Engineering Portfolio

M-MAIS

#23283

Meet the team

Nout Urban - Team Captain, Software Lead, CAD Specialist and Driver

Maria Galagan - PR Manager, Portfolio Lead, Designer and Coach

Enzo Richardson - Hardware Lead, Cassis Specialist, Designer and Driver

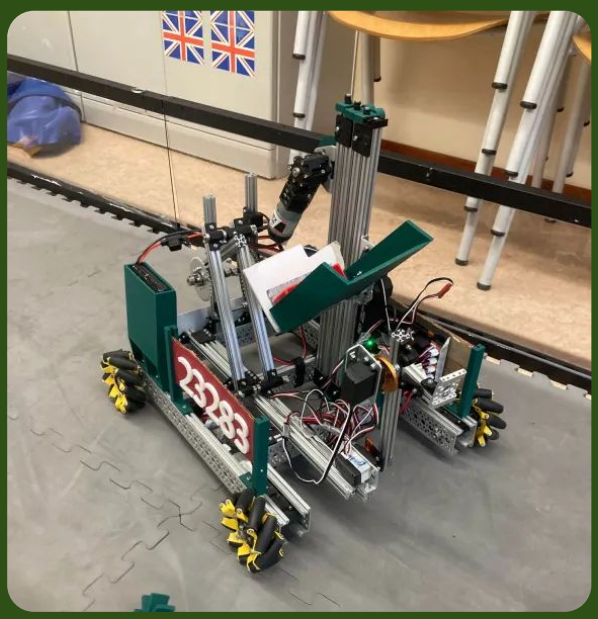
Jasper Geerse - CAD Specialist, Mechanical Engineer and Software Support

David Geleijnse - Software Engineer, Autonomous Specialist and Human Player

Yassine Benhaddou - Mechanical Engineer and Designer

Sander van Geest - Coach

Team **M-Mais** was started in 2023 at Emmauscollege, in **Rotterdam, the Netherlands.** It consists of 6 team members, ages 15-17. M-Mais is a fully **student-led** team, our coach only handling bank statements and communication to our school and parents. This is most members second season, except for one member, its their third season. M-Mais is a play on words of our schools name, Emmaus. Our team's main symbols are **corn cobs, stars**, and our silly mascot, **Pochita**.



Our robot, Mr. Cornbob the Second

As a team we strive to optimize our **individual skills** to the fullest, combining them to form a team that works as one **hivemind**. Our robot lab is considered a **safe space** - apart from us, people outside our team meet to talk about engineering, school and whatever comes to mind. We take pride in **mentoring** our rookie team The Thunders (#21658) who have now learned fromsome of our past mistakes. **Gracious Professionalism** is the number one priority in our team, also outside FTC. For anyone that is reading this Engineering Portfolio, we hope you will be enthralled by reading this :)

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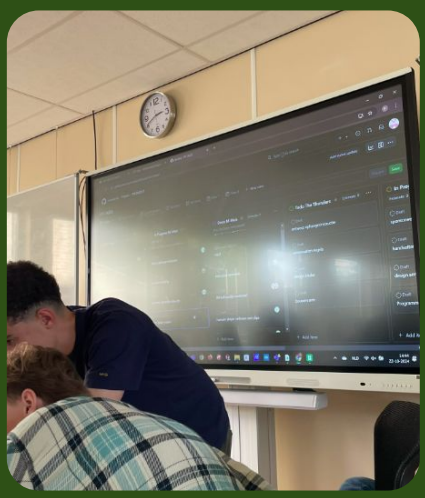
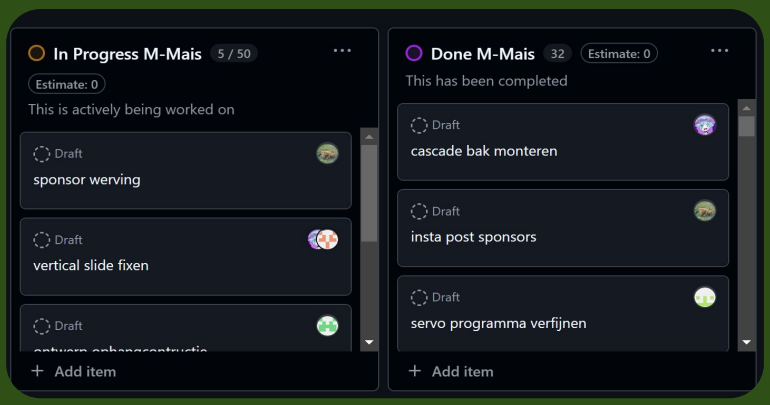
Team plan

Learning from our previous season, we knew a lot of things had to change so we could work more efficiently and create a better robot. Things we wanted to improve on were: **time management, finance and outreach**. Last year our time management wasn't the best, which resulted in a lot of last minute work and changes that did not benefit us. Thus, we wanted to change that and started working with a **Kanban** board, which all members can access through our shared Github repository. Using this method of dividing tasks into To Do, Doing, and Done, we were also able to handle our financial tasks better. This year we are sponsored by **The Robot Engineers,** who's contribution has helped us greatly. With this money we buy robot parts, but also stuff like team merchandise. Undoubtedly we wanted to focus more on outreach this season, as last season we did almost to none. Outreach events proves to be a **positive addition** to our team, acting as both a learning opportunity and team building activities.





THE ROBOT ENGINEERS

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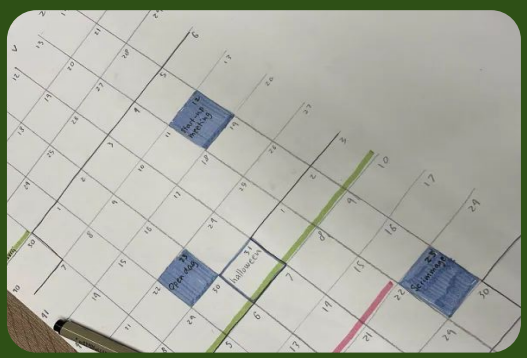


Our team goals and how we achieved them:

- Clear **communication** between subteams to ensure everyone was on the same track and knew what was expected of them.
  - Using a Kanban board helped us achieve this successfully.
- Planning ahead of time and **managing our time** to the fullest.
  - Using tools such as calendars and timelines of events we were able to plan our robots development as realistically as we could.
- Coherent **financial and outreach** goals.
  - Setting goals at the beginning of the season such as wanting to reach a certain amount of people helped us find applicable outreach events.
- **Showcase FIRST** to as many people as possible.
  - Having multiple impactful outreach events has made us achieve this, we found a good balance between outreach and building the robot itself.

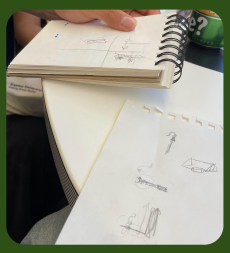
Team goals we are still working on:

- Learn **Fusion 360** to further our design capabilities.
  - This goal is still in process, we are taking our time learning the program from scratch. For now we use **Onshape** for new parts we 3D-print.
- **Risk management.**
  - Assessing risks and treating risks properly.

Timeline

9 September, Kickoff

At the Kickoff we participated in **masterclasses** and had the opportunity to see the full field.



Also during this time we focused on connecting with **international teams**, as we couldn't do a lot of other outreach events without a robot.

9 November, Scrimmage

At the scrimmage we got to test out our robots first version. We communicated with other teams, learned more about our competition and ourselves during matches.

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In between the scrimmage and the sponsor visit we had our midterm exams, so we could not spend as much time on the robot as we wished. Our robot had not changed much between these two events, but we did have a lot of time to **reflect on our faults**. At the sponsor visit we got a lot of **great feedback from professionals** in the industry which we welcomed with open arms. At Heroes Dutch Comic Con we had two **15 hour days** where we could work on the robot. This benefited us greatly, and we made up for the time we lost during our midterms.

8 December, Qualifier

At the **Qualifier** we wanted to score well on the playing field as well as with the judges. Everyone was really excited and ready to face any challenges that might come our way during and after the Qualifier.

In the time between the Kickoff and the Open House we focused on **designing and prototyping**. We still had a reliable drivetrain from the previous year, which the software team used to program Teleop and test out new features we wanted to utilize. This all happened simultaneously, ensuring everyone had something to work on.

23 October, Open House

At our schools Open House we had the opportunity to build up the full field, which gave us some **driver practice** and the time to think of **game strategies.**

During our matches at the scrimmage we noticed a lot of **faults** in our robot. The main one was our cascade lift, which proved to be challenging all the way up to the Qualifier. On the other hand, we also saw our **strengths**, which was the drivetrain and the intake/outtake system. This left us feeling motivated to improve our robot, knowing we were capable of building working parts.

21 November, Sponsor visit

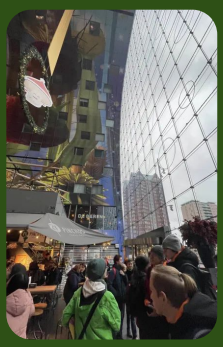
To show our sponsors who we are and what FTC is, we brought them a visit in their office. These **robot engineers** gave us lots of tips.

23 + 24 November, HDCC

Heroes Dutch Comic Con was an amazing outreach weekend where we got to work on our robot and have some drivers practice. Killing two birds with one stone.

8 December, Qualifier

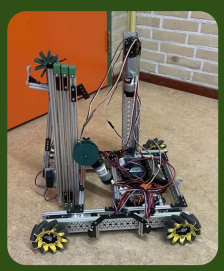
Our experience at the **Qualifier** was quite **stressful** to be frank. Our robot worked perfectly on the practice field and the days before at school, but on the actual matches it seemed to have stage fright. But despite this we kept **calm** and fixed our robot as we usually would. We were awarded the **Motivation award**, which gave us a great sense of accomplishment. When it was announced that we had a **spot in Benelux Championship** because of teams having a double advancement or being ineligible for advancement, we felt blessed. We realised we had to work very hard as this was a **wonderful opportunity** for us.



21 January, PWS presentation

The Dutch education system requires all senior students to present a big research project (**profielwerkstuk**). Our school has made it possible to make this project about the First Tech Challenge we take part in. We proudly presented our robot to a lot of **classmates and close ones**.

At the **Benelux Championship** we mainly want to have **fun and learn from other teams**. The competition is fierce this season so we are excited to talk with as many teams as possible and see how the competition plays out. We changed our robot quite a bit and added some new functions that we're intrigued about on how they will work on the competition team. Either way we will go home **proud and happy**, knowing that we all individually progressed our skills and had fun doing it together.



9 December, RTF + FROG + ILF school visit

The following day we were visited by three awesome, talented FTC teams: **Robotic Tech Frox (#20092), Frog Robotics Of Germany (#10183) and International Lego Frogs (#23052)**. It was a great chance to connect and form some international friendships.

During this time we had our **Christmas break** and so naturally **robot development slowed down** a little. This actually helped our team, having a small break gave us time to reflect and come back to working hard in the new year.

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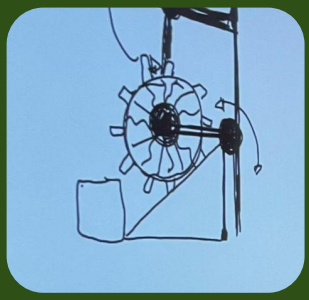
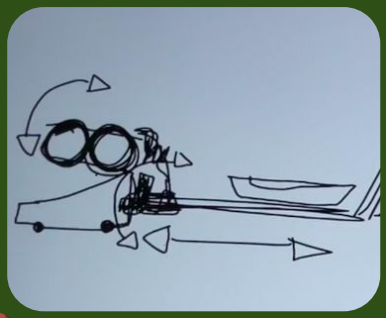
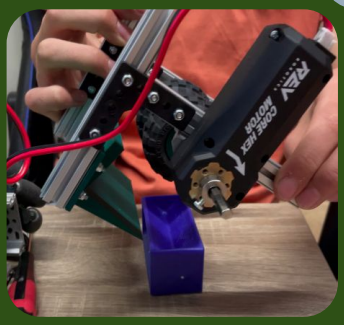
15 February, Benelux Championship

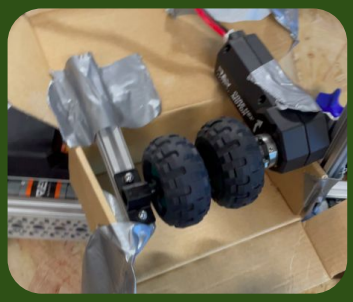
Design process





Before we start designing something, we consider multiple points that make the process easier, such as: **priorities, trade offs, and the use of cost benefit analysis**. Some examples are: the highest basket gives us lots of points, so it is worth it to build a lift that can reach that basket, even if the process is long and challenging. When we analyse a problem we need to solve and keep those points in mind, we start drawing. Drawing usually happens on our digiboard or on paper. We then either build a **prototype** out of materials or immediately design the part in Onshape and 3D-print it to save time. Each subsystem requires a unique approach that we carefully choose.





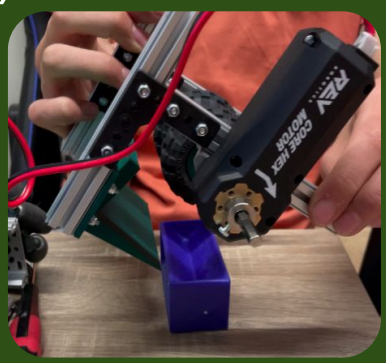
Analyzing this years challenge, we had identified what we wanted our robot to be able to do for the Qualifier. The design process below was for the first version of our robot. After the Qualifier we had decided to change a multitude of things for more and better functions. But for then, we wanted to stay **realistic** what we could achieve with our time and resources. We settled on scoring samples from the field and submersible into the low and high baskets. To achieve this, our robot needed to be able to:

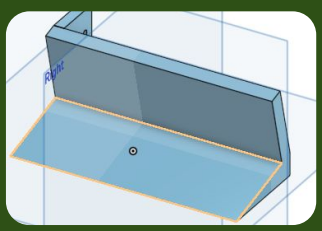
1. Collect samples, from the field and submersible.
2. Transfer samples to a tray connected to a lift.
3. Score samples into baskets

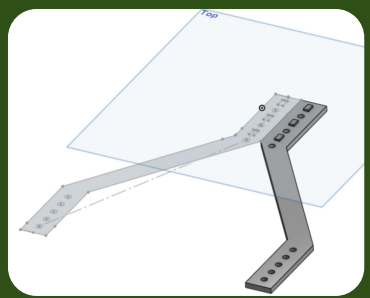
Obviously our robot also needed to be able to drive around fast and smoothly, but as we had achieved that a year ago it wasn't a big challenge for us. Here's how we tackled our new found challenges:

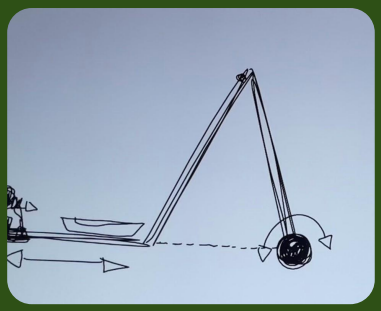
1. Collecting samples -> Intake system & horizontal slider

We wanted to work with an active intake system this season to collect the samples. **Our first prototype** consisted of two lego wheels and a slope, and we would attempt to pull the samples in. After a lot of different designs and troubleshooting, we decided to **move on** as this design would not work for us. It was **unreliable** for a multitude of reasons. For one, the lego wheels would slip of easily, which is not ideal when you want to pick up as many samples as fast as possible. Furthermore, the intake had to be positioned at an **awkward angle** that would not be realistic to recreate with our robot. After this we gained **inspiration** from multiple teams online using a **flipper wheel** to grab the samples. We recreated the design and it was already working better than our previous one. We were working with a Core Hex Motor and a chain at the time, which caused the intake arm to lean to the side, resulting in overall unreliability. More about that later. Our wise friend Igor from team **STT (#3977)** advised us on using a continuous servo instead of a Core Hex Motor. This removed some weight, but added new weight to right next to the flipper wheel. The best solution to this turned out to be to use the chain and continuous servo, this mechanism **balancing** both sides of the intake wrist. Another last change was making the flipper wheel thicker.









To have our intake wrist be able to reach inside the submersible, we decided to build an arm for it, which is a **horizontal slider**. The design is fairly simple and prototyping went smoothly. We first drew what we wanted and then immediately build a **prototype** that worked pretty well with some minor tweaks. We started with a horizontal linear slide that is powered by a Core Hex Motor, connected to a gear and chain. The power pushes the joint, making the slider move forward, helping us grab samples from the submersible.

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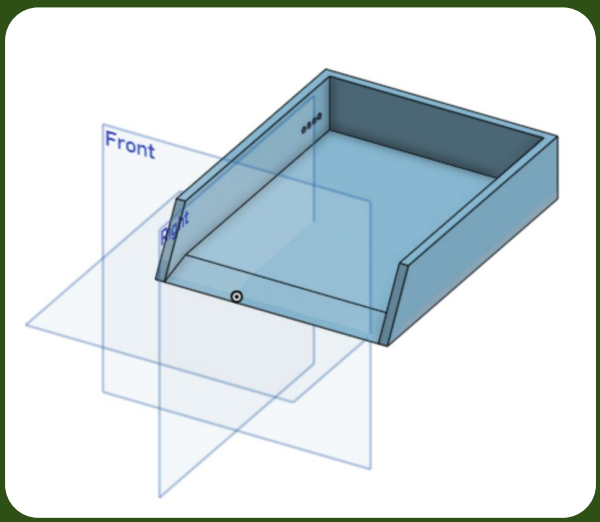
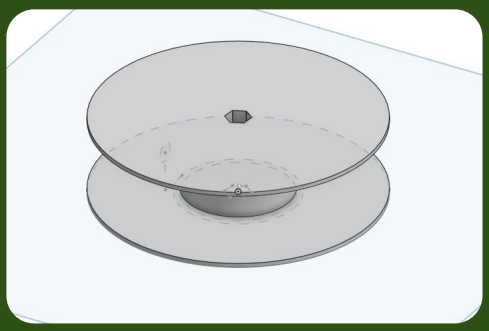
2. Transferring samples to tray -> Outtake & lift tray

Now that the intake was finished and almost near perfect, we needed the ability to **dispense the sample** as well. Simultaneously we were working on our cascade lift, but we also needed to make the bridge between that and the intake. For that we **designed and 3D-printed** a tray that we titled the lift tray, as it is part of the lift. The lift tray has three set positions that ensures the sample won't fall and will be dispensed into the basket timely. The intake wrist is connected to a servo that can move 180 degrees, thus being able to bring the sample to the lift tray. Then the servo turns the other way to slowly but surely transfer the sample. A lot of this was **trial and error** with positioning the flipper wheel at the right place, but we have gotten the hang of it.

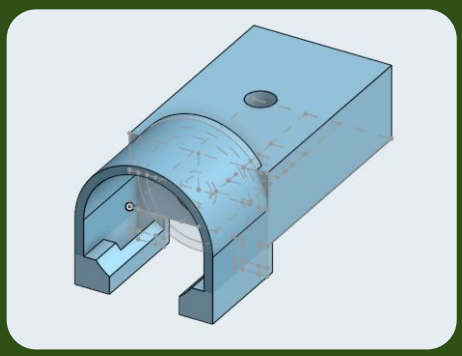


3. Scoring samples into baskets -> continuous lift

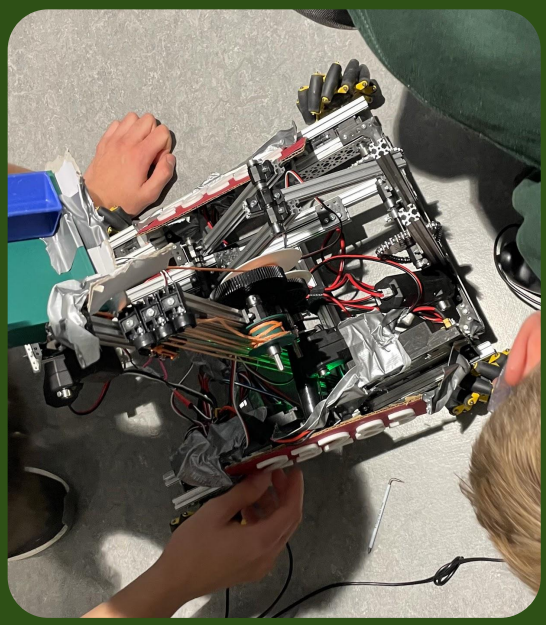
To score the samples into the baskets we use a **continuous lift**. The lift tray is attached at the very top. The rest of the lift works with a rope and a pulley. This proved to be our **biggest challenge**, as the rope has a mind of its own and would be too loose and get stuck in the gears. We mainly noticed this issue in the scrimmage we attended, only being able to raise our lift once or if we were lucky twice per match. So, there was a lot of work to be done. We **redesigned** our pulley by increasing the outside diameter so the rope wouldn't wander off. The next issue we had was the tension being to high, resulting in the pulley covers popping off at random times, messing up the entire system. For this we **innovated** new and improvement pulley covers that would not snap off, but also keep the rope in place. The next encountered issue was that now the **friction** was too high, so we swapped our Hex Core Motor for a HD Hex Motor. This also resulted in our lift moving faster up. But it did not go down yet. We tried adding another parallel rope that would pull the lift down, but the same problems as before occurred. So we resolved the issue with adding extra weight in the shape of an old broken motor, therefore fighting the friction. To keep the lift as frictionless as possible we use WD40. And although the lift works as intended, some of our homemade pulley covers still tend to snap under high tension. This is something we plan to **improve on in the future**, by experimenting with other types of sliders that have less friction.



Pulley with increased diameter



New and improved pulley cover



After the Qualifiers we were planning to design a **hanging system**, so we can be able to perform ascent during endgame. Despite our robot working fine, we will never stop **evolving** it as there are always things to better. For example, our **cable management** was not the best. This and more issues were priority number 1 once when we got back to the robot lab. For the **second version** of our robot, we had decided to change a couple of things and add a new element as well. To save time with prototyping we used more **physics** this time around, especially for the **hanging system**.

Withdrawn aspects

Removed; the 'transfer to lift tray' mechanism, which included the lift tray and the horizontal slider. We had realised that it'd be more time efficient to skip the entire transfer and use the intake system we designed as an outtake system for the baskets as well. This meant we had to put the intake on the continuous lift, for which we had to make sure both the servo for the 'wrist' on the intake was strong enough and the continuous lift itself.

Added elements

With new found space from removing the horizontal slider we were able to make a better cable management compartment. And now we also had the space to design a hanging system. The design itself is pretty easy, but again we wanted to make sure if our robots motors could handle it. Our robot is on the heavier side (6.5 kg) so once again we used physics to make sure.

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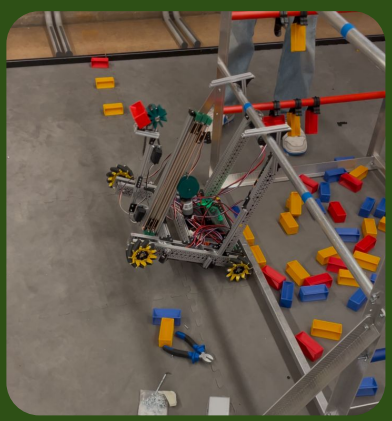

Software

We control the robot with two gamepads, one for the **drivetrain** and **continuous lift,** the other for the intake. Next, let's talk about the movable arms, sliders, cascade lift, and more. Gamepad 2 controls almost all of these features, so gamepad 1 can **focus** on **driving fast** and **precisely**. Driver 2 is responsible for controlling the intake system. Pressing multiple buttons in an exact order can be very difficult, so we added **combo buttons** that perform some actions automatically. We also moved the buttons for the continuous lift to driver 1's side to **reduce stress** on driver 2. We also have a limit set on the lift so our pulley covers don't snap.

This year our goal for **autonomous** isn't that different from TeleOp : score as many samples as possible in the high basket. We tried using **functions** that would execute for certain periods of time, e.g. drive forward for 5 seconds, or lift arm for 2 seconds. This would prove to be relatively easy to program. However, it **wasn't reliable** and consistent at all. The robot moves further at one time than at another, due to the varying battery levels. Realising this would not work, we tried using **IMU**, the internal measurement unit, to read to robots orientation. This also proved to be inaccurate. Then we moved on to using encoders and the inbuilt gyroscope for autonomous, which proved itself by being 9/10 consistent.

For the future we want to use more **sensor inputs**, so we can have a more **reliable autonomous**. This will get us more points and a good head start. The ideal situation would be if we could configure **Roadrunner**. We tried configuring it but just haven't quite figured it out yet, which simply means that there is another challenge waiting for us in the off-season before next season. .

Outreach

Our first outreach event of the season was the **Open House** day at our school. Here we got to showcase the First Tech Challenge, but also **STEAM** activities. A lot of kids and parents were interested in the robot, software or 3D-printer. With this event we not only recruited more people for future robotics season, but we also **peaked people's interest** in engineering. We got a lot of positive feedback from kids, parents and our own teachers. It was a productive day where we also got to work on our robot.

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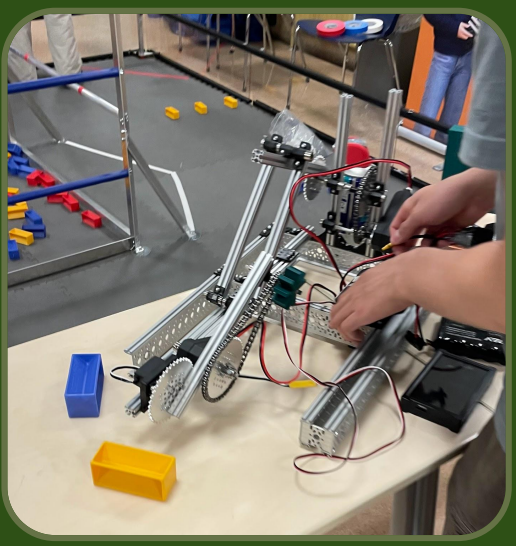

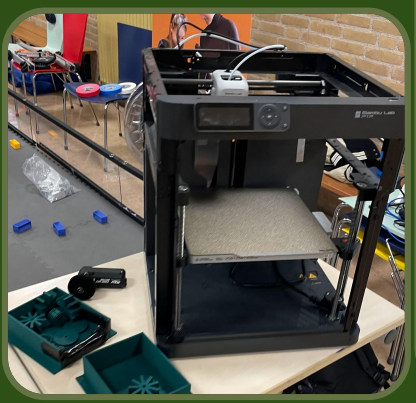

Our second outreach event was a visit to a **primary school** organised by our rookie team The Thunder (#21658) At this visit we gave 11-12 year olds three **workshops** all related to robotics and STEAM. The workshops were: programming, designing and building. Each of these workshops reflected something we do for FTC, and the kids enjoyed it greatly and all learned something new about themselves and their **capabilities**.

In the weeks following we brought a visit to our **sponsors, The Robot Engineers**. We gave them a presentation on FIRST and FTC specifically, explaining this years challenge and limitations. We also gave them a demo of our robot, which they found very interesting. This visit was right after the scrimmage, so they helped us brainstorm a little on possible **solutions** to problems we were facing. We also got to see their **workspace**, and how people in society can **benefit** from robotics. Their workplaces were really cool to see for us, as we saw a lot of what we did come back in their practices. We still keep in **close contact** with them and invite them to events and share photos/videos.

Our by far most fun outreach event this year was **Heroes Dutch Comic Con**. We got to man our own **stand**, where we set up the field, had a working space and a 3D-printer. This event allowed us to do so much, such as: showcase robotics and FTC to a wide variety of people, work on our robot for full days, and even have some driver practice. This weekend was full of **excitement** of talking to people who were interested in our robot. It was also a good team building experience, as we got to wander around Comic Con together and see our interests come to light. We also had the opportunity to host a panel, where we gave a **presentation** on robotics in the Netherlands and how to get started with it. We had quite the audience and a lot of people had questions about the topic.

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The next weekend we went to a Ukrainian Saturday school in The Hague, **Ukrainian school Wesselka**. Here we showed a demo of our almost complete robot to students **aged 3-15**. Once again there was a wide variety of children, some being born here and some being forced to evacuate their country due to Russia's full scale invasion in 2022. The kids had a lot of **fun** high-fiving the robot, feeding him samples and watching him dance. It was a nice distraction from their regular lessons, where they learned something and got their **interest peaked** in engineering.

We find **connecting** with other teams very important, and so we also make sure to make time for that. Internationally, we have spoken to **Tennessine Titans (#21457)** from the USA and **XMachine (#17801)** from Brazil. Other than that, me also have connections with teams that compete in the Benelux, such as **Robotic Tech Frox (#20092), STA (#13953) and in peculiar STT (#3977)**. We often talk about our robots progression and exchange tips. They have helped us out and we want to thank them for that! Additionally there was a **mini scrimmage hosted** at our school with them, right before the Qualifiers.

The day after the Qualifiers we had a visit from three german FTC teams, Robotic Tech Frox (#20092), Frog Robotics Of Germany (#10183), and International Lego Frogs (#23052). We showed them around our school and invited them to sit in on one of our computer science classes. We exchanged info, tips and tricks and overall had a very good time. Afterwards we took the teams for a city tour in Rotterdam, showing them some of our unique architecture and general city life. It was a great day and many friendships were formed.

One of the last outreach activities we did was present our PWS presentation for a lot of schoolmates and family members. A PWS project is a mandatory research project in the Dutch education system, usually spanning over 80 hours of work time. Our school gave us the opportunity to do it about FTC. All of our attendees really enjoyed the informative presentation and we got a lot of positive feedback.

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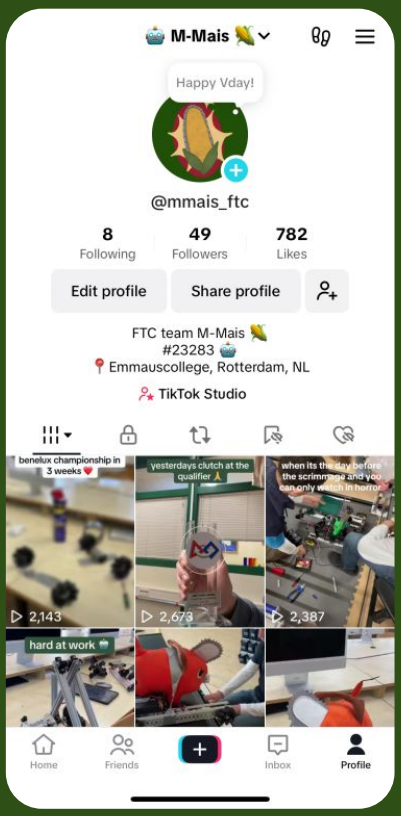
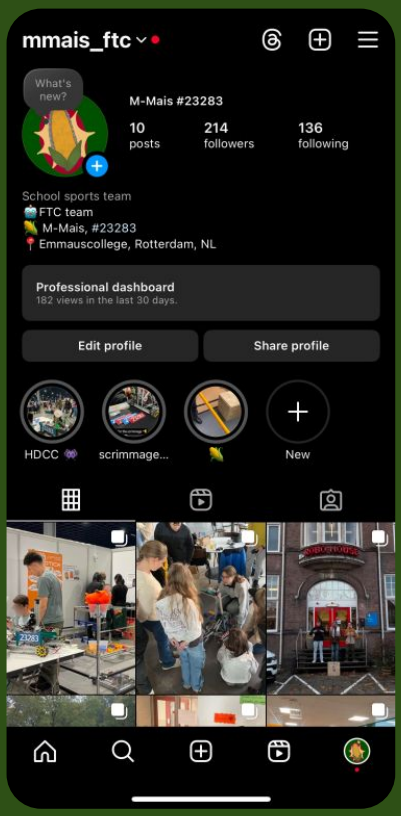
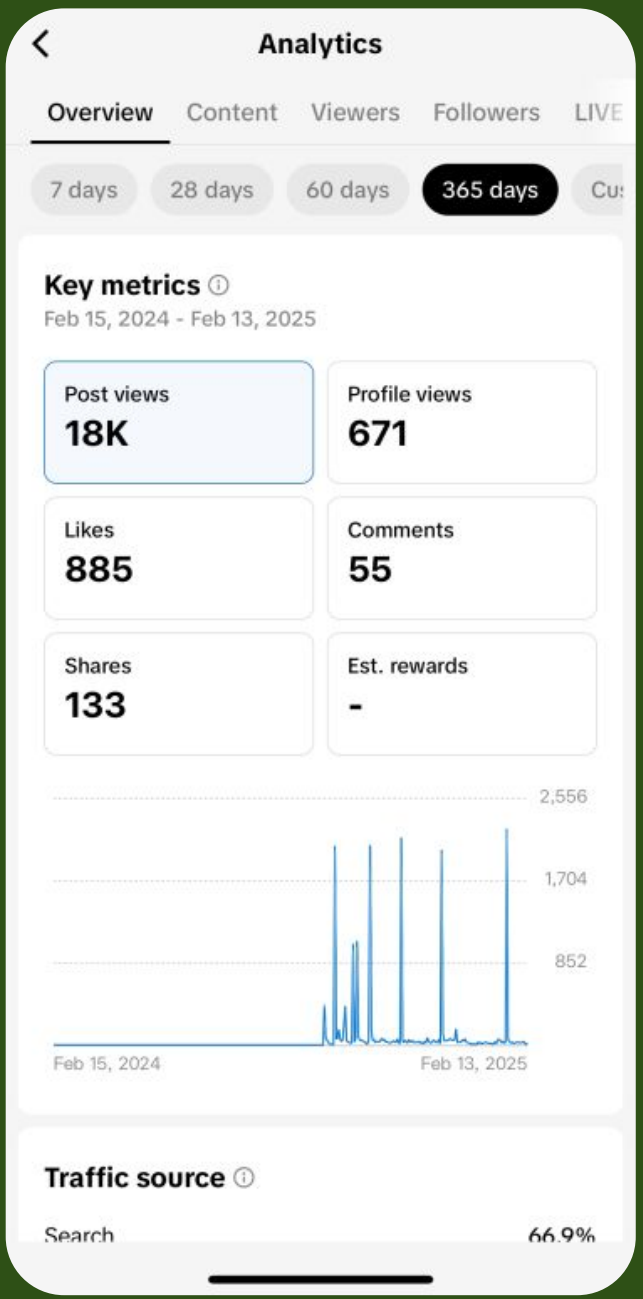
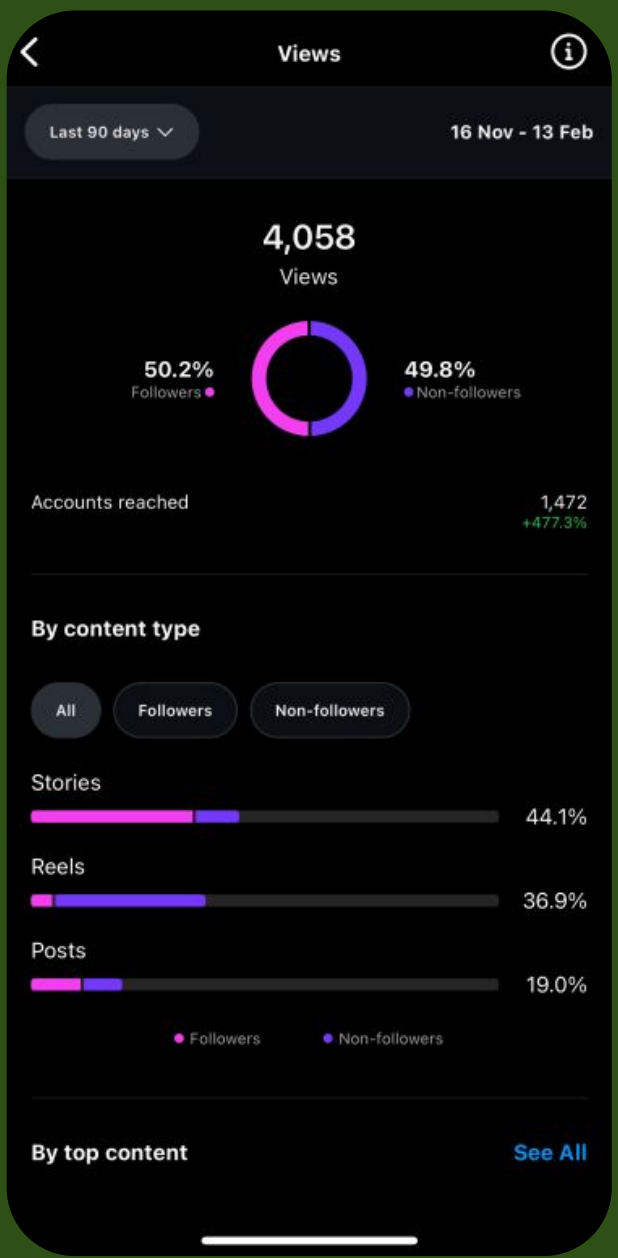




We are active on social media such as TikTok and Instagram. Its a great way to connect with other teams, share our progress and maybe even inspire other teams. Its fun to create content that even people outside of FTC will see and enjoy. We get approximately 3000 views a month when posting regularly, most viewers being from the Netherlands.





@mmais_ftc on both Instagram and TikTok if you wanna check us out!

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Our moodboard

Other than being a team, we're also just friends that like to goof around. Us and our rookie team (The Thunders #21658) are pretty tight knit. We like to play Super Smash Bros and chess during breaks, lots of pull ups as well (gotta stay lean) and the KFC is our holy grail after a long day of working in the robotics lab. We thank whoever took the time to read our Engineer Portfolio and we hope that you enjoyed it and found it informative :)