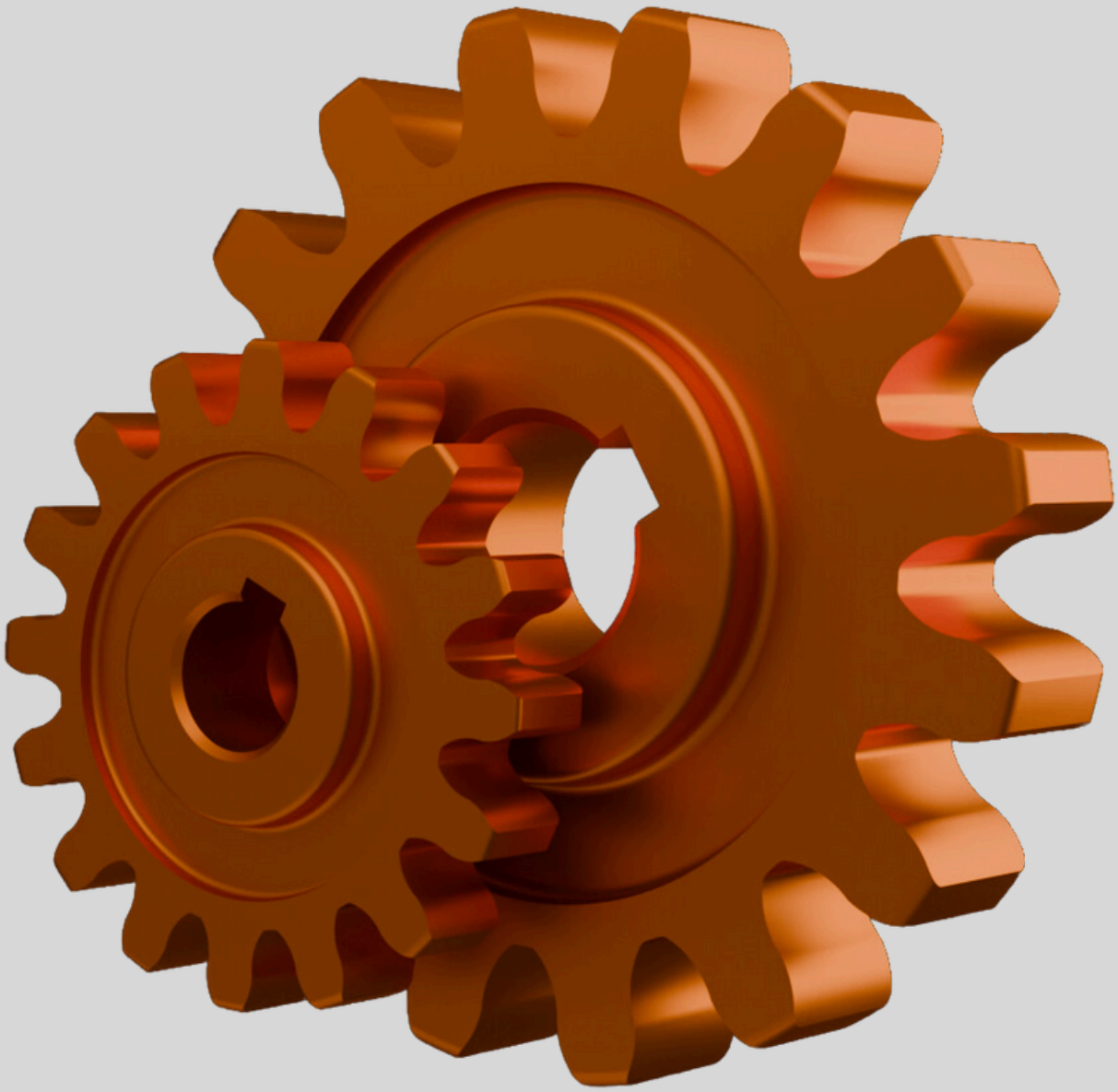
17097
PROTOSTARS

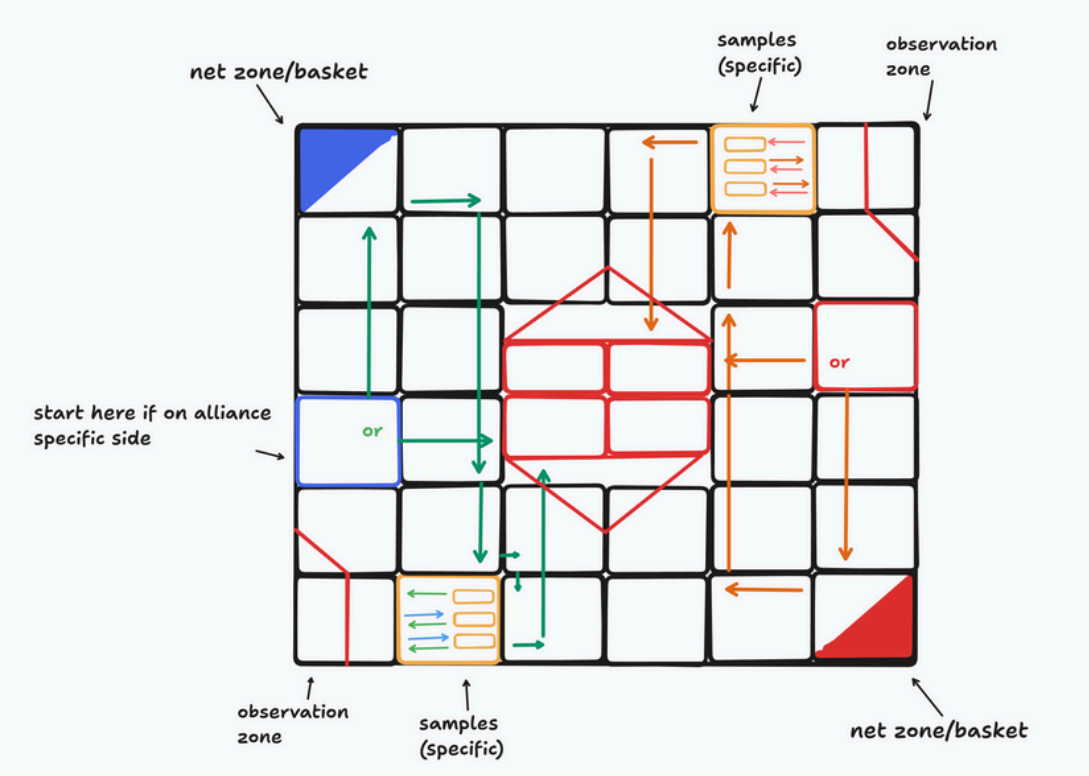


2024-25 INTO THE DEEP

GOALS

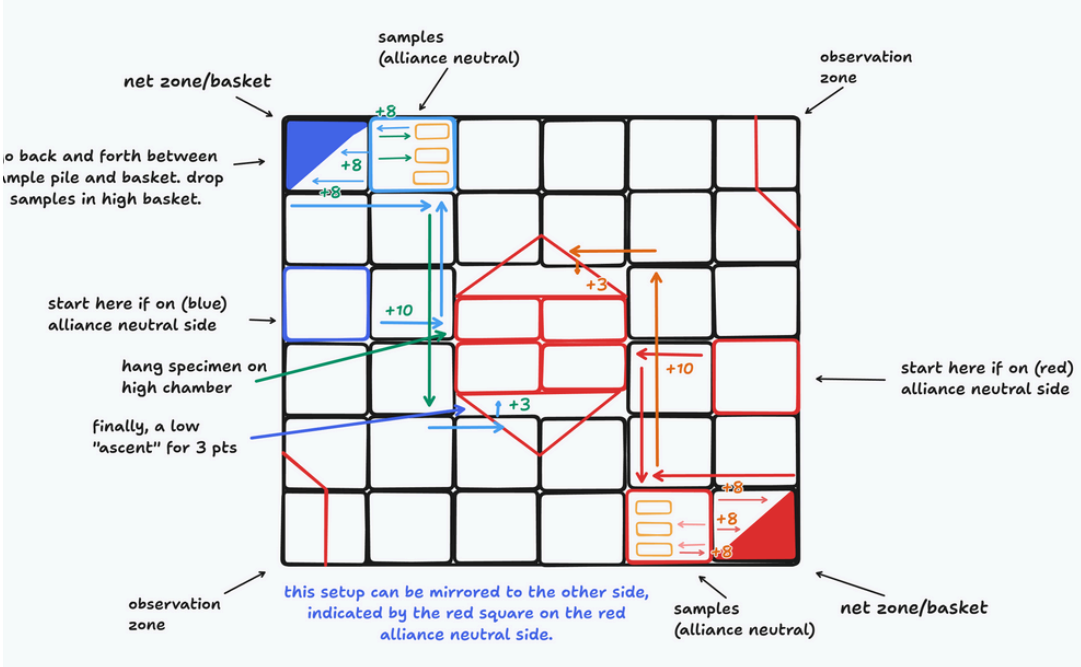
This season, our goal has been to develop not only as a team but also as individuals. Since the most rewarding aspect of FTC is competing at our best against other teams at their best, we aim to support any teams that may require assistance. Finally, staying true to the spirit of FTC, we are committed to practicing Gracious Professionalism in every environment we encounter.

STRATEGIES



One strategy for autonomous involves starting from the side of the field with alliance-specific samples. The robot then moves forward, hangs a specimen, and then navigates to the alliance-specific samples while avoiding collisions with other robots. After moving samples to the drop-off zone for human players, the human player will clip the specimens, we then move to the submersible for a Level One ascent.

The imiage to the right is a visualization for a future autonomous program involving starting on the alliance neutral side of the field. We would start by hanging a specimen, which is then followed by putting all the alliance neutral samples in the top basket. And concluding by moving to the sumersible for a level one asccent as in the previous autonomus.



EXPENSES

Revenue	Estimated	Actual
2023-24 Season Carry-Over	NA	NA
Team Dues	$1,750.00	$0.00
Fundraising	$3,000.00	$1,100.00
Grants	$1,500.00	$3,500.00
Total	**$6,250.00**	**$4,600.00**
Expenses	**Estimates**	**Actual**
Season Registration	$295.00	$295.00
Qualification & State Registration	$230.00	$350.00
Print Materials	$100.00	$0.00
Promotional Materials	$300.00	$0.00
Tools	$250.00	$45.00
Shipping	$100.00	$62.10
Robot Parts	$2,000.00	$1,439.52
Field Materials (Share of whol-org expenses)	$153.00	$153.00
Office Supplies	$50.00	$0.00
Total	**$3,428.00**	**$2,344.62**
Season Surplus/Deficit	**$2,822.00**	**$2,255.38**

GRACIOUS PROFESSIONALISM

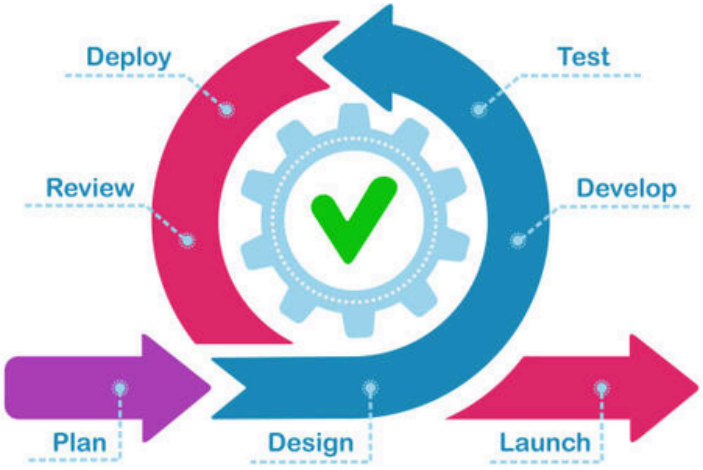
Gracious Professionalism is about fostering a community where respect and kindness are at the forefront, ensuring that competition brings out the best in everyone rather than just focusing on winning. We strive to embody these values both on and off the field, creating an environment where collaboration and mutual support are prized. This approach improves our experience and helps build a network of friendships that extend beyond the competitions.

MENTORS & LEARNING

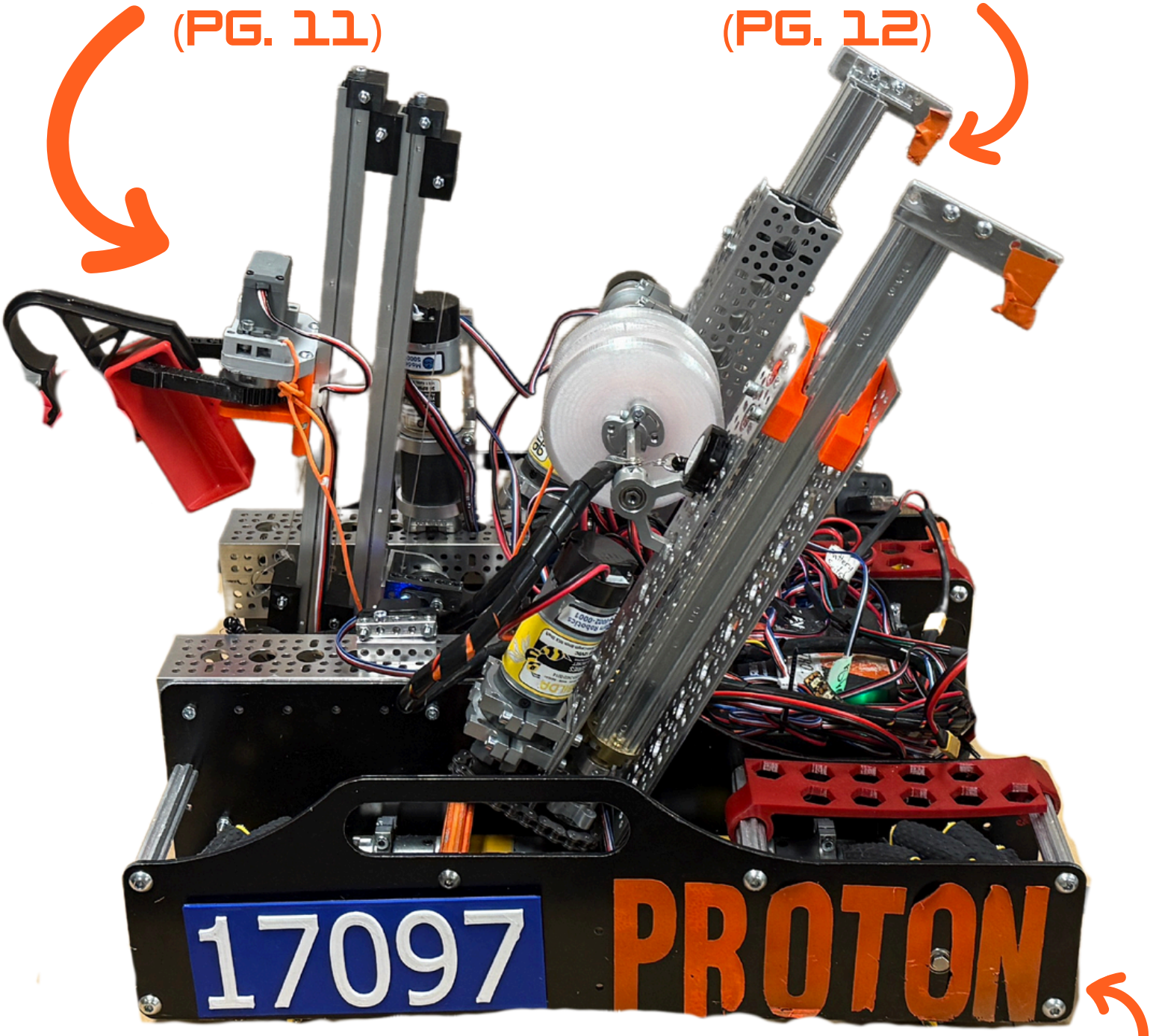
Much like any new skill, engineering requires a large upfront investment of time to achieve even partial mastery.
To speed up this learning process we employ our skilled mentors who guide us through the journey of building a robot. Our team has several recurring mentors who range from a senior director of software engineering at SoFi to ex-team members who come back to share the wisdom they acquired while in the First program. They inspire us to think critically and creatively, encouraging us to push the boundaries of what we believe is possible. By sharing their experiences and offering feedback, they accelerate our growth and empower us to tackle complex challenges with confidence. With their guidance, we learn not only the technical skills needed to build and program a robot but also the importance of teamwork, perseverance, and adaptability in the face of unexpected obstacles.

DESIGN PROCESS

We harness the power of the engineering design process to craft each of our attachments with care. Our quest is to embrace this methodology in its entirety, uncovering both significant and subtle challenges within our designs. Through the alchemy of brainstorming and research, we delve into a myriad of solutions to conquer these obstacles. We conjure multiple prototypes for every component, conduct rigorous tests, and choose the most effective solution—or, if time allows, we may make a new prototype altogether.



ROBOT OVERVIEW



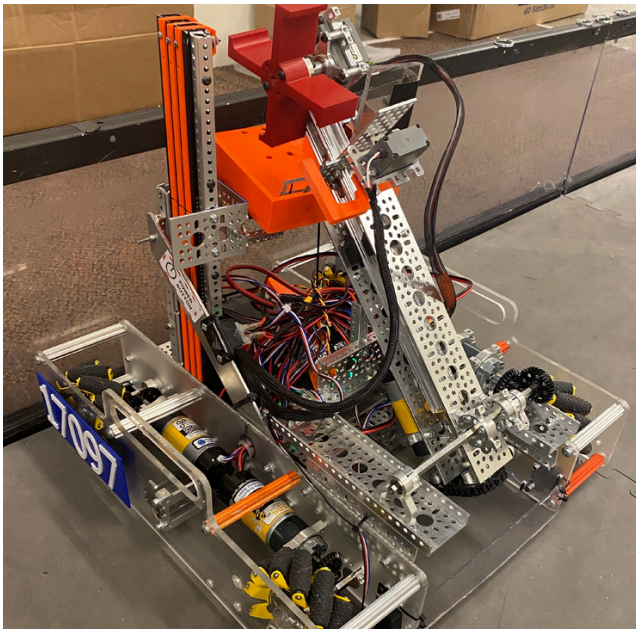
COLLECTION
(PG. 11)

HANGING
(PG. 12)

DRIVETRAIN
(PG. 9)

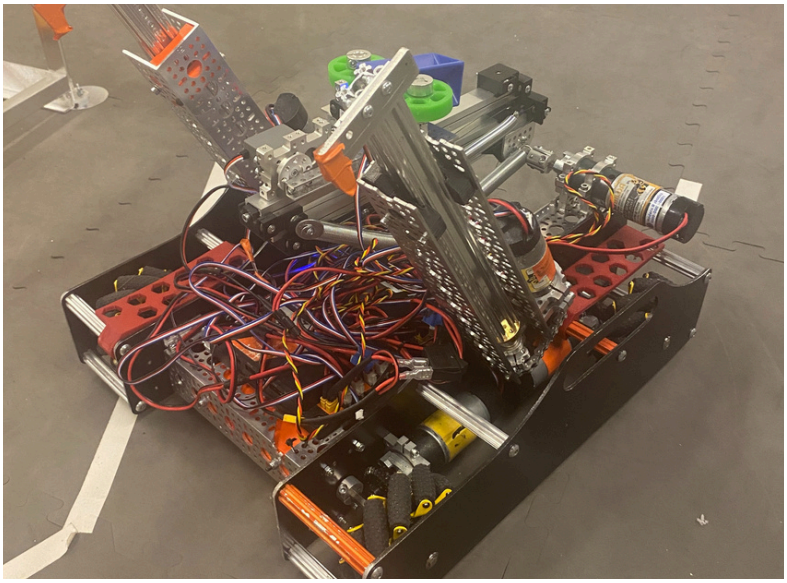
PANELS
(PG. 10)

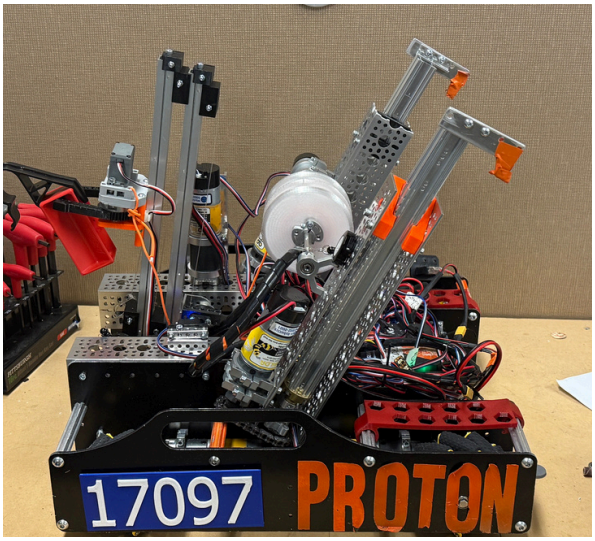
ROBOT EVOLUTION



This is the original design of our robot. This design had an extendable grabber connected to a spin wheel to grab samples. After picking up samples, you could drop them in the basket in the back. We changed this design for multiple reason including the poor reliability and the fact that samples could fall into the robot if not used properly. If a sample fell in, it would make us unable to perform more actions with samples for the rest of the game.

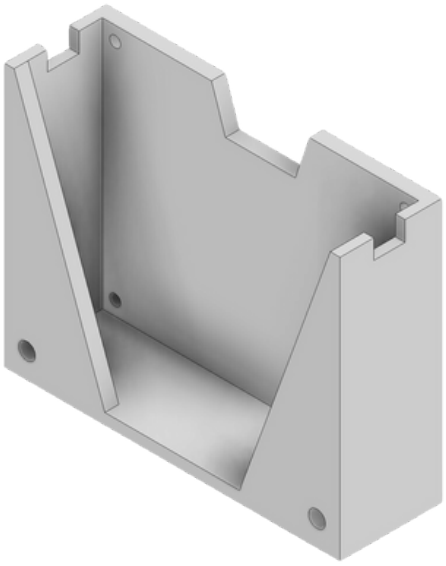
We enjoyed the challenge that was given to us by needing to redesign our entire robot with in two months. It has been a lot of fun to do. We learned a great deal about problem-solving and teamwork during this process. Our new design incorporated stronger materials and a more efficient mechanism to handle the samples, ensuring that they were securely stored without the risk of falling back into the robot.





This is our final design that will be featured in state. It has taken everything we have learned over the several months along with competition. We needed to find something lighter that is quicker and simpler. Most of everything we have now it unchanged with still using the same rails but removed the springs to bring it back and compacting many things to fit better.

BATTERY MOUNT



Our custom-designed battery mount secures the batteries so they have a consistent resting spot and are neatly positioned. This allows us to keep the interior of our robot cleaner and ultimately make it easier to work on. This also allows us to swap batteries faster, so we aren't having to find a spot to tuck them away and secure it so it doesn't fall out during a match. There are four screw holes, allowing us to mount however we need, and the cutouts help with the removal of batteries and allow the mount to fully encase the batteries, being flush at the top while not straining and damaging the cables. They are on both sides to fit the batteries both ways for quick replacement.

SPOOL

Our spool may be the single most iterated object on our entire robot. As dimensions for our entire robot changed spools got moved and as such had to change. Our original design used a double spool to allow spooling string in and out at the same time allowing for retraction of our rail system. This was not used. Instead we opted for more reliable sloped spool for that didn't allow for double spooling as each side of string on our lift would need to extend/retract at the exact same speed, something that could not be accomplished with the changing diameter of a sloped spool. Then we changed our lift system after we determined that the sprung design of our lift didn't work so we went back to a double spool with a smaller diameter to allow for us to extend and retract the rails with the same mechanism.

DRIVETRAIN

DIMENSIONS

As in previous years our robot is sized to be at least roughly 1/2" smaller in each direction. This serves to allow us maximum space for building while producing a healthy barrier as to not stretch the rules of the game. Additionally, the drive portion of our robot is constrained to allow plenty of room in the center of our robot for additional systems.

HORIZONTAL MOTORS

In contrast to last years front vertical and rear direct drive motors we chose to position our motors in a horizontal fashion. This has the effect of both making our “Drive Pods”[1 side of the bot] more compact vertically, in turn, allowing more space for an eventual climbing mechanism and or other components that we plan on adding

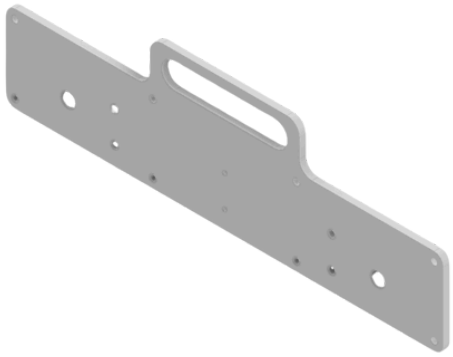
MECANUM WHEELS

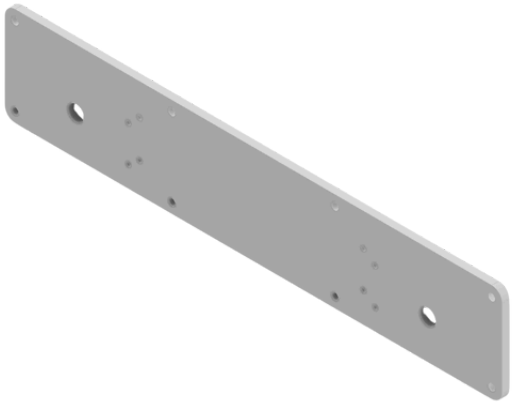
Much the same as last year we chose to use Mecanum wheels for their superior lateral movement abilities and ease of integration with almost any task our robot could hope to achieve.

PANELS

OLD PANELS

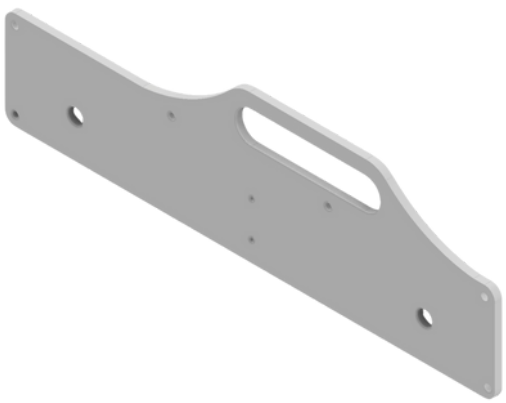
Below are the first designs of the inner and outer panels that we had for our drive train. They were cut in 1/4" plexiglass and had a simple design. Additionally, plexiglass allow easy cutting and drilling of holes making prototyping much easier. The panels were cut in house by us using our Shapeco 4 CNC router, and while a hassle to cut ourselves this was a good learning experience for everyone on the team.

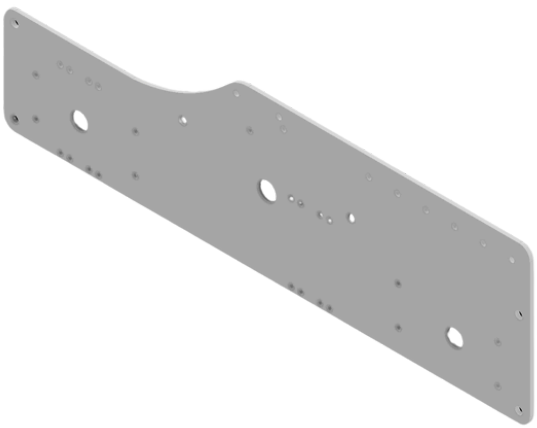




NEW PANELS

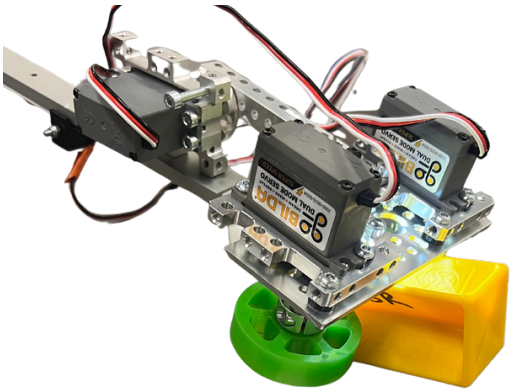
Picured below is our second design for our robot's panels. They are our final design and are cut from 1/8" aluminum. After modifying our original plexiglass panels what must have been over 20 different times we felt confident that we could settle on a final design without needing to make too many modifications as it is much more difficult for us to machine and modify metal quickly. These new designs feature many of the same things as our original plates with the major modification being making them taller to better accommodate mounting our scoring mechanism.





COLLECTION

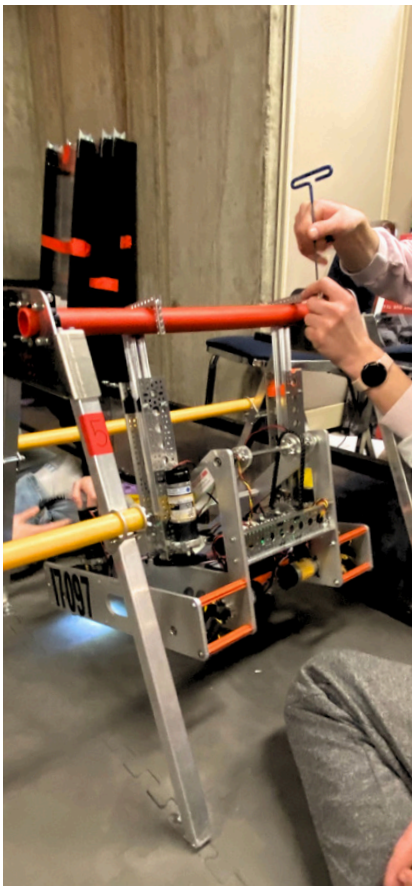
At the start of the season, our collection system used a wheel system grabber where a spinner could latch onto the targeted sample and press it against a wall trapping the sample; however, after testing this system it proved very difficult to pick up oddly oriented samples as well as transfer the sample from the wheel to our lift system. After learning about this, we decided to switch gears. After watching other competitors compete, we came to the conclusion that a new design was needed.

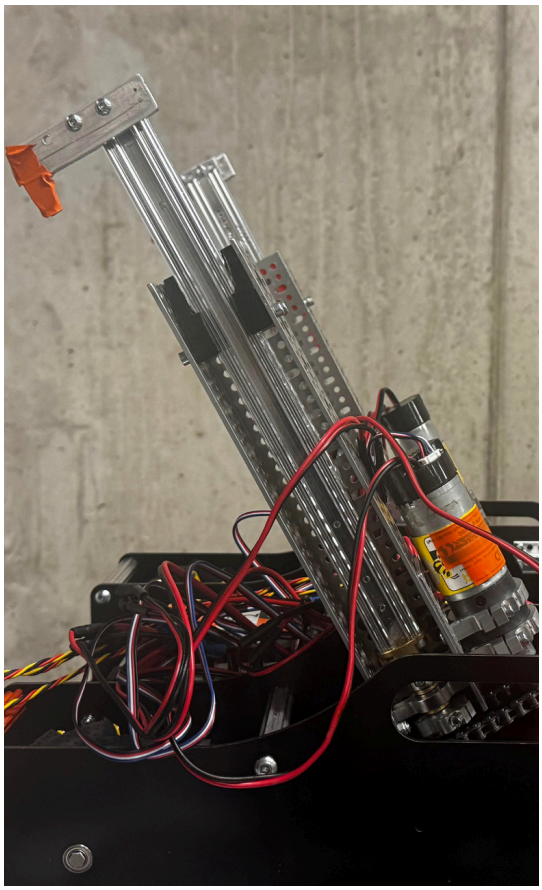


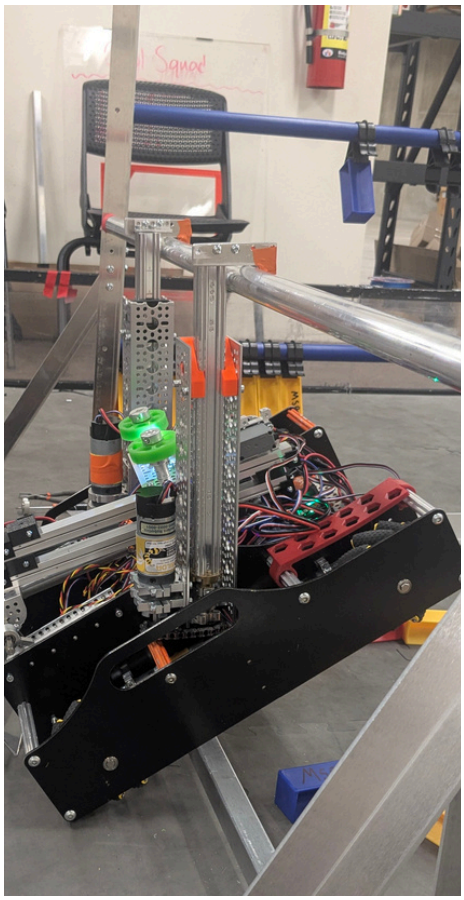
Our next collection system used a different tactic. We used 2 wheels to pick up the samples which proved far more effective. Instead of transferring samples between a collection and lift system we decided to simply send the collection system up with the lift; however, this came with a whole new set of challenges. In order to properly do this we had to make our lift rotate downward to collect samples from the submersible. After dealing with problems in our rails we were able to come up with a design that checks all of our boxes while being reliable and compliant to the new rules added this year.

Even after all we did our system was still too unreliable and was in need of another redesign. we have learned by this point that attempting to use wheels on anything that isn't circular is costing more than its benefits so we switched to a pincer design which we acquired from 14906 Leviathan Robotics in Oklahoma. This decreased the complexity of the robot while increasing efficiency. then we modified our rails to use a 2 string system instead of using a spring to pull it down because spring physics were making controlling the lift and the programming behind it far more difficult.

HANGING







This is the second season that robots have been expected to hang; the only difference this year being that there is a second level to climb. This season, we tried many different ideas to reach the second bar, but eventually we desided that reaching the second bar would be too time intensive and would requrie us to give up a lot for only 15 points, and so we settled on our previous design from last year. after doing some further reasearch, we decided it wasn't worth the effort to reinvent what we already had and used our old design, with the only modification being that we angled the lift such that we could just pull up to the submersible and hang without any pivoting from the hanging mechanism. Our hanging system consists of two lead screws with hooks on the top of them. These hooks latch on to the submersible and allow our robot begin its ascent. Once raised fully the robot will be suspended in air even if the robot turns off. During qualifiers, we were 312 RPM motors. After deciding that 15 seconds to lift up was too slow, we switched to 435 RPM motors, and reported a 30% increase in speed, with about 10 seconds to lift fully.

SENSORS

MAGNETIC LIMIT SWTICH

The REV Magnetic Limit Switch is a three-sided digital hall effect switch with three internal hall effect elements (one on top, two on the sides) connected in parallel. If any element is triggered, the sensor reports as activated. We utilize this sensor for several purposes. During autonomous, it helps us calculate the lift arm angle relative to the robot, allowing us to determine the precise angle needed for tilting the arm. This is essential for stopping the arm at the right moment to hang a specimen on the rung correctly. In TeleOp mode, we employ a similar algorithm based on motor RPM to determine the arm angle, preventing our drivers from moving it too far and causing damage.

```
public static double getArmAngle(DcMotor arm, double uprightTick) {
    double diff = Math.abs(arm.getCurrentPosition()) -
Math.abs(uprightTick)) / 5281.1) * 360;
}
```

```
(gamepad2.right_trigger > 0.05 &&
    (Math.abs(getArmAngle(collectionArmTilt, uprightTick)) < 35
||  Math.abs(getArmAngle(collectionArmTilt, uprightTick)) > 60)
)
```

DISTANCE SENSORS

Our robot is equipped with a distance sensor mounted near the ground on Mecanum wheels, serving multiple functions. Firstly, it enables dynamic stopping during autonomous mode, allowing the robot to halt at any distance up to 2 meters from objects, including the central submersible and field walls. Secondly, during the TeleOp phase, the sensor measures proximity to field walls and other objects, providing haptic feedback to drivers to prevent collisions with the field or other robots.

COLOR SENSORS

To reduce the chance of our robot grabbing the wrong color sample, we installed a color sensor on the collection mechanism. The sensor is programed to light an LED strip on the side of the robot with the color of the sample it sees. This system allows for us to avoid penalties for grabbing the other alliance's samples.

PROGRAMMING

This season, our team is using the Java SDK for programming our robot due to its customization options and versatility, despite requiring more programming experience than block coding. The Java SDK enables complex algorithms and simulations, enhancing our problem-solving capabilities. We program in Android Studio with the REV Hardware Client, continuously improving our code and testing various scenarios. Features like self-driving, sensor integration, and data processing have been added.

Our team has 2 autonomous programs—one for the side with a neutral sample and one for the side with alliance-specific samples. We traverse the field using encoders, the internal gyroscope, and the distance sensor. Tests with the new sensors have a higher success rate than autonomous programs from seasons past. Integrating the new sensors was a challenge, and we needed to rely on our mentors to guide us through how to weave them into our code. The experience has been incredibly rewarding, as it has broadened our understanding and skill set in robotics programming. As we continue to refine these autonomous programs, our focus remains on achieving consistent accuracy and responsiveness during competitions.

```
public void turnByEncoder(double iPower, double iDegrees, TurnDirection iDir, String iRobot) throws
InterruptedException {
        double iWidth = 0; //side to side (center of wheels) everything is in inches/degrees
        double iLength = 0; //front to back (center of wheels)
        double startPosition = leftBack.getCurrentPosition();

        //Replace the width and length with the width and length of your robot, this is incredibly
important for the circle math it's doing
        //you can also just get rid of the else if statement if you don't need it
        if (Objects.equals(iRobot, "Dum-E")) {
            iWidth = 14.75;
            iLength = 15.25;
        } else if (Objects.equals(iRobot, "Electron")) {
            iWidth = 16.27;
            iLength = 16.8;
        } else if (Objects.equals(iRobot, "Proton")) {
            iWidth = 16.25;
            iLength = 15.2;
        }

        double iRobotRadius = Math.sqrt(((iWidth / 2) * (iWidth / 2)) + ((iLength / 2) * (iLength
/2)));
        double iCircumference = 2 * 3.1415 * iRobotRadius;
        double iTurnDistance = (((iCircumference / 360) * iDegrees) * ticksPerInch) * 1.125;

        if (iDir == TurnDirection.LEFT) {
            leftFront.setPower(-iPower);
            leftBack.setPower(-iPower);
            rightFront.setPower(iPower);
            rightBack.setPower(iPower);

            while ((Math.abs(leftBack.getCurrentPosition()) - startPosition) <= iTurnDistance) {
                //keep empty
            }

        } else if(iDir == TurnDirection.RIGHT) {
            leftFront.setPower(iPower);
            leftBack.setPower(iPower);
            rightFront.setPower(-iPower);
            rightBack.setPower(-iPower);

            while ((leftBack.getCurrentPosition() - startPosition) < iTurnDistance) {
                //keep empty
            }
        }

        leftFront.setPower(0.0);
        leftBack.setPower(0.0);
        rightFront.setPower(0.0);
        rightBack.setPower(0.0);
    }
```

Code for turning with encoders

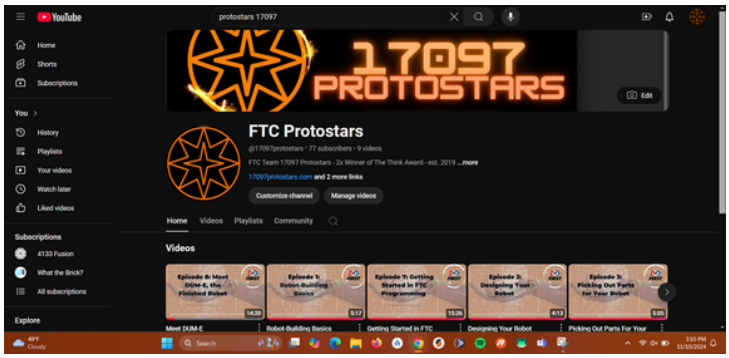
This season's telelop will require 2 drivers. One will control the drive train while the other will control just about everything else. The first driver uses the left joystick to drive and strafe, the right joystick turns the robot, and the triggers will control speed to allow for more precise control. The second driver will use the joysticks, buttons, and triggers to control grabbing and lifting. after endgame is initiated driver 1 will drive to the submersible and input a button combo that will have the robot hang on its own so that human error has no possibility of damaging the robot while it is off the ground.

BILL ROBERT'S GOLF COURSE

Over the summer our team gained the opportunity to present our Robot and team to community members at Bill Robert's Golf Course during a HBIA [Home Builders Association] tournament. We enjoyed showing how the season and our robot worked. We also received several generous donations from the golfers and enjoyed answering their questions about First. The experience not only helped us raise funds but also allowed us to interact with local businesses and individuals interested in supporting STEM education. We engaged in meaningful conversations about our team's mission, future goals, and First values. This event also sparked interest among some attendees to follow our journey and stay updated through our Instagram and YouTube. Overall, it was a rewarding day that strengthened our community ties.

YOUTUBE

We occasionally share videos showcasing our robot in action, along with helpful tutorials on building and programming it. Our channel aims to be a valuable resource for first-time FTC teams, offering insights into the challenges and triumphs we've encountered on our journey. We actively encourage our viewers to connect with us through comments and suggestions. Since March, our videos have garnered 9,608 views from viewers across the globe, including the US, Jamaica, Brazil, Romania, and India. This demonstrates our global reach and our commitment to providing valuable information to teams that could benefit from it.



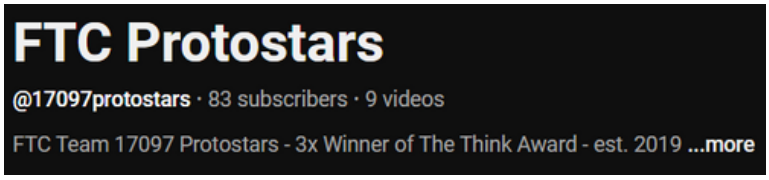
HELENA, MONTANA FLL QUALIFIERS

Our team volunteered at the FLL qualifiers that our some of our organization's teams were competing in. We assisted in score keeping, reffing, and field resetting. It was very fun to see what the younger teams had been doing this season. The energy and enthusiasm of these teams was truly infectious, and it was inspiring to watch their creativity and teamwork in action. We took the opportunity to connect with the students and mentors, sharing our experiences and offering advice. This event not only allowed us to give back to the community but also to learn from these budding engineers. Their passion reminded us of the importance of fostering a love for STEM from an early age. We left the event feeling more motivated than ever to continue supporting and mentoring the next generation of innovators.

OUTREACH

INSTAGRAM

On Instagram, we regularly post updates of robot progress, team spirit, and behind-the-scenes information on our season. When sharing photos and videos of our process, we hope to inspire and connect with other teams and audiences. Our posts also show the importance of teamwork, innovation, and perseverance; values that are at the core of our mission and the larger FTC community. Through Instagram and YouTube, we not only celebrate our own achievements, but also learn from other teams; making a network where we can share ideas and help others.



HOW WE USE OUTREACH

At outreach events, we receive lots of feedback relating to our team and robot. With this feedback, we take into account key points and suggestions that can help us improve our designs and strategies. Engaging directly with the community allows us to gain valuable insights and perspectives that we might not have considered otherwise. Outreach is not only beneficial for refining our technical skills, but it also helps us grow as a team.

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