system that would be both compact and fast to ensure maximum effectiveness.

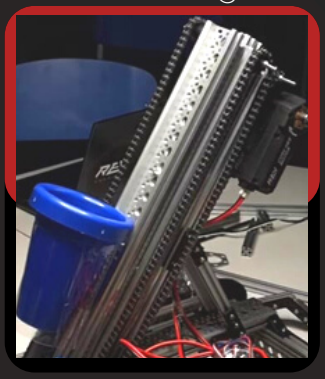
Prototype



Problem

Linear slides are not the strongest mechanism because they are only powered in one direction of motion which goes against our simplicity goal.

Final Design

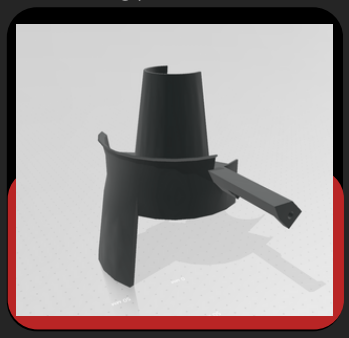


We changed the approach and used sliders to create a faster transportation system. The assembly of this lift took a lot of time and brain activity, but it turned out just as we expected. Fast, unbreakable, and effective.

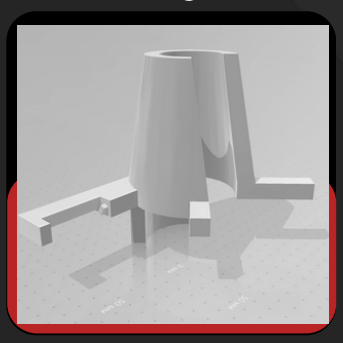
NB: p. 115 - 120 calculations

2. Basket

Prototype



Final Design



Problem	Solution
The first model of the basket was too short for the cone which made it fall out every time the lift went up.	We removed the borders and added some support below the basket to make aiming easier.

The basket is one of the key points in our cycle. Unlike our previous designs, this basket would save time by not flipping the cone to the junction. Therefore, the current design is faster and more efficient.

3. Claw

Problem	Solution
We took inspiration from crab tentacles and developed two identical claws. However, due to modifications in the chain lift mechanism, we faced a shortage of encoders for a third servo motor.	We modeled another claw which consisted of servos for gripping the cone and putting the cone into the basket). The construction was perfect, so it became our final design.

Prototype

The claw plays a huge role in the robot's performance.

Final Design

A good claw ensures a big number of picked-up cones, while a bad one destroys our chances to win.

4. Telescopic Slide Intake

A telescopic intake is highly important for our robot since our past construction lacked an extending part. Now, our intake is implemented with sliders for a better reach.

Final Prototype

3D model

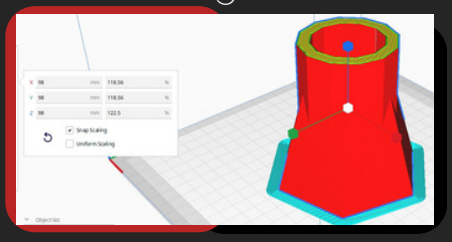
Problem	Solution
It was a fastening mechanism. To remedy the issue, we added a servo for their movement, but this also resulted in occasional discrepancies in the motion.	We designed 3-dimensional component that could securely attach to the slides. These parts provided a stable hold and upon activating the servo motors, the slides remained steady without any shaking.

5. Beacon

The custom beacon is a nice bonus, giving us more points for the robot game.

Prototype

Final Design

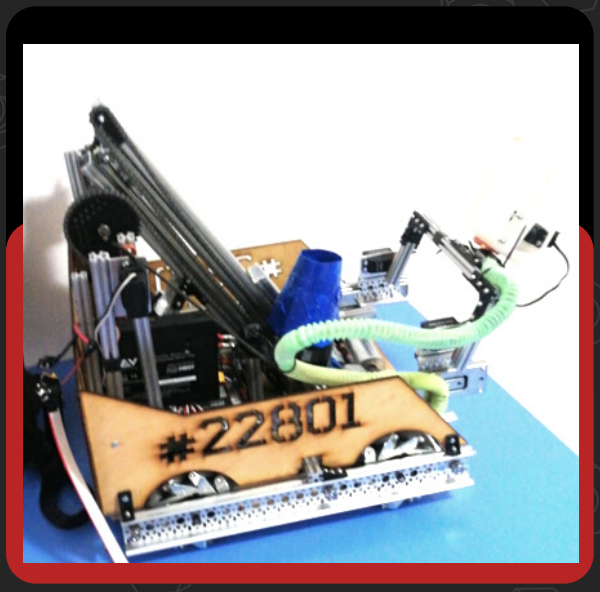


Problem	Solution
The prototype was notable for its utilization of regular paper cup material, lightweight design, and lack of rigidity.	We changed the beacon to 3D detail with full occupancy and created the markings of 3 inches min - 4 inches max.

Innovate Features:

INNOVATE

- Telescopic Slide Intake quickly pick up cones from any position;
- Lift Height enables putting cones on all junctions;
- The 3D-printed basket can hold one cone and fastly place it on the junction without flipping it;
- A claw with a sponge on it has a clear grip on the cones;
- The Telescopic Slides and the Mechanum Wheels allow moving in multiple directions.
- The chain makes the Lift Mechanism faster;

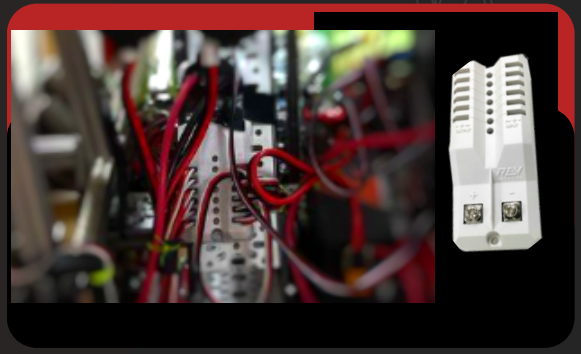


We acquired the skill of evaluating whether our ideas merit further investigation by going through this process and encountering additional challenges. It took some time to feel at ease, but eventually we grasped the concept of not becoming too attached to an unfeasible idea.

Telescopic Slider Intake allows quickly up cones from any position.:

Problem:
The Slides were too slow, and scoring many points for cones was complex.

Innovation:
There were problems with the servo motors.
So to solve it, we connected them to the servo power module.



NB: p. 58 - p. 132

3D-printed basket fastly place cones on the junction:

Problem

Unfortunately, we faced the problem of its low density, so it broke even with a total occupancy rate.

Innovation

To solve it, we started heating it so the plastic settled, and the density of the material increased.

Claw with a sponge on it has a better grip of the cones:

Problem

Our previous intakes kept losing the cone whenever moved on a high speed. Therefore, we had to solve the problem using a material that would increase friction between the claws and the cone.

Innovation

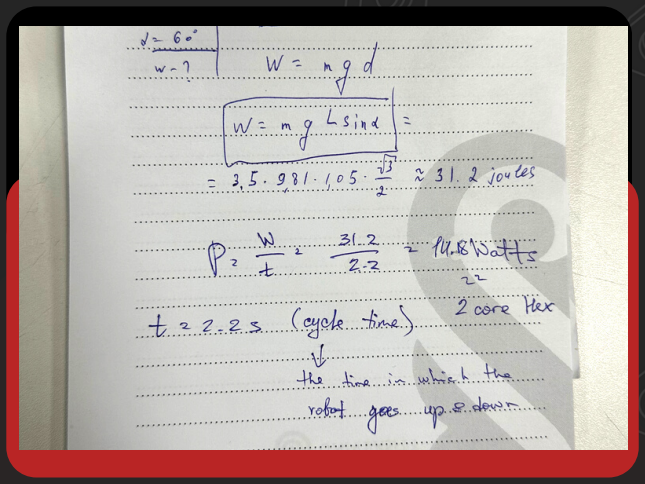
According to the Mechanical properties of the luffa sponge study (Jianhu Shen, 2012), the sponge is a great alternative sustainable engineering material since it has characteristics such as stiffness, strength and energy absorption.

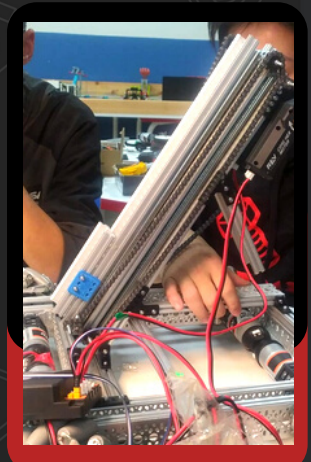
The Telescopic Slides and the Chain make the Lift Mechanism faster:

Problem

As aforementioned, initially we had a string lift mechanism. But due to an unstable system we changed it to a chain mechanism. We had to to make sure that the elevator from the chain is really effective, so it was necessary to derive a formula proving it.

Innovation





In this extract, we calculated the number of Hex Motors needed to make the lift go up fast.

CONTROL

Software

Strategy

To create a simple yet adaptable program for drivers on the top part of the game and to make the highest scoring and efficient program on the autonomous region of the game.

Driver compatibility

Our cycle and cone putting algorithms contain little delays between extending and grabbing cones to allow our drivers correct little errors and grab cones properly.

Dual control

Two controllers and two drivers.

More in the NB: p. 150 - 156

Intelligent controls

automated cone intake, an automatic cycle algorithm combined with button shortcuts, set intake.

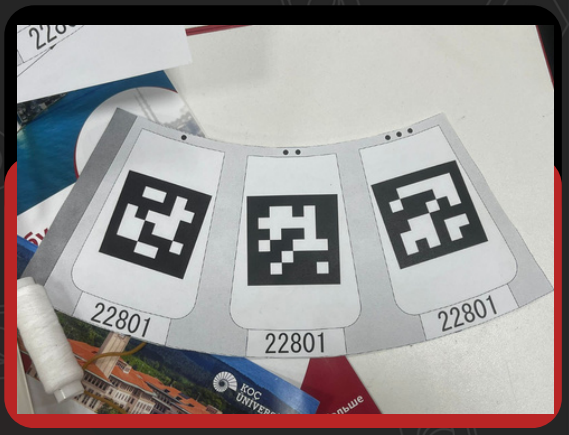
Beakon Sleeve

- QR Code/Barcode

- Library: FTC April Tags

- Id: 17, 18, 19

Start of the Match



Key Algorithms

Autonomous:

- Detector.getTag()
- GRABIntakePosition
- PUTCONEIntakePosition
- ThrowCone

Tele-Op:

- GRABIntakePosition
- PUTCONEIntakePosition
- threadFULLExtend
- threadPUTCONE