WARRIORS

24226

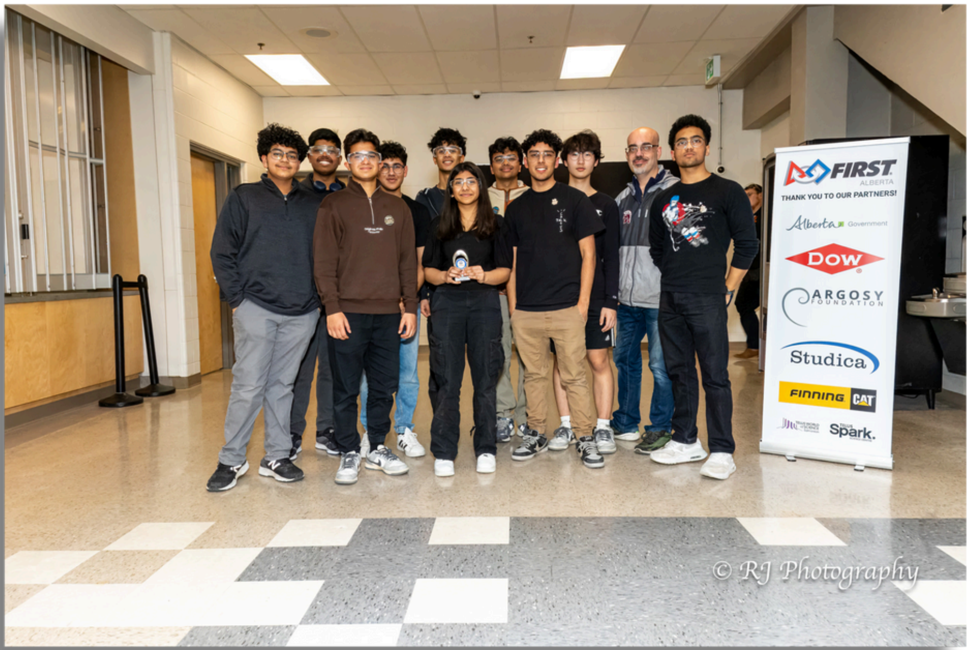
Engineering Portfolio

2023-2024

FIRST

MEET WARRIOR ROBOTICS

Our Team



Left to Right

Dhruvil Metha	**Mechanical**
Shourya Baranwal	**Mechanical**
Tanmay Shah	**President/Founder**
Pranay Oza	**Software Lead**
Rijwal Sangey	**Software Lead**
Vaishvi Shah	**Electrical**
Kartik Budihal	**President**
Shivam Walia	**Mechanical Lead/Founder**
Maxwell Li	**Electrical**
Jad Abboud	**Mentor**
Udit Sharma	**Mechanical**
Arav Talati (Absent)	**Software**
Jennifer Grafier (Absent)	**Mechanical**
Kevin Zhang (Absent)	**Software**
Jacob Yi (Absent)	**Mechanical**

SUSTAINABILITY

RECURITING

Members are recruited via an application process in September, after our presentation at schools club fair. During the off-season Inexperienced members are taught technical skills, such as CAD and programming by veteran members through instructional videos, workshops and presentations. These skills are improved upon throughout the season by hands-on experience.

Our team conducts robot demonstrations throughout our school to generate interest and we have developed a strong connection with other clubs in our school as well. We work with the STEM club to both promote the field and give students the opportunity to experience real world engineering.

FUNDRAISING

While our school has generously provided us with initial funding, we aspire to surpass expectations in our competitions and require sponsors to achieve this goal. Our fundraising endeavours are multifaceted:

1. Securing Sponsors:
    a. Using personal connections to secure sponsors with companies
    b. Crafting compelling emails to companies, articulating the mission and impact of FIRST and the benefits of sponsoring our team.
    c. Delivering presentations about FIRST and its mission to inspire the STEM field
2. Crowd Funding
    a. Organizing bottle drives and bake sales within our school and community
    b. EducationMatters: Similar to a GoFundMe but for schools in Calgary

We aim to not only meet but exceed our financial targets, enabling us to excel in our competitions and contribute meaningfully to the FIRST community. Below are a few of the companies we have connected with and photos of our fundraising initiatives.

KAD CONSULTING SERVICES

InnovatED

AMIT GUPTA REAL ESTATE TEAM RE/MAX Professional Services by an IIT'ian...

TEC CANADA

AIREASE™ Built for life. Yours.

OUTREACH

Connected with
5
Companies/ Businesses

100+
Students Inspired

6000+
Social Media Interactions

Worked with
10
Industry Level Professionals

Connected with
10
FRC and FTC Teams

MISSION STATEMENT

Our robotics team is committed to achieving excellence, inspiring others, and making robotics accessible to all. We are dedicated to winning competitions, fostering a passion for STEM, and breaking down barriers to participation.

Driven by innovation and collaboration, we strive to push the boundaries of technology while embodying integrity, teamwork, and respect. Through our actions and achievements, we aim to inspire individuals of all backgrounds to pursue their interests in robotics and engineering.

With a focus on inclusivity and outreach, we actively engage with our community to provide opportunities for learning and growth. We believe that everyone deserves access to the transformative power of robotics, and we work tirelessly to create an environment where diversity thrives and talents are nurtured.

Together, we will continue to lead by example, demonstrating the endless possibilities of robotics, and empowering individuals to reach their full potential.

COMMUNITY INVOLVEMENT

As outlined in our mission statement, our primary objective is to inspire as many students as possible to embrace STEM and pursue careers in engineering. To achieve this goal, our team has meticulously planned and executed numerous events across Southwest Calgary, aimed at showcasing our robot and illustrating the transformative power of Robotics and the FIRST organization. These events serve as platforms to engage with our community, offering firsthand experiences of robotics and emphasizing the invaluable skills gained through participation in STEM activities.

OUTREACH

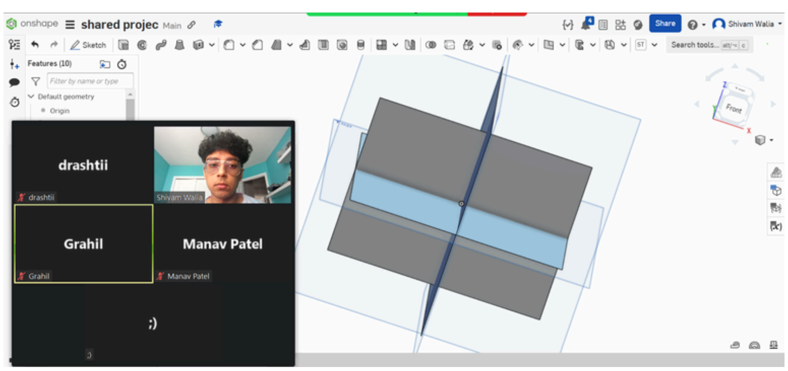
COMMUNITY (Continued)

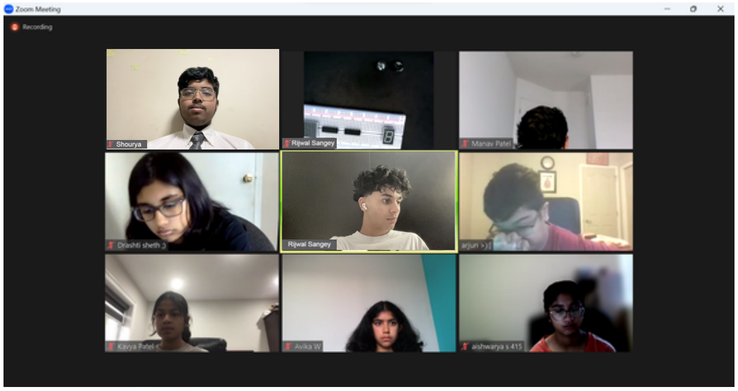
Through our outreach efforts, we aim to ignite curiosity, foster innovation, and cultivate a passion for lifelong learning among students of all backgrounds. Below is a list of events conducted and planned by our team including a few photos.

Conducted Events

Online CAD and Arduino Workshops

Our sponsor, InnovatED, graciously provided us with the opportunity to conduct workshops for students aged 9-14 to teach introductory engineering skills such as 3D modeling, electronics, and programming. InnovatED conducts workshops; however, for the past two weeks, we have been able to give the students a crash course in 3D modeling, electronics, and programming, as our team was allowed to be the teachers. We were able to reach out to 50 students from all across Canada interested in STEM and Engineering and allow them to learn about STEM and high school options they might have. A few of the programs that we mentioned the students could join were FIRST, SHAD, and Junior Achievements. Below are a few pictures from our online outreach events showcasing a few of the skills we taught the students.





STEM Club Demonstration Day

We were able to connect with the STEM club and inspire approximately 50 students to get involved with our robotics club. Our team is attached to a robotics clubs that conducts a variety in school challenges and competes in other STEM and engineering competitions such as SkillsAlberta and Fusion360 Design Challenge. By combining the two clubs we were able to inspire so many more students to get them interested in STEM. On the right is a picture of some of our team with STEM club leads.

Planned Events

A few of the planned events we have are listed below, they are in the works of being organized or planned for a day during the offseason.

OUTREACH

FFCA South Middle School Robotics Demonstration and Workshops

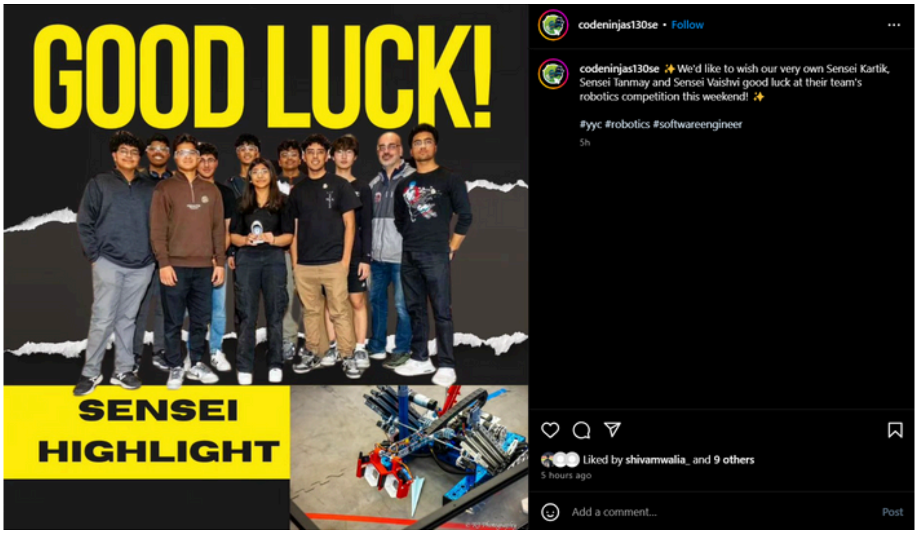
Our team successfully organized an event in collaboration with our valued sponsor, InnovatEd, hosted at FFCA South Middle School. This event is planned to be comprised of half a day of enriching workshops tailored for the Grade 7 and 8 sections of the school, covering programming, 3D modeling, and electronics. Generously supported by our sponsor, we will be equipped with essential materials, including Arduino kits, to facilitate hands-on learning experiences for the students. We are scheuled to conduct the event of March 20th, 2024.

Fairview Junior High School Robotics Demonstration and Workshops

A similar event as the one planned at FFCA South Middle School our team will be conducting workshops at Fairview Junior High on April 3rd, 2024.

Code Ninjas Robot Demonstration Day

We are also planning to host an event at Code Ninjas' 130th location. Code Ninjas is a franchise-based company that offers computer programming and coding education for children aged 7 to 14. The company aims to teach kids valuable coding skills through a fun and interactive approach. Similar to our approach at InnovatED, our team will be the mentors for a day at Code Ninjas. Recently, our team was featured on the Code Ninjas Instagram, wishing us good luck for the provincial competition.



Connections with Professionals

From our robotics team, we foster a strong connection with professional engineers who serve as mentors and advisors. Their expertise and guidance provide invaluable insights into real-world engineering practices. Although we only have one mentor currently, a variety of professional engineers have given us technical advice about our robot, including engineers from Obsidian Engineering, Fluor, Nutrien, and Jacobs Solutions.

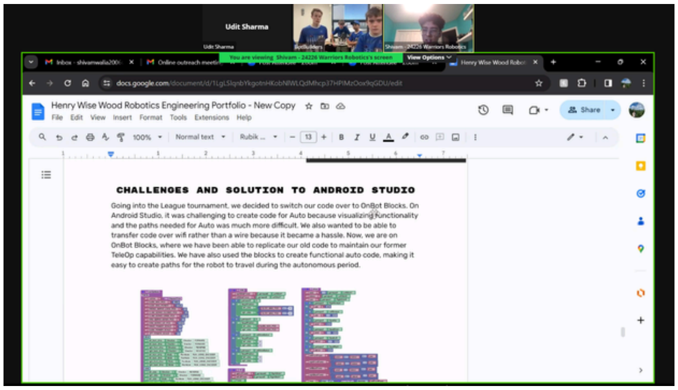
Connections with FIRST Teams

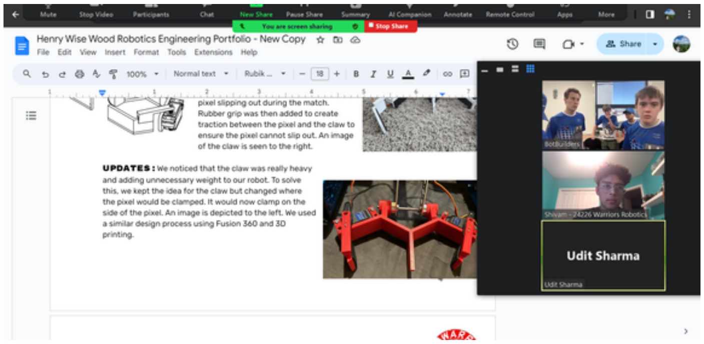
Our connection with other FIRST teams is vital for collaborative learning and growth in robotics. By exchanging ideas and resources, we collectively improve our performance in competitions. This collaboration fosters a supportive community where teams can learn from each other's experiences and strengthen the overall quality of robotics programs within the FIRST community. Our team is primarily composed of former FRC students from the team 4421. We set out to create this team to create a more affordable and accessible pathway into engineering STEM. Our team has an enrollment fee set at $60 compared to $1500 for some FRC teams.

OUTREACH

Connections with FIRST Teams (Continued)

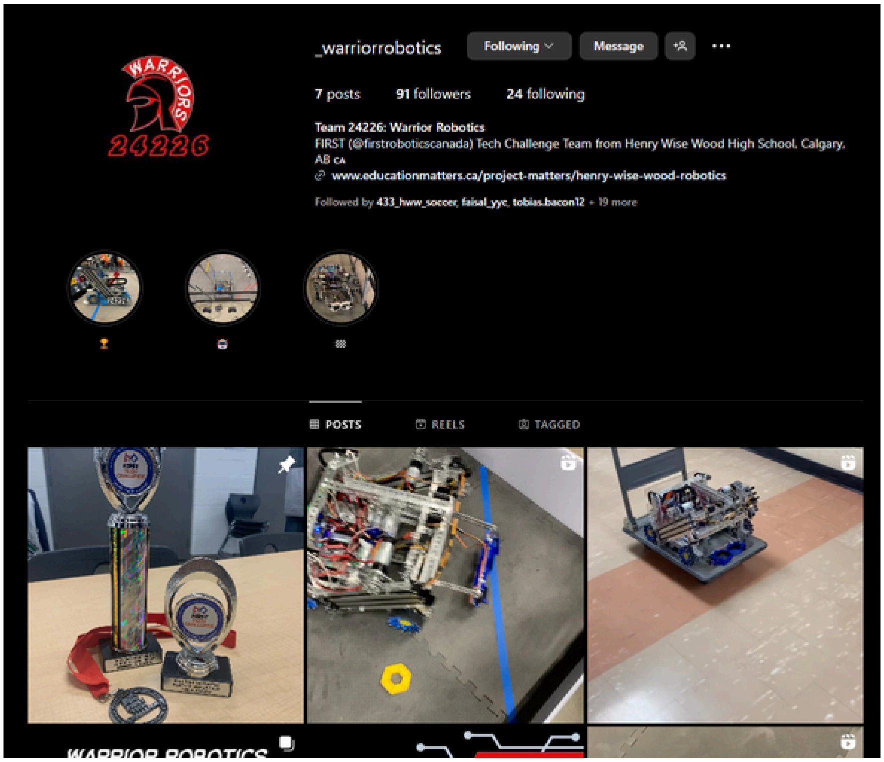
Our team has also conducted a variety of meetings with various FRC and FTC teams. A few of these teams include 7558 ALT F4 (FRC), 2935 NACI Robotics (FRC) and 14380 Blue Botbuilders (FTC). Below are a few pictures from our meetings with other teams





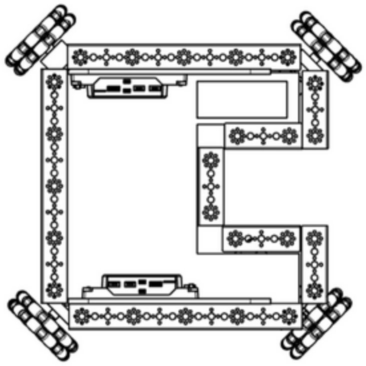
SOCIAL MEDIA

We have utilized social media to promote our team and build a community around robotics in our school. We created our own Instagram account where we post our progress on the robot and share stories to highlight competitions and build sessions. Our page has 90+ followers and 2000+ views on multiple 'Reels'



MECHANICAL AND DESIGN

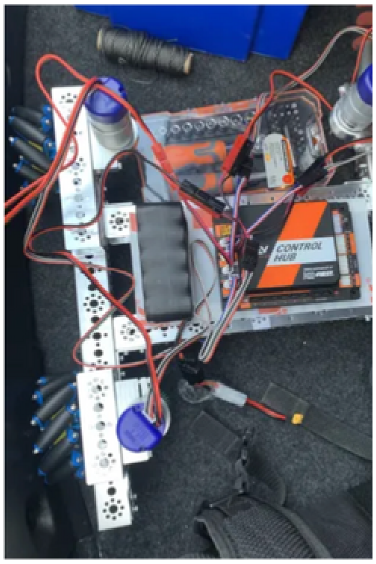
DRIVE TRAIN



Initially: In our inaugural year, we were assigned the crucial task of choosing an efficient drive base. Equipped with standard Omni wheels and a 60:1 gearbox for the motors, our team embarked on crafting an X-Drive configuration. This selection was predicated on its inherent attributes, notably the 360-degree turning radius and omnidirectional mobility, affording movement along any axis without necessitating reorientation.

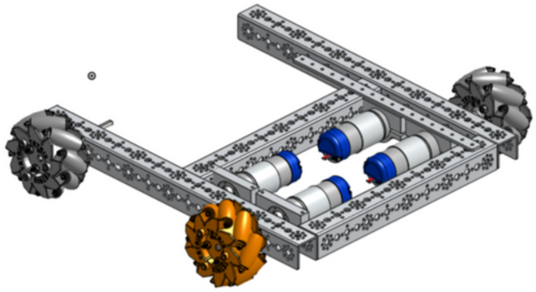
Challenge #1: The X-Drive faced difficulties due to confined spacing, motor mounting issues, and suboptimal speed. The configuration of the motor mounting undermined stability, exacerbating operational challenges. Moreover, the limited space constraints hampered the seamless integration of additional components such as a drone launcher and hanging mechanism, posing further obstacles to the vehicle's functionality and adaptability.

Solution #1: We conducted online investigations to explore alternatives, leading us to discover the mecanum system. Comparable to the X-drive configuration employing omni wheels, it features a 360-degree turning capability and unrestricted directional maneuverability. To tackle the spacing challenge, we elevated the motors above the base and implemented a linkage to the wheels via bevel gears. The updated iteration of the drivetrain is depicted on the right side.

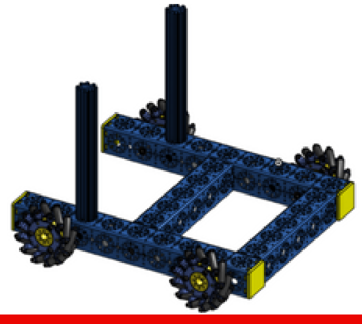


Challenge #2: We faced ongoing challenges with gear slippage and drift during operation. The downward translational movement of the motors would disrupt the accurate engagement of gears, resulting in impediments to effectively maneuvering the robot.

Solution #2: We integrated a belt-driven mechanism for the wheels, repositioning the motors nearby. This setup, combined with a belt pulley system, guaranteed a heightened level of reliability and efficiency in power transmission. By situating the motors beneath the frame, we effectively resolved the spacing concern. Furthermore, we optimized speed by modifying the gear ratio, yielding a frame with improved stability and dependability. Our team deployed this configuration for the league tournament and observed satisfactory performance, albeit with limited reliability. The CAD representation of this design is depicted below on the left.

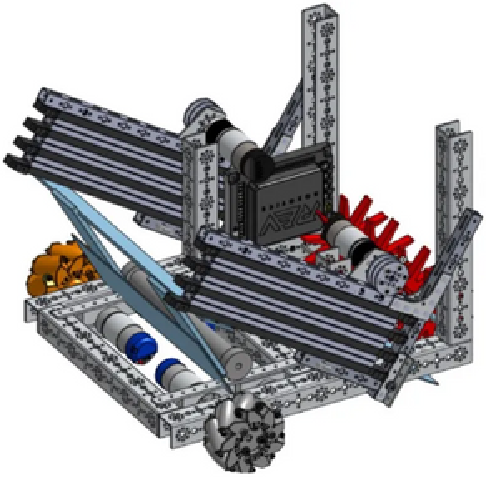


Updates: In our pursuit of improved efficiency and speed in the drivetrain, our team chose to upgrade using a new drivetrain kit from Studica Robotics. This decision ensures that we will possess two kits for our secondary team in the following year. Opting for a standardized kit rather than a custom-built solution offers the prospect of superior performance and smoother transitions for future team iterations. Below is an CAD Model of the drivetrain without wheels, featuring supports for mounting linear motion slides, which will be discussed further.



MECHANICAL AND DESIGN

INTAKE/OUTTAKE

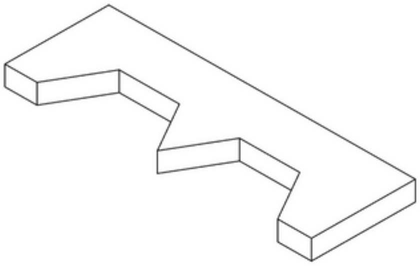


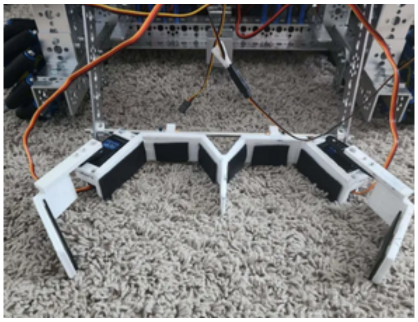
Initially: Use entrapption stars to spin the pixel onto the plate and then onto a conveyor belt. The initial design is seen on the left

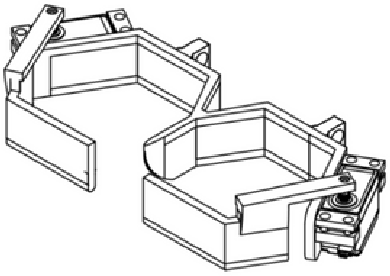
Challenge #1: When mounting the entrapption stars and belt, our kit did not allow for a feasible mounting of both components.

Solution #1: We had already brainstormed the idea that our outtake would be specified to release two pixels on the board. The outtake would rest on the belt and be extended using linear motion slides. The initial design of the claw is below.

Solution #1 (Continued): We retained the intake/outtake concept depicted on the right, incorporating a hinge motion on the claw to facilitate pixel placement by our drivers. Additionally, the outtake functionality serves as both an intake and outtake, simplifying tasks for our drive teams. Our drive strategy is elaborated on in the following section.

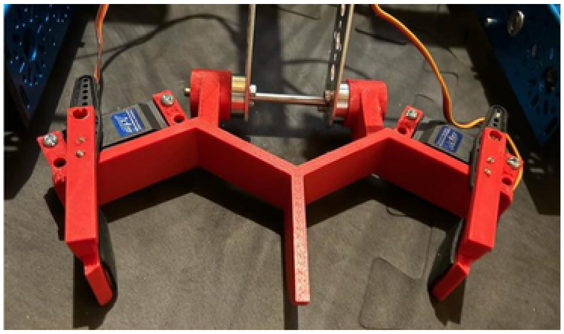






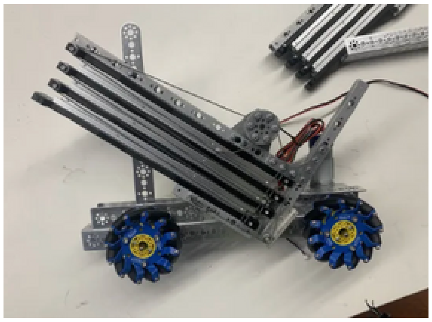
The claw design was developed using Fusion 360 software and subsequently produced using 3D printing technology. The CAD drawing is visible on the left, detailing its specifications. To guarantee pixel retention during matches, the claw incorporates two 12 kg-cm torque servos. Furthermore, a rubber grip was incorporated to enhance traction between the pixel and the claw, ensuring secure handling. An image of the completed claw can be observed on the left.

Qualifier Update: Observing that the claw's weight was excessive and detrimentally impacting our robot's performance, we devised a solution to address this issue while retaining the core claw concept. The adjustment involved relocating the clamping mechanism to grip the side of the pixel. A visual representation of this modification is provided on the right. Employing the same design process involving Fusion 360 and 3D printing, we executed this redesign. Additionally, we pursued weight reduction by eliminating the bulky axle component from the assembly.



MECHANICAL AND DESIGN

SLIDES



Initial Solution to Pixels Stacking on Top of Each Other
To reach the maximum height, we purchased ANDYMARK Linear Motion Slides. The slides used pulley motor system with standard NevRest Orbital motors and a 13.7:1 gearbox. This allows for fast extension and retraction to maximize our cycle time. The slides are depicted on the right.

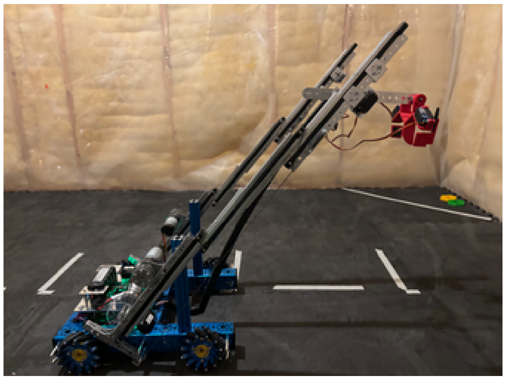
Challenges:

- The slides were too tall to pass under the truss.
- Claw mounting would need to be lowered because of the way the slides extend.
- Flimsy support. The slides were made out of plastic which greatly reduced the stability of the slides.

Solution:

- Used sin law to determine an angle that would be allow the robot to pass under the 12 inch truss. Our calculations are depicted in a section called Mathematics. We realized that we wouldn't be able to pass under the stage if we optimized it to reach the max height on the board. We chose to pass under the truss as it would greatly improve our cycle time.
- Added 'arms' made of metal flats to lower the claw to the ground. The claws were attached onto servos to add more extension to the slides.
- Attached the slides to each other using metal brackets and axels to add support.

ARMS

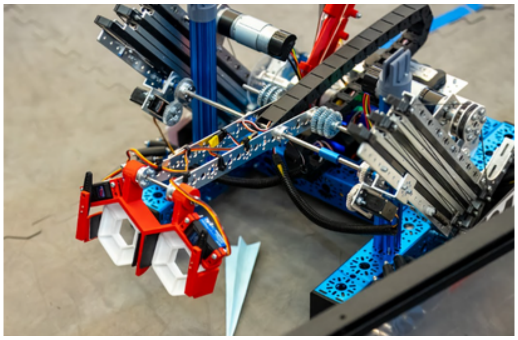


Initially:

- Used metal flats to rotate the claw up to add height to our slide extensions
- Utilized 7 kg - cm torque servos to rotate the arms
- The arms were fairly solid and efficient for our league tournament so we didn't change them in between our League Tournament and Last Chance Qualifier
- We used bevel gears as counter weights for the arms as the 7 kg - cm servos did not have enough torque to turn the arms.

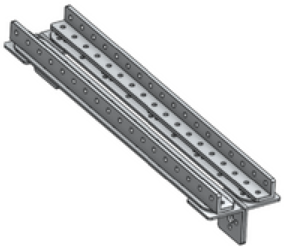
Updates:

- Majority of our updates are detailed in the provincial updates section however some are included below
- Our team wanted to keep the robot in the same orientation for the whole match to optimize the cycle time of the robot. We did this by adding servos that rotate the arms by 240 degrees.
- We increased the servo torque to be able to fully turn the arm.
- Added two drive chains to bring the wiring up to the claw.

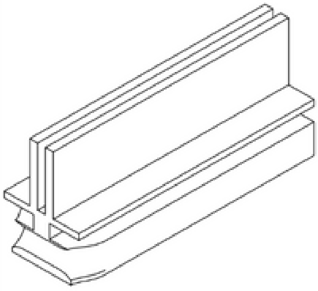


MECHANICAL AND DESIGN

DRONE LAUNCHER



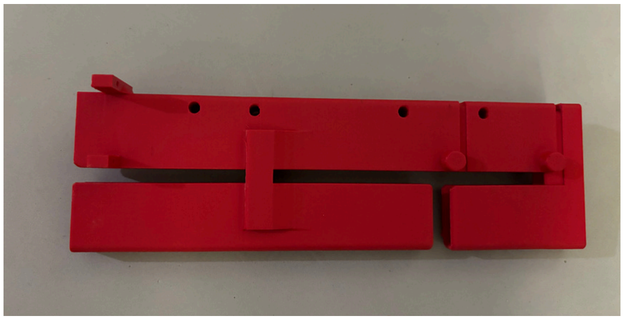
Acknowledging the necessity of a launch trajectory to transfer kinetic energy to our aircraft, we developed a CAD model for our launcher. The construction of this trajectory utilized components extracted from our TETRIX kit, as depicted on the right.



Following this, our focus shifted towards fabricating an optimal glider platform to serve as the resting place for the airplane. The ultimate version, presented on the left, showcases a meticulously designed groove engineered to accommodate rubber tubing and the airplane. This tubing acts as the channel for transferring initial spring potential energy to our aircraft. A servo-mounted plate is utilized to restrain the slider.

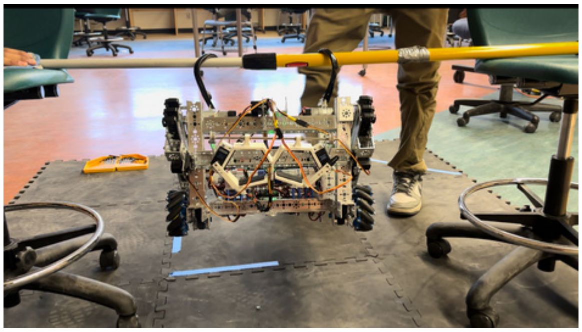
However, complications surfaced with the preliminary design, particularly regarding the servo's capability to withstand the tensile forces exerted by the rubber band, leading to recurrent misfires during competitive events. In pursuit of a solution, we engaged the expertise of Team 14380 Bot Builders to enhance and optimize our design.

Utilizing the combined capabilities of OnShape and Fusion 360, the launcher underwent an extensive redesign process. The resulting design, featured on the right, represents a seamless integration of innovative approaches and precise engineering techniques. This redesign effectively resolves the limitations of the previous version, guaranteeing peak performance and dependable operation in competitive scenarios.

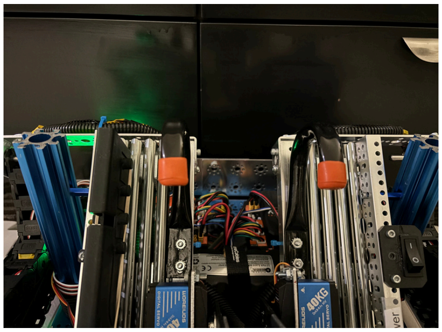


HANG

Previously, our robot employed a hook and winch system, necessitated by the limitations of our slides to support masses exceeding 15 lbs. However, with the acquisition of the newly procured 4-stage viper slides, we could directly affix our hooks onto these slides and employ them for hanging by extending and retracting them. This approach not only simplified our design but also facilitated a reduction in the overall mass of the robot. Additionally, we capitalized on parts reusability, as components from our previous hanging system were repurposed after their removal.



Previous hang system

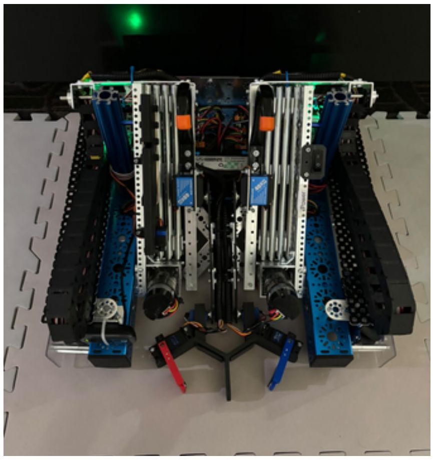


Current hang system

MECHANICAL AND DESIGN

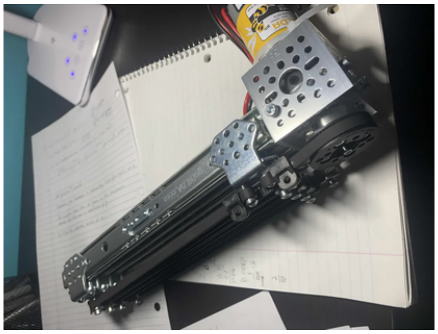
PROVINCIAL UPDATES

Our robot underwent a another major redesign being our third one this season. Our robot swapped out the slides, arms and wiring to make our robot have a faster cycle time. Our robot is depicted on the right.



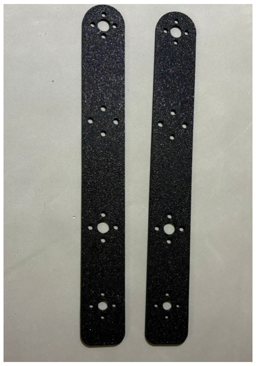
Full Robot

The first step of our redesign was adding GoBuilda viper slides to drive chassis to solidify our slides and reduce their unreliablity. The GoBuilda slides offered reliablity and efficient extension of our robot to reach heights. The slides are depicted below



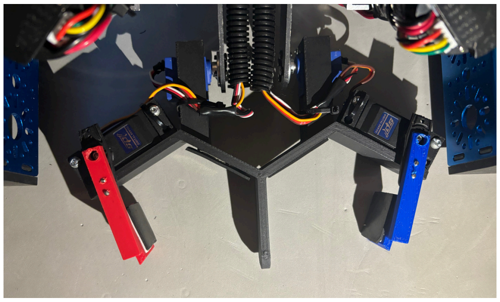
Viper Slides

As previously stated, our team aimed to maintain the robot's stationary position throughout the entire match, prompting us to incorporate a flip mechanism into our arm design. One challenge we encountered with the arm design involved ensuring that the claw remained parallel to the ground. To address this, we engineered custom arms that facilitated precise mounting of the claw. The custom arms, which enable optimal claw positioning, are depicted on the right.



Custom Arms

The latest major overhaul of our robot centered on refining the claw mechanism. We removed the gravity-dependent hinge motion and replaced it with servo motors to control the movement. This enhancement allows us to selectively extract white pixels from stacks during autonomous maneuvers and offers superior precision when placing pixels. The redesigned claw assembly is showcased below.



Lastly, we had a really fun time this season and we wanted to share a few moments during our build season showcasing our progress and some of our funny moment!

MECHANICAL AND DESIGN

OUR MECHANICAL PROCESS

FTC Kit

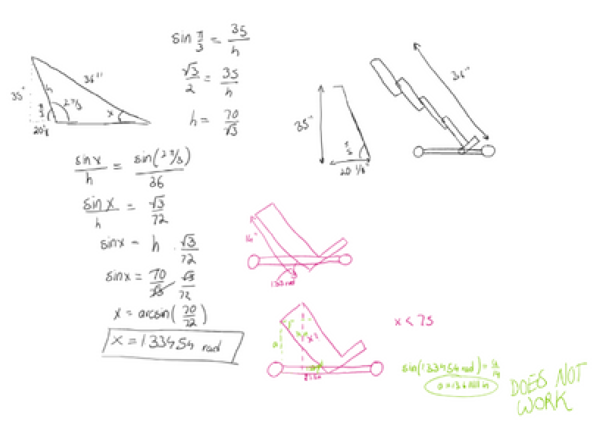
As this is our rookie year, we had to purchase a kit to assemble our drive chassis and provide us with preliminary parts. A few issues we found with the kit was that the parts it came with were bulky and heavy. We try to utilize parts that are as light as possible but our robot still weighs approximately 30 pounds. If we are beginning any new designs we try to utilize parts from the kit and make the best of the weight issue.

3D Printing

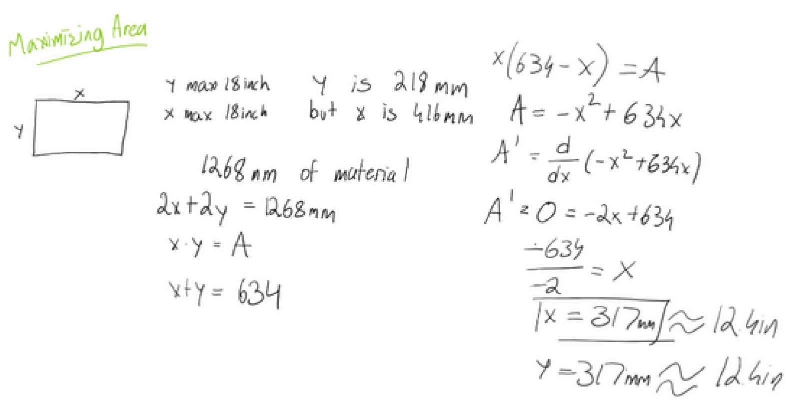
During many iterations of the claw design, 3D printing technology has been a massive aid in the efficiency of prototyping, as it allows us to make specific design changes and test them the day after. Using pre-built parts, such as the ones that came with the kit, would not have allowed us to create such a specific and optimized design since there wouldn't be as much flexibility with the dimensions compared to 3D printing. This is evident in our experience with our drone launcher, as a launcher developed using preliminary parts proved unsuccessful. Another benefit of printing is increased time efficiency because we can work on the claw design without the need for physical materials. We have similarly used 3D printing for the drone launched. The software we use to 3D print is Fusion 360 and all our team members learn the process through our mechanical lead teaching them.

Mathematics

Before building or ordering components for our robot, we utilize mathematics that we have been taught in school. A few of the topics that we have utilized include the sine law and trigonometry to calculate angles and sizing of our robot, derivatives to maximize the area of our chassis, and the torque formula to determine if our motors/servos can handle their task. Displayed below are a few of our calculations.



Using sin law to determine the mounting of the slides

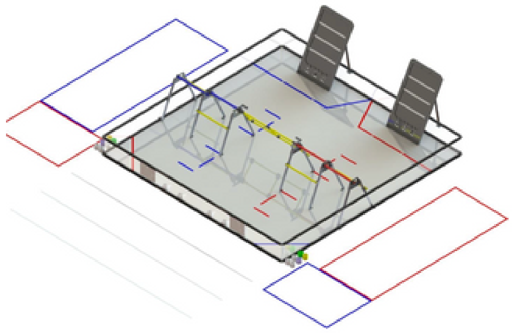


Using derivatives to maximize the area

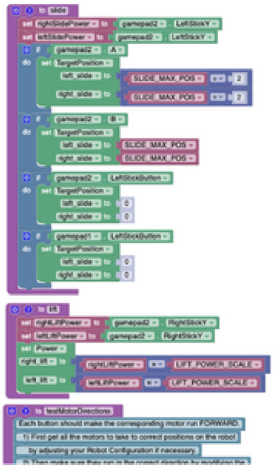
GAME STRATEGY

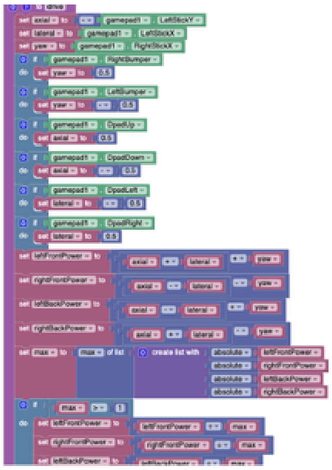
In this year's FTC competition, there are four ways to score pages :

- Pixel placement
    - placed in backstage
    - placed on backboard
- Hanging
- Drone Landing
- Autonomous Mode (color detection, april tags)



In the early stages of our teams design, our primary emphasis was on placing pixels on the backboard.





In the early phases of designing the robot, our primary emphasis was on **placing pixels on the backboard**, prioritizing it over earning points during the endgame. We believed that creating mosaics (comprising either three pixels of one color or three pixels of three different colors) would be key for point scoring. In the coming weeks, we tailored our subsystems to focus on achieving the required height using linear slides and claw mechanisms. We also dedicated a specific sub-team to drone placement, testing various models and launching methods. We developed our scoring up until the Southern Alberta Last Chance Qualifier, where we scored well with pixels, but didn’t have a strong endgame. We focused on improving our endgame scoring while optimizing our scoring in the time between our last chance qualifier and our first provincials. In terms of our robot's autonomous period, the programming team's choice to use block coding has significantly streamlined the integration of color detection, April tags, and pixel placement into our robot. Our game strategy aims to secure points across all four aspects of the competition.

Drive Strategy

With both an operator and a driver on our team, our approach involves preventing clashes between the assigned sub-systems for each individual. For example, when operating our claw mechanism, we ensure that the driver utilizes the D-pad instead of the analog sticks for slower robot movements, to allow for smoother pixel grabbing by the operator. We also do driver practice whenever there is a chance during meets on the practice fields. We have recently begun optimizing our cycle speed and ensuring enough time to release our drone and hang on the trusses.

SOFTWARE

Progression of Software

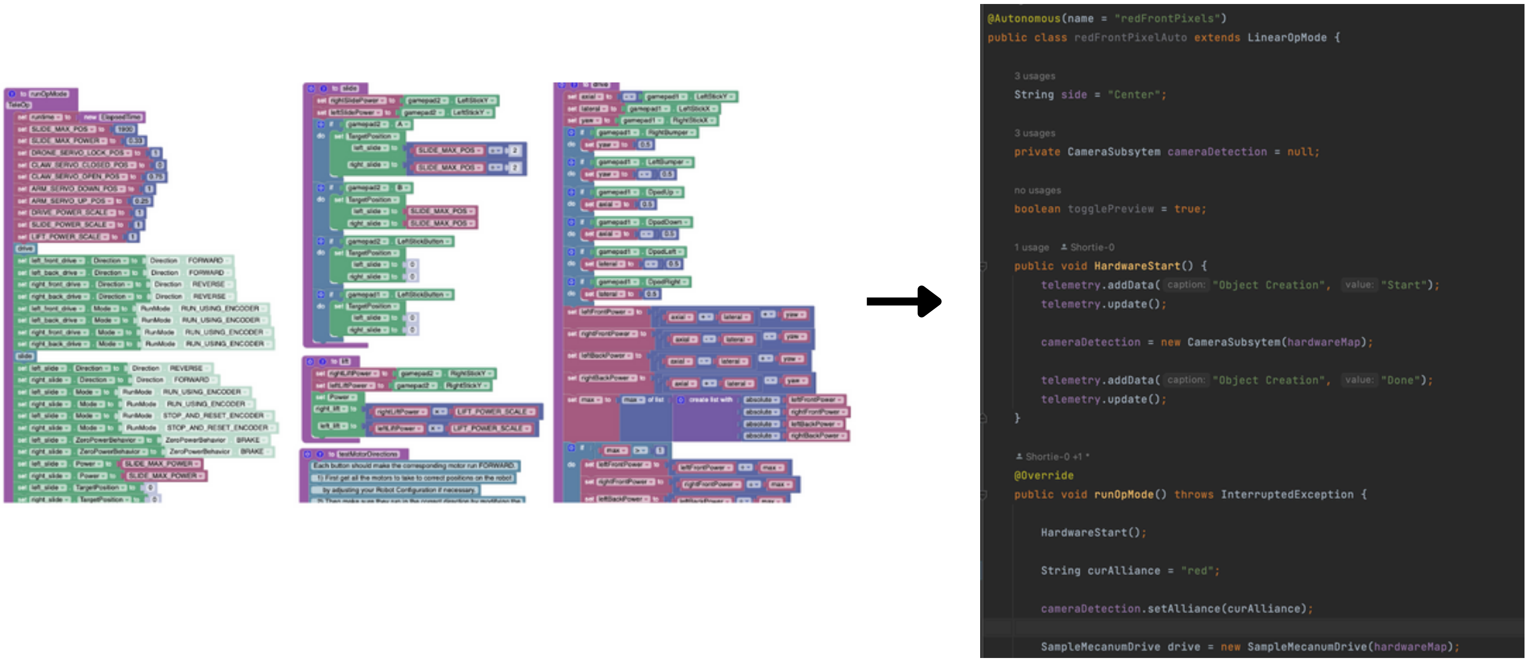
Over the course of our participation in various events, the software development of our robot has undergone significant enhancement. Initially relying on the FTCRobotCode package and standard holonomic x-drive code for basic TeleOp functionality, we gradually expanded our capabilities by creating custom functions for slide and servo control within our outtake/intake system.

During the initial stages, we utilized Android Studio for coding, but challenges arose, particularly in Auto mode development due to the difficulty in visualizing functionality and paths needed. Additionally, the inconvenience of transferring code via wires prompted a transition to OnBot Blocks for the League tournament. However, recognizing the limitations and the need for enhanced flexibility, we reverted to Android Studio, allowing us to fully leverage libraries to enhance our robot's autonomous performance.

The transition back to Android Studio facilitated significant improvements in autonomous and drive code, with notable enhancements such as the adoption of field-oriented drive, utilizing the IMU integrated into the control hub. This approach provided greater precision and control.

Moreover, the integration of the RoadRunner library revolutionized our autonomous pathing. By offering advanced capabilities for trajectory planning, the RoadRunner library significantly enhanced the accuracy and reliability of our autonomous routines, contributing to our team's overall performance in the Southern Alberta Qualifier.

Our programming is described in further detail in our control award



WARRIORS

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