Engineering Notebook

Team 21658

Team Thunder Wonder

Emmauscollege Rotterdam

2023-2024

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Introduction

Welcome to the Engineering Notebook of Team Thunder Wonder! Our team originates from the school Emmauscollege in Rotterdam, The Netherlands.

Meet our team!
Our team consists of twelve members:

Sander (Team Coach)	
Jasper (Team Coach)	
Aaron (Software Engineer)	Mohammed (Mechanical Engineer, Team Captain & PR)
Delnia (Software Engineer)	Bobby (Mechanical Engineer)
Klaus (Software Engineer)	Lide (Mechanical Engineer)
Maria (Software Engineer)	Reshano (Mechanical Engineer)
Xinyi (Software Engineer)	Barry (Photographer)

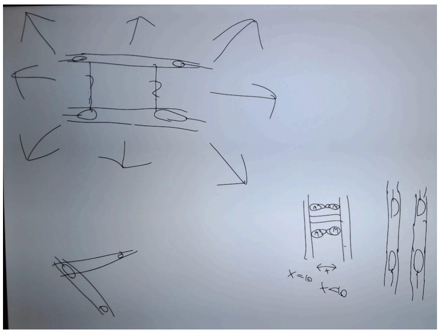
Most of us are currently in the fifth grade of the Dutch school system, which is equivalent to the tenth grade in the American education system, except for Klaus (who is a year above us), and of course our team coaches and photographer. The team used to be a lot smaller (seven members when entering the Rookie Challenge in July 2022), but at present we have enough manpower to manage developing as a team.

Goal
Our primary goal is to secure a ticket to the World Championship in America while also improving our 3D printing skills. Additionally, we aim to inspire the younger generation by visiting elementary schools and introducing them to the wonders of the FIRST Tech Challenge.

For anyone who reads this Engineering Notebook, we hope you will be enthralled by reading this!

Hardware

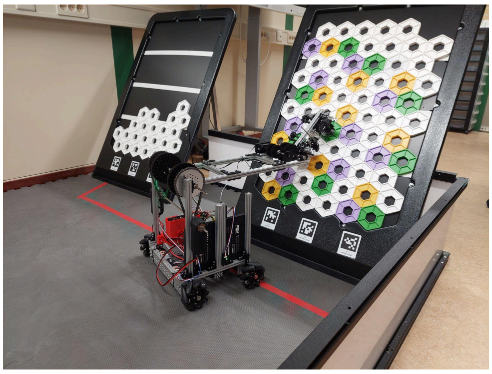
For this season of The First Tech Challenge, we were challenged with creating a robot that can perform a certain amount of unique tasks. These tasks consist of driving, picking up pixels (hexagon shaped objects), holding onto a bar and throwing a paper aeroplane. All these assignments call for a robot that can not only do all these things, but is also relatively small in order to be able to move under and between the obstacles laying around and above us.



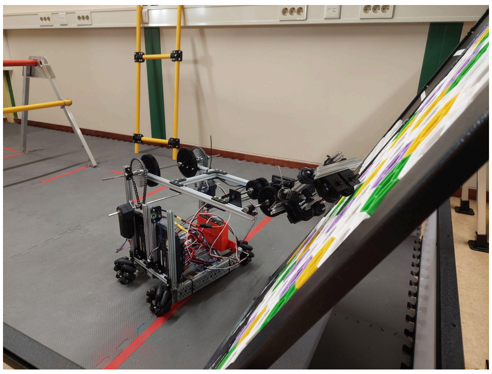
Our first drivetrain design

Drivetrain

We first started out with creating a basic design, which consisted of four Mecanum Wheels, Hex Motors and small extrusions, which formed a rectangle shaped base. The reason for using small extrusions was that we wanted to make the robot as compact as possible. To achieve this, we used four Hex Motors instead of chains or gears, like we did last year. We then positioned the battery, the Control Hub and the Extension Hub on top of these extrusions. We did this for the purpose of being able to easily reach these parts if something were to go wrong with our cabling and for achieving better cable management than if we would have placed them elsewhere.



The path of making a robot is not as easy as going in a straight line. After a few weeks into the new season, we encountered some problems. First up, the frame of our robot was not as solid as we had hoped it would be. To solve this problem, we picked a long 15mm x 30mm Extrusion and sawed a few centimetres off. We then screwed it on the robot, gave it a durability test, and the robot was sturdy. All's well that ends well, right? Not really. Another problem popped up. For the wheels that were attached to 75mm HEX Shafts, to prevent them from popping off the HEX Motors, you would need a really tiny screw in the motor. This tiny screw did eventually prevent the HEX Shaft from detaching, but it immobilised our entire robot. We unscrewed as many of the pesky screws in the HEX Motors. Most of these screws were screwed so tight that we could not undo what we had done. We eventually had to swap HEX Motors on one side. After brainstorming for solutions, we managed to address the problem mentioned earlier without a specific plan. We tried it, and it just worked. We used one 15mm Plastic Rod End Bracket for each wheel, which was attached to the frame of the robot. We ran the HEX Shaft through the hole of the Plastic Rod End Bracket, and to prevent

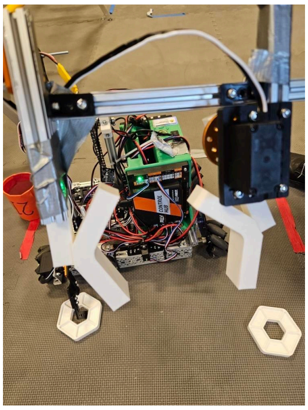


the shaft from popping off the motor, we placed the Plastic Rod End Bracket between two Shaft Collars. We also used a singular spacer in the hole of the Plastic Rod End Bracket to create extra sturdiness for the HEX Shaft. What we also needed were 3mm spacers. If we had not used these spacers, the wheel would have been too close to the frame, so that it would not be able to drive, because it would scrape the frame. The last step was to secure the Mecanum Wheels on the HEX Shafts with some spacers on both sides of the wheels. For most of the wheels, we put two spacers on the inside of the wheel, but for some, we put three, and topped it off with a Shaft Collar at the end. While it was a genius thing to do, we already had other more compact parts to screw the HEX shaft to the HEX motors. The Locking Motion Hub was used for this process. Space was a problem for the small frame we had. Had we put the Locking Motion Hub on it without removing a gear from all 4 HEX motors, we wouldn't have had space to fit everything in the robot. So we did exactly that: remove a gear from the HEX motors. Life wouldn't be without problems, right? And so there were more. The screws that held the gears of the HEX motors together should not have been screwed too tight, otherwise they wouldn't turn because of friction. We screwed them tight to a point where they would turn smoothly. There were other screws that held the HEX motor in place, which couldn't be screwed too tightly, because then the motors wouldn't turn as well.

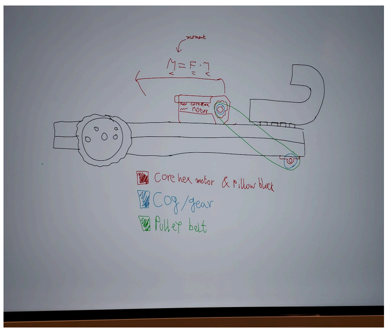
Scoring mechanism

After creating a basic robot, which was only capable of driving, we used tutorials made by REV Robotics to find a compact but viable design for an arm. Based on said tutorials, we created our own design, since we didn't possess the extrusions that were utilised in the tutorial. We also did this because the design of the tutorial was colossal and would under no circumstances have fit on top of our small robot. Following all these steps, we've created a robot that should be able to drive and pick up pixels.

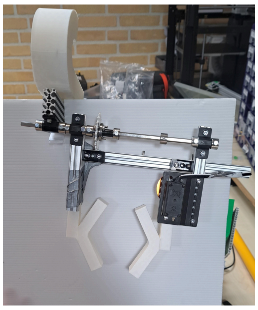
On October 28th, we went to the startup meeting in Eindhoven to improve our robot and receive tips. The tips that we received were really helpful to further improve our robot. An example was to use chains to lift the arm. We ran into a problem with the current design we had. The 90 and 60 Tooth Plastic Gears we used would not roll smoothly on each other because of the weight of the arm it had to lift. Back at school, we used the knowledge received at the meeting to make an arm design with a chain in it. We kept the same design, but we replaced the 90 and 60 Tooth Plastic Gears for metal gears. We put the gears as far from the middle as possible. This was another tip given at the meeting: the previous position of our gears was in the middle, which caused a lot of pressure on the Hex Shaft it was attached to. We also put the Core HEX Motors as far down 'as possible' to prevent the robot from falling over. 'As possible' is emphasised, because the Control Hub and Expansion Hub were in the way. That was eventually fixed when the motherboard came into play. As the days went on, we started to realise something: our arm was too short. We could have replaced the current extrusions of the arm with longer ones, but that would only cause too much weight to be supported for the Core HEX Motors. The solution? We made a whole new design. We kept the chain idea, but we went for a whole different arm. Like last year, we went with a lift system for the arm. We used the REV Robotics Three Stage Cascading Lift Guide as the foundation of the arm. We used our 3D printer to print out pulley covers, as the pulley covers of REV Robotics were ineffective (last year, it wasn't the best decision to use them, but we didn't have a 3D printer yet, so we had to do with what we had then). We also added strings on both sides of the lift: one to lift up the arm, and one to lower the arm to its original position. With a saw, we cut three tiny extrusions to put on the lift. The extrusions would then house the HEX Motor with HEX Shaft, the 3D printed spool and the metal gear. For the arm to go on the robot, the motherboard had to be replaced on the side of the robot. We put two smaller extrusions on the middle extrusion (the one that strengthened the frame) where the lift would be attached via a 90mm HEX Shaft. Right under the motherboard we put another HEX motor to 'lift up the lift'. What we had planned was to turn the lift (not entirely 180 degrees) to easily pick up pixels, be it to the front or backside. An excellent idea, but the resources we had were scarce and of poor quality. The strings we put on the lift instantly snapped when tension was put on it. We had no other choice but to go over to a one joint arm (still with the same idea of an almost 180 degrees turning arm). An upgrade for the gripper was also required. A new gripper was designed and 3D printed. After the first gripper, we 3D printed a nice pair of green grippers. This pair did eventually break at the first league meet of the 2023-2024 season. One small change to the design and some testing, and it worked. What we also did was using only one servo for the gripper system as that would save some thinking time for the human driver controlling the arm and less lines of code for the programmers. Another thing we did was making a design to only bring one pixel instead of two as this was, again, more efficient for the human driver. After the first league meet, we decided to install a ground gripper (see the bottom of left picture) to the robot. The special gripper was there to make the autonomous period easier to execute. At the first league meet, we had to use the normal gripper to go through the autonomous period, but the flaw of that was that it had to fall due to the height. It was so inconsistent that the pixel would just fall out of the zone. The ground gripper solved this problem. Now it was far more consistent.



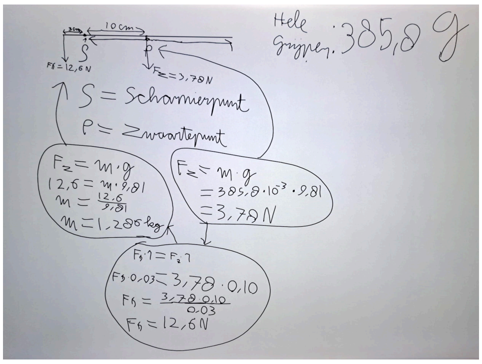
Unfortunately, a few days after the second League Meet, the servo that was holding and allowing the gripper to move up- and downwards broke. The servo was the only thing that was attached to the gripper, which wasn't very strong. It was a wonder that it lasted for over two League Meets. The problem with this single servo is that it wouldn't turn the way it should go. It stuttered halfway through and the part that held the servo and gripper together was bent. We came up with a solution that made the wrist of the arm stronger and faster. We disassembled the gripper from the arm and unscrewed the servo with its bracket from the arm. We then went ahead and drew the plan for the new wrist. As seen



here in the first picture, we planned on using a Core HEX Motor for the wrist plus a chain. We initially wanted a pulley belt system for the wrist, but we realised that we were just one gear short, so we went for the good old chain. Now that the plan was visualised, we applied some physics to the plan. This was needed because the gripper hung a bit crooked. It tilted a bit to the right as you can see in the picture. When we attached the chain, it became even worse. So an opposing force was needed to counteract the position it was in. We calculated what the force needed to do this thanks to the formula of momentum, this being M = F * r.



First we weighed the whole gripper to get its mass. With that mass, we calculated the force that was tilting the gripper to the right. That force was 3,78 N. To define the centre of gravity we used a rope, each end of the rope tight to the sides of the gripper. Then we used a finger to hold the middle of the string and moved till the gripper was balanced. Lastly we took the point perpendicular to where the finger was. That is where the centre of gravity is. We then measured the distance between the centre of gravity and the hinge point. Now that we know the force and the distance to the hinge point, we can calculate the momentum. With this momentum, we can use the law of torque to calculate the momentum of force needed to balance the gripper. This is done by saying that M1 = M2, or how you also write it, F1 * r1 = F2 *r2. In this case, F1 is the force balancing the gripper and F2 is the gravity of the gripper. The lengths of each piece of the arm, r1 and r2, are 0.03 m and 0.10 m. filling in the formula gives us F1 * 0.03 = 3.78 * 0.10:

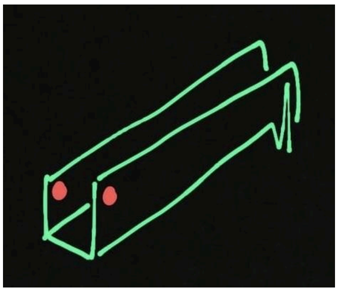


$$F1 \; * \; 0.03 \; = \; 3.78 \; * \; 0.10$$
$$F1 \; = \frac{3.78*0.10}{0.03}$$
$$F1 \; = \; 12.6 \; N$$

We now know that we need an opposing force of 12.6 N. The last step is calculating the counterweight required to balance the gripper. We used the formula of gravity to get the counterweight:

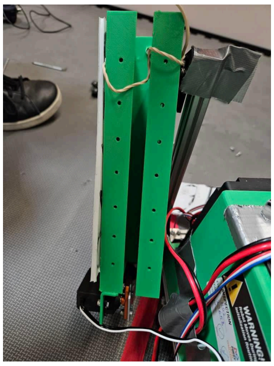
$$Fgrav. = m \; * \; g$$
$$12.6 \; = m \; * \; 9.81$$
$$m \; = \frac{12,6}{9,81} \; = \; 1.284 \; kg$$

Drone launcher



Drone launcher sketch

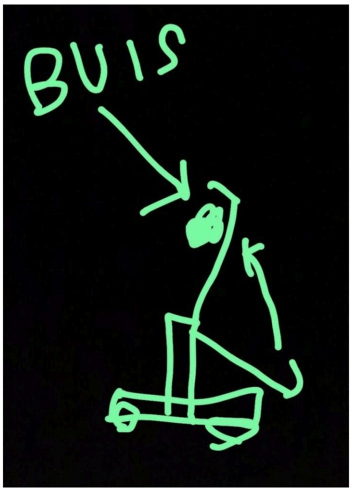
Our next step was creating a design for throwing a paper aeroplane. Before actually starting to build this paper aeroplane throwing contraption, we first gathered the whole team and folded various styles of paper aeroplanes to test which one could fly the farthest and most stable. Then we used cardboard boxes and a simple construction to make a demo to test the usability of the paper aeroplane throwing device. To make sure our aeroplane was efficient and trustworthy, we asked for advice from students at the Technical University of Delft from the faculty of Aerospace Engineering. They explained how weight distribution has a big impact on how an aeroplane works. If the weight is centred more at the nose of the plane, the plane will have the tendency to lean forward during its flight. If, on the contrary, the weight is at the back, the plane will fly upwards. When you want the plane to fly for long distances, the weight should be distributed evenly. To create an almost flawless paper aeroplane, we had to create lots of paper aeroplanes and test them all.



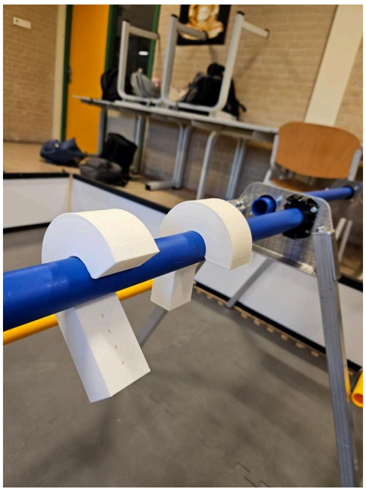
Final drone launcher

Hanging system

For the new hanging system this season, we 3D printed a strong and very wide hook. To prove that this hook was strong enough to hold the weight of the robot, we stress tested the hook. We used a trash can from the classroom, an extrusion, the hanging hook prepared with 4x 20mm screws, 4x M3 nyloc nuts and a whole lot of tape. We taped the extrusion with the hook screwed on it to the trash can and put anything heavy in the bin. All filled up, it was held up by one of our teammates. The sole hook we stress tested, held the weight of everything in the trash can until the very end. The only step left was to screw the hook onto the arm of the robot and to test it on the field. We tested it and the robot hung on the barrier without touching the ground.



Sketch of hanging system



3D-Printed Hooks

Stress Test

Software

Autonomous

As mentioned earlier, we have participated in the LEGO League and Robot In A Week (a week in the context of programming with robots with the same blocks system used in this competition). In spite of that, we didn't actually have any experience with programming in Java. When beginning with coding, it was solely with blocks. After a while, we started looking for tutorials on the internet, and commenced with actually writing code. This year however, we were able to use our knowledge from past years and develop the code that we used for this season.

In this code we utilised a distance sensor, so that if it detects the object that was placed in one of the zones, the robot would get the pixel from that zone and execute the rest of the autonomous code.

Initially, we faced challenges making it work because we hadn't determined the sensor's placement, resulting in numerous code changes and errors. When we had a final design for the robot, the code looked like this:

1. Scan for an object in zone 1. If there is an object, continue with the following code lines. If there isn't, go to zone 2.
2. Scan for an object in zone 2. If there is an object, continue with the following code lines. If there isn't, go to zone 3.
3. Scan for an object in zone 3. If there is an object, continue with the following code lines. If there isn't, go to zone 1.

In the beginning, the sensor wasn't able to detect anything, so it would just move around in circles until the 30 seconds of autonomous were over. We fixed the issue and the robot could detect the object and do as the code said.

For the next step, which was placing the pixel on the scoring board, we wanted to use a webcam. Last season we had a lot of problems with the webcam. We originally tried to employ Vuforia, which did not work at all. This year, on the other hand, we wanted to re-attempt getting it to function normally. The idea was quite simple: we were going to use the AprilTags on the scoring board to easily navigate the robot and place the pixel in the correct area.

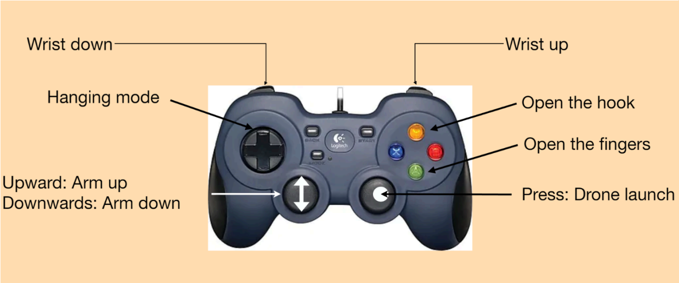
Driver Controlled (TeleOp)

Since the rules of this season include many tasks that require movement and an arm, we still have one person controlling the driving of the robot (Mohammed) and one person controlling the arm (Lide) this year. In our plan, the robot still uses mecanum wheels to support movement in all directions. However, compared to last year, the arm needs to have the ability to perform a larger amount of tasks.

For navigating the robot, we have used a joystick to support movement in all directions, and an acceleration and deceleration button to control small-distance operations. When pressing the left trigger, the robot will move slightly slower, and by pressing the right trigger, the robot will move slightly faster. In addition to manually increasing or decreasing the speed, there are also preset speeds that can be accessed by the face buttons: the Y button makes the robot slow for more precise movement, the B button makes the robot faster in order to traverse the field faster and the A and X buttons both return the robot to the default speed. The driving of the robot is controlled by both joysticks; the left joystick allows the robot to move forward, backward, left and right while facing the same direction, and the right joystick makes the robot turn left and right. When the robot starts moving, it doesn't go full-speed instantly, instead it increases in speed gradually, which is done to make it jar less when the robot starts moving. It can however be toggled off if desired.

The robot's arm is divided into three parts: arm, wrist and fingers. Our plan was to have these three parts move simultaneously and finally reach a position at the right height and angle to place the pixels. The height of the arm can be adjusted by using the left joystick and the wrist can be changed with the two triggers on the back of the controller. The fingers are the parts that actually pick up the pixels and are controlled by the face buttons on the controller. Originally, we had two fingers that could pick up pixels, but after the first league meet, we decided to only have one. This decision was made because we almost always just used one finger anyway and it would be simpler to only control one finger instead of two. The finger is by default closed and can be opened by pressing the A button, this was done so that the button didn't need to be held in when carrying a pixel.

Controller driving



Controller arm

League Meet 1 evaluation

Hardware
After all of our preparations, it was time to show what our robot could do. Unfortunately we encountered a few problems during the first few matches. Our main problem was that our robot kept disconnecting. We later determined that this problem was caused by our electric circuit shorting out. We fixed this problem by taping the ends of the extrusion that were sticking out of the robot.

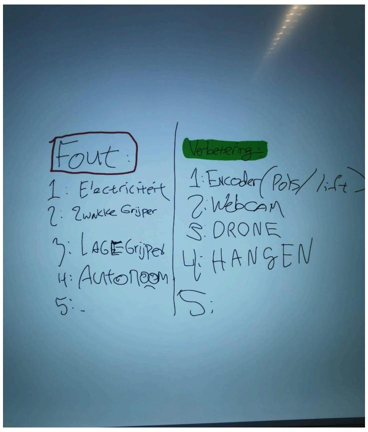
Our second problem happened during match 16. During this match, the gripper of our arm broke down, which led to us not being able to pick up any pixels anymore. We temporarily fixed this by turning our two gripper system into a single gripper system, which wasn't as effective as having two, but it got the job done. This also had a benefit, because having only one gripper would mean that there was less weight, which would also fix one of our other problems. The problem being our arm shaking a lot while driving and moving up and down.

After this match, our main focus was creating a new design for our arm. We came to a decision which led to the robot permanently having one gripper instead of two, because we rarely used the second gripper either way, since putting the pixels exactly at the right place to pick them both up instantly almost never happened. Next to only having one gripper on top of the arm, we also made a small gripper at the bottom of the robot. This gripper would be used during autonomous. This second bottom gripper means that, during autonomous, we don't need to drop the pixels from a certain height and we can instead drop it down from only a few centimetres above the ground.

Luckily, there wasn't only critique, since we still won a lot of our matches. This shows that our robot was indeed capable of picking up pixels, shooting a drone and, thanks to our compact design, driving under the obstacles.

Software
Alongside mechanical issues, we also encountered some issues with our software. The main problem was that our code for autonomous would not work. During our second match of the day, match 9, our gripper let go of the pixel too early and we weren't able to score any points for autonomous. When it was time for match 16, this wasn't a problem anymore, but what did happen was that our robot turned the wrong way and placed the pixel in the wrong zone. Throughout our final two matches, our robot was having an issue with detecting the placed object, which meant that the robot placed the pixel in the wrong zone. Another problem was in match 21: our rotation axis was too big, so even if the robot did detect our object, its rotation axis would still be too big for it to place the pixel in the right zone.

After League Meet 1, we made a table with things that we wanted to repair and things that we wanted to improve about our robot, which you can find in the picture on the right. The only thing that we needed to fix regarding the software was the code for autonomous, since everything else had worked. To do this, we downloaded RoadRunner to update the code without needing the robot. Secondly, we wanted to start using the webcam so we would be able to place the pixel on the board during autonomous. If we still have any time left, we also want to use encoders for our arm and wrist for a smoother and more controlled movement.



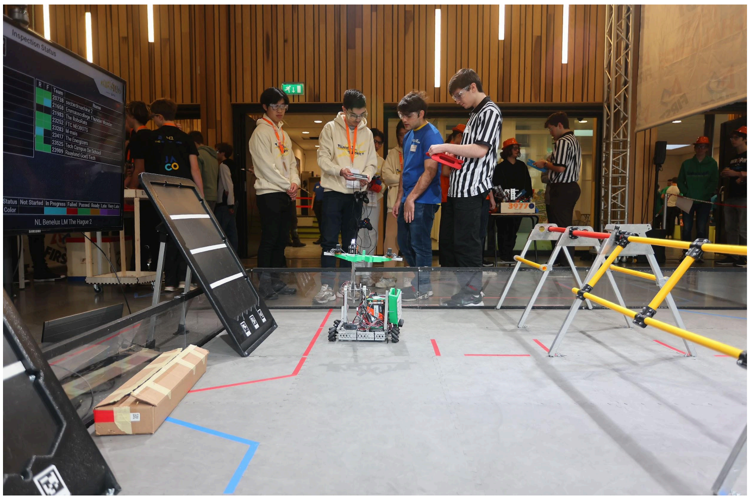
Our overall experiences

The day itself was very enjoyable. We met up with some old friends and we also made new friends along the way. It was great to see all the other robots and to be inspired by their designs. Right before the matches started, we went over to the other teams and discussed our strategy for that match. Our robots always completed each other and we were able to work together to achieve victory.

In between the matches, there was a lot of time in which other teams required help from us. This could differ from needing to borrow an object to needing a third or fourth hand helping them to fix their robot and we tried to help them as best as we could. Fortunately, all the teams were nice to us and also helped us when we needed their help. We have already said that our robot had a disconnection issue, which kept happening during the matches. When this would occur, a volunteer would immediately come and help us. With their help, we were still able to continue the matches.

Preparing the robot for a match

Getting through inspection



Fixing the robot in between matches

Taking a final look at the code

League Meet 2 evaluation

Hardware
Before the league meet in Zeist started, we only had a week worth of time to improve or solve problems of the robot. That is a very short amount of time. Therefore, making big changes to the robot was not ideal. So we just made some small changes. As said before in the hardware part, we replaced the broken parts we suffered from League Meet 1. We also noticed that we rarely picked up two pixels at a time. So we redesigned our intake and attached a brand new 3D-printed gripper to the robot. The newly designed intake is much lighter than what we first had, which made it easier for the robot and human driver to handle. Once we had finished the intake part, we installed the hook that we previously 3D-printed and tested it. At first there were some problems with the software, but after those were solved, it worked perfectly.

Software
During this league meet, our program was not really ideal. There were no problems with TeleOp, but unexpected situations did occur during the autonomous period. Our robot succeeded once at the beginning. It placed the purple and the yellow pixels in the right zone. But after that match, something went wrong. As a result, the robot could not do what it was supposed to do in the autonomous period.

In a later match, the robot went forward for a certain distance, then turned around and headed in the direction of the drivers. We thought there was something wrong with the autonomous program, but when we checked later, we found out that the problem was caused by the webcam, which was facing slightly upwards. The problem was solved after taping it to the frame.

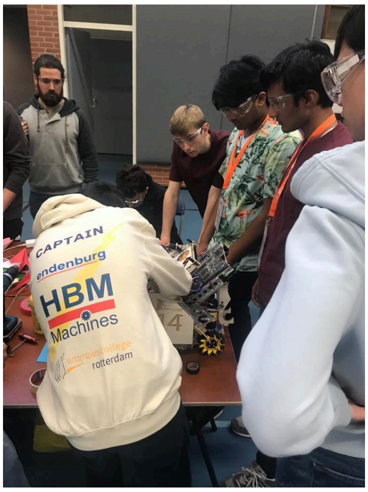
A while later, something quite strange happened. Before the start of the game, we found that our autonomous program disappeared from the drive hub and couldn’t be found anywhere, but it was still there on the computer. We couldn't find the reason, so we had no choice but to give up on that autonomous period. After building the program later, the program reappeared, but we still don't know why it disappeared.

In addition to the above problems, there were also small problems that have always existed, such as the direction the robot turns, always being different after following the same line of code. We thought this might have been related to the wheels. The wheels didn’t have enough grip and would often slide when rotating, resulting in insufficient rotation. For us, this seemed like a reasonable cause, since the code itself and the start location of the robot barely or never changed. Later on, we looked out for the slipping while observing, and we did find out it was true.

The new plan: use three distance sensors to detect objects in different directions at the same time, and the IMU built into the control hub to account for slipping during rotation (see paragraph software).

Our overall experiences

The day was filled with a lot of excitement and new learning opportunities. We saw and met teams that we had not seen before. We helped another team with their connection issues, by making their XT30 ports (where the power connects to the control hub) slightly larger. During that we also talked with them about FTC and what their robot is capable of. There were lots of intriguing and innovative robot designs we had not seen before, and it was inspiring to see what everyone came up with. We found fun and harmless ways to entertain ourselves while waiting for our turn at the judged presentation. When something went wrong with our robot, we came together as a team and fixed it swiftly. In comparison to league meet 1, we gratefully did not have any connection issues.

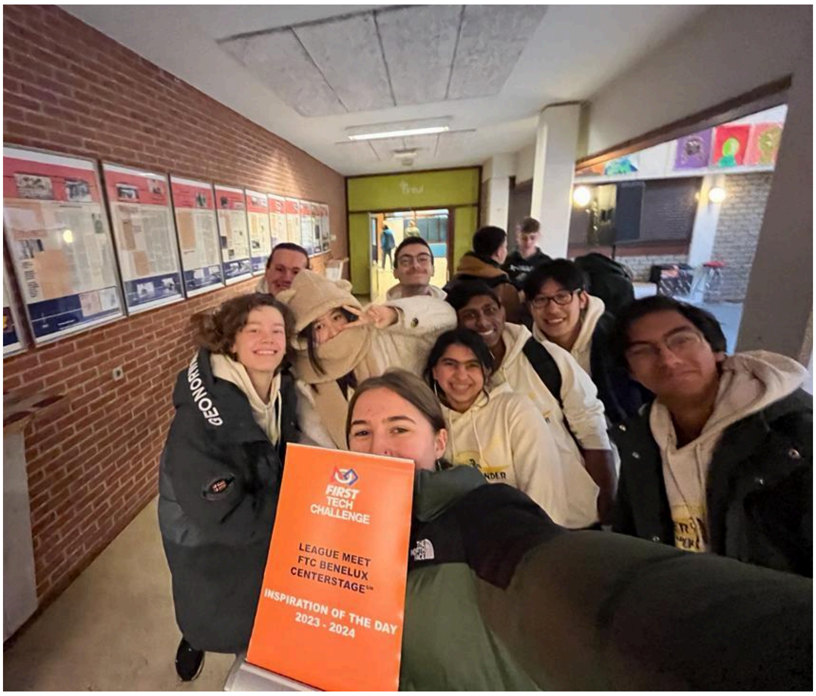


Helping other team

Our presentation went great and we received an abundance of praise. The judges liked our work at elementary schools and asked questions about it. We believe this was the reason why we won the Inspiration of the Day award. We are very proud of this achievement and we are going to use the feedback we got to improve for the Benelux finale, to hopefully get a chance at winning the inspire award. Overall, it was a very fun and memorable day, and we ended with a nice spot of second in the rankings.


PROGRAMMER
endenburg
HBM
Machines
MECHANIC
endenburg


CAPTAIN
endenburg
HBM


FIRST
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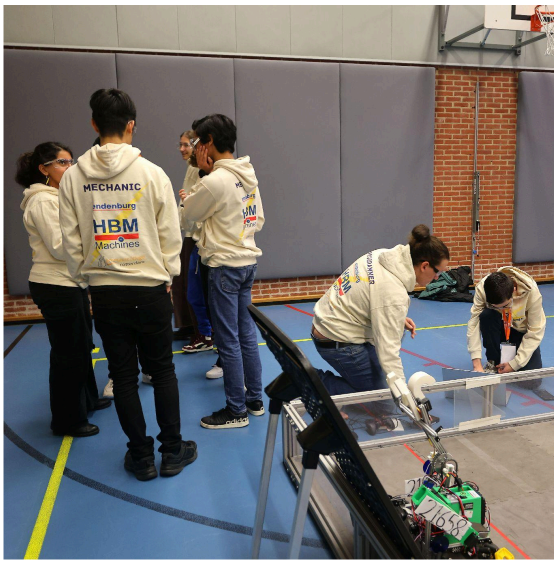
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Machines

Outreach

Last year, because we had just started participating in the FTC competition, we didn't have much experience and couldn't arrange an outreach plan. Although it was not successful the first time, with last year's experience, we immediately prepared our outreach plan at the beginning of this year.

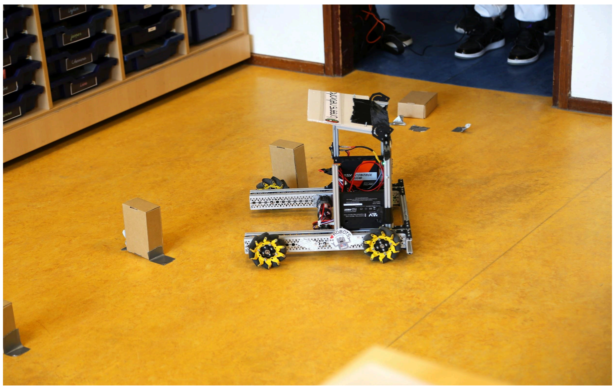
School visit

Our first activity for outreach was going to an elementary school, De Contrabas, to arrange an activity for children in the sixth grade. This elementary school was attended by three members of the team (Lide, Maria and Xinyi). We first went to the school to tell the teachers about our ideas. After receiving their approval, we went back and looked for a possible date. With the date and time in mind, we started planning the day.

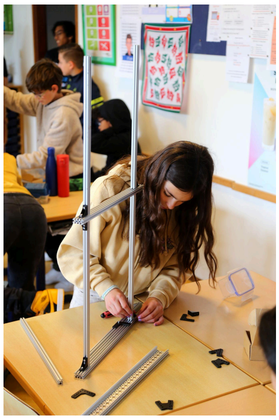
We divided the engineering part into two segments:

It was quite difficult to come up with something that had to do with engineering that we could realise. At the time, we didn't have a lot of resources like building materials and other essential hardware. We only had enough materials to make one fully functional robot. So a simple exercise for the kids, like "build a robot" was not possible. Even if we had enough materials to build multiple robots, we wouldn't be able to do it due to a time crunch. So we needed to come up with something else.

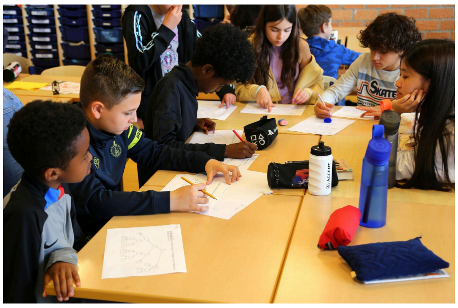
Then after some brainstorming we realised that we still had our own working robot. So we came up with a fun little race. We designed a small racetrack from scratch that we could quickly build up on-site. The racetrack consisted of a few boxes taped to the ground, a ground junction with one cone and the star of the racetrack, our humongous homemade balance board. The idea was to ride between the taped boxes, then ride over the balance board and finish by putting the cone in the ground junction. We had one member of the engineering team explain to the kids how to control the robot and what they had to do on the racetrack. Another member was there to time how long it took to complete the racetrack. The kids would take turns controlling the robot. We told them that the fastest time would get a reward, which made the children very competitive.

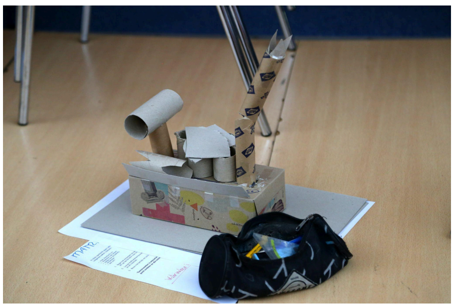


The racetrack is of course an amazingly fun activity, but has little to do with engineering. After thinking for a long time, one member had the idea to have yet another race. This time, however, without a robot. We gave the kids all the building materials we had left over instead. Of course we divided all the materials fairly. The idea was that the kids would build an as high as possible tower with the available materials. The group of kids was divided into a few smaller groups. The team with the highest tower would win a prize. After hearing they could win a prize, they were yet again very competitive. The kids obviously didn't really know how to use our equipment, so two (different from racetrack) members of the engineering team would explain how to fasten, for example, two extrusions to each other. They also explained how a strong foundation is important in case you want to build something tall. In the end, the first and second place were just a few centimetres apart. We may call that activity a success.



For the programming part, considering that children cannot understand programming languages as quickly, we came up with two activities: using relatively easy LEGO League programming (blocks) and creating a simple robot design. Interestingly, this elementary school had already started participating in the LEGO League competition just last year and had members who were in the class. This made it far easier for us to explain programming to them. We decided that half of the class would go to the LEGO group to solve the programming problems we had written for them. At the end of solving the programming problems, we let the children's imagination run wild and gave the students a task of creating a problem on their own and then solving them afterwards. The other half went to the design group to build the robots they designed using cardboard. Every team got several Huffman tree puzzles with a sentence or word in them, which were all related to either robotics or high school. When the teams solved a puzzle, they would get a material of choice to create their robot with. However, during the second round, we changed the rules a bit, because of time shortage. Now the teams could get multiple materials after solving just one puzzle. The most interesting problem that was created and the most

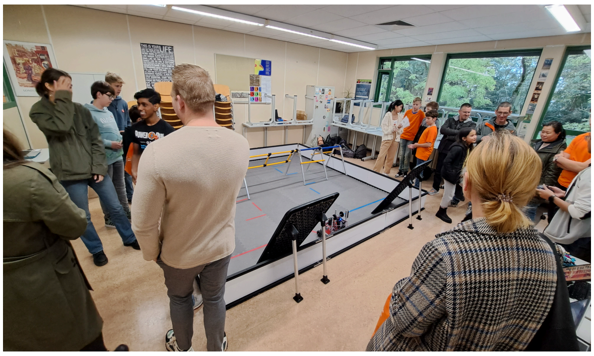




perfect robot design received an award at the end of the day.
This day may be called a success. We believe we left a lasting impression, as we still hear from students and teachers alike.

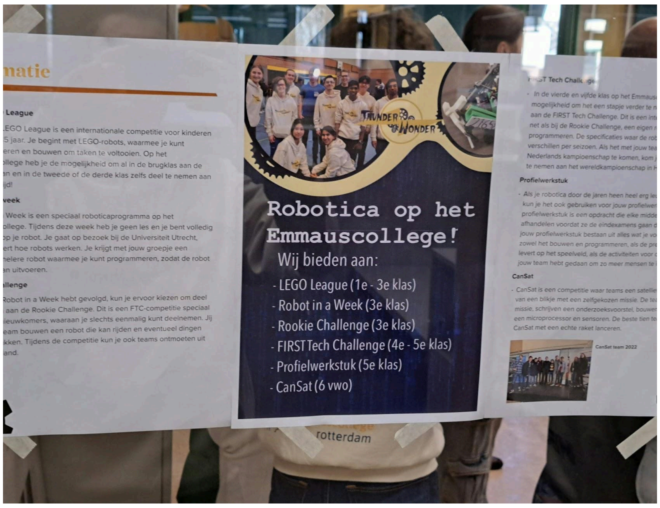
Open day

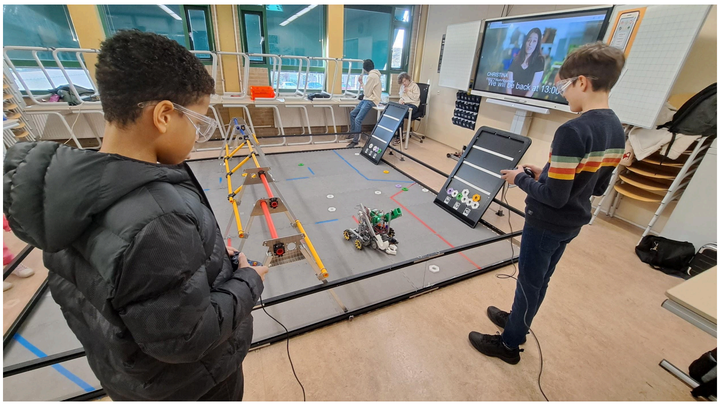
Aside from that, we, alongside team #23283, better known as M-Mais, participated in the open day that our school had organised. During the open day, the children that came to visit our school were able to operate our robot on this season's playing field. While the children were playing, their parents were being told about everything that our school has to offer and what FTC exactly is. They also got to know our team better and learned about our previous victories. For more information, every family got a flyer containing even more information.



Break-In

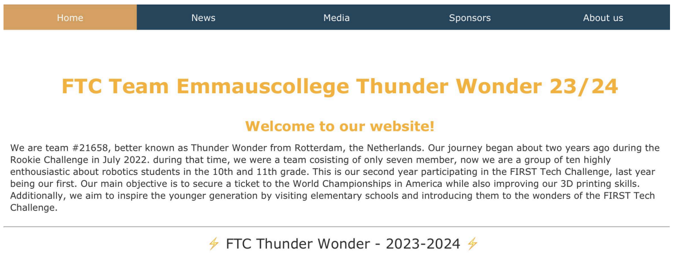
We also helped our school during the second open day, the “Emmaus Break-In”. This time our robot also had an arm, so the children could control the robot together with their parents or with other children, one controlled the arm and gripper and one controlled the movement of the robot. The rest of the setup was pretty much the same: we gave information about our school and FTC and gave everyone our updated flyers. During the Break-In, we played the livestream of League Meet 8 in Hasselt on the board. This way we could show everyone what real matches looked like.





Website

Next to enlightening students about and inspiring them to join us and the rest of the FTC competition to bring robotics to the school curriculum in person at, for example, primary schools, we as a team try to inform anyone that is interested via our website (a work in progress) as well. Every member of Thunder Wonder has the subject informatics in their educational program at our school. The goal of this subject is to instruct students about the spectrum of programming languages the world of computer science has to offer, and to focus on a couple of these programming languages (e.g. HTML, CSS and JavaScript), to ultimately utilise them for certain projects, like building a website. After finishing this individual project, we came up with the idea to also build a website for our FTC team. We created a new repository on GitHub and shared it with the GitHub accounts of every team member. Subsequently, we copied the base site we received from our teachers on which we were supposed to make our individual website for informatics with, and copied it to our repository. For this site, we first started creating a theme (we went all yellow with our colour scheme) and eventually had finished our base, on which every page of our site could be based on (for evenness). At last, we gave some of our team members a certain part of this project to work on, for instance writing the code and text for the part on outreach or fabricating the page for our contact information.



School newspaper

At our school, we have a yearly school newspaper, in which is written about a large part of the activities our school has done in that year. This year we decided to join the newspaper and we wrote about who we are as a team, what FTC is and all the fun activities from the past years. With the help of some friends, who are editors for our newspaper, we were able to dedicate two pages to our FTC journey.

DIT IS ROBOTICA OP HET EMMAUS!

Wie zijn wij?

Wij zijn het roboticateam Thunder Wonder. Dit is ons tweede jaar dat we meedoen met de **First Tech Challenge (FTC)**. Dit is een wereldwijde competitie tussen teams van jongeren tussen 15 en 18 jaar, waarin de teams een robot moeten bouwen en programmeren om opdrachten uit te voeren.

Ieder jaar wordt er een nieuw thema bekendgemaakt en de teams moeten deelnemen aan twee wedstrijden om in de finale te mogen komen. Als je als eerste eindigt in de Beneluxfinale, krijg je toegang tot het wereldkampioenschap in Houston (VS).

Wij hebben vorig jaar deelgenomen aan het PowerPlay-seizoen in Nederland en Duitsland, waar we de **Judges' Choice Award** (voor onder andere samenwerking) en de **Winning Alliance Award** (voor het winnen van de finale) hebben gewonnen.

Dit jaar zijn we weer druk bezig met het nieuwe seizoen, CenterStage, met een gloednieuwe robot en gezelschap: het nieuwe vierdejaars team **M-mice**.

ROBOTICA ZOEKT TALENT!

Zit je in de derde klas en ben je geïnteresseerd in robotica? Het roboticateam zoekt enthousiaste leerlingen die gemotiveerd zijn om deel uit te maken van het **vierdejaars roboticateam 24/25**. De EMC-uren vinden altijd plaats op dinsdag het achtste en negende uur. Als je interesse hebt, kun je tijdens deze uren altijd langskomen om een kijkje te nemen en vragen te stellen in B41/B42.

ONZE ACTIVITEITEN

FTC Benelux Championship 2023

Excursie Kaiserslautern

Open dag

Teamuitje

Visites

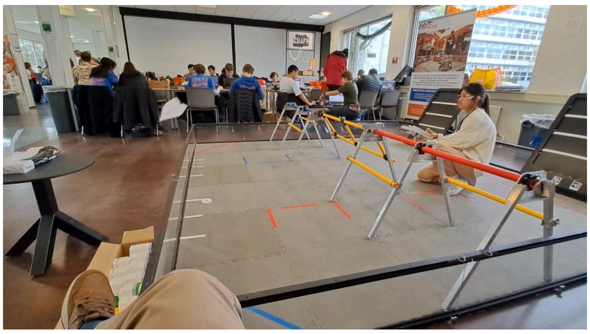
GSA & Thunder Wonder

Our school has a GSA (Gay-Straight Alliance) that organises activities like Purple Friday, Coming-out day and more. They strive to make everyone feel welcomed and safe at our school. Thunder Wonder absolutely agrees with these values and actively participates in the activities organised by our school's GSA. Some of us are also members of the GSA, which we hope will lead to more collaboration in the future, as we find it important that everyone should feel safe and accepted at our school.

Startup meeting

At the start of the season, we also went to the startup meeting. During this type of meeting, there are volunteers and other teams present to help each other. There is also an entire field for teams that want to practise or want to try out their new designs. At that time, we had some trouble with our arm and wrist. However, there were a lot of volunteers offering to help us, which led to us ultimately creating a working arm. We also created our drone launcher which we were able to try out with various drone designs.

Not only did we receive help, we also helped other teams with improving their robots. For example with creating their drone launcher, since we had a great design which worked with reasonable consistency.



Supporting other teams

In the spirit of gracious professionalism and collective growth within the FIRST Tech Challenge community, we extend our commitment beyond personal achievements to actively support fellow FTC teams. Collaborating with teams such as Stanislas Tech Team (and Academy), Lituanica X, and M-Mais has not only been about sharing knowledge, but also about building a tight-knit community within the dynamic realm of FTC.

Stanislas

We have a very close relationship with the Stanislas Tech Team (and Academy). We first met them during the off-season of Freight Frenzy (2022) when we were still a rookie team. In fact, FTC was new to our school, so we lacked any experience. Our team coach thought it would be a good idea to collaborate with another FTC team to get a jump start and learn from their years of experience. Since our coach already knew the Stanislas teams, communication was easy. Shortly after making contact, we visited their school. They demonstrated how they managed their team, which consisted of builders, programmers, and PR. We hadn't even known about PR before. Thanks to the Stanislas teams, our team gained structure. The convenience of a structured team became a blessing as we started constructing and coding a new robot. They also showed us their robot design process and what to pay attention to. Overall, it was a very successful first visit. Since last year, we've visited them a few more times. They've helped us with problems, whether mechanical or software-related. In return, we assisted them with some PR tasks during our visits. Once our robots are

functional, we often invite each other to play practice matches, which are beneficial for getting used to real matches in league meetings. This collaboration has been very beneficial for both our team and the Stanislas teams.

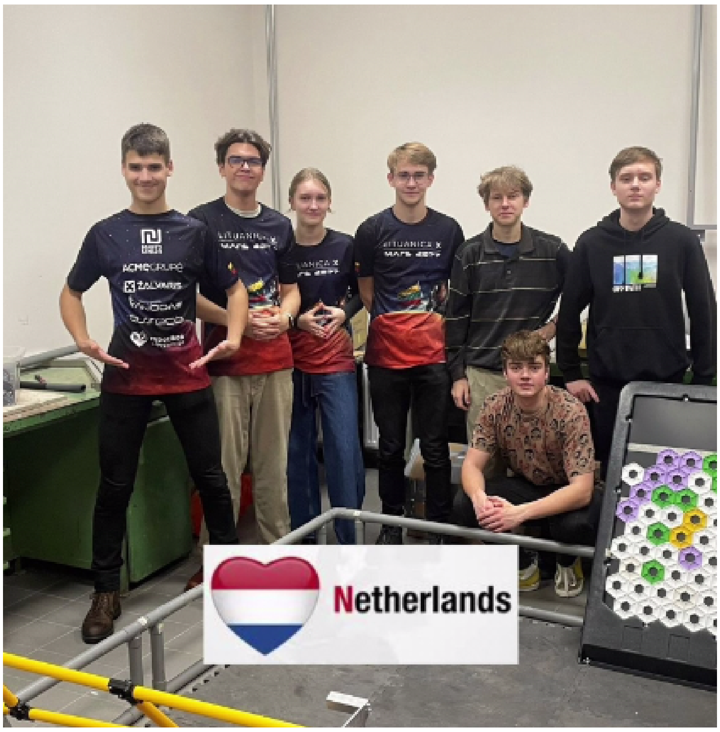
During our second league meet last season, we performed well, but unfortunately, one of our motors broke and burned out. Fortunately, the Stanislas teams were kind enough to lend us another one. Coincidentally, at the same league meet, Stanislas Tech Academy had a malfunctioning mecanum wheel. We stepped in and provided them with a working mecanum wheel for the rest of the season. This incident strengthened our bond with the Stanislas teams, and since then, we've consistently supported each other, whether it's a hardware, software, or PR question.

Lituanica X
At the beginning of the season, we successfully bought an official FTC field, complete with this year's field elements. We were able to make this big purchase because we explained to our school's parent association the advantages of having an official field. This includes the ability to showcase, during open days and information evenings, how an FTC competition looks in real life to both parents and children. Of course, it also greatly benefits our team, as we now have a full field for practice sessions. Upon hearing about these benefits, the parent association approved our request to get the field from their budget.

This purchase left our old self-made field unused. Rather than discarding it, our team coach suggested offering it to another FTC team. Our Team Captain reached out on the FTC Benelux Slack, asking if any team needed it and requesting them to send us an email if interested. The following day, we received an email from the team coach of FTC team Lituanica X (22042), expressing their interest in using our field for all FTC teams in Lithuania. Initially, we planned to hand over the field at a League Meet, but considering their mode of transportation (by plane), this wasn't feasible. Instead of going the easy way by donating the field to a Dutch team, we decided to send it to them via UPS Shipment, covering the shipping costs as well. By doing this, we have made a big difference in the development of interest in robotics and the First Tech Challenge in Lithuania.

Our old field

Our new field



Lituanica X with
our old field

M-Mais

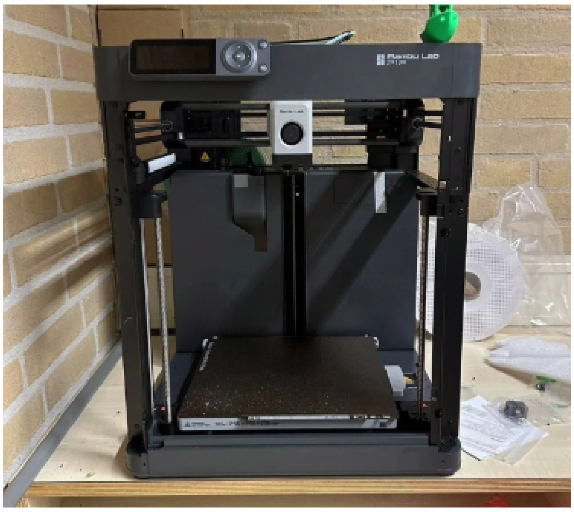
At the beginning of this season, we started helping the second FTC team at our school M-mais. They are rookies this year, as we were last and so we had lots of advice to give to them and help them with designing, building and programming their robot. Our teams keep a close bond and help each other out when needed. We lend them materials, tools and a sponsor budget. We also try to coordinate all of our trips so that our teams can go together.

Sponsors

This year, unlike last year, we did not send as many emails. The main reason for this change in tactics is that we had already made all the important purchases last season. We also had €700 left from last year. The only things we didn't have were a 3D printer and electric tools. Our sponsorship goal for this season was to get them sponsored. Since we maintained good contact with our tool sponsor (HBM Machines) from the previous season, getting sponsorship for electric tools was quickly arranged. For the 3D printer, we visited Endenburg, another sponsor from last season. We were given a tour of the building, and they explained what Endenburg does. They also showed us how they use their 3D printer and allowed us to see an apartment complex they had designed through Virtual Reality.

Group picture at Endenburg


Looking at their design through Virtual Reality


Our sponsored 3D printer

Our sponsored HBM Powerkit

endenburg

HBM Machines

Log

(Digitally available)

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