TECH BINDER

ROBO'LYON
The FIRST French Team

CONTENTS

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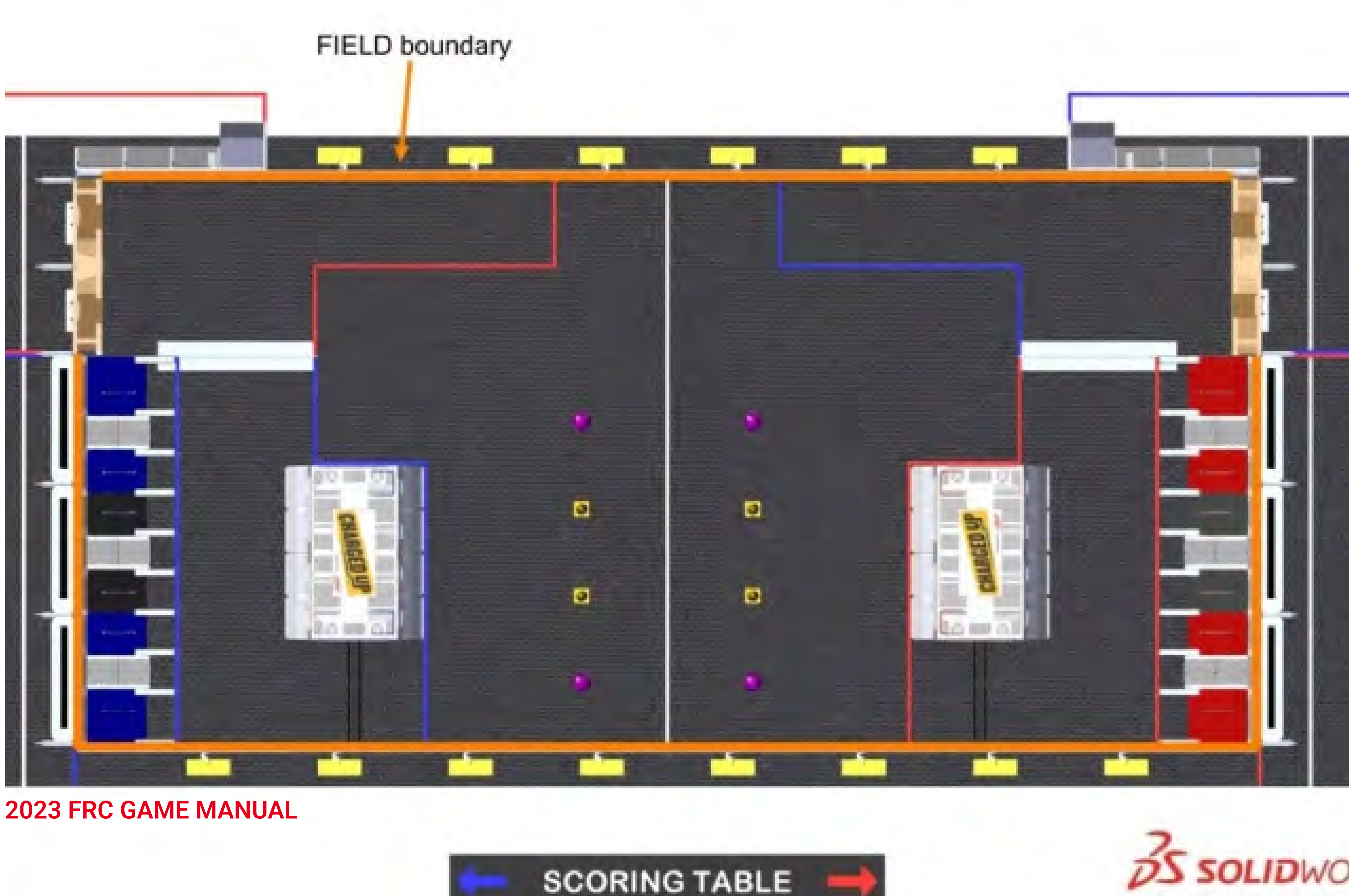
01.

GAME

CHARGED UP

This season, each alliance has to bring energy to its community by dropping game pieces (cones and cubes) into the grid in the alliance's community zone. Cones and cubes can be retrieved from the field or from the sub-stations assigned to each alliance. At the end of the match, robots can dock (or engage) their charge station to earn additional points.

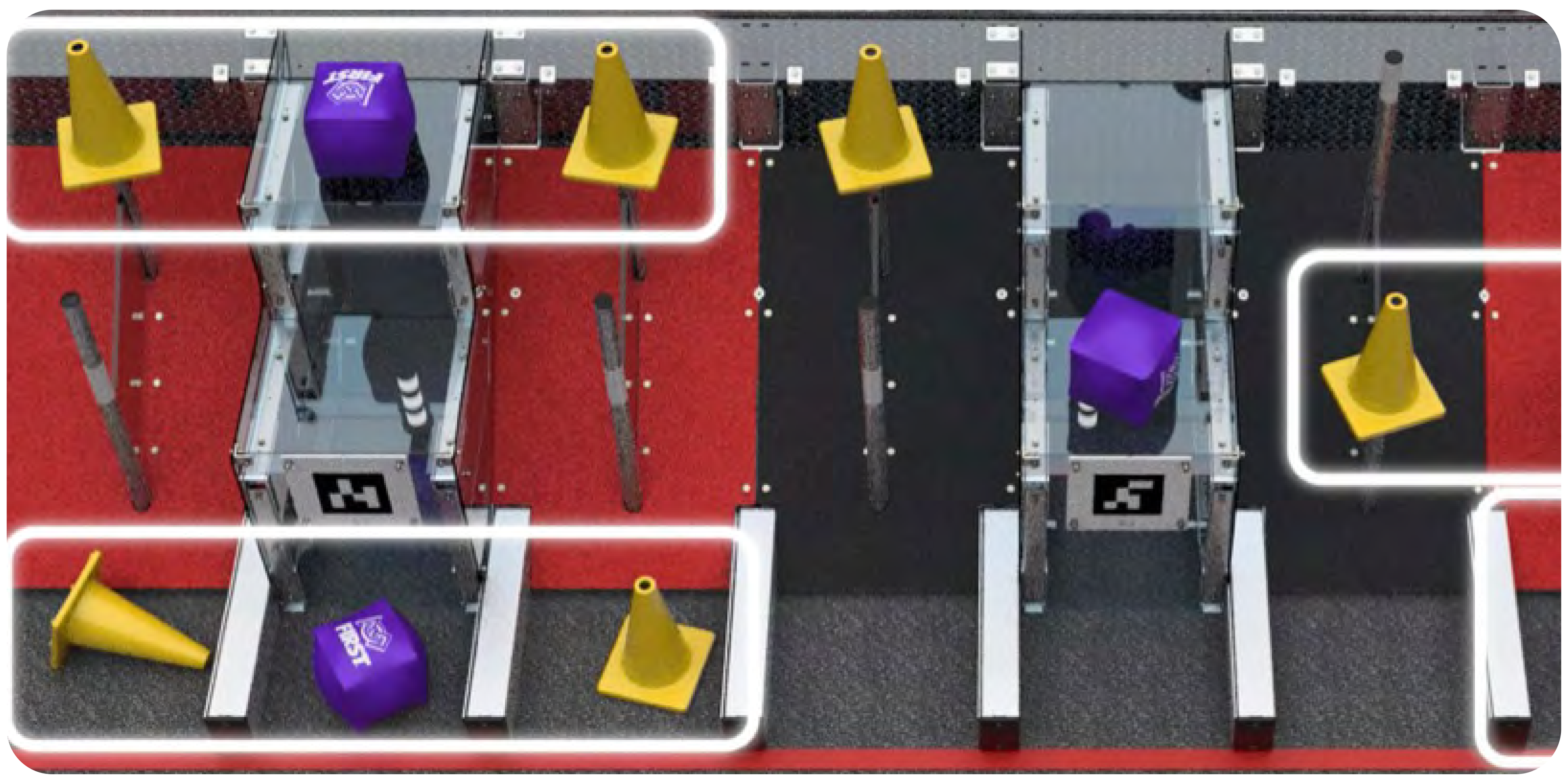
One match lasts 2:30. The first 15 seconds are called the Autonomous Period (AUTO) when robots operate without any input from the Drive Team. The remaining 2:15 are called the Teleoperated Period (TELEOP). During this time, Drivers operate robots remotely.



2023 FRC GAME MANUAL

POINTS

Robot leaves completely its community	3
Game piece **SCORED** on a **BOTTOM** row	3
Game piece **SCORED** on a **MIDDLE** row	4
Game piece **SCORED** on a **TOP** row	6
One robot **DOCKED** and not engaged	8
One robot **DOCKED** and **ENGAGED**	12


2023 FRC GAME MANUAL

POINTS DURING AUTO

Game piece **SCORED** on a **BOTTOM** row	2
Game piece **SCORED** on a **MIDDLE** row	3
Game piece **SCORED** on a **TOP** row	5
LINK: game pieces scored on 3 adjacent nodes in a row	5
Each robot **DOCKED** and not engaged	6
Each robot **DOCKED** and **ENGAGED**	10
Each robot **PARKED** (completely contained within its community but not docked)	2

POINTS DURING TELEOP

SUSTAINABILITY BONUS: at least 5 links scored	1 RP
ACTIVATION BONUS: at least 26 charged station points earned	1 RP
TIE	1 RP
WIN	2 RP

RANKING POINTS (RP)

COOPERTITION BONUS: If at least 3 game pieces are scored on each alliance's co-op grid, both alliances only need to score 4 links to activate the SUSTAINABILITY BONUS.

ACTIONS & CYCLES

	Scoring cube picked from ground on bottom row	Scoring cube picked from ground on middle row	Scoring cube picked from ground on top row	Scoring cube picked from sub-station on bottom row	Scoring cube picked from sub-station on middle row	Scoring cube picked from sub-station on top row	Scoring cone picked from ground on bottom row	Scoring cone picked from ground on middle row	Scoring cone picked from ground on top row	Scoring cone picked from sub-station on bottom row	Scoring cone picked from sub-station on middle row	Scoring cone picked from sub-station on top row	Engaging charge station in AUTO	Engaging charge station during End Game
Moving (forward/backward/left/right)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Adjusting robot's position	X	X	X	X	X	X	X							
Climbing on the charge station													X	X
Balancing on the charge station													X	X
Descending from the charge station													X	
Picking a cube from the sub-station				X	X	X								
Picking a cube from the ground	X	X	X											
Picking a cone from the sub-station										X	X	X		
Picking a cone from the ground							X	X	X					
Straightening a cone up							X	X	X	X	X	X		
Dropping a cube on bottom row	X			X										
Dropping a cube on middle row		X			X									
Dropping a cube on top row			X			X								
Dropping a cone on bottom row							X			X				
Dropping a cone on middle row								X			X			
Dropping a cone on top row									X			X		

GAME

STRATEGY

To maximize ranking points in qualification matches, we must do the following:

- **SUSTAINABILITY BONUS** If the coopertition bonus is activated the ranking point linked to the sustainability bonus becomes much easier to obtain as this drops the number of game pieces to place by three and thus the number of cycles by three.

- **ACTIVATION BONUS** Scoring charge station points can be done during the autonomous period. Having a robot docked or engaged during the autonomous period brings the ranking point threshold to 18 or 14. This means that there only needs to be two robots docked and engaged on the charge station during end game, since each docked and engaged robot brings 10 points. Making sure our robot can dock during the autonomous period is a must. If we do not manage to do so, we will need two more robots during the endgame and we must have a slim robot to enable other robots to dock and engage with us on the charge station.

STRATEGY

To maximize points earned during matches, we need to optimize our way of interacting with the charge station and our way of scoring game pieces.

It is imperative to enable two other teams to dock and engage on the charge station during endgame. This means our robot has to be as slim as possible.

Since links increase the number of points significantly, it is crucial to minimize cycle time to get these game pieces. Most of the links need a combination of cubes and cones. This means our robot must be able to score cones as well as cubes reliably.

Defense will also be something to watch out for. This will happen during the cycles between the grid and the charging station on opposite sides of the field. Our strategy is to be powerful and heavy enough to protect ourselves against defending robots.

This analysis leads us to our Subsystem Strategy:

General:

1. Fast and heavy robot to minimize cycle time without being bothered by defense.
2. Precision and versatility to minimize scoring time.
3. Low center of gravity to prevent tipping during high acceleration maneuvers and collisions but also when docking and engaging on the charge station.

(See following pages for our strategies regarding each mechanism)

GAME

1. PROTOTYPING
2. MATERIALS

02. DESIGN

PROTO TYPING

When designing and building a robot, we work in an iterative way. We start by conceiving possible versions of mechanisms in CAD. Then, we build prototypes made of MDF or plywood to test the feasibility and efficiency of our ideas. After the testing phase we go back to CAD to improve our mechanisms. This back and forth process continues until we are totally satisfied with our robot's efficiency.

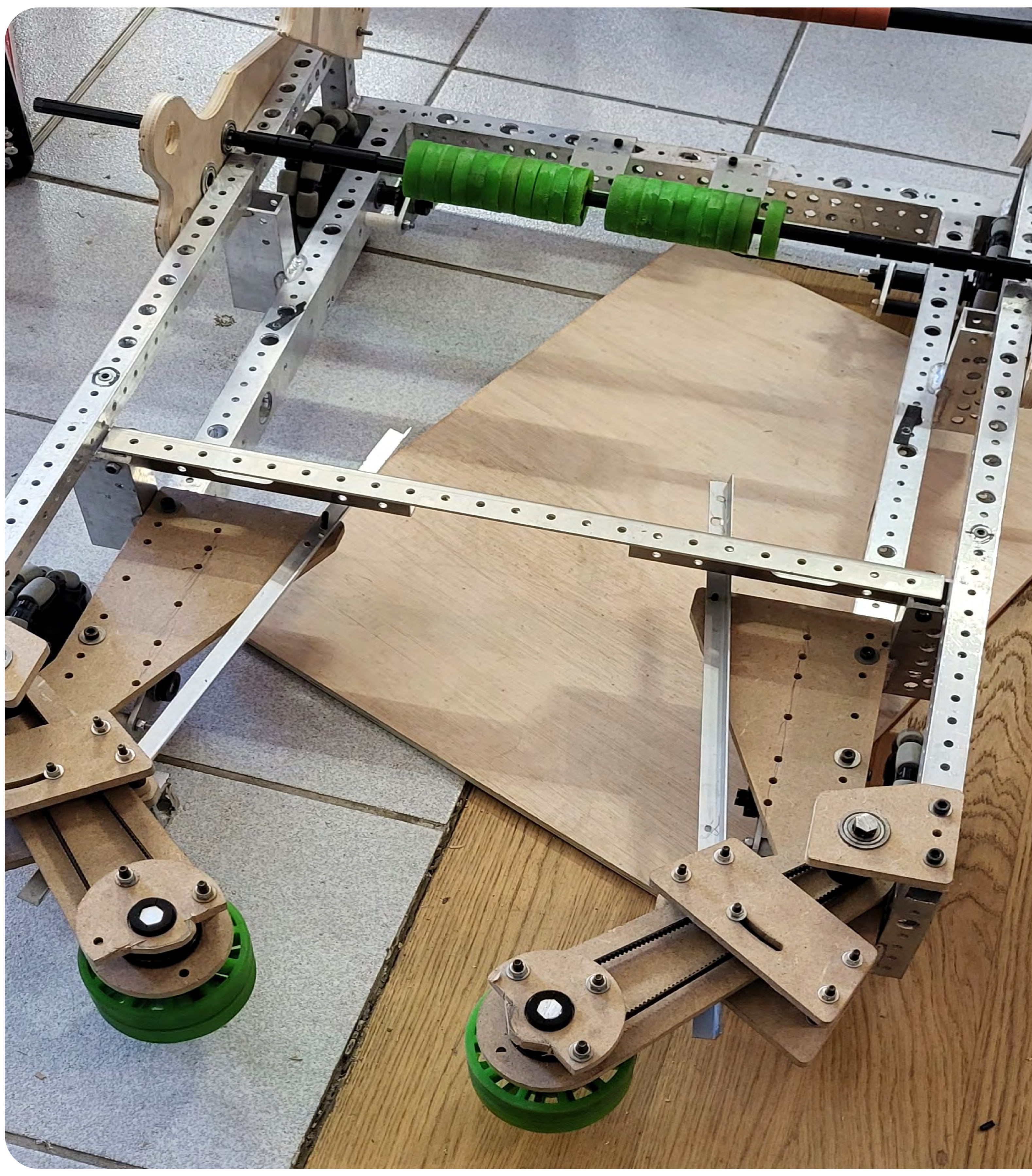
We use a **CNC** (Computer Numerical Control) to machine MDF and plywood ourselves for our prototypes. We also use it to machine some parts of our final mechanisms out of PTFE.

We also own a **3D printer** to make small elements for the robot, like struts.

DESIGN

MATERIALS

MDF : Medium-density fibreboard is principally made of wood fibres. We can machine it ourselves using our CNC. Machining MDF is easier than plywood but it is less sturdy. We do not use it to build the final robot but it is very convenient to use on prototypes.



PLYWOOD : Plywood is composed of thin layers of wood. It does not break easily so we use it on prototypes that need to be very sturdy. We can machine it with our CNC but it is more difficult than MDF. It often ends up wrapped or the CNC can’t manage to pierce it completely. We don’t use it to build the final robot either.

PTFE : Polytetrafluoroethylene is a synthetic material with lots of properties. It is light and sturdy (almost as sturdy as aluminum) and bends before breaking. It is smooth which can be very interesting. We can also machine it using our CNC. It means we can build some pieces used on the final robot ourselves without any help from a partner.

ALUMINUM : It is the main material used on the final robot. We use it for plates and folded sheets. It is less sturdy than steel but lighter. We also need help from our sponsors to machine it.

STEEL : It is the sturdiest material we get to use on the final robot but it is also the heaviest. We only use it on parts that need to be very sturdy (e.g. the gears used in our 3 Falcon motors gearboxes). We can't machine it and need help from our sponsors.

ROBO'LYON
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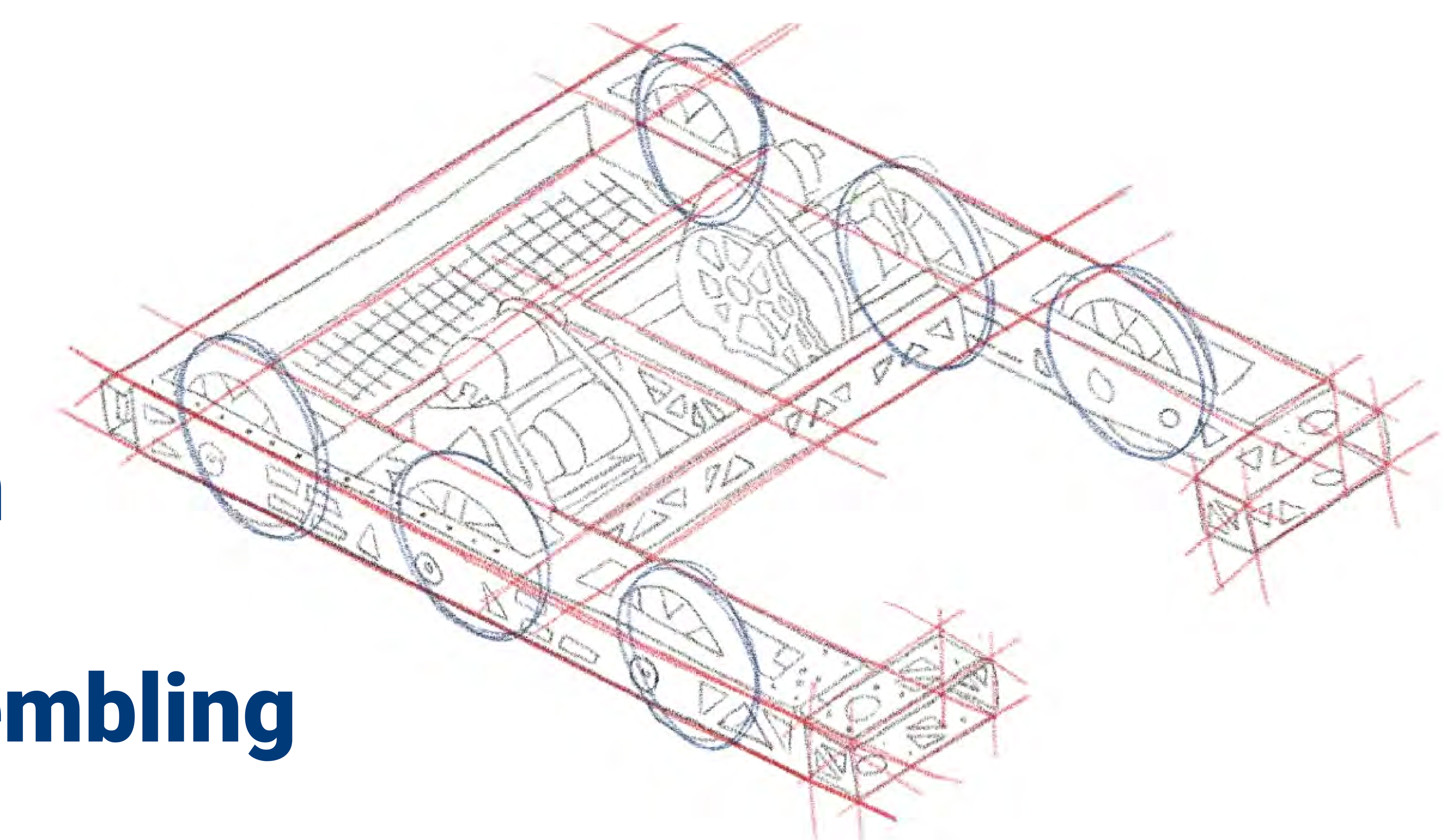
1. DRIVETRAIN
2. INTAKE
3. TURRET
4. ELEVATOR
5. GRIPPER
6. ARM

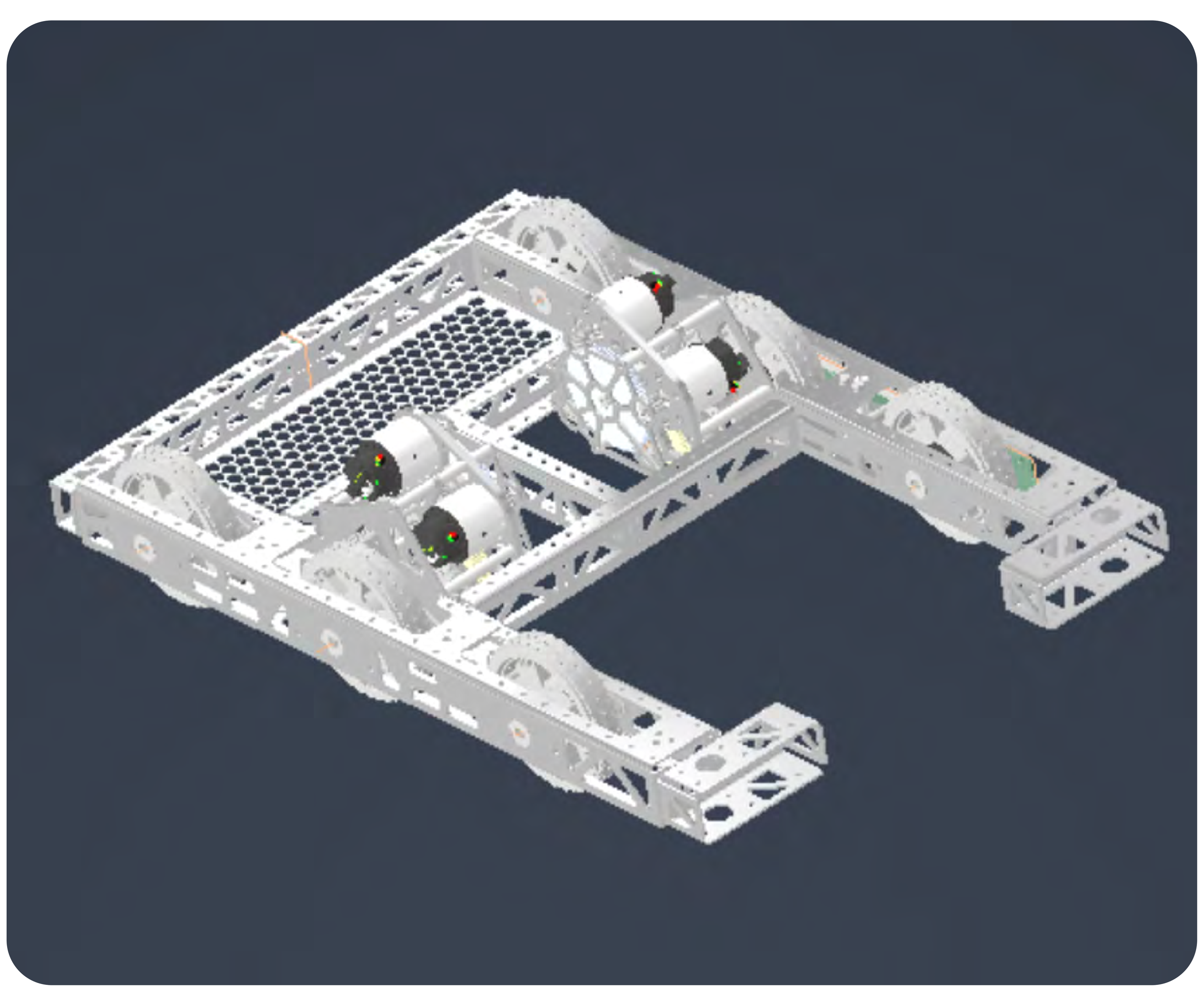
03. MECHANISMS

DRIVETRAIN



GOALS

- Powerful and sturdy drivetrain
- Fast movements
- Quick assembling and disassembling



FEATURES

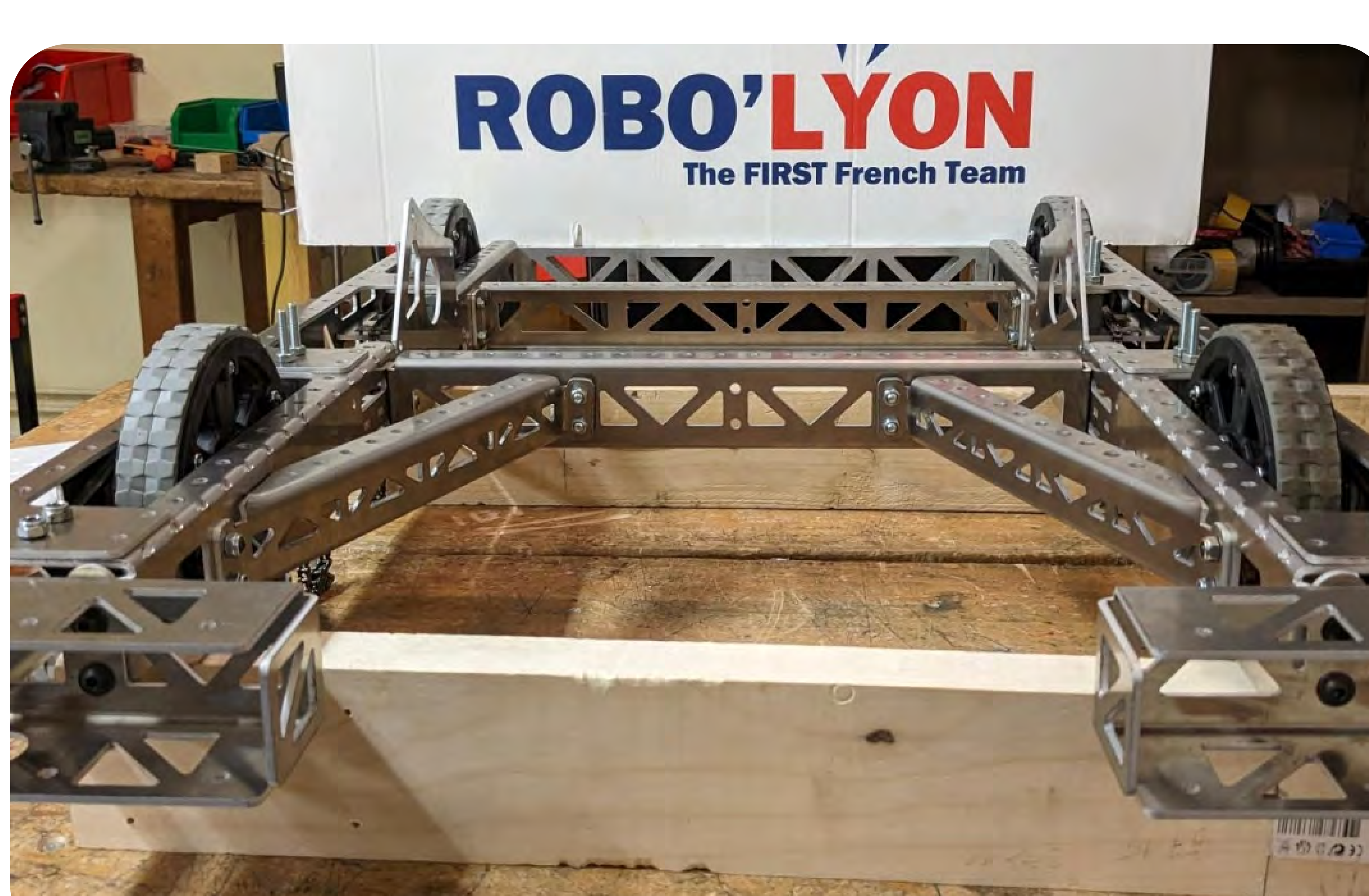
- Use of folded sheet metal instead of welded tubes
- Gearboxes: 3 Falcon motors per box
- Reduction of 12.6:1 in low gear
- Reduction of 8:1 in high gear

BENEFITS

Important torque and speed allow the robot to cross the field very quickly.

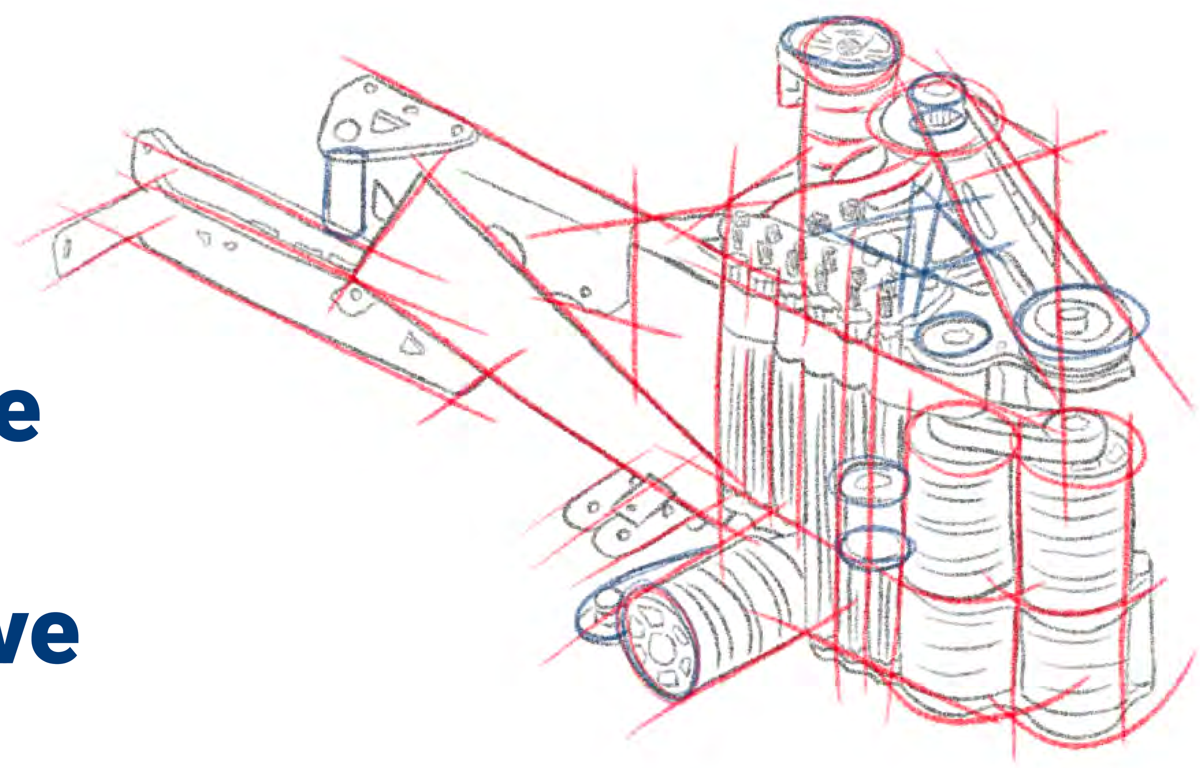
DRAWBACKS

Less maneuverability than a swerve drivetrain.



INTAKE

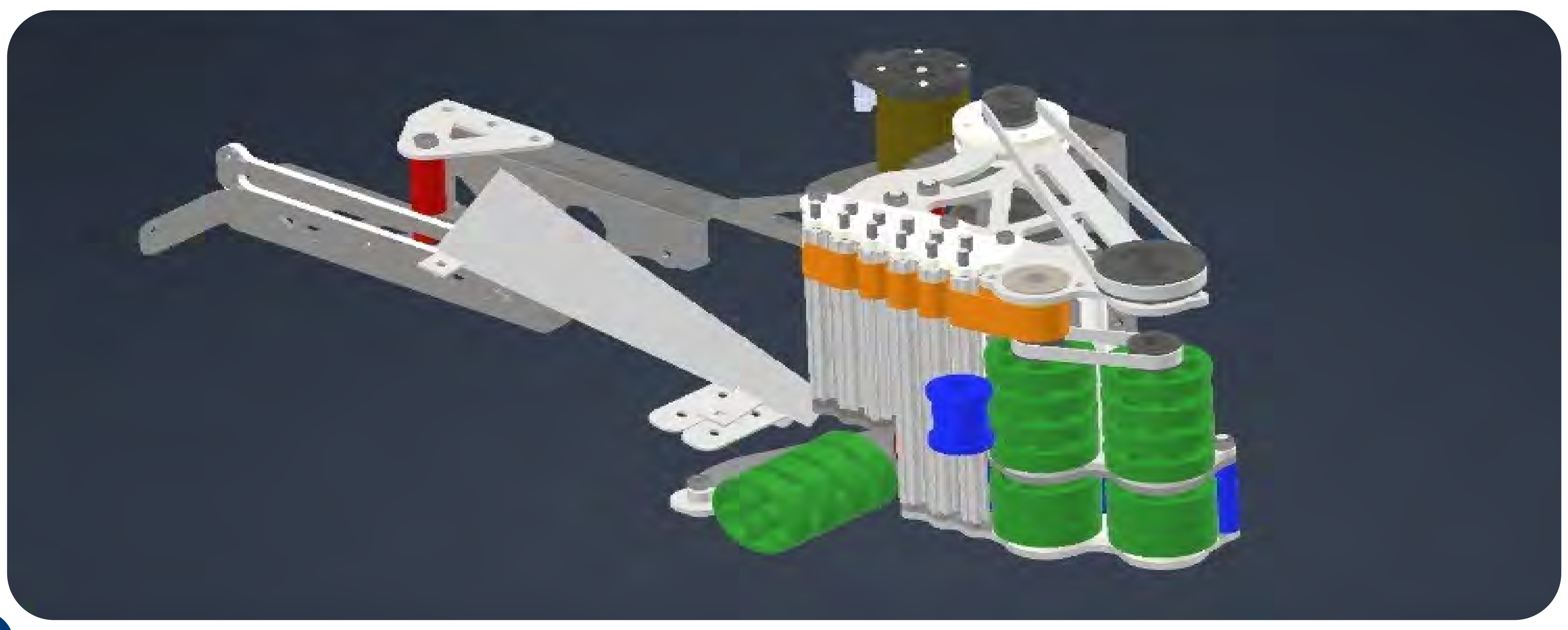
GOALS



- Bringing cones and cubes inside the robot when the mechanism touches a game piece regardless of position.
- Vertical axes so that the gripper can retrieve the object.

FEATURES

- 2 motors 775 pro with a reduction of 10
- 2 jacks with a 100mm stroke

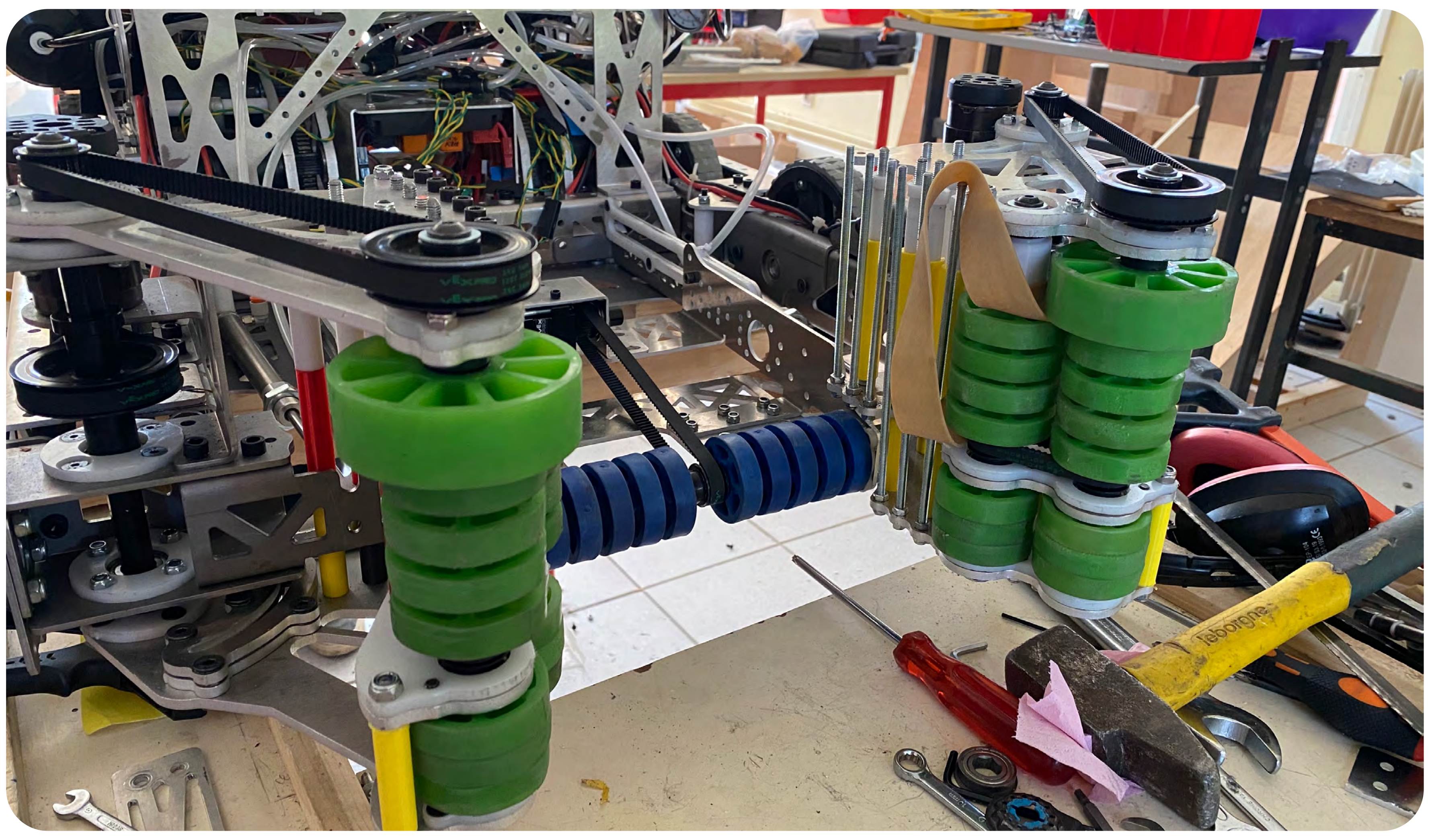


BENEFITS

Does not take much space on the robot and allows us to pick up the different objects no matter their position.

DRAWBACKS

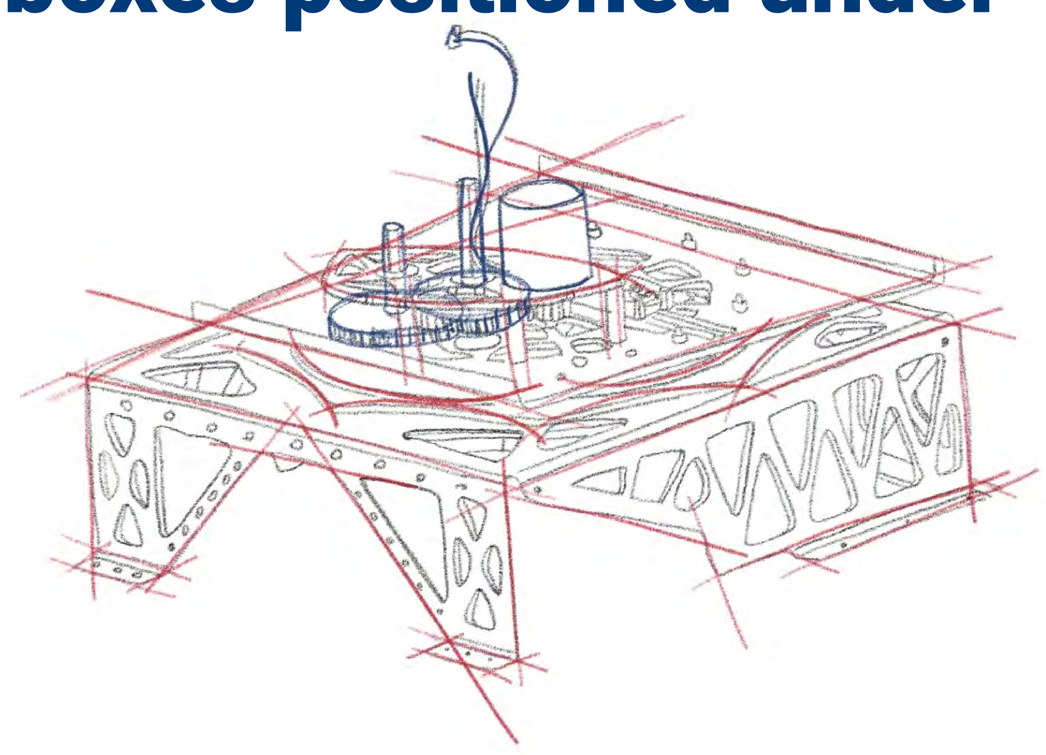
Mechanism with many parts that is therefore difficult to assemble and disassemble and is very heavy.



TURRET

GOALS

- Supporting the robot's upper part – elevator and gripper – and making it turn 360 degrees.
- Keeping an easy access to the gearboxes positioned under the turret.



FEATURES

Fixed part:

- Attached to the drivetrain
- Folded sheet metal structure supporting everything
- Support plate for bearings guiding rotation
- PTFE gear – 54 teeth module 5 millimeters

Movable part:

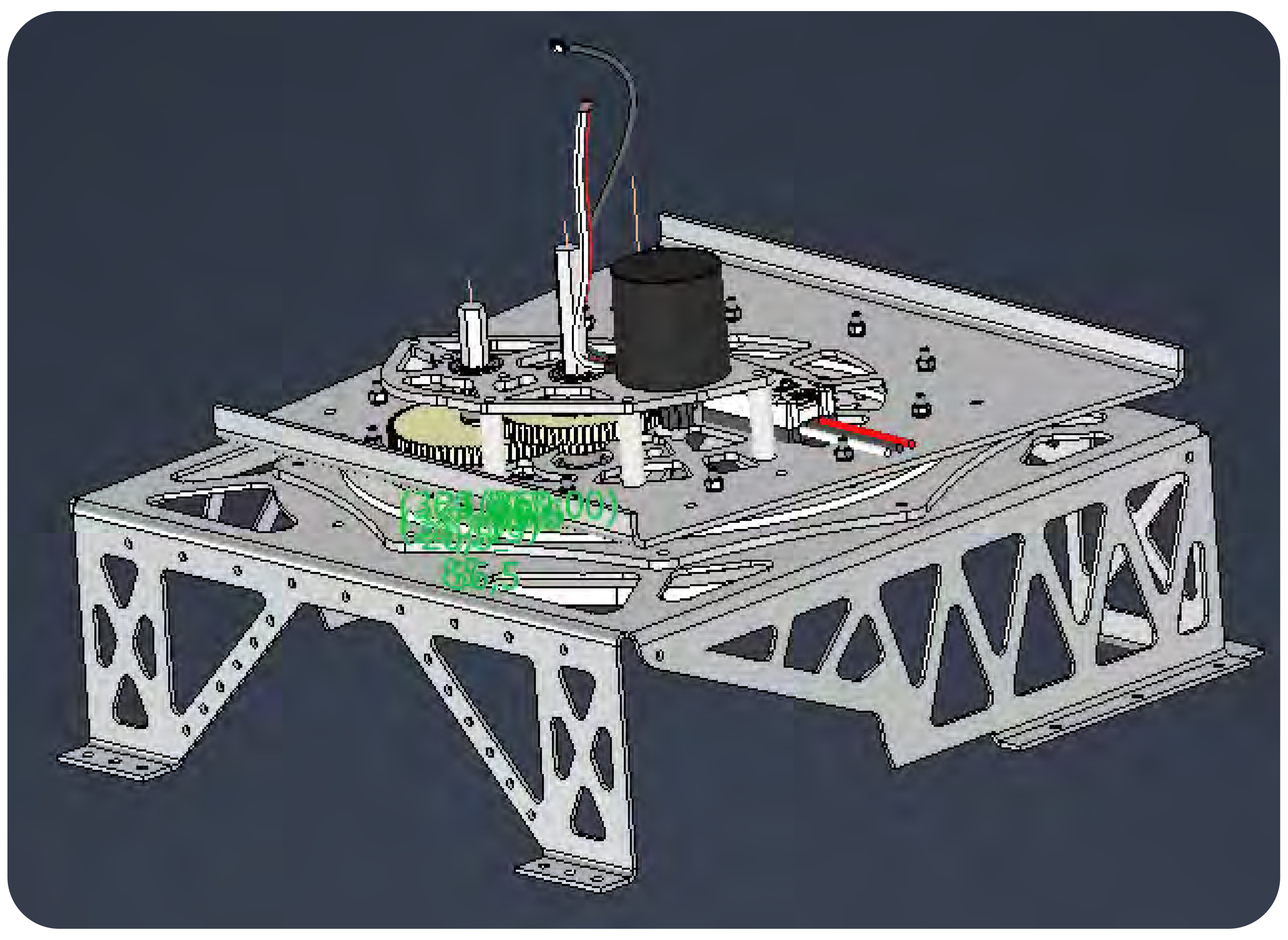
- NEO motor gearbox: reduction of 95
- PTFE cogwheel – 14 teeth module 5 millimeters
- Bearings guiding the motion
- Plate linking the turret with the elevator

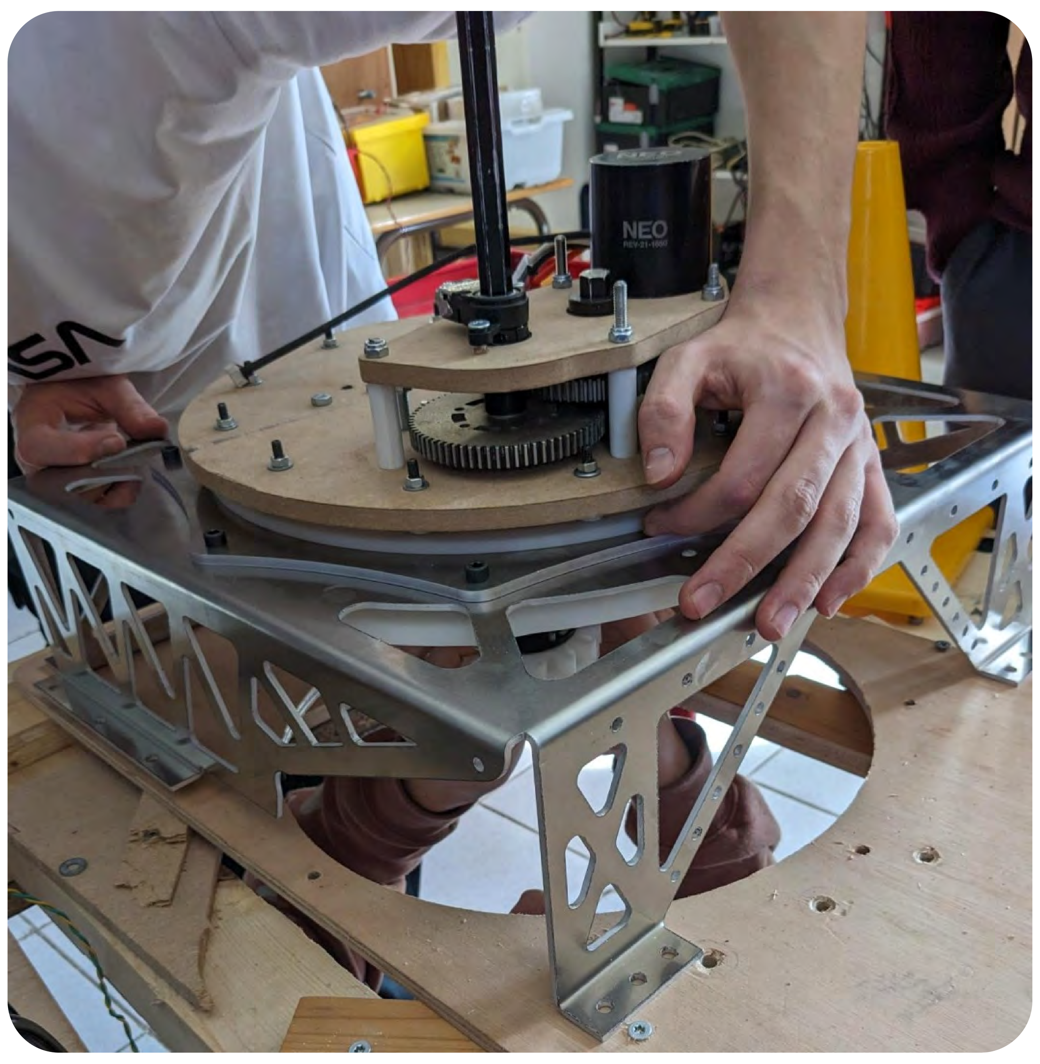
BENEFITS

Robot can set game pieces 360 degree round.

DRAWBACKS

Can make the robot fall over if the turret is moving too quickly.



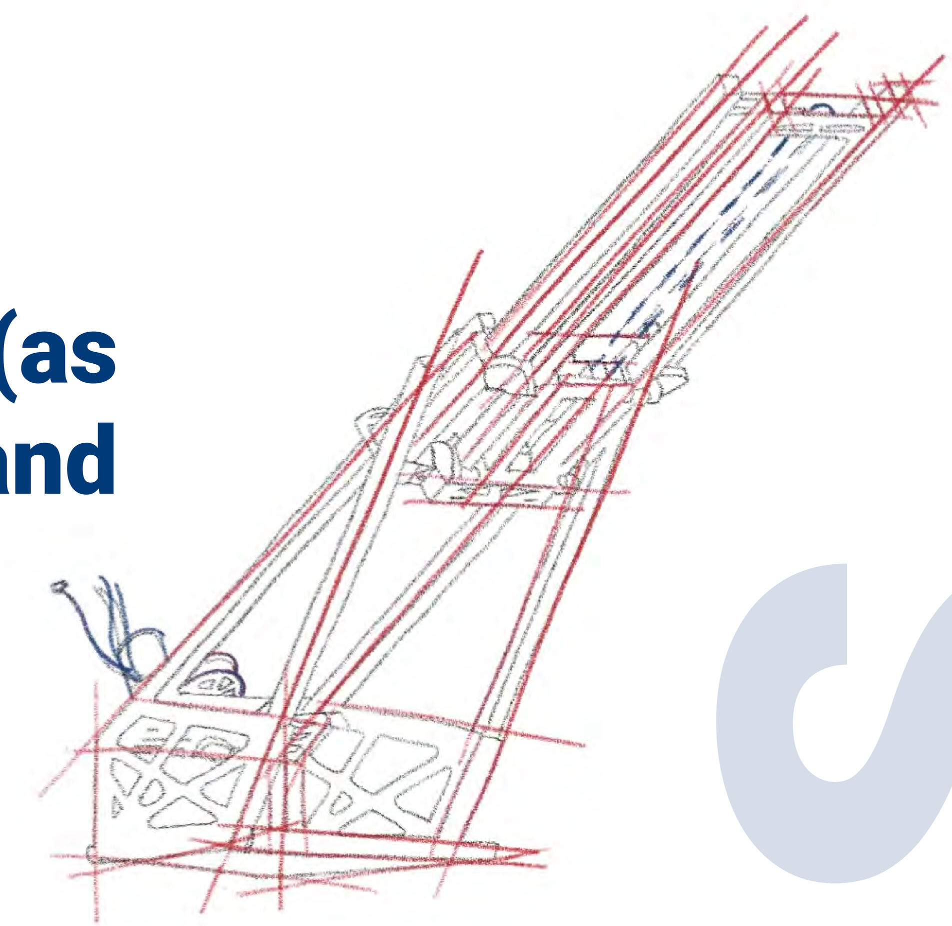


MECHANISMS

ELEVATOR

MECHANISMS

GOALS



- Allowing the gripper to move up and down (as well as forward) to pick up game pieces and set them down in the grid no matter the row.

FEATURES

- “Diagonal” elevator to be able to move up and forward at the same time
- NEO motor gearbox: reduction of 12
- Extension with waterfall effect with a chain linked to the first level and a cable to bring it up

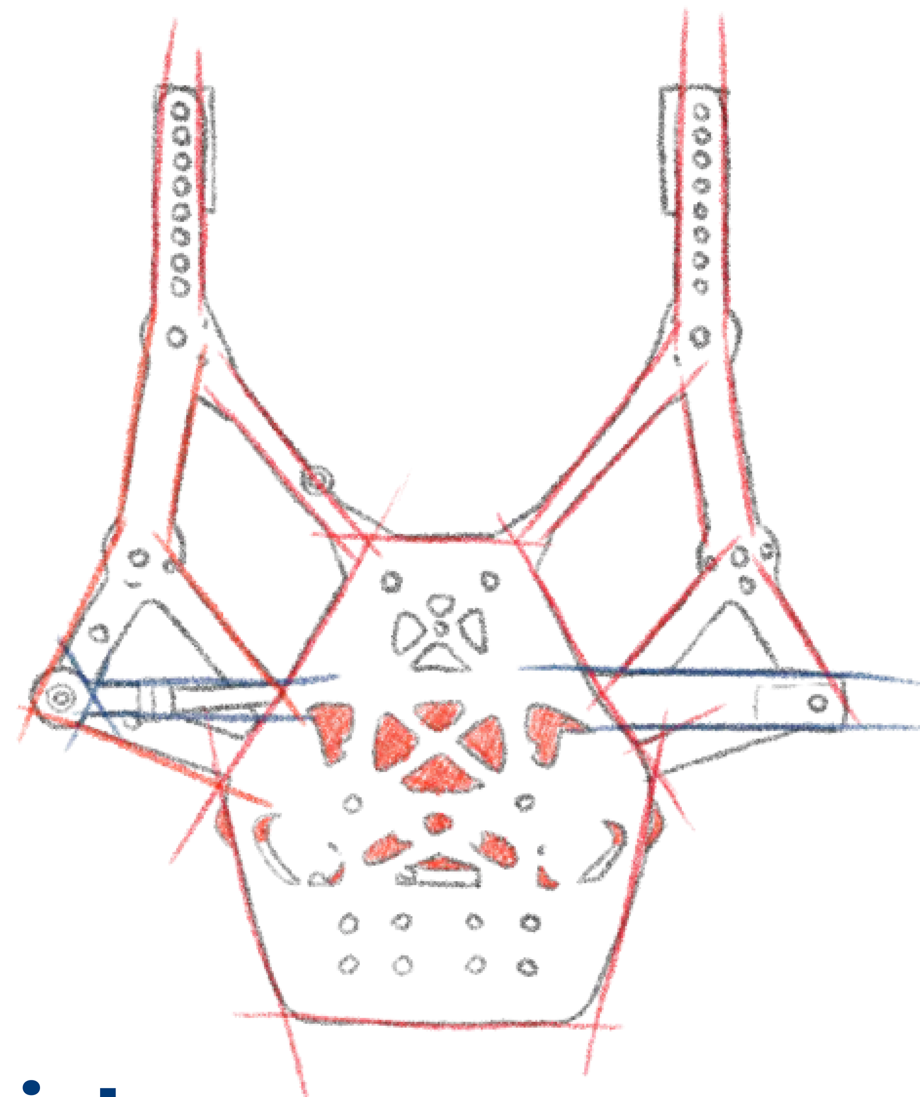
BENEFITS

The waterfall effect allows the weight and the current needed to be evenly distributed.

DRAWBACKS

Both levels of the elevator need to move simultaneously.

GRIPPER



GOALS

Catching game pieces stocked in the robot or on the field.

FEATURES

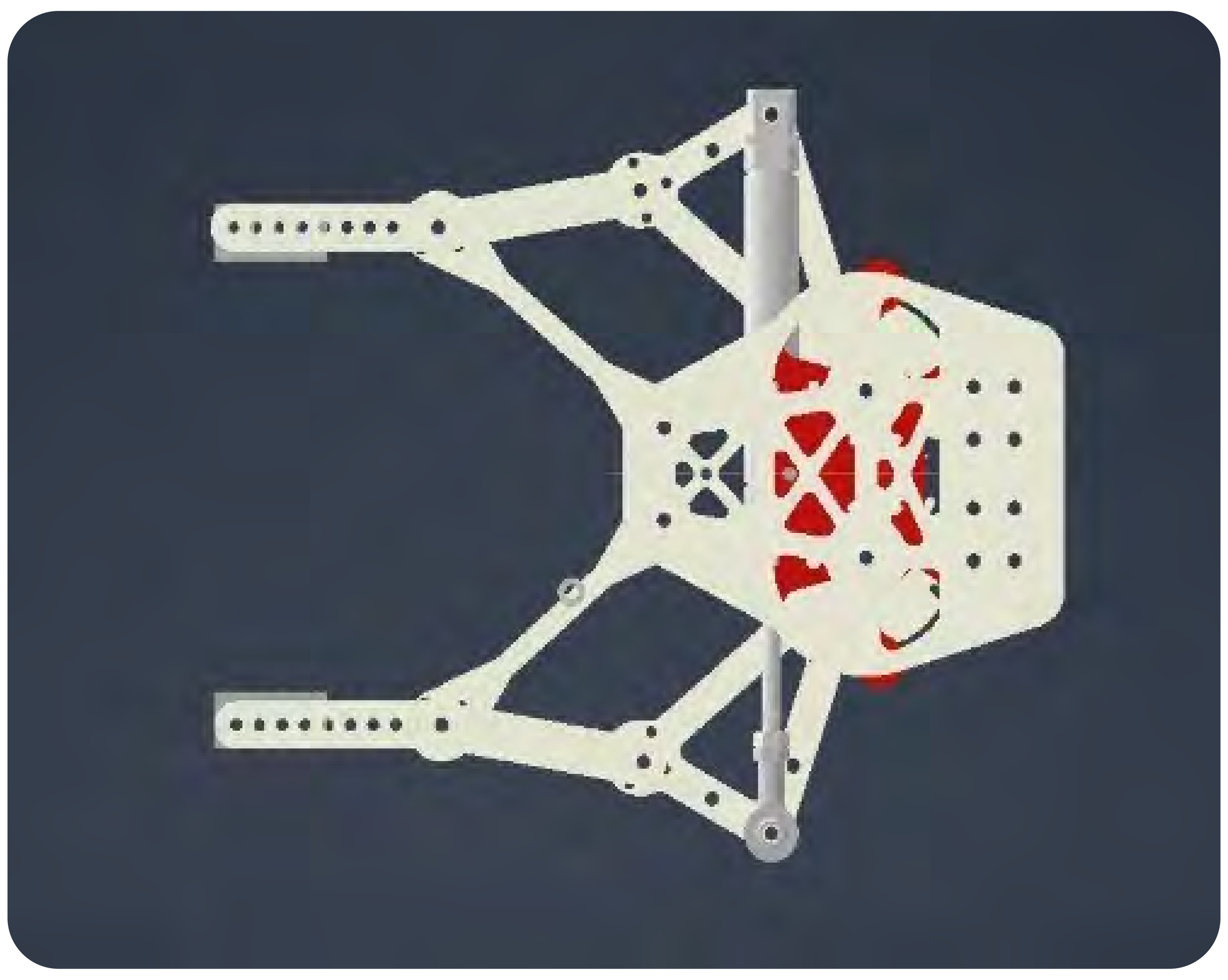
A jack with a 100mm stroke and a piston diameter of 16mm with just two unique positions: open and closed.

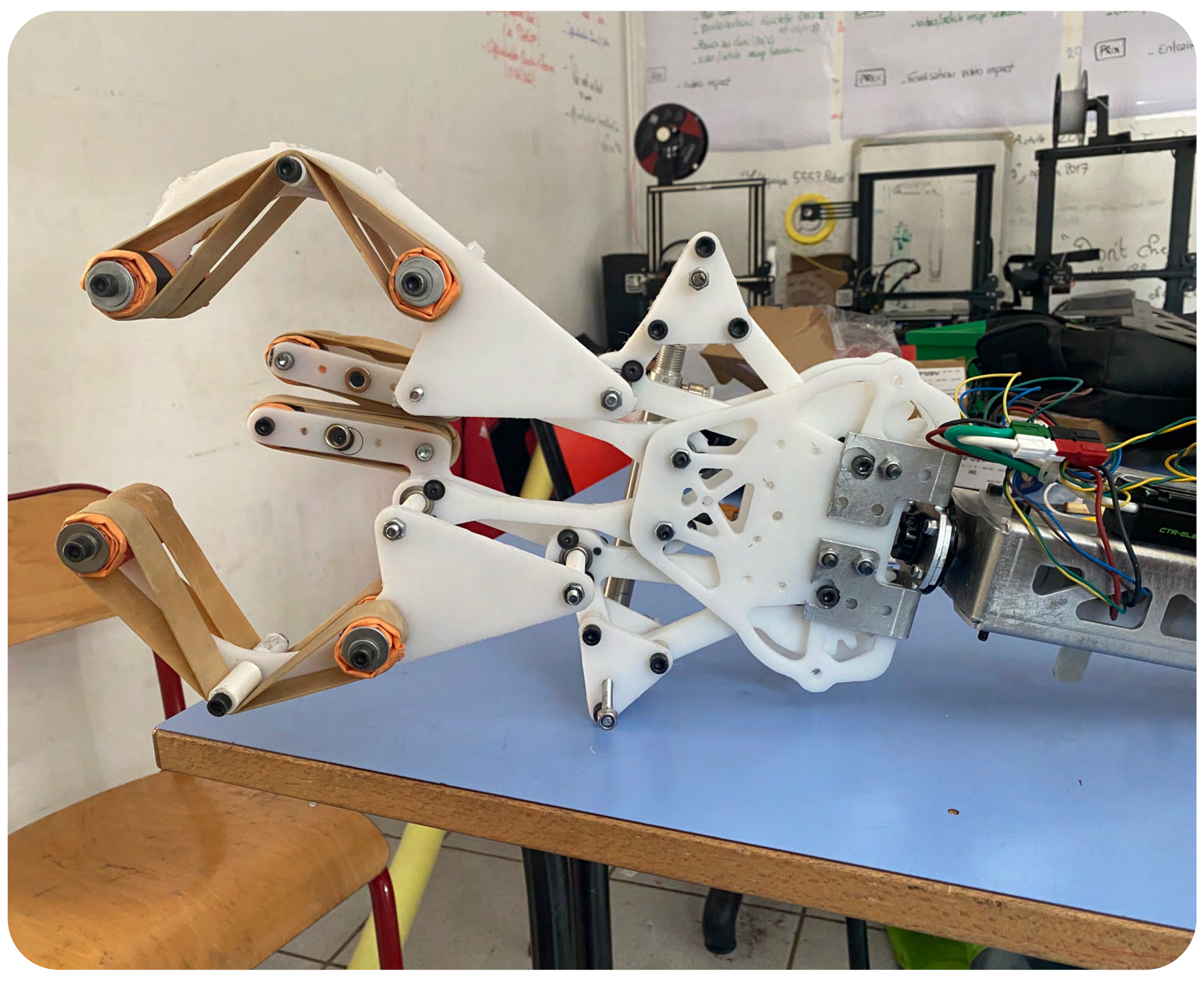
BENEFITS

System that allows the gripper to move forward and close at the same time, and allows us to catch the object even from a distance.

DRAWBACKS

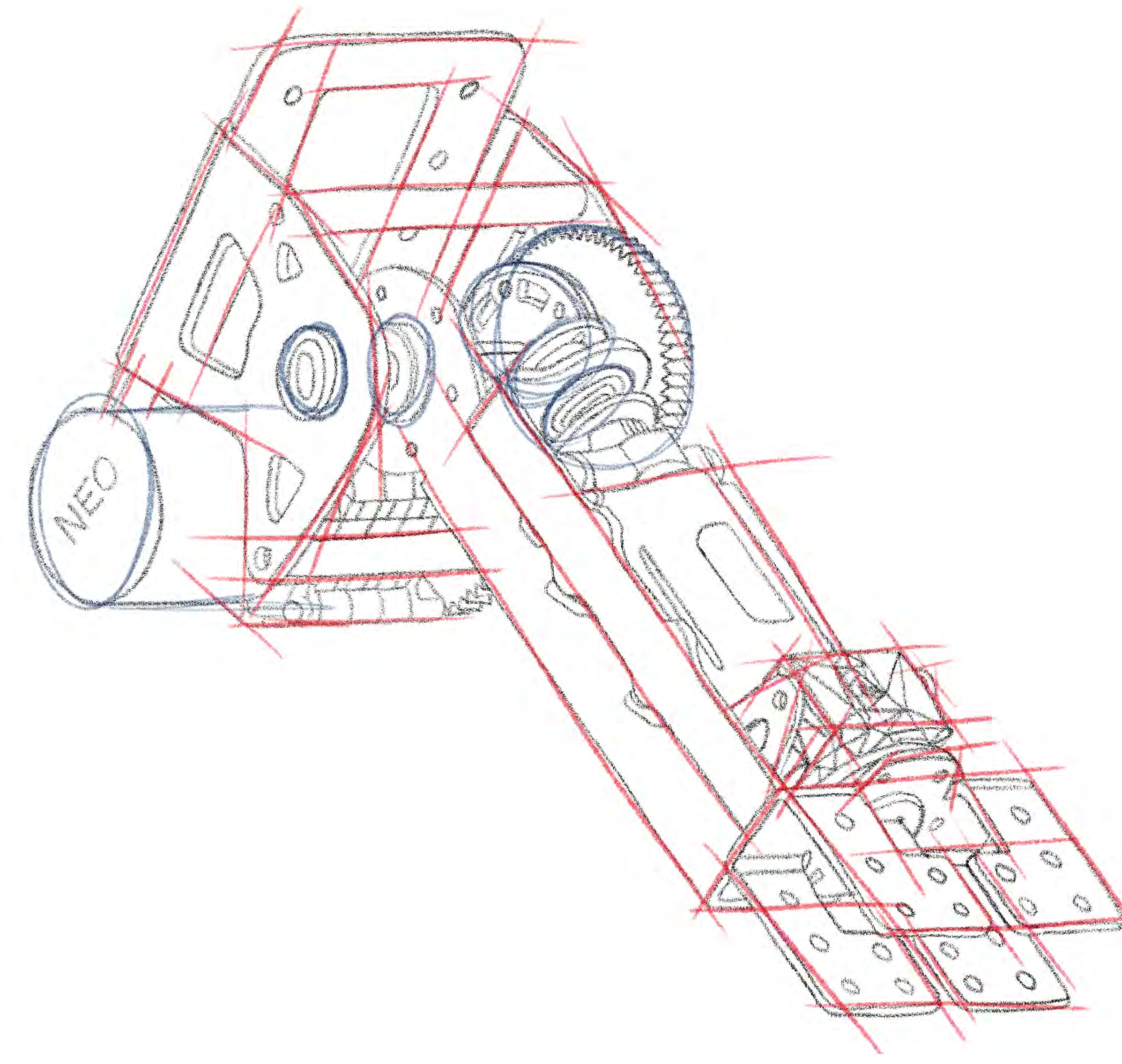
It was difficult to decide how and where we should place the jack because it takes up space and it needs to be firmly hooked. We opted to fix it towards the end of the clamp, to optimize the space it takes, even if it weighs down the jack.





MECHANISMS

ARM



GOALS

Linking the elevator to the gripper.

FEATURES

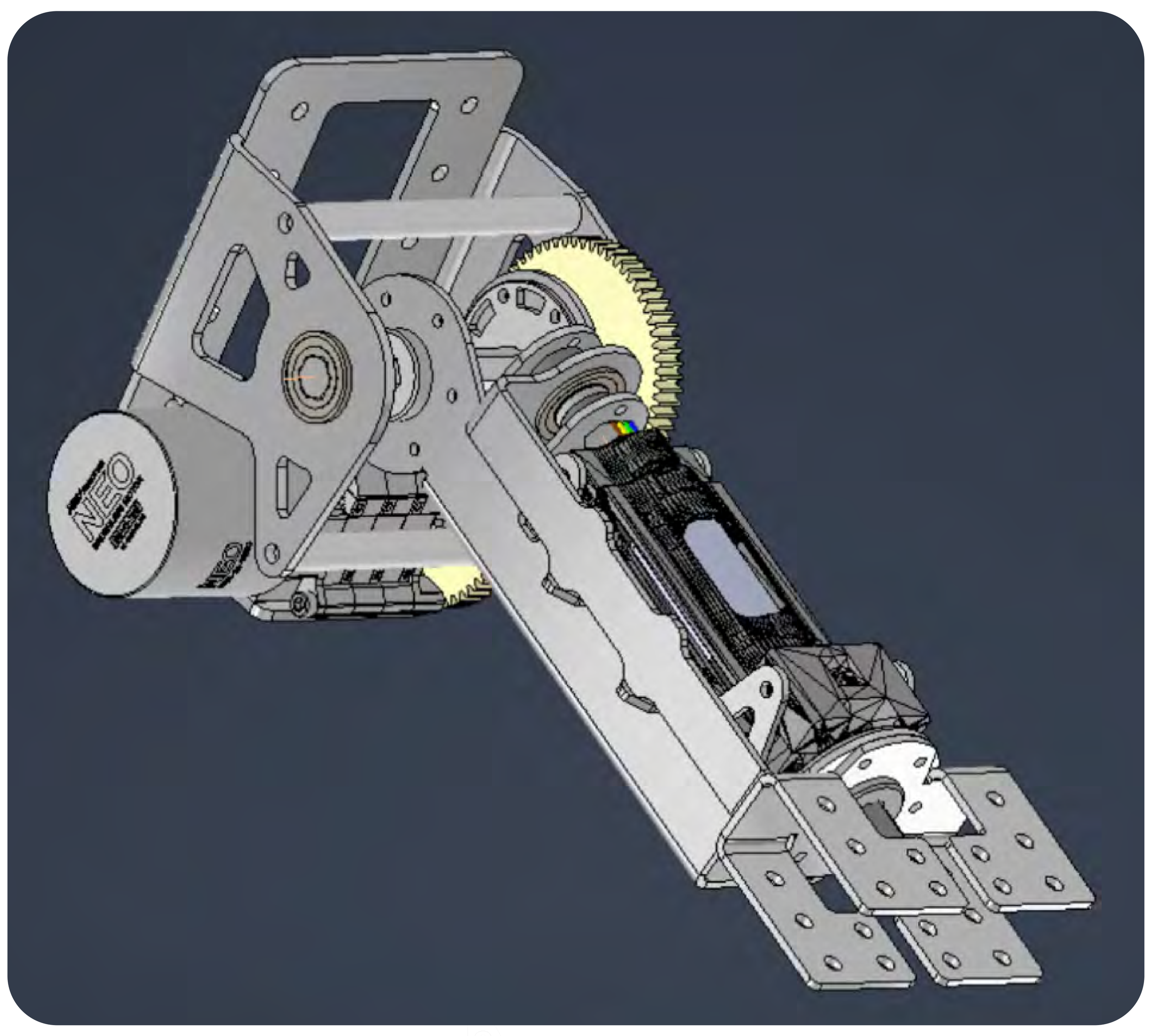
3 hinges akin to a shoulder, an elbow and a wrist

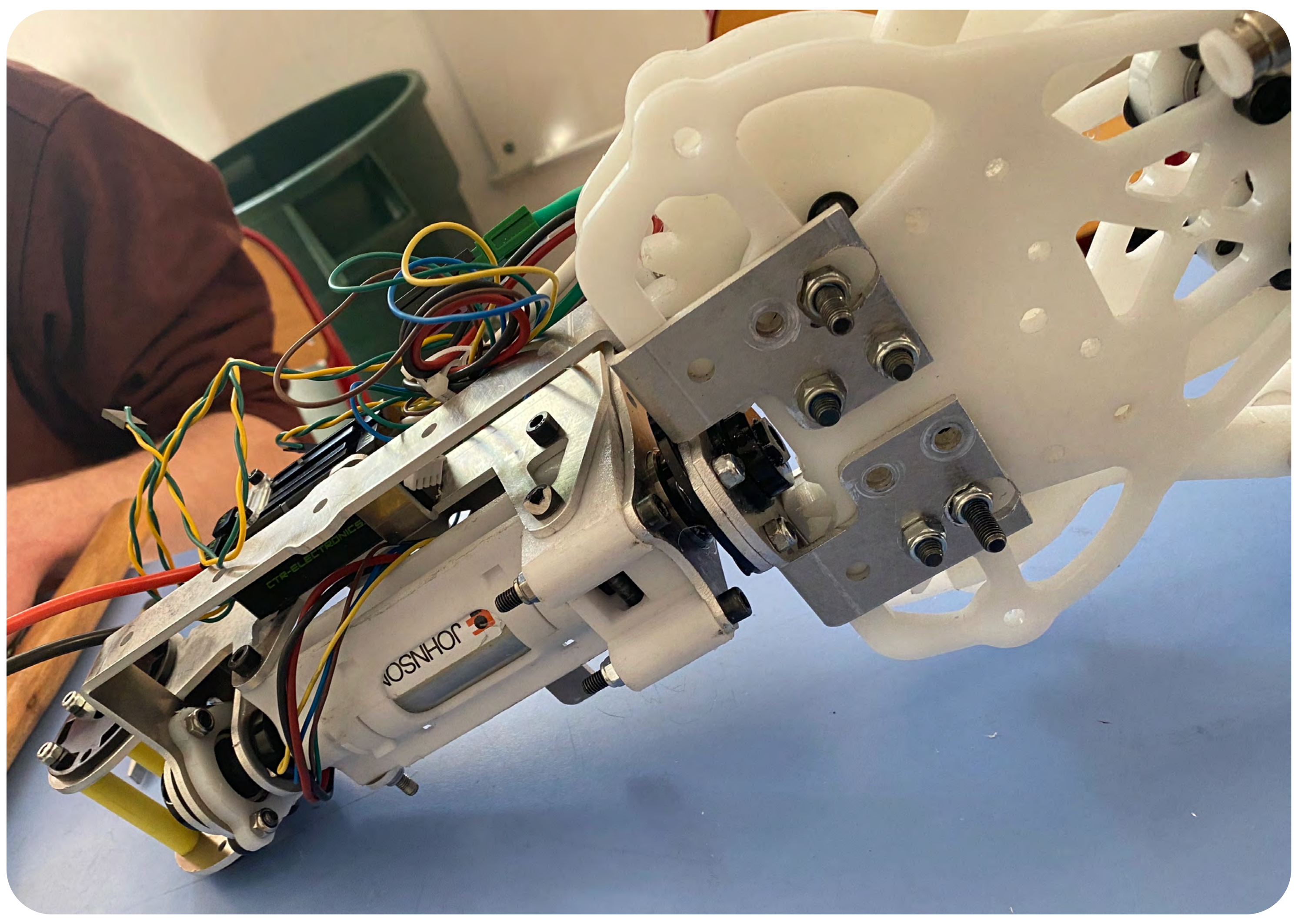
BENEFITS

High mobility and straight to the point design.

DRAWBACKS

The arm has to fit the elevator and gripper perfectly.





MECHANISMS

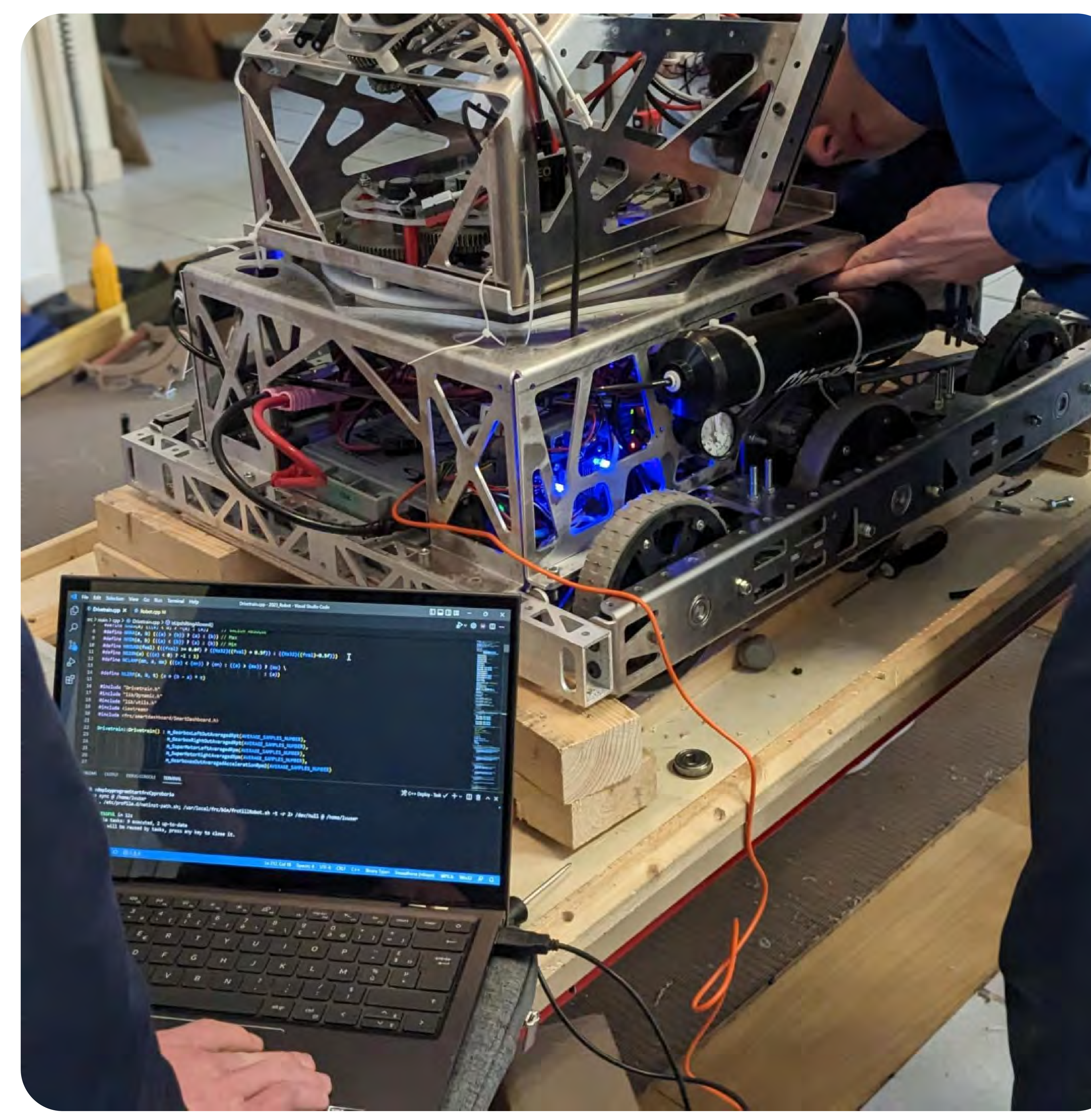
ROBO'LYON
The FIRST French Team

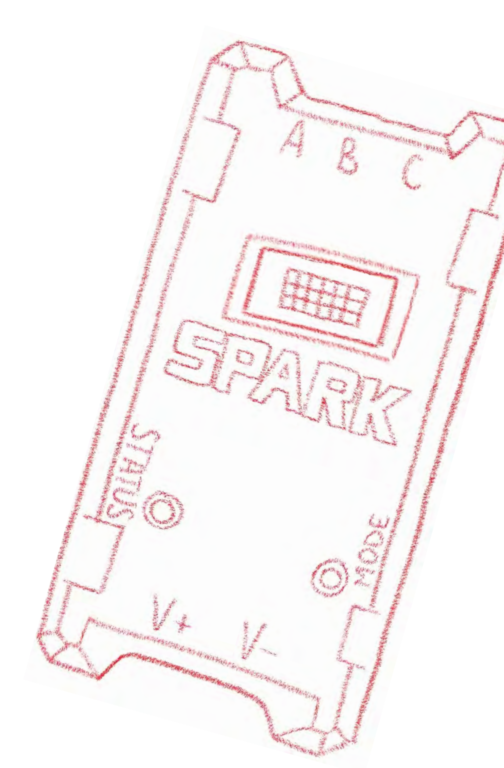
1. PROGRAMMING
2. VISUAL PROCESSING

04. PROGRAMMING

CODING

PROGRAMMING





- **Command-based programming:**
  -more flexibility
  -better organization
  -object-oriented programming

- **Use of lib custom generate splines to follow during the AUTO period: fast and precise trajectories.**

- **Use of either the Through Bore Encoder or the VersaPlanetary encoder for the drivetrain to count the distance**

- **Use of PID controller to enslave the pivot of the robot**

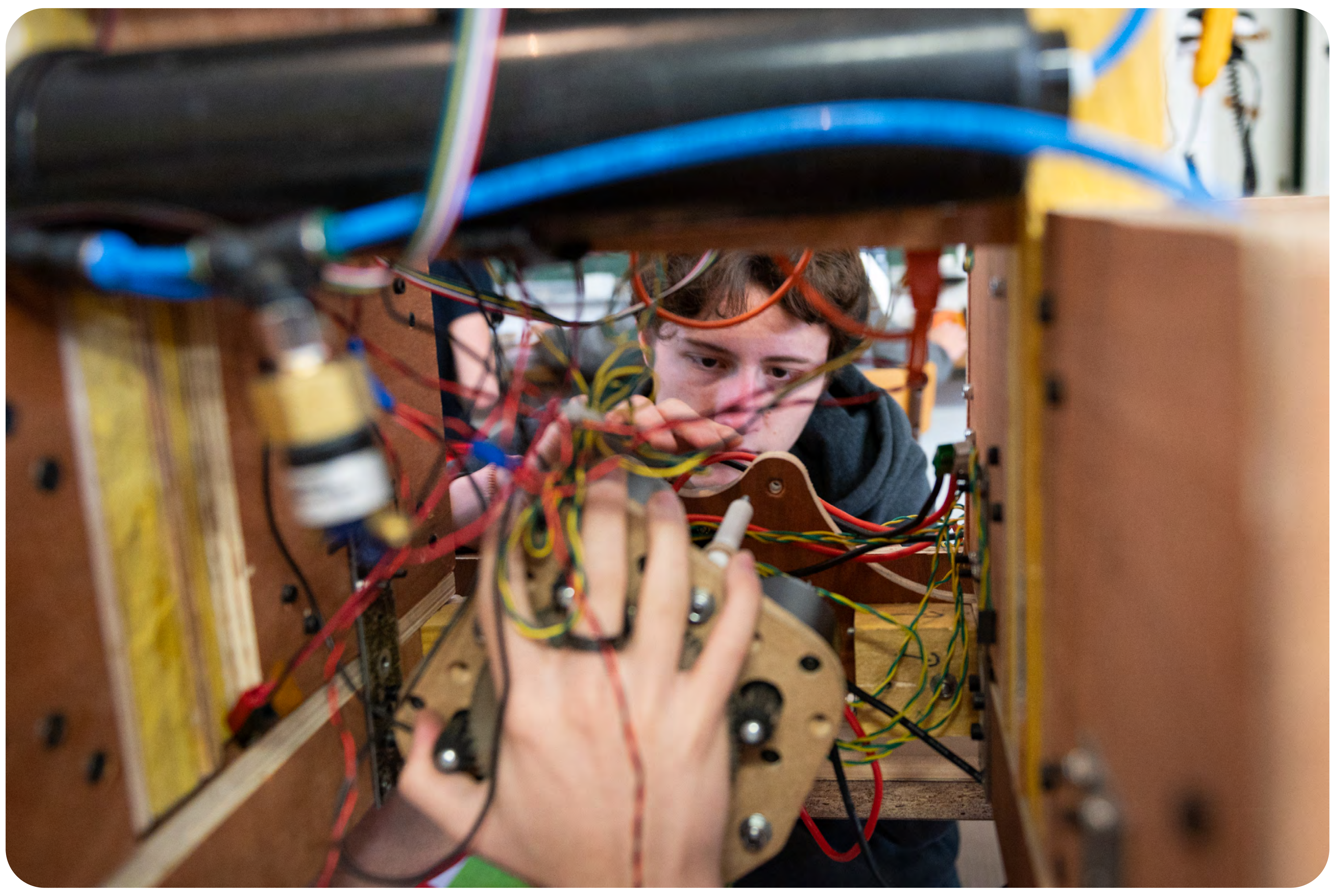
- **Use of ultrasound technology to measure distance between the robot and its surroundings**

VISUAL PROCESSING

PROGRAMMING

Use of the Photonvision library for image processing

Use of the library Network table to communicate with the robo rio



The program is operating with a raspberry pi 3b+ to improve performances. It is divided in different stages:

1. Converting the image from RGB to HSV
2. Filtering each pixel according to its color
3. Image processing with canny filter
4. Contour's detection
5. Contour's filtering (according to their properties)
6. Contour's coupling, creating a new target
7. Tracking the optimal trajectory to reach the detected target thanks to the use of odometry and motion control
8. Aim the turret, control the hood angle, and adjust the flywheel speed


NEO

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