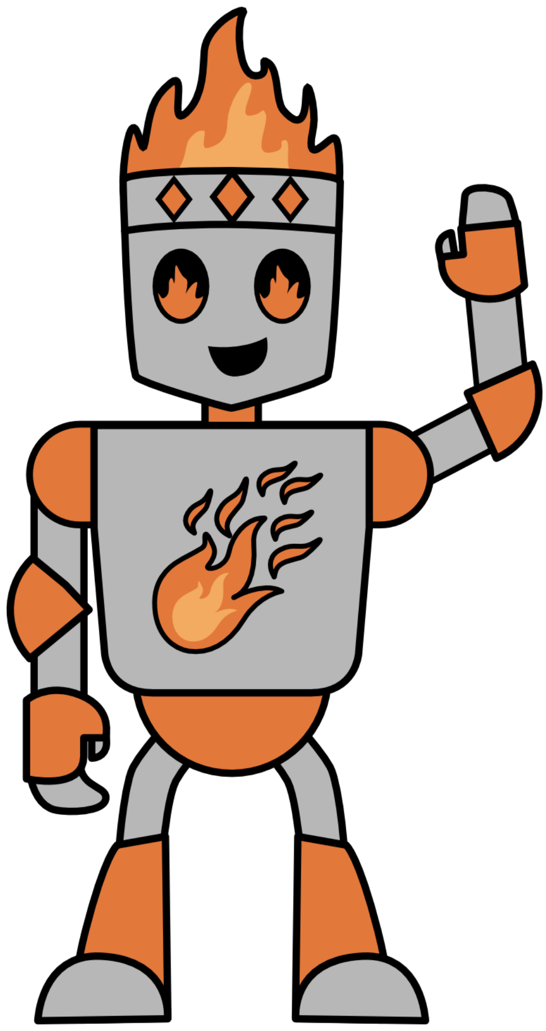
Fremont High Robotics
FTC Team #16533

2021 - 2022

16533 Infernobots Engineering Portfolio



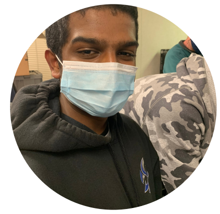
16533
FREMONT HIGH
INFERNOBOTS

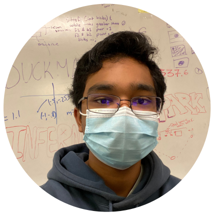
About Us

Team Members

Tanvi (Junior) - Team Lead
3rd year organization
Enjoy: Basketball, Reading, & Listening to Music

Lokesh (Soph.) - Mech
2nd year on Infernobots
Enjoy: Reading & Playing Video Games





Vinay (Junior) - Mech
2nd year on Infernobots
Enjoy: Tennis & Hanging Out With Friends

Dhruv (Freshman) - Mech
1st year on Infernobots
Enjoy: Basketball & Football

Eshika (Junior) - Events Lead
1st year on Infernobots
Enjoy: Cheer, Working at Golfland, Spending Time With Friends

Neel (Freshman) - Mech
1st year on Infernobots
Enjoy: Reading, Music, Playing Guitar

Mahika (Soph.) - Software
2nd year on Infernobots
Enjoy: Reading, K-pop, coding, writing fiction

Nikash (Freshman) - Mech/Design
1st year on Infernobots
Enjoy: Tennis & Video Games

Shivani (Soph.) - Software
1st year on Infernobots
Enjoy: Public Speaking (Speech Captain), Baking Bread, Music

Brian (Freshman) - Mech/Design
1st year on Infernobots
Enjoy: Playing Basketball & Doing Science Olympiad

Jaidev (Soph.) - Software
1st year on Infernobots
Enjoy: Basketball & Graphic Design

Aditya (Soph.) - Mech
2nd year on Infernobots
Enjoy: Reading

Mihir (Freshman) - Mech
1st year on Infernobots
Enjoy: Playing Video Games, Build Legos, Biking

Aagrim (Soph.) - Software
1st year on Infernobots
Enjoy: Marching Band and Being with Jaidev

Mentors

Our mentors act as the team's most valuable and trusted resources. Volunteering their time and energy to help our team, we would not be where we are today without their knowledge and advice. They've taught us how to look for new perspectives, think through ideas, and practice professionalism while working as a team.

Arie - 3rd year with Infernobots
2 Year FRC Mentor
Manages team of network engineers at Google

Matt - 1st year with Infernobots
Been a member of, and mentored FRC
Software Engineer at Google
Plays Japanese taiko drums

Mission Statement

The Infernobot's mission is to spark interest in STEM to all students regardless of background in a fun and instructive way, allowing students to be a part of a supportive system as they develop their interest in robotics.

Team History

The Infernobots were founded in 2019 as a part of the Fremont High Robotics Organization, with 15 members. With guidance from FRC adult mentors, the team was able to work together and successfully built a robot in time for competition. Despite the challenges we had to overcome as a rookie team, every member gained valuable knowledge about robotics, and was rewarded with a fully functioning robot that everyone took pride in.

In 2020, restrictions from the COVID pandemic forced quick adaptation from the mentors and newly implemented leads. With support from our mentors and each other, we developed innovative solutions to get value out of the online season. Through summer online trainings, weekly online meetings, and socially distant in-person meetings on Saturdays, we were able to build a robot and learn from a season with unexpected obstacles.

Team Structure

To ensure that the team runs smoothly, the Infernobots are split into sub teams:

- BaM team (nontechnical)
  - Business
  - Media
  - Events
- Mechanical and Software (technical)
  - Design is counted as a subsection of mech
- Students may choose one technical subteam and/or one non-technical subteam

Pre-Season

The Head Mentors of all three FTC teams took part in the Selection Process. They interviewed and looked through the students' portfolios and presentations. Rather than searching for previous experience, the mentors highly valued potential and a willingness to learn.

During training, students who choose to specialize in mechanical dismantled the robot from last season to get some hands-on experience, and took some Onshape training courses to gain an understanding of CAD. Students who choose to specialize in software did some basic practice with motors and different functions to understand what the block code for the season would be like.

Team Goals

Mechanical: This year, our goal is to come up with an efficient and effective design process that allows us to work together to create mechanisms that we're proud of. We also want to build on our usage of CAD to model designs, so we can visualize our work in a more effective way.

Software: Our goal is to keep the code simple, and not too hard to debug. We want to try to have an efficient and effective autonomous plan, along with intuitive tele-op controls.

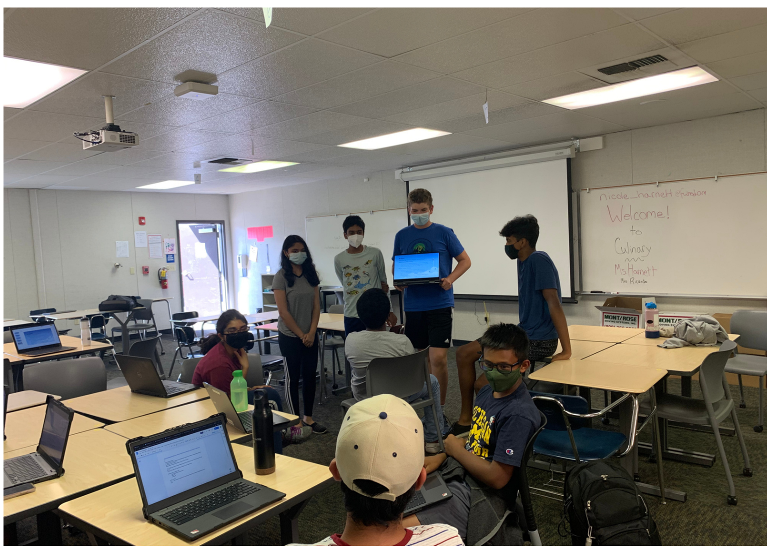
Drive: Through constant, clear communication, our drive team must have full trust in one another and work cohesively to effectively score points.

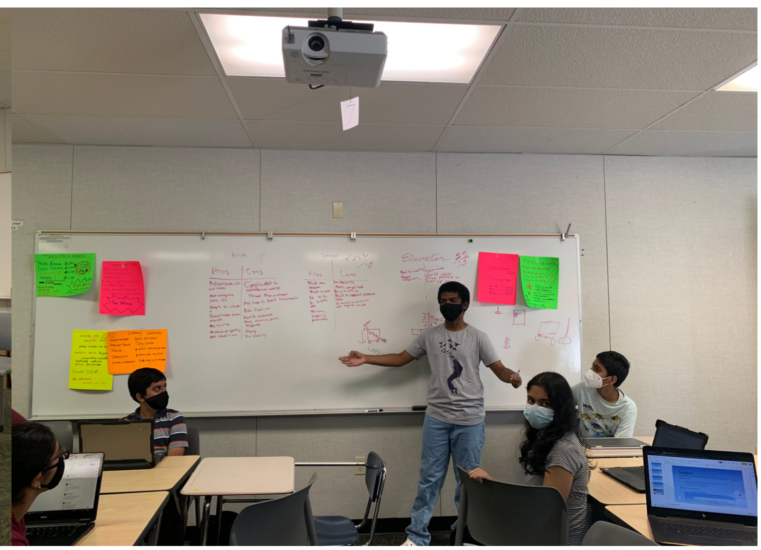
BaM: We want to try to do more in-person outreach events, to foster more personal connections with our community, and garner an interest in STEAM.

Team Plan

This season, our main goal was to bounce back from a season in which COVID created an obstacle. Through perseverance and an increase in experience, we wanted to see an improvement from previous seasons. At the beginning of our season, we didn't know each other incredibly well, but through the amount of time and effort that we've spent working together, we've grown into a close-knit team. The experiences that we've had throughout this season allowed us to grow closer, and to grow as individuals.

We began the season learning about FIRST and the FTC competition, analyzing games played in previous seasons. Our first meeting was the kickoff where we began brainstorming a design for this season's robot. As one of the first official meetings for our team, we set a positive and lighthearted environment that would remain for the duration of our season.





Sustainability

The Infernobots are fortunate to be in a position to acquire grants from our generous sponsors. Being based in Silicon Valley, our team is grateful for the mentors' extensive knowledge and expertise. Since starting our team, we have been able to fund our operations with grants from a number of sponsors.

By increasing our technical expertise and leveraging existing and new connections, we aim to provide additional career development opportunities to other FTC teams. With these goals, the Infernobots hope to continue our pursuit of excellence in engineering, leadership, and community service.

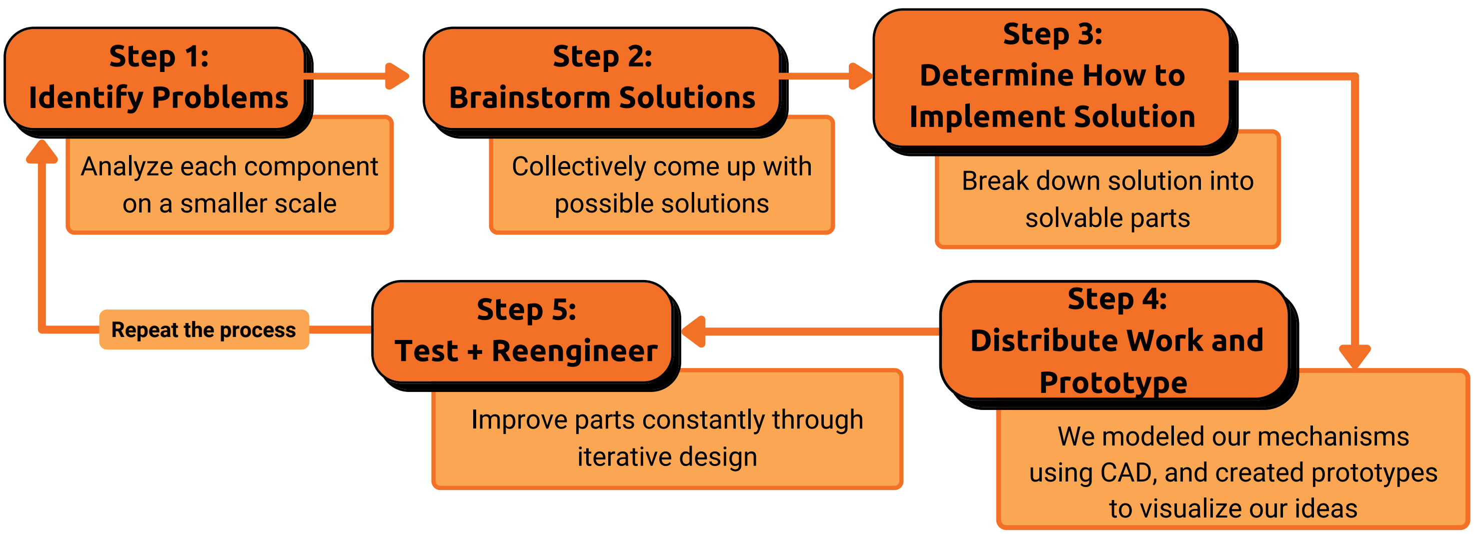
Engineering

We keep these key principles in mind when designing, prototyping, and testing:
Simplicity: Our robot needs to be easy to fix and maintain, enabling quick adjustments, singling out errors during decoding, and sharing ideas

Reliability: By rigorous testing, prototyping, and redesign, we can adapt to different game conditions that can change in an instant without breaking.

Usability: However advanced our robot is, we cannot score points if we can't use it. Allows us to score points and conjoin mechanical, software, and drive team aspects.

Design Process



Lessons Learned In Design Process

Over the course of our build season, we witnessed the long–sometimes frustrating–journey to build an robot. However, by developing a design process that works for us, we learned that this journey is incredibly rewarding. We learned the importance of considering all possible ideas when brainstorming, and considering all possible variables. An insight that proved to be particularly impactful was documenting everything, which included taking pictures, videos, and writing about the specific work that we did. When we had to rebuild mechanisms, as we often did in our iterative process, it proved useful to have lots of documentation to provide a template for our work.

After a brainstorming process in which we determined the strengths and weaknesses of every mechanism, we utilized iterative design to complete our first prototypes of the mechanisms. During the build process, we found that spending careful time on design rather than immediately jumping into prototyping allowed us to be more efficient and find shortcomings before disassembling. We discovered how important this was while working on the arm mechanism. On many occasions, we needed to rebuild due to issues with the reach of the arm. After that experience, we all learned how important it is to stress the design planning beforehand, then carry it out.

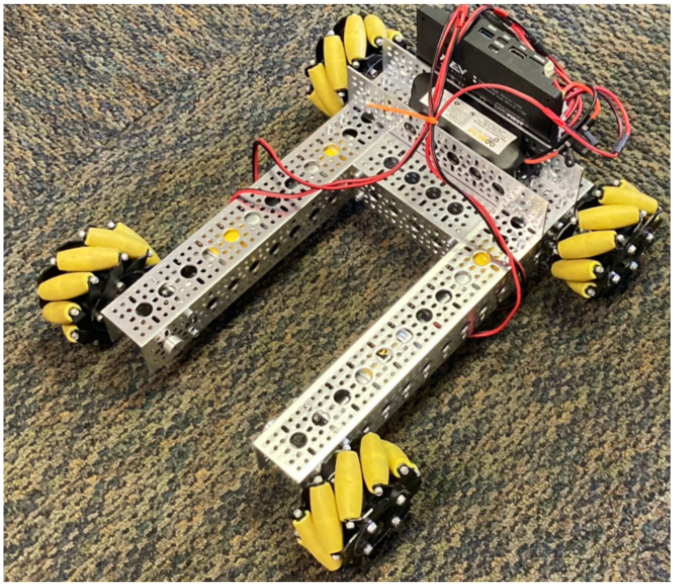
Mechanical

Drive Base

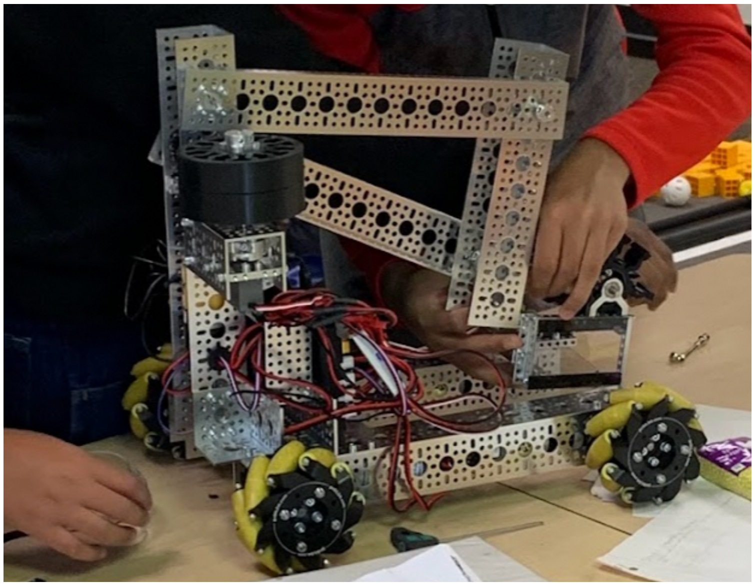
The first drive base prototype featured mecanum wheels for strafing left and right, while also being able to move forwards and backward. It is much more efficient than having to pivot left or right using regular omni-wheels. Our next prototype featured a slimmer body and the removal of the expansion hub. We needed to make a robot that could fit in a 13.7-inch gap, so we slimmed down the chassis. We also calculated the number of ports for motors and servos we would need and decided that we wouldn't need the expansion hub.

Once we understood the different types of chassis, we had a good idea of what we wanted to build for our final drive base design.

Our new drive base design is small enough to fit between the wall and barrier gap and be slightly shorter for easier maneuvering. It supports our parallelogram arm, intake system, and carousel wheel. This is our main chassis for this season, we put the control hub on the back of the robot to free up space in the front.

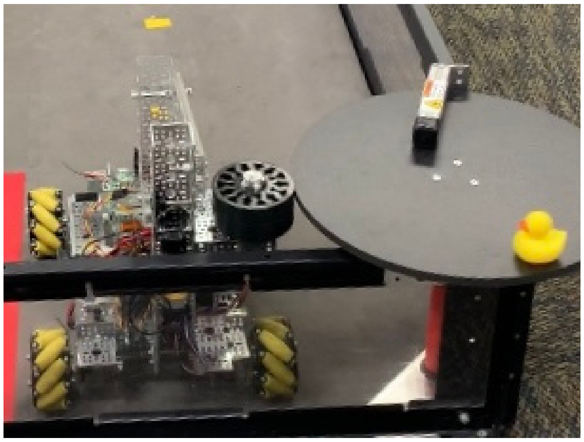


Slimmed down chassis with mecanum wheels



Final drivebase with mechanisms attached

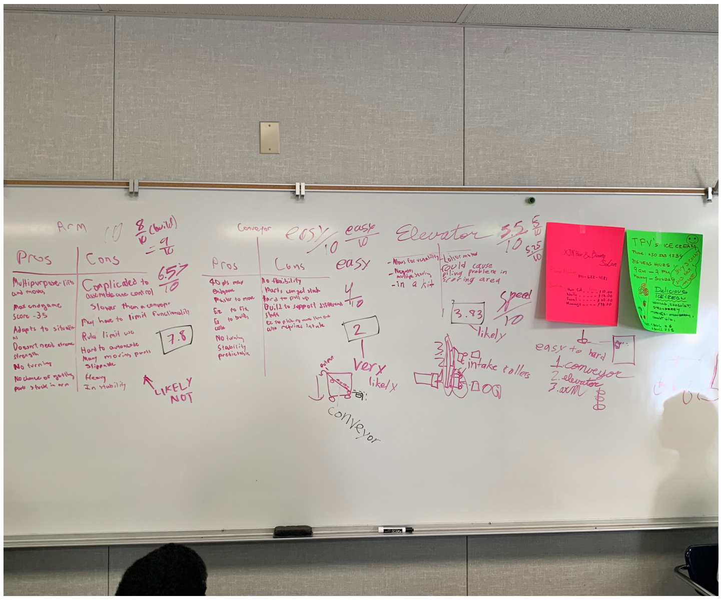
Carousel

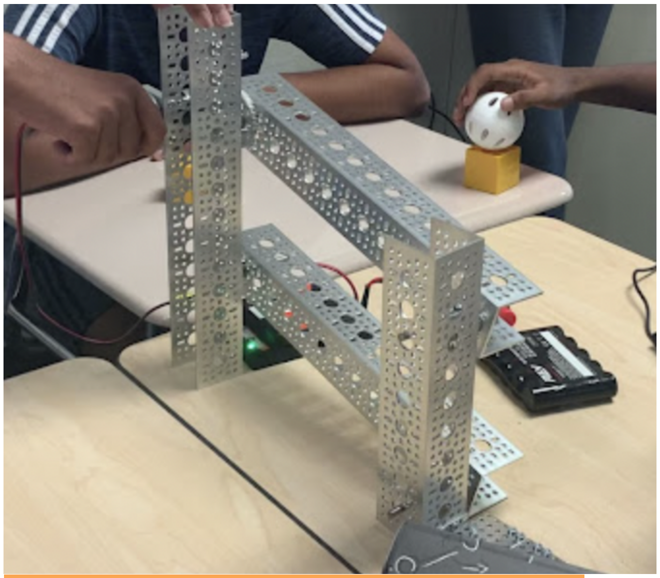


After analyzing the carousel, we decided on how to create an efficient and streamlined design. Our first prototype was essentially a servo attached to an axle with one wheel. We decided to make the area where it is attached to be bigger, so it is easier to mount, and we made it have 2 wheels instead of 1, so our robot's position doesn't have to be extremely precise. Finally we used a smaller axle because we wanted to mount the carousel higher on the robot, in a more convenient spot.

Arm

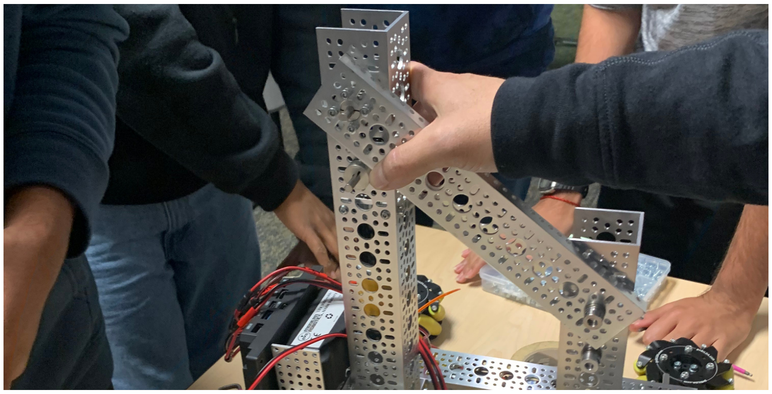
Coming up with a strong, reliable arm mechanism was one of the biggest challenges we faced. After a significant amount of brainstorming, we narrowed our choices down to three options: a "grabber" arm, a parallelogram mechanism, and a conveyor. Through further brainstorming, we decided that the best way to go was the parallelogram mechanism.





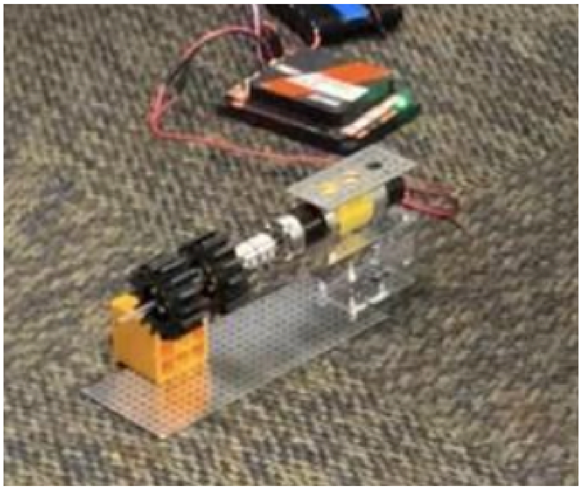
An early prototype of our parallelogram

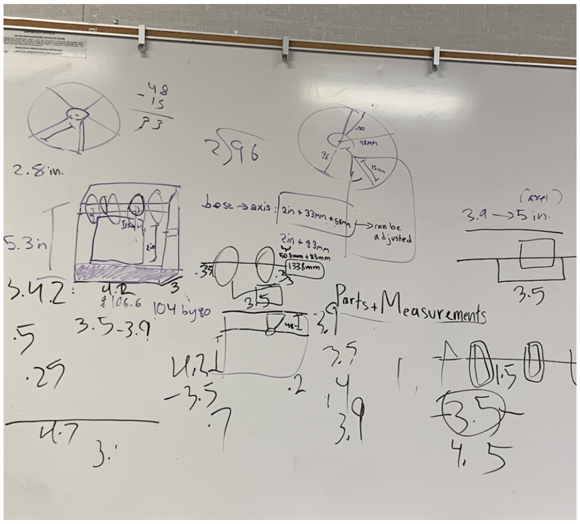
The first thing we did was determine that having the arm at rest would form a right triangle which allows us to use the pythagorean theorem to determine the dimensions of the arm. We then determined the specific dimensions of the arm by testing out different values for the height of the supporting beam and the length between it and the lowest point of the arm. We also decided to replace our original 312 rpm motor for a 30 rpm motor in order to have an automatic brake engaged when our arm is at various stages of height.



We faced multiple issues throughout the build process of this mechanism, but they were all eventually solved. Our first time attaching the arm channels to the end piece, we placed our arm channels too low, hindering our ability to attach the intake. We moved our arm channels further up to solve this, but once we did that, we realized that mounting our motor on the top side of our base U-channel exceeded the height limit for our robot. Also, we mounted the arm channels higher up on the robot in order to reach the top goal. Lastly when testing our mechanism, we found out that the screws that we used to mount the motor were restricting the arm's range of motion so to fix this, we moved the screws to a different location. Later, we realized that our robot exceeded the length limit, so we tested various options for the length of our robot arm in order to find out the optimal length.

Intake





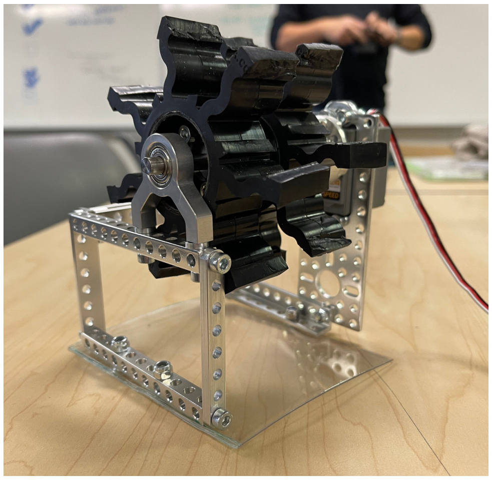
We decided to design an intake because we wanted to have a way of delivering freight. We saw that the other option, a "grabber" arm, would be more complex with more moving parts, which leaves more room for failure. This is why we decided to create a simpler intake mechanism to avoid this.

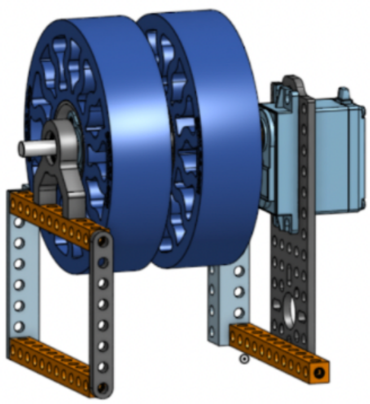
How did we come up with the core idea? During the start of the season, we were scouring the internet for different Freight Delivery methods.

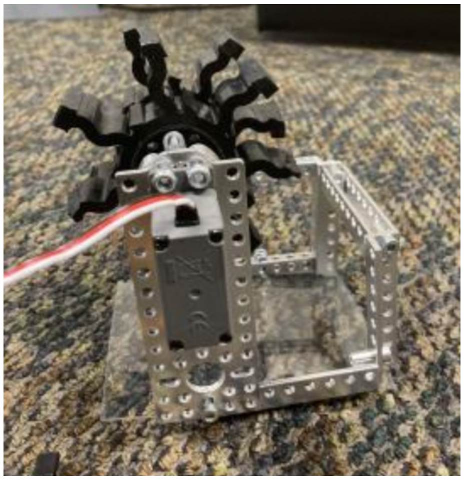
Then, we came across a photo of an intake system used in previous years. Although that wasn't really a system that worked with our current drivebase/arm/strategy, after some team discussions and brainstorming, we came up with a (very) rough prototype of the intake.

Since we noticed that this prototype was very big and heavy, we decided to try to make a smaller box with the wheels controlled by a servo. After a lot of calculations we decided on what types of parts we'd need and how they should be positioned. After discovering that many parts we needed were out of stock, we chose to figure out alternative parts we could use to make the intake. We then used OnShape to create the CAD for the intake.

We then built the box and the intake wheels, later having issues with attaching the plastic piece on the bottom to hold the freight. We first made the plastic piece exact, and fully circular holes, but this caused a lot of tension with the plastic piece making it arch. We fixed this by making the piece shorter in length, and made the holes more like ovals with washers. We then mounted it to the elevator, and added plastic to the sides, and moved the wheels to the front to make it work.







Autonomous

Our auton consists of 3 main sections; detecting the barcode, rotating the carousel, and putting the cargo into the shipping hub on the right level. Also, we needed to move up to 3 or 4 times between these tasks, and drive into the warehouse at the very end of the autonomous period.

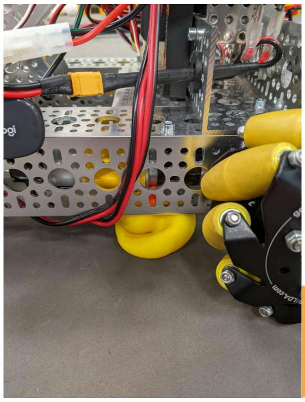
We have two main sectors to initialize: the motors and TensorFlow OD. To initialize the motors, we have to set the wheels zero-power behavior to COAST, which will allow the wheels to rotate freely after the motors are powered to 0. With TensorFlow, we first have to use the built in Vuforia library to set up the camera. We had to find the proper webcam that was connected to our RC and set up a suitable confidence value for identifying objects.

To detect which position the duck was in, we used TensorFlow, the built-in machine learning library used for detecting objects in the camera. As our camera doesn't have the field of view to see all three ducks, we place the robot between two barcodes, and only look for the duck in two of the three positions; we can infer if the duck is in the third position if we don't detect a duck in the other two positions.

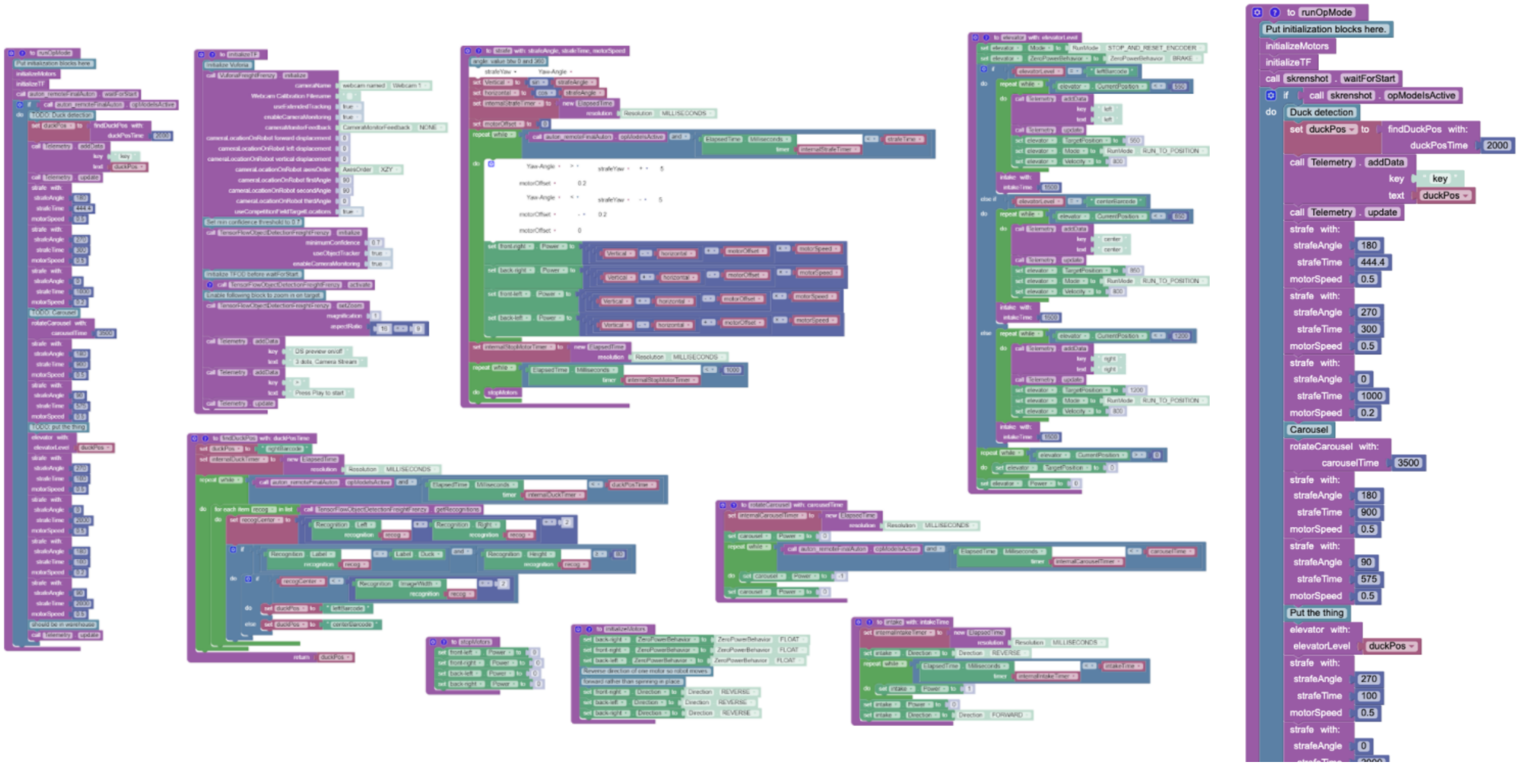
The carousel rotates on a continuous rotation servo. This will be the first step of our autonomous period. It works by first (gently) running the robot into the carousel to make sure that the wheel is contacting the carousel, and then setting the servo's power at the right time and then turning it back to 0 after a certain amount of seconds. This rotates the wheel and the carousel, which pushes the duck off.

To place the cargo on the shipping hub, we raised the elevator into one of 3 predetermined positions by using the run to position mode of the motor. Then, we rotated the intake in the opposite direction, ensuring that the block is pushed out of the intake. Finally, we bring the elevator back down and continue on our way.

We made a function that takes in the time, angle, and speed of which to strafe at. The way we determine motor power is by taking the sine and cosine of the angle, adding them, and then multiplying by the motor speed. We have a time input compared to an internal timer to determine the runtime for the motor. At the end of each movement session, we stop the motors for about half a second for the motors to coast to a stop.



duck stuck under robot during Auton



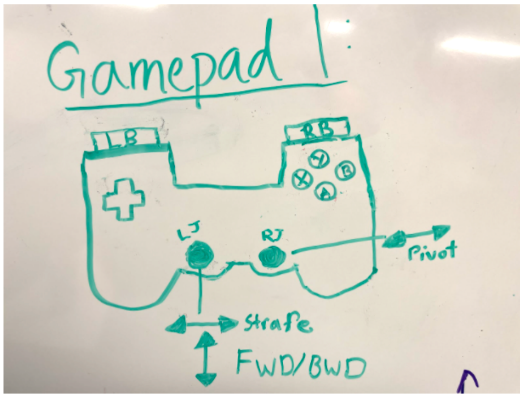
Driver-Controlled

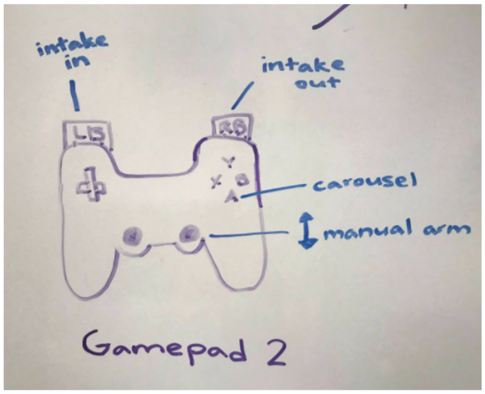
Our goal for the driver-controlled period was to make driving as intuitive with the gamepad controls as possible. In our TeleOp code, we made sure to incorporate four main parts needed to control when driving. They are: Driving (forward, back, strafing, pivoting), elevator movement (up and down), Intake/Outtake and the carousel.

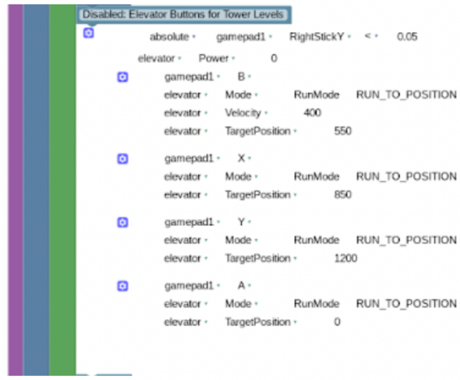
To decide which buttons are intuitive and easy for our drivers to remember, we drew out a diagram to map things out. Firstly, we decided that our two drivers will divide the actions between 2 controllers. Gamepad 1 will control the driving exclusively and Gamepad 2 controls the mechanisms. We used the joysticks for our driving motions and our elevator movement. The development of this is a continuous process that changes as we discover new things.

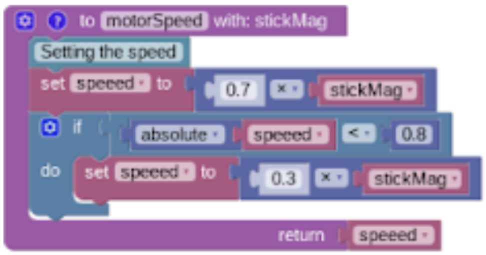
We used math and our understanding of piecewise functions for the driving to become easier. We noticed that having one value for the speed was too fast for a driver to accurately move. By having the speed depend on the position of the joystick, it makes driving a lot easier and more controllable.
For the driving code, we made three variables – pivot, vertical, and horizontal – in order to have each wheel move accurately. We also assigned the front left wheel to a servo port in order to have a port available for our intake.

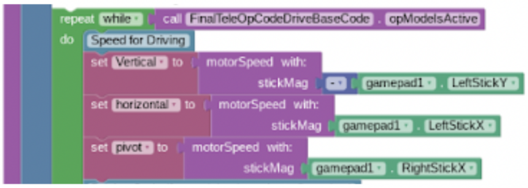
As for our elevator, we decided to assign it to the right joystick. Initially, we used the A, B, X, and Y buttons on the gamepad to correspond to different levels on the shipping hub, but we eventually found that it was far too complicated as the zero level was different every time the code was run. For our intake and carousel, we chose to use one button that can be held to run the mechanism, as we figured this would be very intuitive for the drivers.

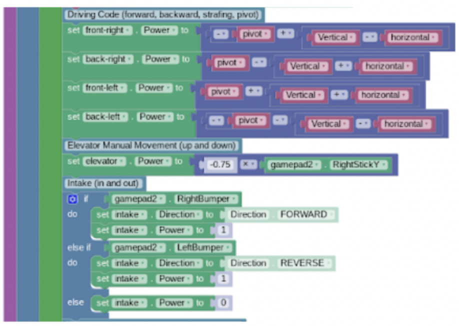


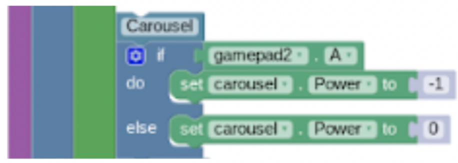












Drive Team

In the days leading up to the competition, we determined the interest level of driving the robot in the team members. We separated the members interested into groups of 3: one driver for the arm, one for the robot, and the coach, who is fluent in the game manual and team strategy.

To aid in the decision process of determining each role, each member with interest drove the robot for a short amount of time to gauge their own abilities. In their three-person teams, they decided their own roles, ensuring that they have a role best suited to their individual capabilities.

Once deciding the drivers and coaches, they practiced and studied their individual areas to guarantee maximum efficiency and rhythm during the game.

Outreach

Robo Fun: Sunnyvale Public Library Event 2020

50 Attendees

At the Fremont High Robotics' "Robo Fun" event, games such as Guess the Robot and dancing to the Cha-Cha slide taught children about how robots are similar to humans and robot components.

STEM Scouts Series: Infernobots x Scout Troop 87

15 Attendees

The Infernobots hosted an outreach event with around 15 attendees from Boy Scout Troop 87. During the event, we hosted a workshop on Zoom teaching our attendees how to design 3D objects using OnShape, and we showcased our robots to the attendees. In our presentation, we helped them take steps toward achieving their Robotics Merit Badge by introducing them to different types of robots and their applications.

Robo Fun: Sunnyvale Public Library Event 2021

80 Attendees

Fremont had its annual "Robo Fun" event with the Sunnyvale Public Library, going back in person in the library plaza. The Infernobots helped staff the event.

FLL Presentation & Demo

19 Attendees

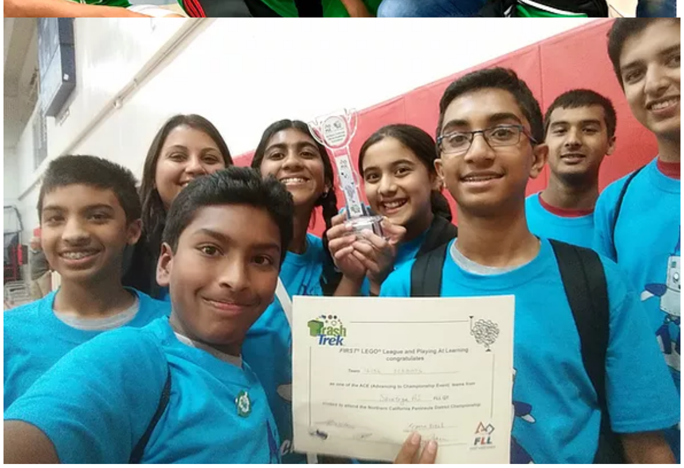
The Infernobots hosted a webinar at an FLL tournament hosted by FHS robotics with around 19 attendees. During the event, we gave in-depth explanations about the mechanical aspect and the software aspects of the team. The attendees also played a game called, "Identify the Command" in which they viewed software code and tried to identify its function.

FLL Mentorship

Beginning in 2015, the Firebots extended beyond FRC and founded two FIRST Lego League (FLL) teams with middle school students from the Cupertino Middle School Area. Our goal was to help students pursue STEAM with hands-on experiences and build character through the values FLL emphasized. Since then, we've mentored over 4 teams and helped them earn multiple awards, including advancing to the regional level.

In 2020, a dedicated team of students spent the summer working on a video series to help FLL Challenge teams start their season during the pandemic. We still wanted to make learning accessible, so a set of videos immortalized our guidance for all future teams. The videos covered basic concepts of the 4 main sections: Fundamentals, Project, Robot Design and Strategy, and EV3 Programming.

This year for the 2021 season, we aren't mentoring teams directly to pursue a larger community impact project, however, we continue to encourage interested students to start their robotics journey through FLL at our outreach events.



Business/Finance

16533 FREMONT HIGH INFERNOBOTS

2021-22 Season FTC Budget

CATEGORY	ITEM	COST
TOTAL		*$6925.00*
Competition Registration		
	FTC 1 Season Registration	$300.00
	FTC 2 Season Registration	$300.00
	FTC Qualifier 1 Registration	$75.00
	FTC Qualifier 2 Registration	$75.00
Competition Kits (FTC)		
	FTC 1 Competition Kit	$1,000.00
		$1,000.00
Robot Parts		
	FTC Robot Parts	$2,000.00
Competition Travel		
	FTC (food)	$500.00
PR / Marketing		
	T-shirts	$375.00
Other Competition Expenses		
	FTC Field Elements	$500.00
	FTC Pits	$200.00
	FTC Scouting / Strategy	$50.00

Platinum Level ($3501+):

Google
the foundation FREMONT UNION HIGH SCHOOLS
Howard Family
Family Foundation of FHS Alumnus
Apple
ClickUp

Gold Level ($1000+):

INTUITIVE SURGICAL
Rotary Club of Sunnyvale
Igx
BAE SYSTEMS INSPIRED WORK
QUALCOMM
FIRST NorCal
Sreedhar Family
The Corfmat Family
The Loldj Family

Silver Level ($500+):

TURBINE
Ghanta Family
Joshi Family
Lau Family

Bronze Level ($250+):

NASA
A.K. Singh
Anonymous
Panse Family
Rebecka Estrada
Shivaram Bhat
Stone Family
The Jarada Family
The Oh Family
Vinay Jain
Ziper Family

Fremont High Robotics is a 501(c)3 non-profit organization and relies on community support through corporate grants, fundraisers, and private donations to cover various expenses, including tools and tool upgrades, safety equipment, marketing supplies, robot materials, and much more. The generosity of our sponsors is what allows us to keep the individual costs low and enable students in our diverse community of all socioeconomic backgrounds to learn and try hands-on experience in STEAM from FLL/FTC to FRC.

Our business subteam help manages money spent and raised and communicates with each division in the Fremont High Robotics family. Through applying for grants, the business subteam has also learned valuable skills connecting with companies in the business world.

We would like to thank all our sponsors for supporting us throughout the years!