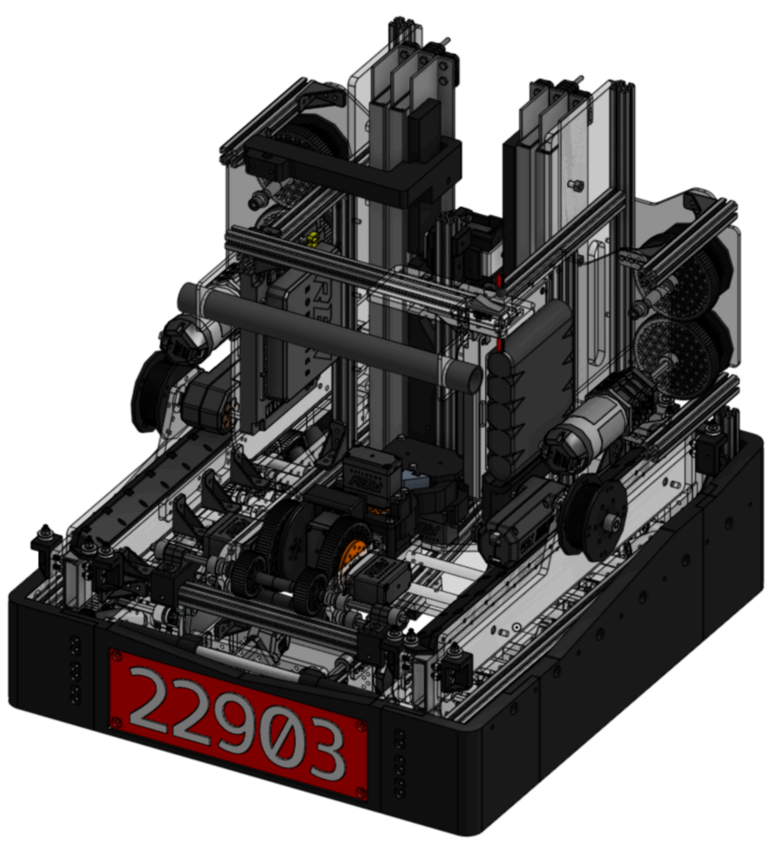
<u>#22903 VegaMind</u>
Engineering Portfolio

Karambol



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Design

Current robot design

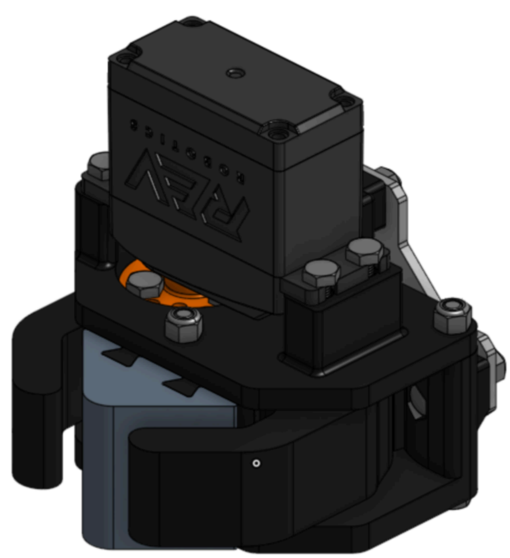
We divided our robot into three separate systems:

- Drivetrain
- Lifter
- Horizontal slider

For the drivetrain, we use a standard mecanum drivetrain, which also includes dead wheels, that we are developing as a part of our new project called “Project Strand”. You can read more about the project at the end of this notebook.
The drivetrain is configured to use REV Robotics Ultraplanetary HD Hex motors and REV Robotics Mecanum wheels, with all four motors at the bottom of the drivetrain. During testing it has proven itself really reliable.

The lifter is assembled out of four drawer slides we bought from an online store, L profiles, inside of which we made holes to be able to assemble the slides into a lifter, acrylic plates for mounting the lifter to the drivetrain and mounting hardware for the outtake and SPECIMEN claws we have for handling SAMPLES and SPECIMENS.
We figured out a way to make the lifter work without using active tensioning for the string. We found out that if you make the string run as parallel to the movement of the sliders as possible, you actually make the string almost always stay under tension, no matter how much you extend the sliders. We achieved this by precisely positioning the pulleys on the side of the sliders, making the string run extremely parallel to the slider’s movement, removing the need for complicated active string tensioning.

The horizontal slider is made out of slightly longer slides from the same manufacturer as the ones in the lifter, wood plates and an intake claw we took care in designing. It uses a very similar principle for routing the string as on the lifter, just that here we still use a very simple active tensioning design, which gives us just enough tensioning throughout the movement.



On the robot we have a total of three separate claws, two for handling SAMPLES and one for handling SPECIMENS. They’re interchangeable, meaning we can use the exact same claw as a replacement for the other two, requiring less design and print time, as we only need a few sets of backup parts to be able to fix any claw on the robot.

The intake claw is mounted on a mechanism that rotates the claw in a specific way as it is rotated around a fixed gear. A more detailed look at the mechanism can be found in the Intake claw section.

The entire robot is held together with brackets we are also developing as part of Project Strand, which go around the standoffs in our drivetrain and clasp onto them really tightly. This makes it so we can hang the entire 16kg robot on just 6 of these mounts.

Around the robot are 3D printed bumpers, which are there just to prevent the drivetrain from breaking immediately on impact with another robot or a part of the field. They also act as mounting for our number plates, providing a simple but effective way of displaying our team number and alliance without requiring any specialized mounting.

Intake claw

The intake claw uses a mechanism, which uses a 1:2 gear ratio, a fixed gear and a specially designed bracket to make the intake claw rotate 270 degrees when the assembly itself only rotates 180 degrees. As this system is quite complicated to explain in text, we'll try to use pictures to show how it actually works.

Here's the gist of it:
A servo rotates a bigger gear around a smaller gear, which is fixed relative to the robot, producing a motion that would otherwise require the addition of more servos. This makes the system simpler to code and maintain while also keeping it lighter.

Custom parts

Our robot has many different custom 3D printed components, many of which hold the robot together. They're printed using different materials (PLA, ASA, TPU, PETG), each one chosen for a specific use case. ASA and ABS for example are used for things that are not supposed to break immediately if put under stress, while PLA and PETG are used where we either don't need or don't want the prints to survive high stress situations.

The parts we printed in ASA and ABS are the following:

- The claws we use for handling game objects
- The bushing mounts we use to attach different parts of the robot to the drivetrain
- The pulley covers on our lifter that stop the string from falling off and causing damage
- The outtake claw's mounting bracket which is used to attach the outtake arm to the lifter
- The intake claw's mounting bracket that's used to flip the intake claw in and out of the robot
- The tensioning mechanisms for the lifter and horizontal slider
- The mounting plates on the lifters that we use for mounting various different things to the lifter itself
- Some other minor things we mentioned in the Current robot design section of the portfolio

We printed the following out of PLA and PETG:

- The bumpers that we installed just in case somebody's robot crashes into our robot or our robot crashes into somebody else's robot
- The number plates we have for displaying our team number and alliance color in a match
- Some spare parts

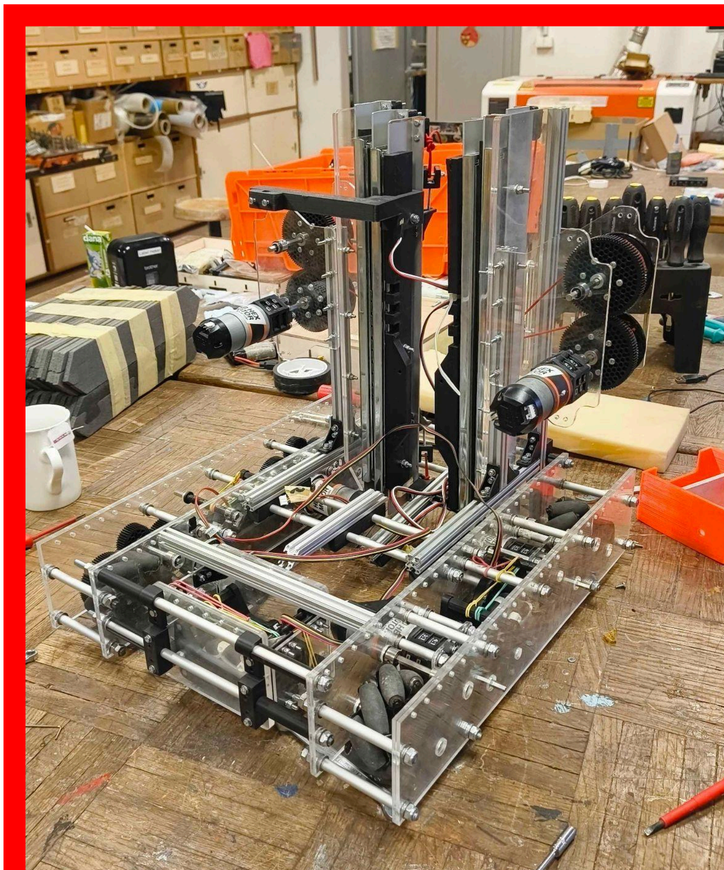
And out of TPU we only printed some triangular parts for the claws that let us clasp onto a game object without damaging it or the claw itself.

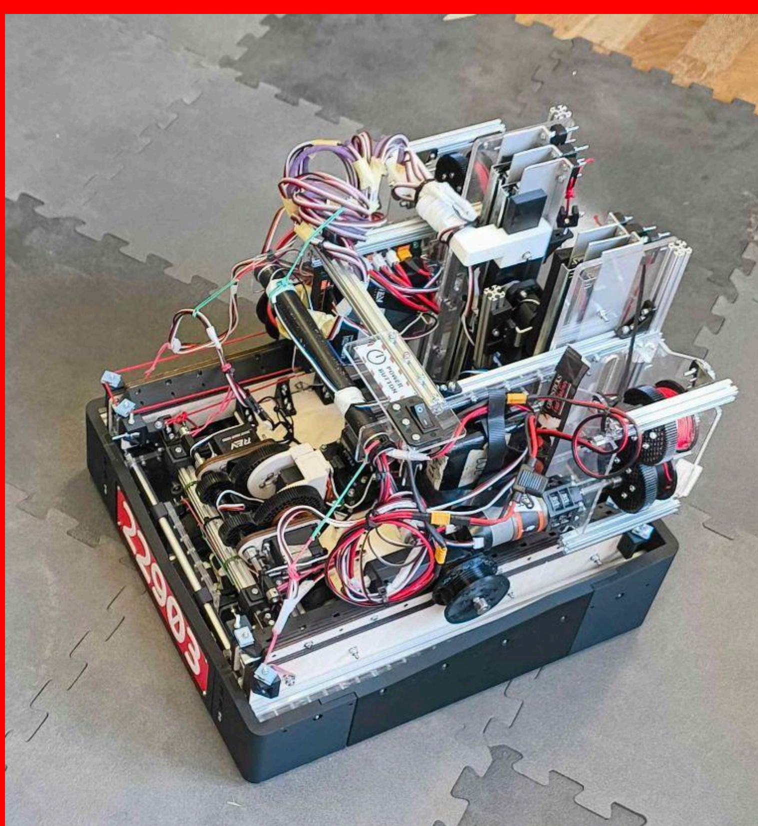
Just like many other teams, we also made some custom parts for the robot. We laser cut plates for the drivetrain, lifter and horizontal slider, we cut threaded rods and aluminium tubes to make standoffs for the drivetrain and we modified the aluminium L profiles to use in our lifter

We made the plates for the drivetrain and the lifter out of acrylic, stacking two 3 mm thick sheets on top of each other *without* gluing them together, in the hopes that if one of the sheets shatters, the other one can stay intact for at least the rest of the match.

We made the standoffs from M6 threaded and aluminium rods that we cut to size to hold the plates an even distance apart all around the drivetrain.

We made a coiled up Ethernet cable, to which we strapped the servo cable extensions we need for connecting the servos that are on the lifter to the expansion hub. By having the cable in this shape, we are able to ensure that no matter how much we move the lifter, the servo extensions will always store themselves in a safe place once we finally lower the lifter all the way back down to its bottom position.

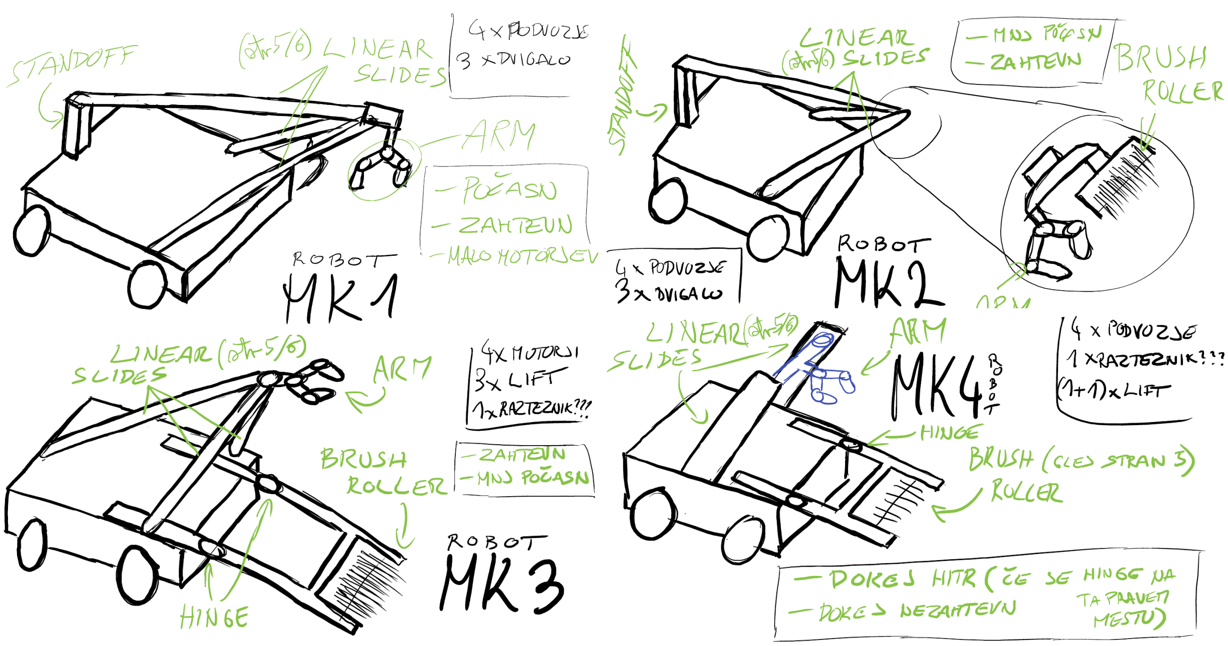




Design related decision making process

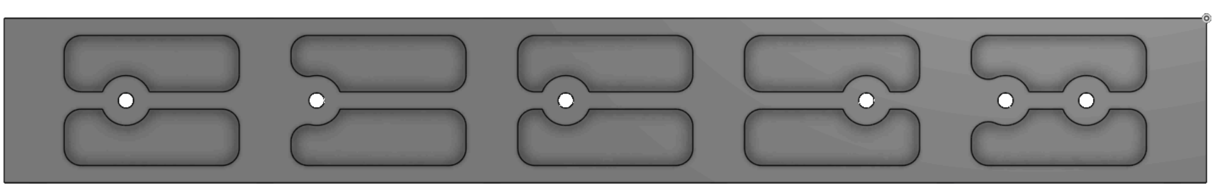
We started brainstorming basic ideas for the robot all the way back at the start of the season, even though we were still quite busy with the FGC competition we had at the end of the september.

We started off with a pretty complicated design, but as time went on we made it more and more simple, perfecting our design and adding better mechanisms for different sections of the game object handling process. Our designs went through the following variations:

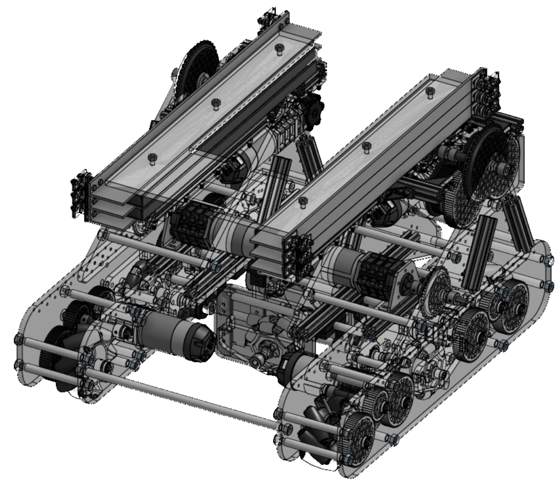


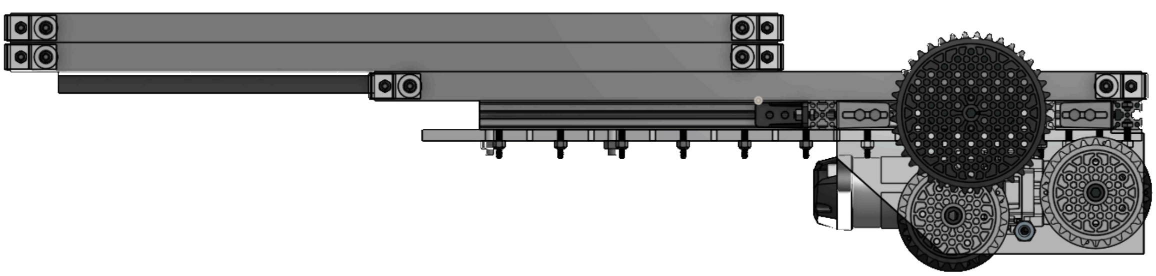
After a while we decided to just start designing the robot from scratch, as none of the designs we had come up with so far seemed quite doable enough for the time we had to make them.

As we have already explained the current design in full extent in the Current robot design section we will only go over the things that changed since this decision was made.
At first the lifter was supposed to have a 10 mm thick block of aluminum in between the slides to give us enough space for pulleys, but we soon figured out that it would be both too bulky and too heavy. While trying to reduce the weight would've helped, it would still be too thick for our lifter. That's why we switched to using L profiles for it.



After the scrimmage in Stuttgart that we participated in we learned that our lifter design was quite bad, as before our current design we had decided to use one where the entire lifter turns around an axis. While this was a great idea in theory, in practice the lifter was way too heavy and fragile because of the way we had designed it. During a match the lifter design experienced a critical failure in a structural part of its mounting.
This later led to us moving to a fixed lifter design, which is accompanied by a horizontal slider.





And the last thing we changed because we found a big issue with it is our intake. At first we planned to use an active intake, but we soon found designing it too difficult to do within a reasonable timeframe, so we decided to switch to using claws for everything.

Software

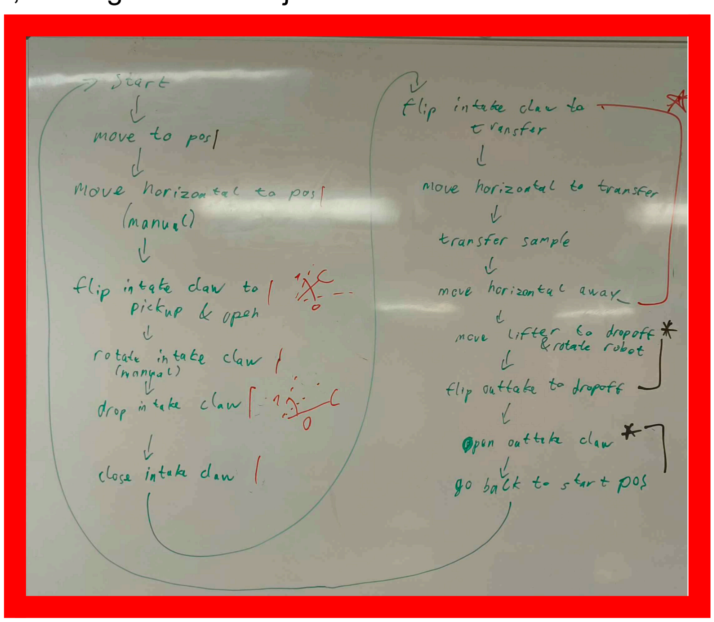
For software we opted for Java instead of Blockly. This allows us to Road Runner for the autonomous stage and overall more freedom with the code design.

Since we have many separate systems on our robot that need to work in perfect sync with each other in order to score points we use a state machine. This allows us to jump in between steps or even skip them; if for example, a sequence of events that just started needs to be cancelled we can do so without any trouble. We can very easily switch from robot centric to field centric drive and back and in between control schemes which allows us to test new features quicker and can be used on all our TeleOps from now on. Lastly our software allows for handling of unexpected edge cases by allowing us to cancel any ongoing operation at any time for any reason. We also implemented a special "override" mode that allows for full manual control of each individual part in case anything goes horribly wrong.

Coyote Core

In order to orchestrate these events easier and in a standardized way we have developed a library named Coyote Core. It still works on the principles of a state machine and is completely non-blocking. For each step of the sequence defined in Coyote Core you can set a callback that is invoked when it is finished and a custom condition that is checked every frame to know when a step starts.

All in all the software on this robot is written in a robust and expandable way. It allows for easy and fast development, making the coder's job much easier.



(An example of how a typical sequence looks like)

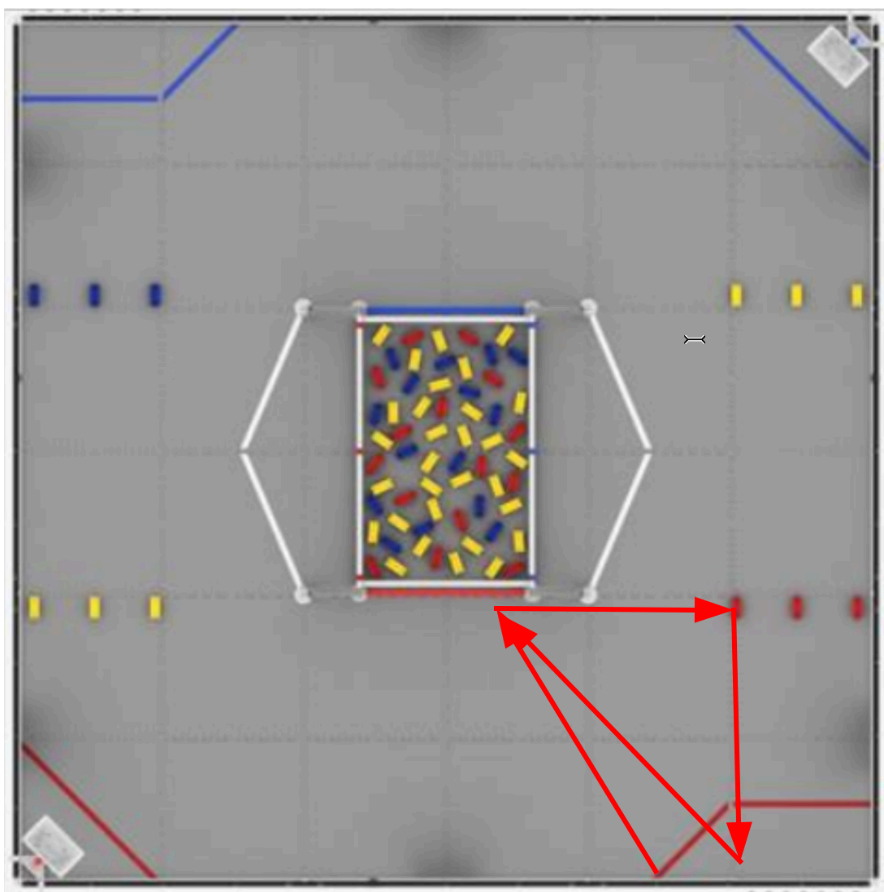
Game strategy

To put it shortly: *Get as many points as possible!*

We use both teleop and autonomous operation modes for our robot. This means we have two separate strategies, depending on which operation mode we are currently in.
For autonomous we have two different options, depending on the side of the field we start on:

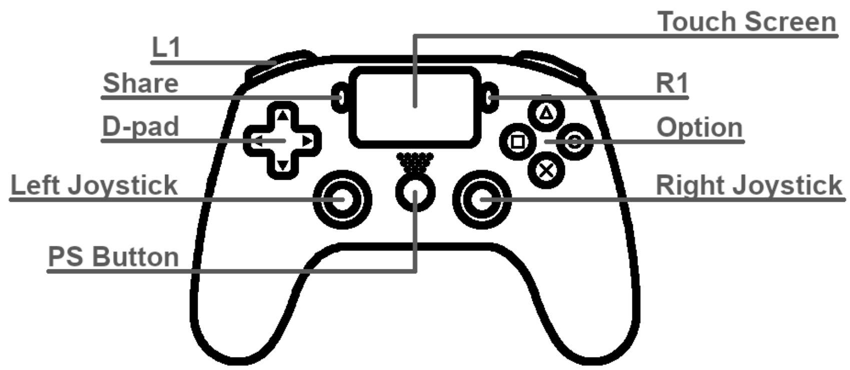
- On the left side of the field we go pick up the yellow SAMPLES that are on the ground and throw them in the HIGH BASKET
- On the right side of the field we go start preparing the alliance coloured SAMPLES to turn them into SPECIMENS, which we later deposit on the HIGH CHAMBER

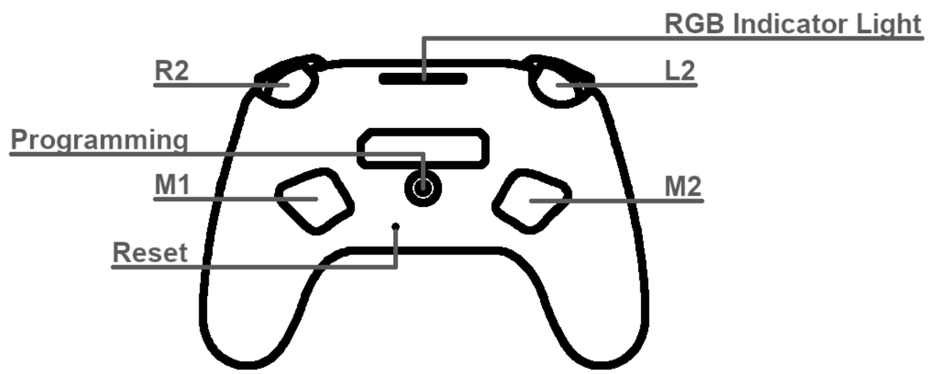
In both autonomous periods we deposit a preloaded SPECIMEN in the HIGH CHAMBER and park the robot for the 3 point bonus points you get when parking in autonomous.
When in teleop however, we mostly adapt to the other team on our alliance, trying to get as many points as possible as an alliance rather than just by ourselves.



Controls

We divided the controls between two drivers, giving each their own systems to control and things to take care of during the matches. For better visualisation we made these images.





The so-called primary driver controls rough movement of drivetrain and SPECIMEN deposits. The robot is programmed to use field centric controls, which means that no matter how the robot is turned, it will always move relative to the field.
Controls:

- *Left Joystick*: movement
- *Right Joystick*: rotation
- *Triangle*: prepares the lifter for outtake or releases the SAMPLE

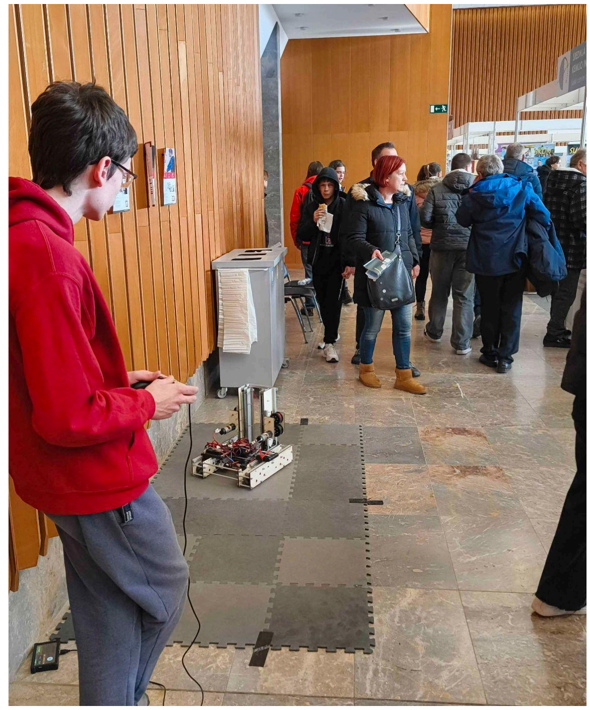
The so-called secondary driver controls the horizontal slider, intake, SPECIMEN handling and fine controls of the drivetrain.
Controls:

- *Triangle*: hanging SPECIMENS
- *Circle*: prepare intake for transferring sample to lifter
- *Cross*: picking up SPECIMENS
- *Left Joystick*: precise movement of the robot
- *Right Joystick*: horizontal slider movement
- *Right Shoulder*: initiate pickup
- *D-pad left*: rotate intake claw counter clockwise
- *D-pad right*: rotate intake claw clockwise
- *D-pad top*: close intake claw
- *D-pad down*: drop down intake claw

Social media and outreach

Social media

This year we really focused on trying to grow our social media, posting about anything and everything we thought would be interesting, of use or just good to post.



As part of *FIRST* Slovenia (the group of teams we are a part of) we posted a YouTube video documenting the scrimmage competition we attended in Stuttgart, Germany, which got 85 views, which is better than our average of 50 to 60 views.

On our Instagram account we posted over 100 stories, 4 posts and a reel, which all together got a total of over 17,000 views and 83 followers.

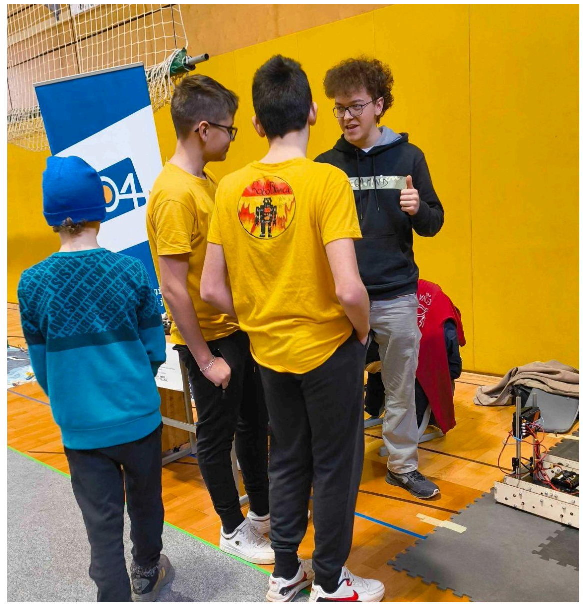
Outreach

Informativni dnevi
Information days are annual presentations held at every secondary school in Slovenia with the aim of giving primary school goers first-hand information about what these schools are like. The FIRST activities we present there draw the most attention by far from the soon to be students and their parents. A lot of the attendees don't know about them, so we are always happy to present them and invite them to join our team in the future, when they are students at our school.

Informativa
Informativa is an informational convention hosted in Ljubljana, the capital city of Slovenia, where most high schools and faculties present their programmes and activities. This year, we had an FGC robot as well as a prototype of our robot driving around, showing the future students what their future could hold if they attend our school or another school, if that school starts its own team.

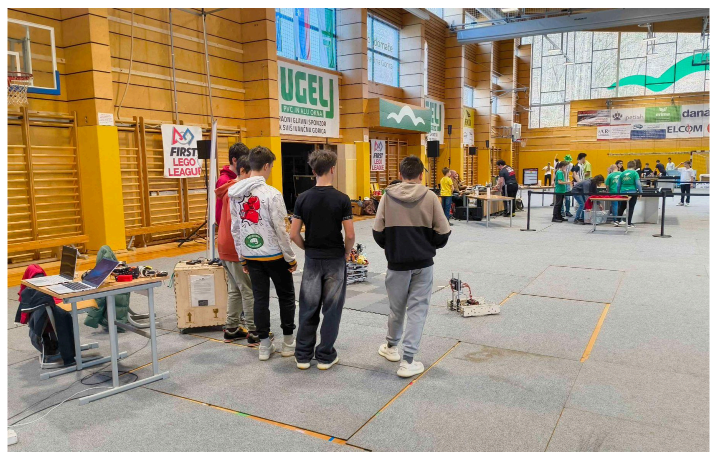
FIRST Lego League

FLL is really widespread in Slovenia, so we went to two FLL regional competitions, one in Stična and one in Ljubljana, where we presented FTC and FGC with the help of our prototype robot and one of our FGC robots. We impressed many youngsters and hopefully inspired them enough to further work on their love for robotics. We are planning to join the FLL Alpe Adria open championship in Koper on 15.March.



Mednarodni obrtniški sejem

MOS is a big international fair where different craftsmen show off their work. We presented FTC and FGC alongside other school activities, where we attracted a lot of attention with our robot. There we also met the Slovenian Minister of Economy, Tourism, and Sport, to whom we presented a bit of what we do.

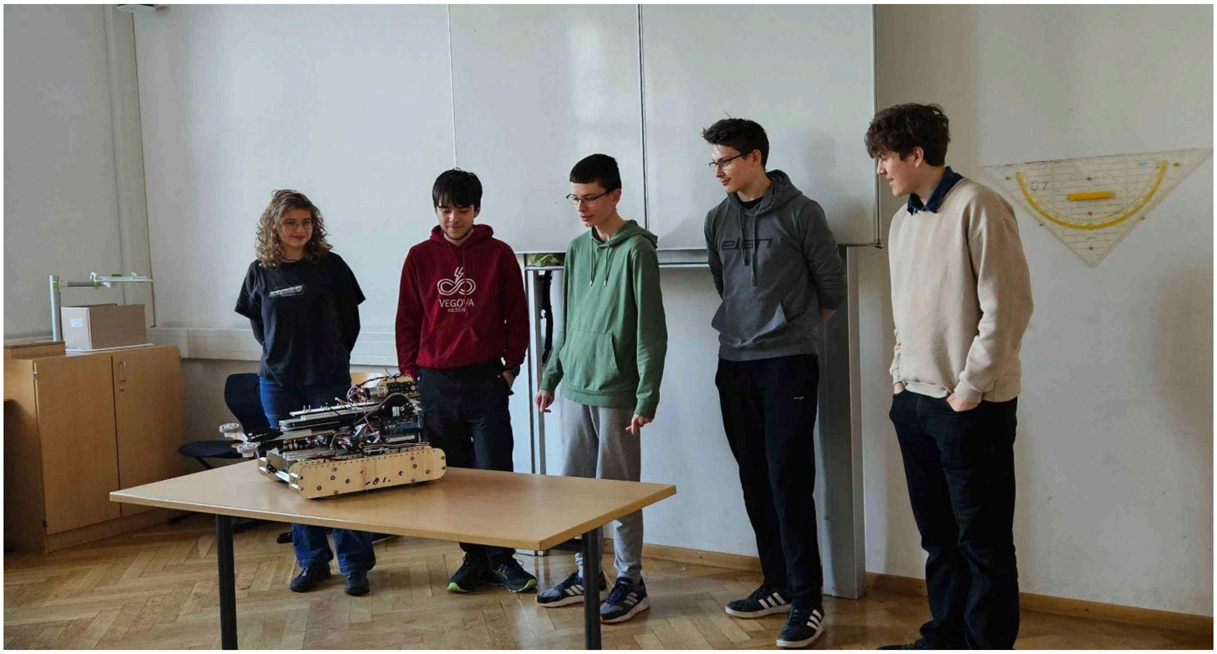


Elektrofest

Electrofest is an event held at the Faculty of Electrical Engineering in Ljubljana, where students from the electrotechnical field get to see a lot of the most prominent electrotechnical projects. With the help of our FTC and FGC robots, we try to encourage students and other schools to get involved with FTC, which will hopefully enable us to host our own regional competitions in Slovenia in a few year’s time.

Scrimmage in Stuttgart, Germany

This year our friends from Germany invited us again to their scrimmage event in Stuttgart, where we made a lot of new friends, got some contacts that later helped us out with the design of our own robot and learned that we should pivot with the core design of our robot.



Meeting with the mayor of Ljubljana

The mayor of Ljubljana invited us to come present *FIRST* programmes and talk about our time in Singapore and Greece at FGC 2023 and 2024. We also discussed our plans of spreading awareness about *FIRST* and how to encourage more schools and students to participate in these events.

Expanding the community

As the first, and for a long time the only team in the country, the most important thing for us is seeing more Slovenian FTC teams being formed, as we believe that this would really help the wider student base become more educated in the technical field.

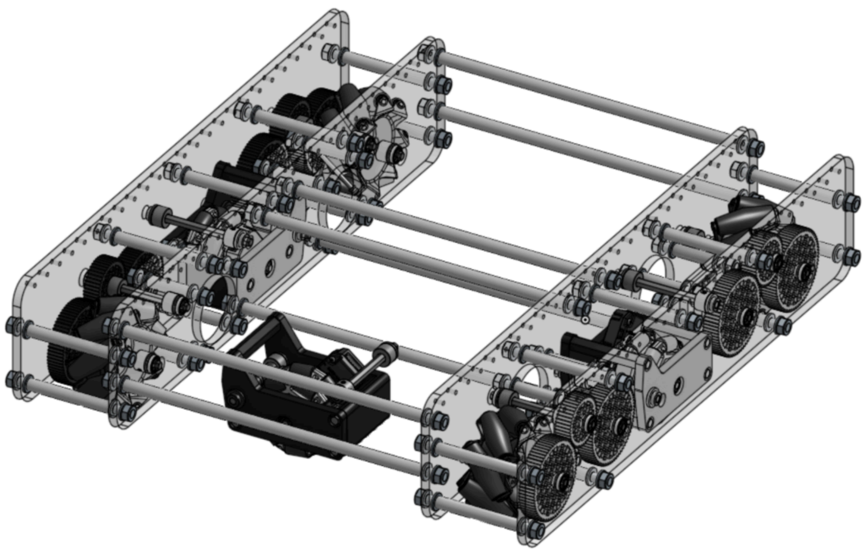
This year we saw an sudden increase in the number of participants on our team, so we decided to help get our mission started and formed a new team, #28080 VegaTech, from the participants that joined us for the first time this season. Because we put mostly just brand new students on that team, we mentored them, helping them put together their very first robot with their own ideas, strategies and designs for mechanisms.

Project Strand

Project Strand is a project we started this season with the aim of standardizing robot parts for teams from *FIRST* Slovenia, making development of new robots faster and cheaper, as the same parts can be used for different seasons.
So far as part of this project we have started developing and are currently testing:

- A drivetrain (including optional dead wheel odometry module)
- Specialized mounting for attaching things to the drivetrain

We have open sourced the current version of the drivetrain, as so far we have found it to work quite well, but the specialized mounting hasn't been tested quite enough yet. We will open source it once we have confirmed that it is in fact at least 99 % reliable.



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