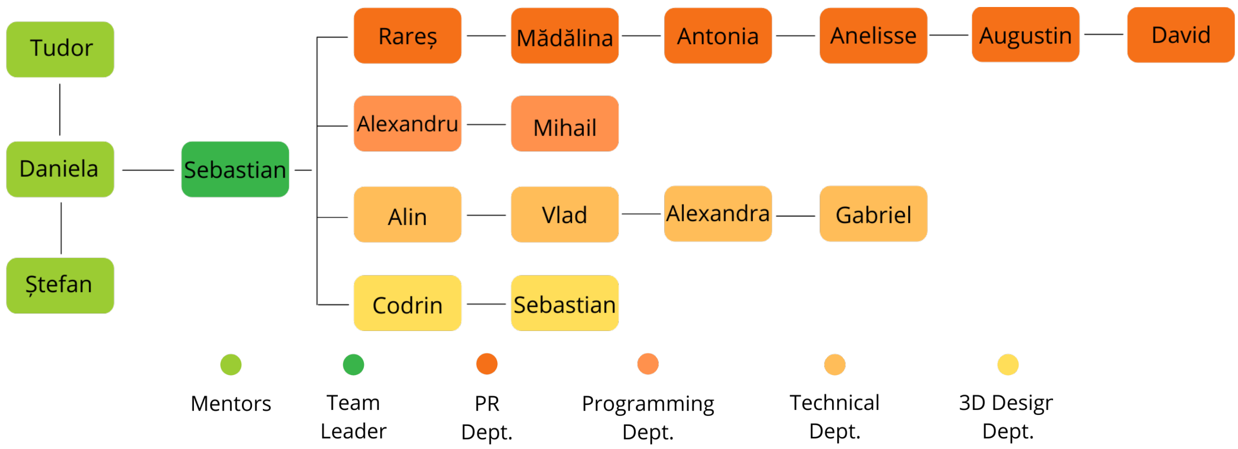
1. Team section

InfO(1)Robotics is a robotics team in which 15 students from the National College "Ion Luca Caragiale" and 3 mentors create innovative robots and original content as a part of the program First Tech Challenge. Everything started 4 years ago when our mentor, Daniela, started InfO(1)Robotics along with some students who were passionate about robotics and programming. To work clean and be efficient, we divided our team in 2 big parts: Technical and Nontechnical, and to be more specific, in 4 departments.

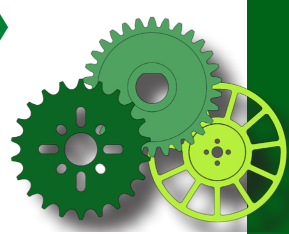


We are motivated to follow 3 important principles just to stay productive and concentrated and also to have a plan of our working statements. Those 3 essential principles are :

- **Purpose**- is the principle of every member of the team when they want to do something. Our main goal as a team is to progress in the process of evolution of humanity using robotics, STEM fields, and Gracious Professionalism.
- **Interdependence** - the feeling that we can always count on each other. This means that we can ask for help when we need it and take care of every member. Trusting is one of the most important things for us.
- **Relaxed atmosphere** - exploitation of new ideas, asking questions, saying your opinion without the fear of judgment. The liberty of failure has brought us a lot of winnings, ideas, and smiles.

Essential values - with those we made our connection from the beginning. We guide our way around values such as respect, communication, creativity, and inspiration.

In this season, we decided to work on sprints for one or two weeks, keeping an eye on efficiency, and increasing the percentage of tasks solved on time using this method. At the final of every sprint, we had a meeting to discuss how the sprint was and if we had any problems during the process of creating and also to talk about distribution in an equal way of the tasks for the next period.

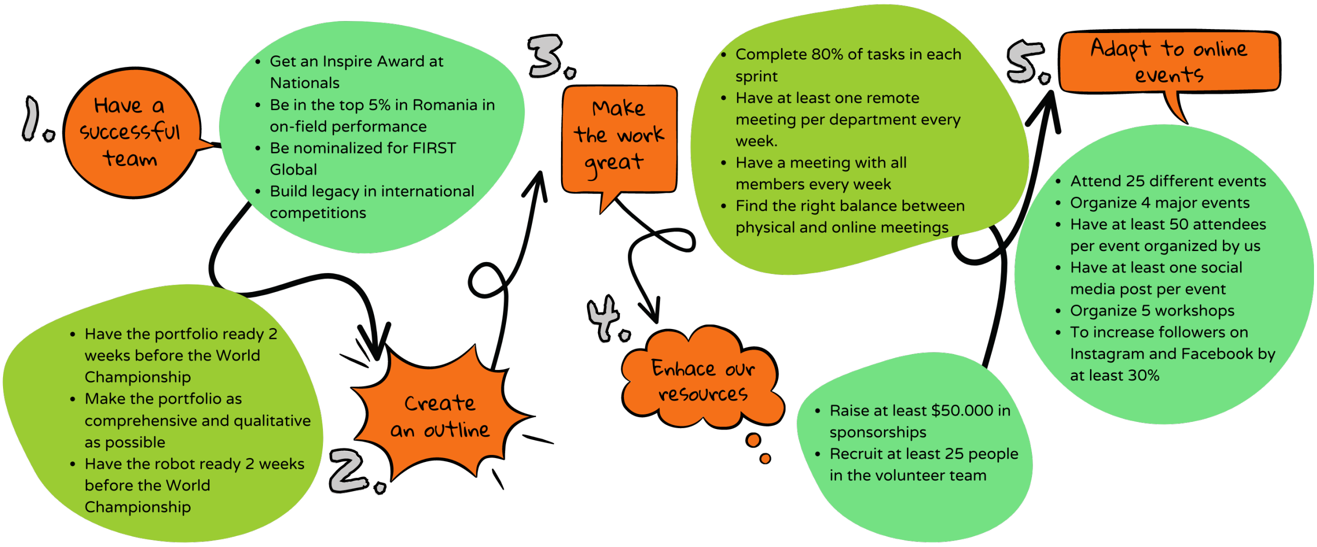


Agile Management is the last part of our team organization model. It is our third year of using this strategy for implementing ideas and the organization schedule. We manage to combine 2 forms of Agile: **Scrum** and **Kanban** in one, **Scrumban**. With Scrum's workflow and Kanban improvement process, we've evolved as a team and managed to complete all tasks faster without affecting the quality of the final product.

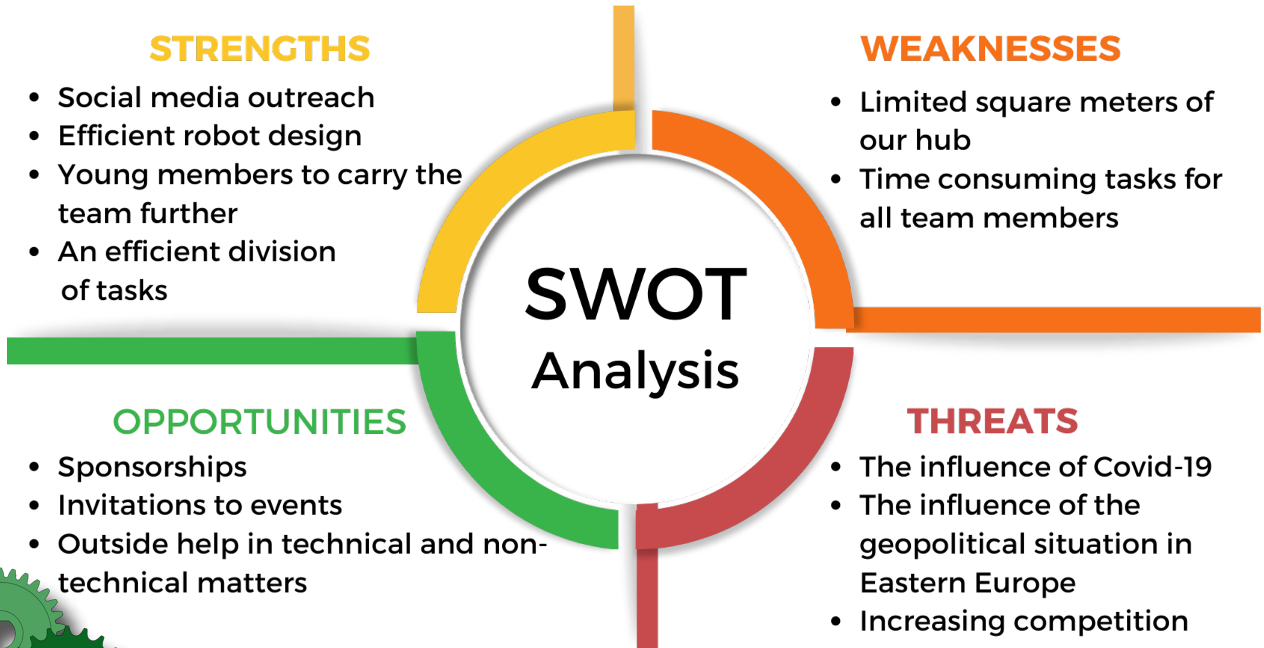
1.1 Objectives & key results

Two years ago we started using OKRs, because the benefits of using them are significant, the work we do is more practical and better organized. Their principle is simple, and their methodology helps us set more challenging and ambitious goals with measurable results. Goals are simply what we want to achieve.

They are meaningful, concrete, action-oriented and inspiring. Each objective has a set of measurable and variable results, also known as key results. They evolve as they progress. Once each key result is complete, the goal is achieved.



2. Business plan



2.1 Strategic plan

Short-term strategy

Firstly, we organized the tasks of each department and the connections between them. Our technical departments have worked together to create a functional robot that performs all the tasks necessary to get as many points as possible. During the season, all the departments worked together to develop the Technical Notebook and Portofolio.

Long-term strategy

- **Team development**

  This tries to aim the team dynamic and the balance in it, with the direction of achieving the objectives. Development refers to the process by which the team gets to perform better and better on a specific set of tasks.

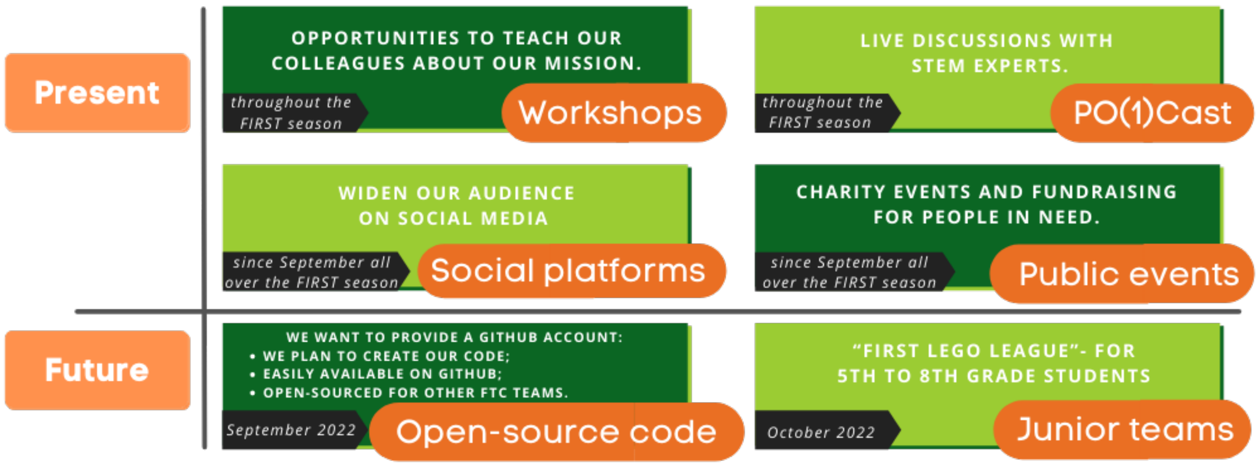
- **Mentoring for new team members**

  We will be able to help new team members have an excellent course in this competition by organizing various speaker-related workshops by each department, with the help of current and alumni members.

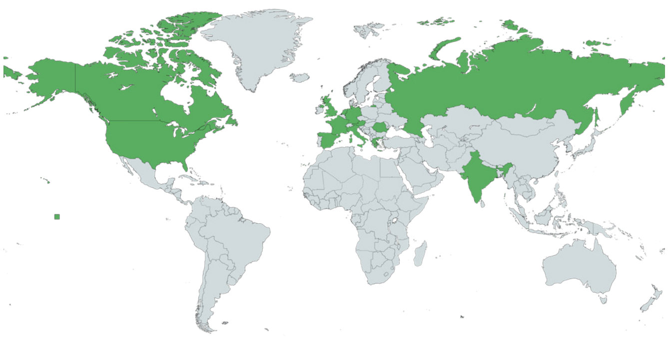
- **Brand improvement**

  Finally, achieving brand awareness means that the team becomes known and easily recognized. We want to increase interactions on social networks, in order to reach a wide audience interested in the values of FIRST.

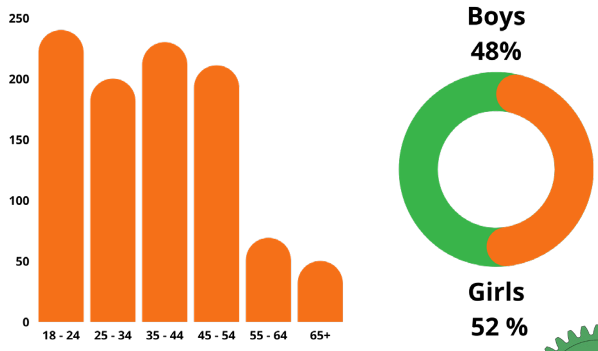
2.2 Present & future actions



2.3 Marketing analysis



International audience



Age and gender distribution

*Analytics from the **"Meta Business Suite"** application*

Social media platforms

1319 followers
126 posts
Over 1600 stories

16 videos
Over 6000 views
PO(1) Cast

Maximum interactions: 2755
1633 followers

www.info1robotics.com
Our site that directly documents our general activity

2.4 Outreach

We felt that raising awareness about STEM and FIRST values should be our philosophy for connecting different social categories. We wanted to make a connection between STEM and our name, and we think did it. Our audience regularly engages with the S.T.E.M. content we provide.

Facebook & Instagram outreach

Using social media helped us to meet new people, make connections, promote events and reach a lot more people. In *Fig.1* and *Fig.2* you can see our **Instagram** and **Facebook** reach since the 25th of September to the present. We used the app called ***"Meta Business Suite"*** to track our evolution and to see our reach this season.

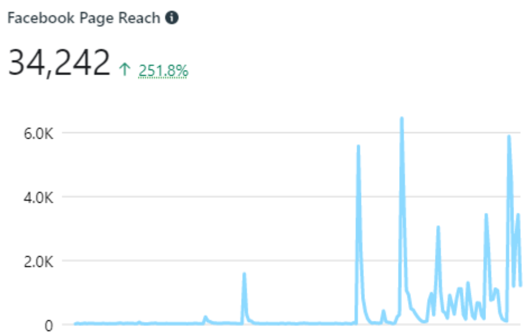


Fig.1 Our reach on Facebook between 25th Sept. and 6th Apr.

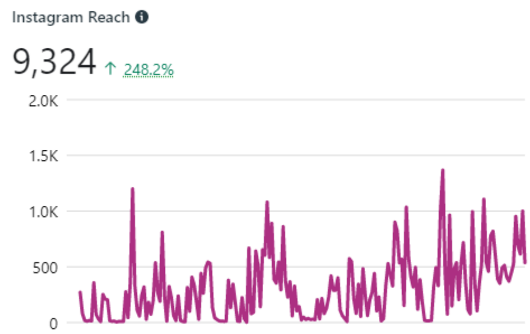


Fig.2 Our reach on Instagram between 25th Sept. and 6th Apr.

2.5 Financial Plan

In the 2021 FTC Freight Frenzy season, we manage to raise over [redacted] from sponsorships *(Fig.1)* and expenses around [redacted] *(Fig.2)*. You can see more details about that looking at the graphics that are below.

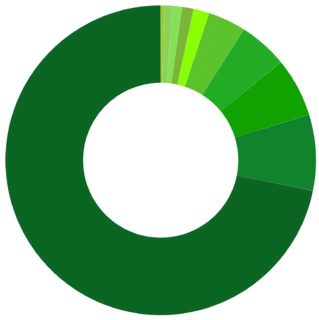


Fig.1 Budget

- **Ploiești City Hall -** [redacted]
- **Conpet -** [redacted]
- **PION Impex -** [redacted]
- **Professional Pharmacy Farmaline -** [redacted]
- **Crisman -** [redacted]
- **International Alexander RO -** [redacted]
- **Dental Office Superdenstist -** [redacted]
- **Audiolux -** [redacted]
- **Servotop -** [redacted]
- **Asalf Invest -** [redacted]

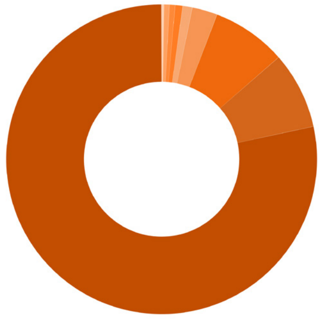


Fig.2 Expenses

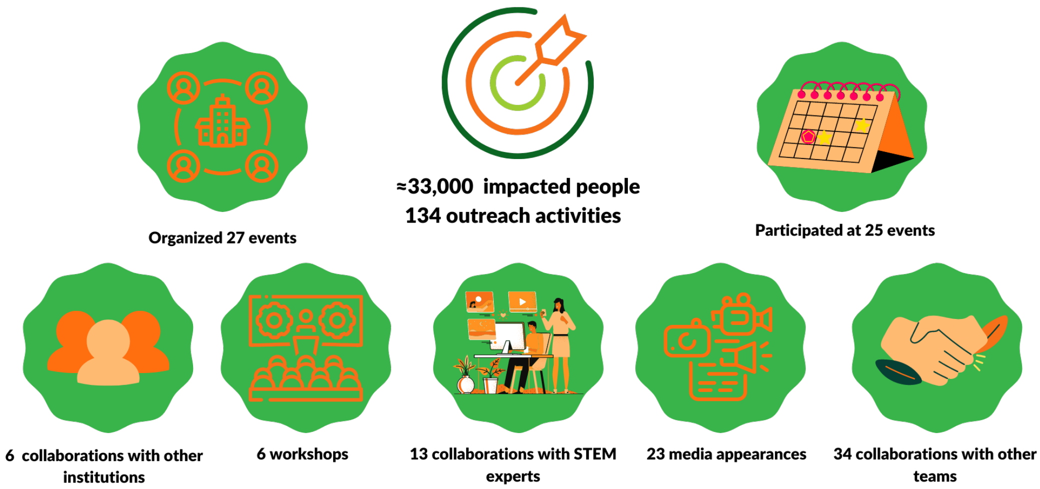
- **Trips for competitions -** [redacted]
- **Robot pieces -** [redacted]
- **T-shirts, Hoodies, Jackets -** [redacted]
- **Events -** [redacted]
- **Perimeters of the field -** [redacted]
- **Promotional materials -** [redacted]
- **Game elements -** [redacted]
- **Protocol materials -** [redacted]
- **Covid-19 Antigen tests -** [redacted]

3. Events

In this FTC season we managed to set up both live and online events attended by over 700 people and teams taking into account the convenience of online applications as well as respecting the restrictions imposed by the authorities.

On the other hand, the principles applied in the organized events for us were interactivity, compassion and personal development which helped our goal of motivating, teaching and cultivating people. All of this being said, we tried to combine moral values and intellectual growth as much as possible.

The format of the events organized by us



Treasure Hunt

Date: 18 October 2021
Reach: over 100 participants
Budget: 127.34 $

Our Treasure Hunt with the theme "Human Rights Defenders" in partnership with the Association of Volunteering and Personal Development "Un strop de Fericire" was one of the most popular events. Considering the pandemic restrictions, we had to hold the event into a hybrid form, the number of participants exceeding 70 people. The competitors had to follow a set of tasks which involved communications, analytic thinking and adaptability aptitudes. Through these tasks, participants learned a considerable amount of information about human rights.

Photo with the organisers and one of the participants teams

Kindergarten visits

Date: 8 December 2021
Reach: 40 participants
Budget: 24.56 $

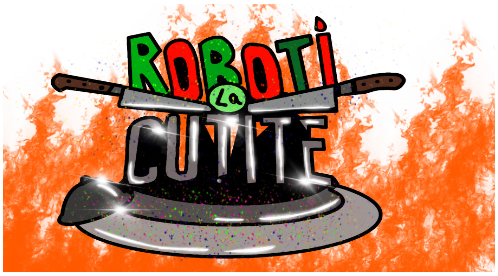
In partnership with the Youtube channel @stacs.tv, as part of the "Start la Fericire" campaign, we printed over 100 decorations in the spirit of Christmas and offered them to children from a kindergarten in Valcanesti. An act of compassion that brought joy, laughter and the Christmas mood to those children. We are always happy to interact with as many age groups as possible.

Our team leader interacting with the kids

Masterchef Robotics

Date: 14 December 2021
Reach: 160 participants
Budget: 49.23 $

This Christmas event tested the culinary skills of the participants by challenging them to post a short clip in which they made a Christmas-themed dessert. Ten teams participated in this contest. The participants with the highest ranked plaiting on their plate were rewarded with 3D printed knives made by us and other kitchen tools. The winners were ABSO-Tech#19068, Clockworks #19075 and Snake-Tech #19139.



The logo of the contest

Fundraising for Ukrainian refugees

Date: 3 March 2022
Reach: over 100 donations

Ukrainians are going through difficult times and as we consider helping each other to be an important element of the FIRST spirit, we managed to organize a fundraiser. We quickly mobilized the community, raised a considerable amount of money in less than 24 hours and delivered them personally to the refugees staying in Barcanesti, Prahova, along with hygiene products.


Our team members helping the refugees

S.T.E.M. WEEK

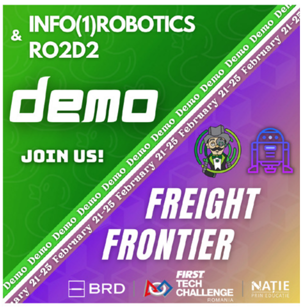
Date: 21-25 March 2022
Reach: over 200 participants
Budget: 959.86 $

During March 21-25, along with AFI shopping center, we organized different S.T.E.M activities. Over 100 students from preparatory, junior and senior school enjoyed demonstrative games, contests and a conference with experts from this domain. We succeeded organizing this event along with another team from our town, BraveBots#19141. Together we succeeded in transmitting to students interested in science, technology and mathematics, the FIRST values.

Kids learning about FIRST, FTC and STEM values

3.1 Collaborations

From our point of view, for sharing FIRST values and information exchange, the need for collaboration is essential. This year we have collaborated with other FTC teams and other organizations from our community. A few examples of collaborations in this season are: organizing a demo on academic debate with BraveBots #19141, organizing a demo along RO2D2 #17962, shooting a podcast and debating on FTC related themes along Pink To The Future #3954 and organizing an ecological related debate with a students group from the University of Eindhoven, Holland.



Posts on our Instagram page to announce events we've organized

34 COLLABORATIONS WITH OTHER TEAMS

With just a little planning, team STEM projects help us develop the essential skills that will prepare our team for the diversities and realities of the modern working environment. When involved in well-structured team activities, we develop and practice skills in decision making and problem solving. A few examples of collaborations in this season are: Mrs. Nicoleta, the coordinator of school educational projects and programs, within our college, she gave us some advice during the FTC season about planning our outreach events. Another example is the fact that we made a conference with 6 STEM experts about the STEM fields.

17 COLLABORATIONS WITH S.T.E.M. EXPERTS

Posts on our Instagram page to announce the conference

Mădălina, Alexandra and Antonia with the educational counselor

4. Robot philosophy

While developing the robot, we implemented a philosophy closely linked to our team and FIRST, chasing to have a design of the robot as efficient as we can get, using mechanisms that have effectiveness risen to the complexity of the topic. For this year's theme, we decided to adopt 3 essential principles for the design of our robot: efficiency, simplicity, and reliability.

- **Efficiency**

We believe that it is best to develop an efficient robot capable of performing this seasons' tasks as efficiently as possible. Taking into consideration that the most troublesome part is the entrance of the warehouse – we have to pass over the barriers or build a narrower robot to get around them – we chose to combine the obvious options in an ingenious and effective way so that the robot can pass both ways.

- **Reliability**

A reliable robot means a machine designed to play a large number of matches without having to be repaired, therefore we spent a lot of time improving and pushing our robot to its limits. To develop a robot that is safe to use, we have used qualitative materials and we have carefully designed each subsystem.

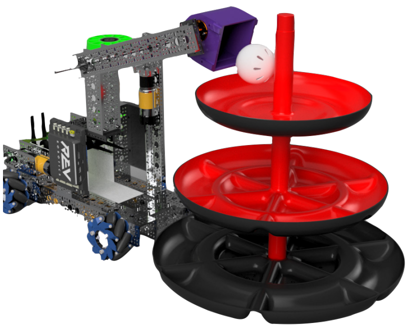
- **Simplicity**

During our previous FTC seasons, we realized that a simple, modular robot is easier to build and maintain. Taking into consideration that it allows us to experiment with it and test every single component individually in an easy way, it is very convenient to maintain the robot. Hence, we decided to divide our robot into 5 subsystems, as you can see in the table on the next page.

Chassis	The main driving train of the robot
Intake	Sub-system used to collect Freights from the Playing Field
Intermediary	Sub-system used to ensure that the Freights collected by the Intake reach the Outtake
Outtake	Sub-system that takes the Freight from the Intermediary and can place it on any of the 3 levels of the Shipping Hub
Auxilliary Systems	Any sub-system that is not used part of the Robot Core (e.g. : the duck-delivering system)

5. Bobot

In this season we decided to let our new team members build their robot with the help of the experienced members, and we called it 'Bobot'. This robot is a beneficial experience for them because they can get hands on experience in building and programming a robot in a short amount of time. In this section, we will present a summary of the 'Bobot'.



The Bobot on the field

From a mechanical point of view, the Bobot is simple, having an intake built with 2 sets of flexible 3D printed blades, which throw the game elements directly into the outtake. The outtake consists of a motor with a GoBilda profile and a servo attached to a container so that the outtake is capable of scoring the freight at each level with ease.

The programming of the Bobot was fairly simple, using the encoders of the motors for the movement of the chassis during the autonomous period and implementing the robot`s control using a single execution of the processor. Object recognition was done with the help of Vuforia and a pre-trained model, called Tensorflow.

It is the first season that our team implemented the Bobot, helping the new members and we consider it a big achievement. They learned how to build a robot for FTC in just a few months by participating in Remote and Traditional competitions. On the other hand, it was a good way to test different types of mechanisms. A good example is the use of the 3D printed blades, which were first used on the bobot before being implemented on our main robot.

6. Chassis

6.1 Strategic plan

The chassis is the base of our robot. It is engineered to provide room for all of the robot's mechanisms while allowing the robot to move very precisely and fast. Analyzing the obstacles and the ground, we found out that we need mobility on the field, so we built an agile, compact and light chassis, so it would be able to support all the mechanisms of the robot. We decided that we need a chassis that could fit between the perimeter and the barriers (13.69 in), or could go over the barriers from the field. Therefore, we built a capable chassis that can go over the barriers as well as between them and the perimeter.

6.2 Prototyping

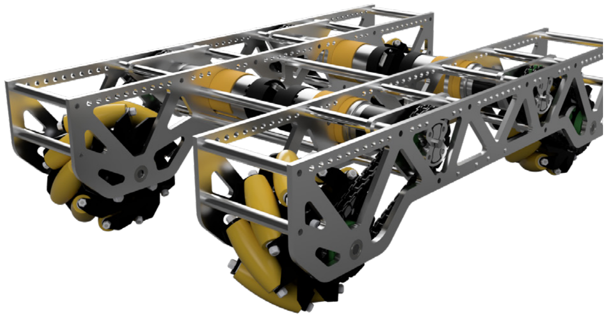
Our first prototype was the Gobilda Strafer chassis, which we had a lot of experience with in the previous seasons. Having the following dimensions of 17.79 in x 17 in it is too wide to slip between the barriers and the perimeter. Also, because it has a ground clearance of 0.094 in, it can remain suspended on top of the barriers (which have a diameter of 1.06 in). Not even the Gobilda Beeline chassis would be helpful, with the dimensions of 17.56 in x 17.01 in and ground clearance of 0.09 in, very similar to the ones from the Gobilda Strafer. This way, we decided to design and build our own chassis using plexiglass plywood of 0.16 in and profiles made of REV extruded aluminum.

6.3 Final Version

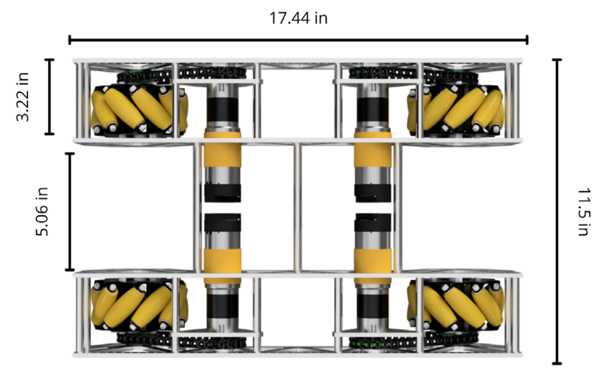
As we said, a thin robot is the best option for the chassis owing to the obstacles. We managed to create this chassis having the dimensions 17.44 in x 11.5 in, passing with ease through the small distance between the barriers and the perimeter and with a high ground guard of 2.56 in so that our robot would not remain stuck on the top of the barriers when going over them.

In the image, you can see a perspective of the chassis, which results in a generous space of 5.04 in, situated in the center of it, necessary for the construction of the other mechanisms.

Before National Championship we found out about an opportunity of making the whole chassis from aluminum at a CNC. We created a new design for the chassis with the same dimensions but, taking into consideration the fact that it will be made from aluminum, we had to try to maintain approximately the same weight. Here is a preview of the new chassis.



New chassis



Our chassis and its dimension

7. Intake

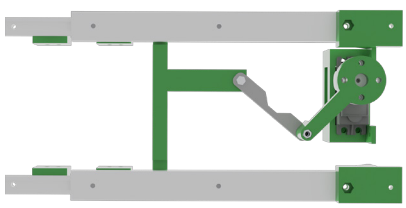
7.1 The mechanism itself

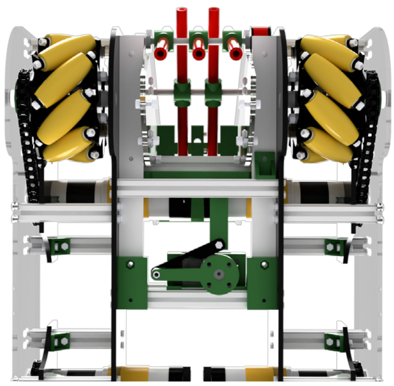
The robot`s intake is based on a compact mechanism of sliding, with an imprint of only 5.08 in x 3.94 in, which is supported by two Misumi slides that can expand for approximately 4 in, with the help of a GoBilda Torque servo, by using a scissor-like system.

Why did we choose the sliding mechanism?

- You can easily pick up freights that are close to the corners of the field or that are not accessible.
- The system minimizes the take-up time of freights.
- It further reduces the risk of failure while picking up heavy cubes or balls from the ground.

Linear slide

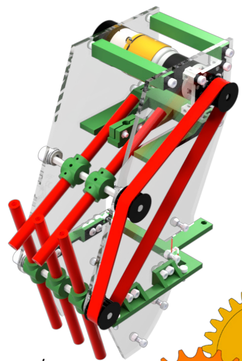




Bottom view of the intake

7.2 Freight pick-up

Initially, we used 3D-printed blades made out of TPU, a flexible material. Those worked well, and using them we managed to score up to 220 points. However, due to the fact that they were quite rigid, it was difficult for the freight to not get blocked and to be taken as fast as we would have liked. In the end, we decided to use rubber tubes with an increased grip, which, being softer, are much more effective. We mounted two rows of such tubes, one to take the freight from the ground and the other to send it to the intermediary mechanism.



Intake mechanism

7.3 The timing belt

Due to the limitation of 8 motors that we can have at the same time on the robot, we saw the need to implement a power transmission mechanism for the two sets of intake tubes from a single motor. Our first thought was to use a mechanism after we designed the system in CAD we noticed that it occupies 1.14 in new with 0.95 in available and is not reliable. So we decided to use our ability to 3D print flexible materials and started experimenting with different types of timing belts. After a series of times in which we changed the depth of the teeth or the size of the belt, we managed to reach the ideal position and we gained the necessary experience to manufacture our own belts.

7.4 Object detection

Initially, we used an endoscopic camera placed in the intake to detect the presence of a freight in the robot, thus avoiding the control of several freights. However, it relied on image processing for detection, which took up to 500 ms to signal its presence. Given that, based on our experiments, the freight spends an average of 1000 ms in intake, and there were cases in which it was not detected. Finally, we used touch sensors placed in the intake ramp for increased accuracy as well as outstanding efficiency. It signals the presence of a freight by an electrical impulse. Thus, we managed to increase the success rate from 50% to 100%.

8. Intermediate mechanism

8.1 Understanding its task

The intermediate system plays a key role for our robot, guiding the freights directly into the outtake. We have tried to provide a linear transition between intake and outtake, in an efficient and safe manner.

8.2 Prototyping

The first obstacle was the larger size of the sphere compared to the cube, which is why we started prototyping. In the end, we came up with an idea similar to a car wash, positioning 6 flexible silicone wheels on either side of the system. Due to the fact that the wheels have a low hardness (35A), it gives them the necessary flexibility when a sphere or a cube is taken over so that the freight is molded regardless of the shape (cube or sphere).

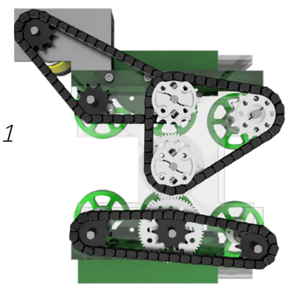
Flexible silicone wheel

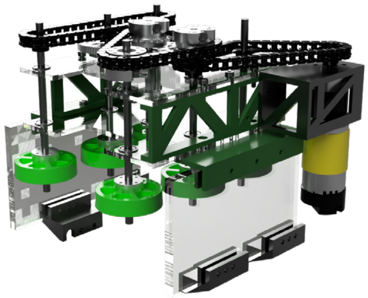
8.3 Final design

After the prototyping stage, we have begun working on the production version. Once the 3D design of the system was ready, we started assembling it. The system is made with two overlaid plexiglass panels (cut at CNC), connected with a set of 3D printed parts. To limit ourselves to 8 engines on our robot, we had to transmit power through a single engine to all 3 sets of wheels.

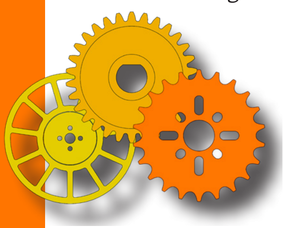
To do this, we used a 1:1 gearbox (Fig 8.3.1), which does not only transmit power to 6 wheels but also ensures that they rotate in opposite directions, so the freight would get to the outtake smoothly. As an improvement, we have added rubber bands to the compliant wheels to make sure the freights get through the system quickly and safely.

Fig. 8.3.1





The final version of the intermediary



9. Outtake

9.1 Understanding its task

After the freight passes through the intermediate access system, it reaches the outtake, with which it will be placed in the shipping hub. Outtake must reach each level of the shipping hub where the freight will score. Because we chose to make a narrow chassis, we had very little space, so the outtake must be compact, but at the same time fast and reliable.

The final version of the outtake

9.2 Prototyping

We came to the conclusion that the fastest and most reliable way to build the outtake would be to use a linear motion. The classic way for linear motion would be to use drawer slides, but this system is too bulky for the space offered by our robot. In the end, we ended up using a linear bearing, reducing the time required to reach the maximum height of the shipping hub from 2.5 s to 0.7 s. One problem we had in the hard project phase was that when it was in the position necessary to score on the lower level, the servo motor operating the container did not take place. The solution we found for this problem was to put it above and transfer the power to the tub using two 3D printed gears.

9.3 Final design

We opted for an MGN9 linear bearing because it offers a balance between size, weight, and strength. The string with which the linear system operates starts from the pulley connected to the motor by a 90° great transmission, to a small pulley at the top of the slide, from where it finally pulls the moving part of the outtake to which it is connected. We chose to tilt the whole system to about 14° so that we could score at any level of the shipping hub from the same position on the ground. This optimization allows us to create a single path for all cases in autonomy but also helps drivers to position themselves more easily in TeleOp.

9.3.1 Container

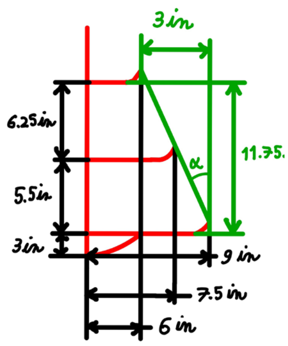
Freight is kept in a movable container operated by a servomotor. The axis of rotation of the container is in a corner instead of in the center so that when it is in position for the point, the sidewall acts as a ramp, so the robot can stay away from the hub.

$$tan(90^\circ - \alpha) = \frac{11.7}{3}$$

$$\Rightarrow \alpha = arctan\frac{11.75}{3} - 90$$

$$\alpha = 75.68^\circ - 90$$

$$)^\circ \approx -14.32^\circ$$



The angle we need

9.4 Programming the outtake

The outtake is programmed to have 4 positions: the three levels of shipping, the hub, and a waiting position in which it sits until the freight enters. The driver can select on which level he wants to put the freight using the directional pad from the gamepad. After the outtake arrives at the desired level, the driver can press the button X to score the freight in the shipping hub, after which it slides back down. Everything is implemented in an asynchronous mode, this way we can optimize the autonomies.

10. Auxiliary systems

- **Delivery system**

To deliver the ducks, we used two compliant wheels of 4 in from Andymark with a hardness of 35A to have the best possible contact with the carousel. Those are placed symmetrically on both sides of the robot to take advantage of the mirrored paths for the red and blue alliance.

$$\vec{F_f} + \vec{F_{cfi}} = 0$$

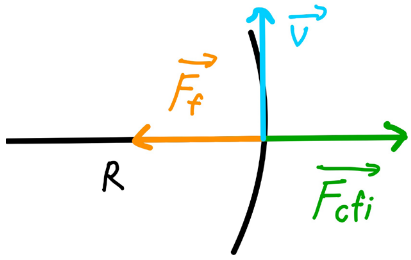
$$F_f = F_{cfi}$$

$$\mu \cdot N = m \cdot \omega^2 \cdot r$$

$$\mu \cdot G = m \cdot \omega^2 \cdot r$$

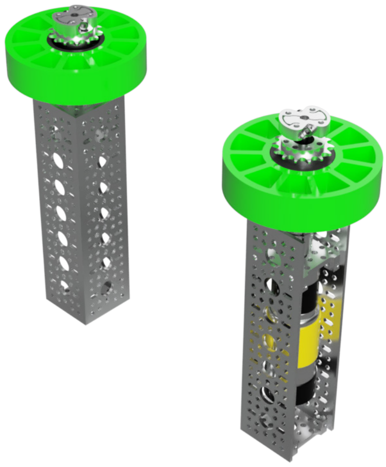
$$\mu \cdot m \cdot g = m \cdot \omega^2 \cdot r$$

$$\omega = \sqrt{\frac{\mu \cdot g}{r}}$$



$$\omega = \sqrt{\frac{0.315 \cdot 9.81}{11 \cdot 10^{-2}}} = 28rad/s = 50.61RPM$$

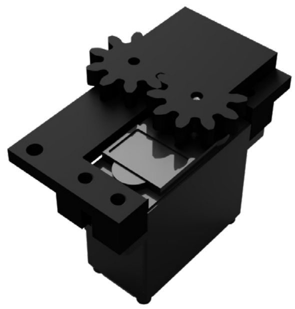
Calculate the maximum RPM of the carousel so that the duck does not slip off it



Duck delivery system

- **Capping mechanism**

The capping system is composed of an arm with a claw at the end actioned by two Gobilda servomotors, one positioning the arm to the right level to grab the team scoring element and another one to cut the connection between the magnet and the metal part. The system is attached to the outtake so it can reach the head of the shipping hub. It is programmed to go in 2 predetermined positions but can be manually controlled in those positions.



Capping mechanism

Team shipping element

11. Programming

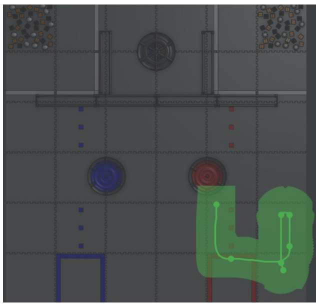
In order for the robot's physical mechanisms to reach their full potential, we have implemented various algorithms for controlling and automating all of its processes, both in the autonomous and driver-controlled periods.

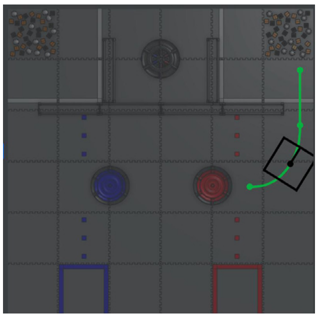
11.1 The Autonomous Period

It is the second year we are using RoadRunner, an open-source FTC library that can both generate motion profiles for various drives and also put them to use. It is an excellent alternative to the basic tick-based (that makes use of pure encoder ticks) autonomous programming.

With the help of RoadRunner, programmers can design trajectories on a 2D plane of the field's plane. These trajectories can then be ran on the robot, with built-in error correction through the use of the built-in PID controller in the REV hub.

Using this library, we have reduced the risk of failing autonomous periods by 20% and scored more points than we have ever before!





Our Roadrunner trajectories

With the help of RoadRunner, programmers can design trajectories on a 2D plane of the field's plane. These trajectories can then be ran on the robot, with built-in error correction through the use of the built-in PID controller in the REV hub.

Using this library, we have reduced the risk of failing autonomous periods by 20% and scored more points than we have ever before!

	PRELOAD	DUCK	PARKING	NUMBER OF CYCLES	SCORING	TIME
Case I	YES	YES	YES	1	52	20s
Case II	YES	YES	YES	2	58	25s
Case III	YES	YES	YES	3	64	29s

Autonomy strategy

11.2 Optimizing the autonomous period

In order to achieve a reliable and efficient sequence of operations, we have decided to calculate the most "tight" curve (a.k.a the smallest radius) the robot can travel along without it sliding across the playing field, which would lower the success rate of localizing the robot and applying correction.

$$F_f \geq F_{cfi} \Rightarrow \mu \cdot N \geq \frac{m \cdot v^2}{r} \Rightarrow \mu \cdot G \geq \frac{m \cdot v^2}{r} \Rightarrow$$

$$\mu \cdot m \cdot g \geq \frac{m \cdot v^2}{r} \Rightarrow r \geq \frac{v^2}{g \cdot \mu}$$

$$r \geq \frac{(30 \cdot 2.54 \cdot 10^{-2})^2}{9.81 \cdot 0.65} = 0.091m = 9.1cm$$

Minimum radius calculation

Two members of our team determinating the coefficient of friction

Thus, we have made some experiments in our school's physics lab in order to compute the radius in question. This information has furthered our progress in optimizing the paths our robot can take.

The method of calculation had to be very precise in order to be useful; For example, with the careful use of an inclined plane, we have successfully calculated the friction coefficient of the field.

11.3 The driver-controlled period

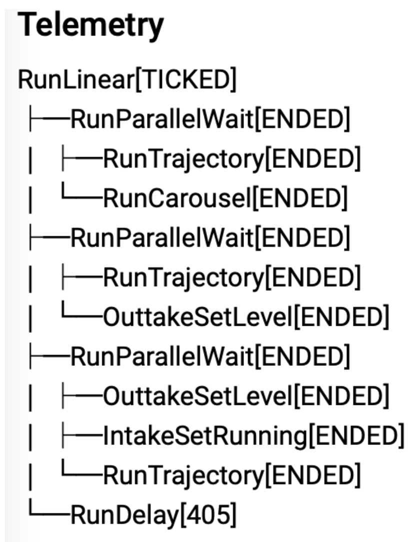
In order to carefully balance the cognitive load on both of our drivers, they have suggested having the tasks of controlling the robot split between its movement and its intake/outtake management, as they can be independently manipulated with coordination and communication. We have also added some nifty automatizations to the routines, such as rotating the CUVA with its opening at the top when lifting the arm, and also lowering the arm after attempting to score a freight. Taking into account the feedback of our drivers, here's the control scheme we have settled on (for now):

Controller of the robot

11.4 Non-blocking code execution

We have decided to go with non-blocking for because blocking code execution would lead to a loss of multitasking in both match periods. One alternative would be to wrap these instructions into a Thread that would execute on another core of the REV Control Hub's CPU, but in our experience this leads to weird concurrency bugs, deadlocks and general performance issues. We have thus developed an in-house library that allows us to write routines in a declarative manner that consist entirely of non-blocking operations. This way, the program can be simplified to a while loop that continuously queries for the next operation it can do. To go along with it, we have written a debug telemetry view that prints the state each operation is (STARTED/TICKED/ENDED).

The aformentioned library (Project KURS) will be readily available on our GitHub organisation right after Worlds, once we have settled on the last implementation details.

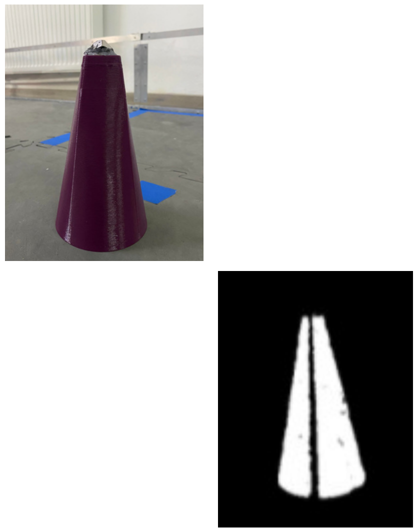


Screenshot of the autonomus action tree

11.5 TSE Detection

After some experimentation, we have decided to use OpenCV in order to detect the TSE. In our opinion, it provides the right amount of functionality required to reliably achieve this task. Our algorithm is also efficient enough to beat other solutions (such as Tensorflow+Vuforia) by a significant margin on a frame-by-frame processing basis. Our TSE is 3D printed using a dark magenta filament, which is a rarely-seen color on the playing field (decreasing the chance of false positives).

The process goes as follows: the image is split into 3 vertical stripes; each one is then color-filtered for magenta, which results in a black/white image where white means magenta, and black means any other color. The stripe with the largest ratio of white/total pixels is then mapped to the left/right/center positioning of the TSE (since the camera is placed facing the center square).



Robot camera feed before and after processing

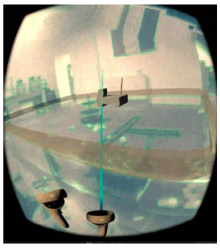
11.6 Future plans

RoadRunner AR

Purpose:

- An app for the Oculus Quest VR/AR headset lineup which allows programming of RoadRunner trajectories visually, by indicating points directly on the physical field.
- Allows for autonomous period simulation, by overlaying a virtual copy of the robot onto in the physical world, projected onto the headset's screen through the integrated infrared cameras.

Field view in AR



Cause:

- The paths followed during the autonomous period are hard to create in the absence of a visual mediu. The current solution we are using is the official RoadRunner plugin for Android Studio, which displays a 2D plane of the playing field and a rectangle representing the robot. While the extension is very useful and has helped us immensely, we always strive to improve and build upon the tech we use.

- The upgrade 2D → 3D will allow us to visually estimate the points of interesest that the robot may need to reach.

Project RVM (Robot Virtual Machine)

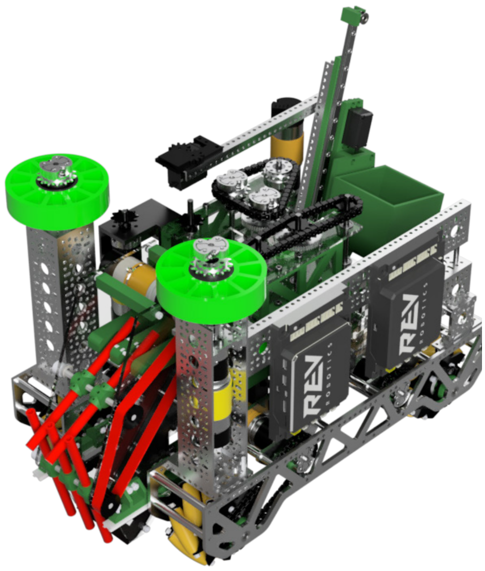
Purpose:

- Allows for code loading almost instantaneously (<1 second)
- JavaScript is the language of programming, which has a syntax easier to use for begginers.
- Leverages the user-friendly nature of JavaScript to boil down complex tasks to an easy to use syntax (meshes well with the Behavior Tree).
- Allows the separation of tasks in the programming department between high-level and low-level ones.

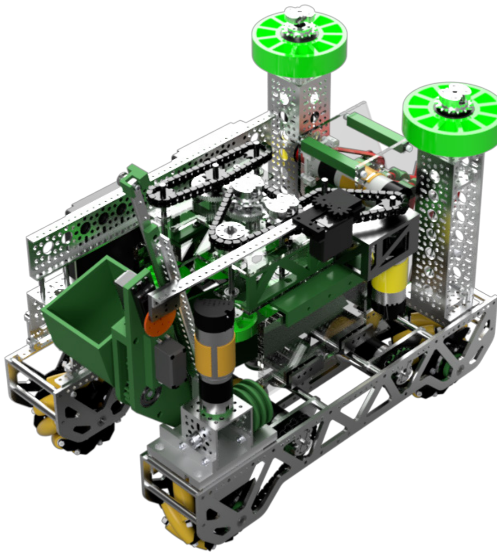
Cause:

- The loading of code has always been a lengthy process which would often take upwards of 30 seconds. The optimization of this routine would be an extreme time saver, considering the amount of times we're uploading new code to the robot (even >100 times/day often times!).
- Contrary to other solutions, such as OnBot Java, RVM could use the existing features written in Java in the TeamCode module of the FTC app.

12. Final Design of the Robot



Front Left
Side of the robot



Back Right
Side of the robot