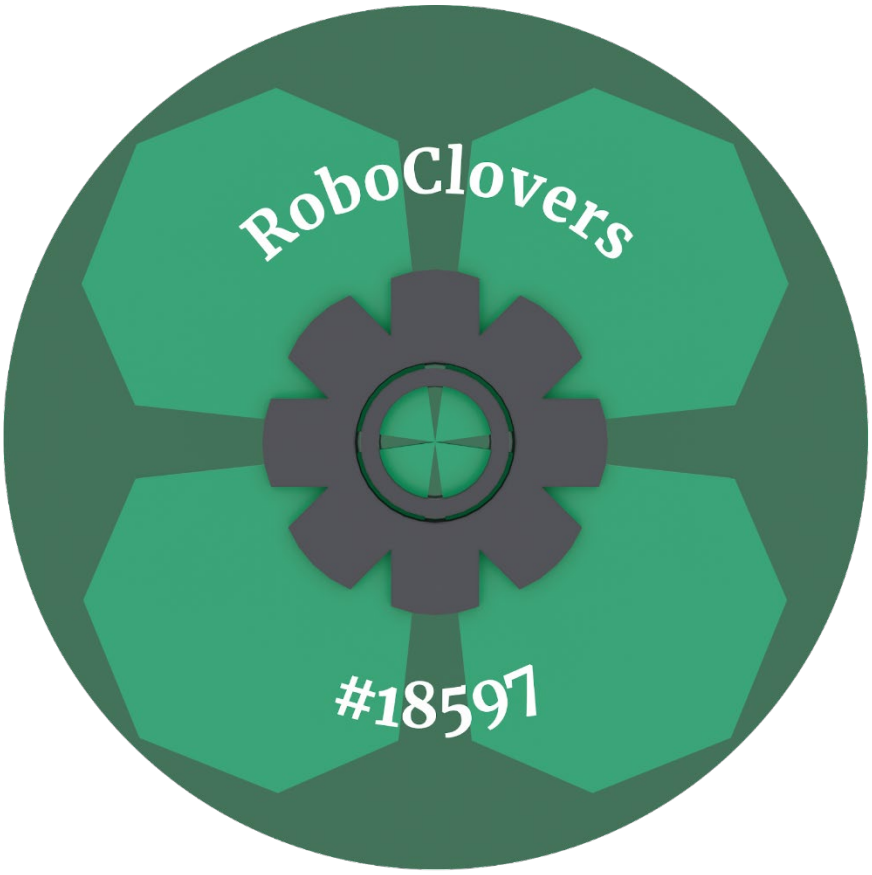
18597

POWERPLAY
ENGINEERING PORTFOLIO
2022-2023



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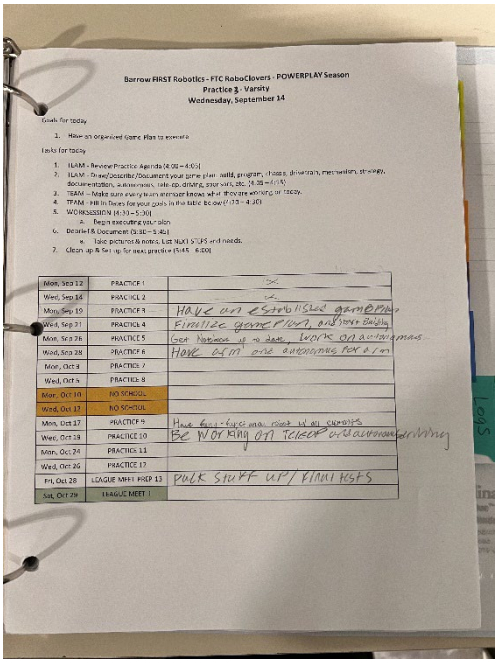
MANY THANKS TO OUR PRIMARY SPONSORS FOR THE POWERPLAY SEASON:

TEAM PLANS & GOAL SETTING

We set TEAM and PERSONAL Goals each practice based on two criteria:

1. TIME
   a. Preseason until Kickoff
   b. Research & Development
   c. League Meets
   d. Tournaments
   e. Postseason
2. RESPONSIBILITIES
   a. Building & Logistics
   b. Programming & Strategy
   c. Business & Communications



TEAM PLANS & GOALS

- ✓ DOUBLE OUR SPONSORS
- ✓ START A JV FTC TEAM
- ✓ MENTOR THREE FLL TEAMS
- ✓ HOST AN FLL TOURNAMENT
- ✓ INCREASE OUR COMMUNITY STEM CONNECTIONS
- ✓ POST TO SOCIAL MEDIA WEEKLY
- ✓ BE THE BEST POSSIBLE ALLIANCE PARTNERS
- ✓ QUALIFY FOR THE ELIMINATION ROUNDS AT OUR LEAGUE TOURNAMENT
- ✓ HAVE FUN AND LEARN SOMETHING NEW EVERY DAY

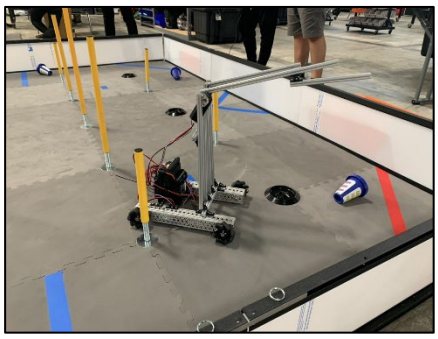
OUR TEAM

SHANE Build Team Sponsor Recruitment FLL Mentor FLL Judge XP: 2 years	**LOGAN** Build Captain Driver FLL Mentor FLL Judge XP: 7 years	**NIKOLAS** Team Leader Coach EN Officer Alliance Scout FLL Referee XP:2 years	**COREY** Programming Team Driver CAD Designer TensorFlow Trainer FLL Referee XP:2 years
SAM Programming Captain Human Player JAVA expert FLL Referee XP:2 years	**KAITLYN** Business & Com Captain Social Media Videographer Outreach Merch/Marketing XP: 2 years	**CATHERINE** Build Team Communications Team Recruiter Merch/Marketing XP:2 years	

HARDWARE & BUILDING

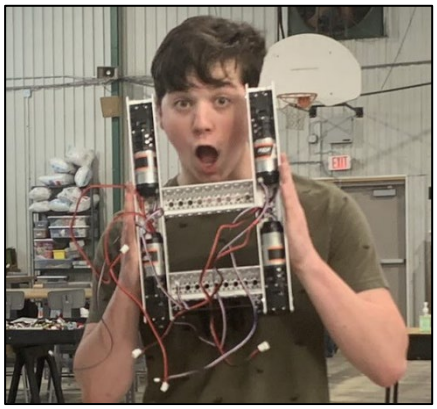
"Hands on experience is the best way to learn about the individual aspects of the robot."
-- Logan, Captain of Building Team

Research & Development - Robot Iteration 1:

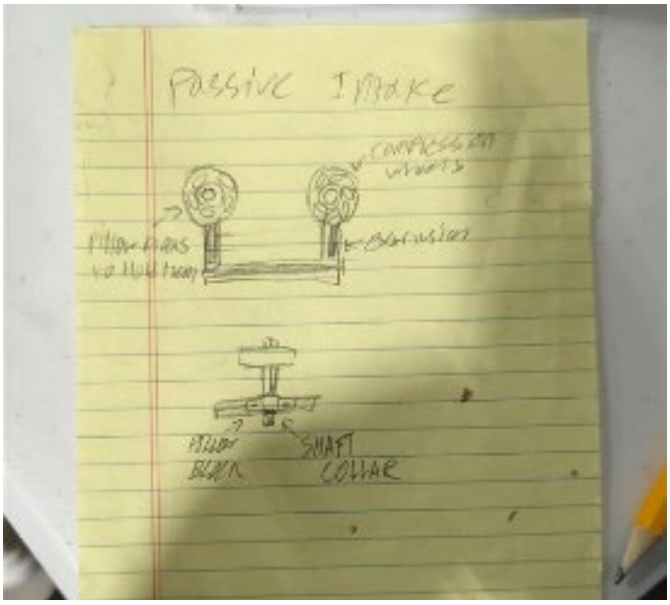


This was the beginning of our robot (September 12 – Oct 3) when we were figuring out what kind of drivetrain, arm, and intake to use. We thought of using a linear motion kit but decided that we could gain more points doing ground, low, and middle goals by moving around the field efficiently with a small and nimble drivetrain base.

- Drivetrain
  - Made with 4 20:1 motor with 90-degree gearboxes inside the frame rails to take up less space and be more efficient.
  - Used 70mm (about 2.76 in) mecanum wheels, which got stuck on ground junctions and would often unplug our wires
  - Used U-channel and inside corner brackets to make a solid and reliable base.



- Arm
  - Had a basic straight arm manipulator
  - Used one core hex motor to move
  - Several Protype intakes were being tested, but none were attached to the arm
- Core
  - The core of the robot stayed remarkably similar throughout this season, it had a control hub, expansion hub, and battery

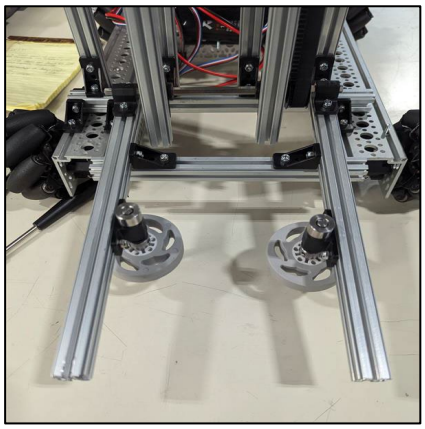


League Meets 1 & 2 - Robot Iteration 2:

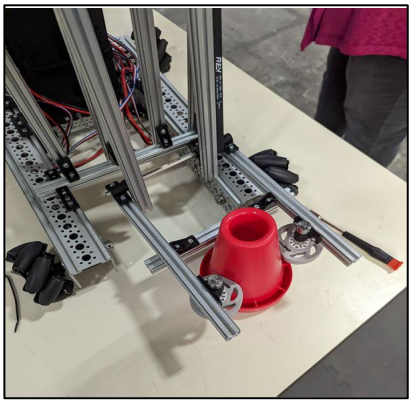
For the first and second meeting, we used the robot shown in the top picture. In this iteration, there were issues with the passive intake not holding the cones and being unable to use them on either side of the field. It also had trouble quickly releasing the cones on ground junctions which made it hard to do the circuit efficiently. The issues with the low ground clearance of the wheels quickly became clear and was something we had to address before the next meeting.

Improvements:

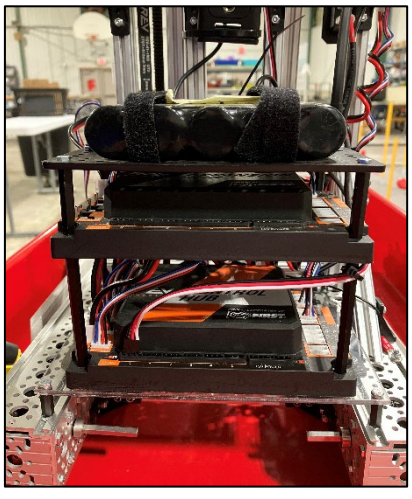
- Drivetrain
  - Chassis stayed the same as the earlier iteration.
  - 720p front-mounted camera for detecting signal sleeves.
  - Consolidated electronics more securely with a stacked tower design to keep it safe and structural.



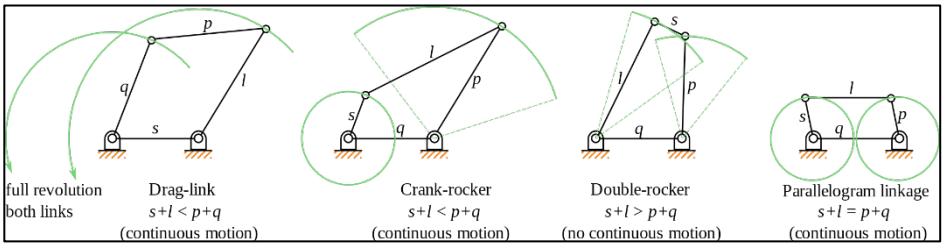
- Arm
  - It was the first test of a virtual 4 bar linkage with a chain and sprocket that allowed us to keep the cone perpendicular to the floor.
  - Arm was not as structurally stable as we wanted, but a good concept to improve upon.
  - We braced the arm with extra support beams which made it more stable
  - It can reach ground, low, and medium junctions.
  - Within this time, we also torqued up the motor with a 3:1 gear ratio to give more strength and accuracy.



- Intake
  - We created a passive intake that can control and possess a cone by pushing against a wall.
  - Slow, but a good prototype



Four-Bar Linkage Reference

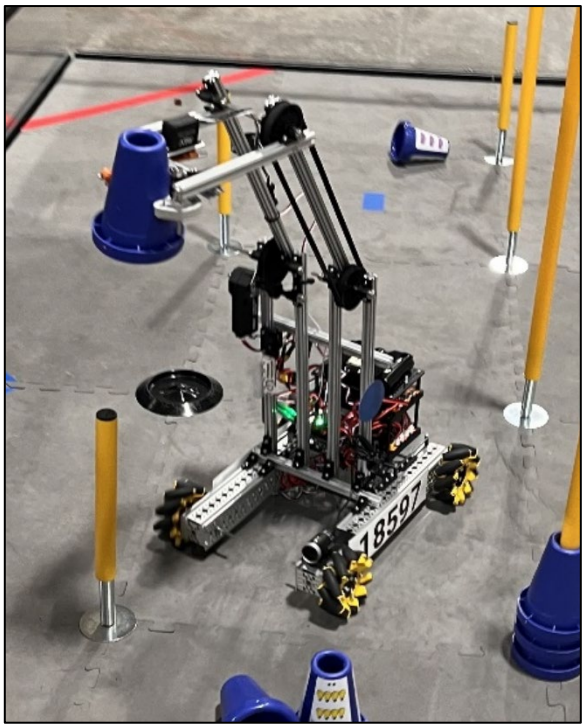


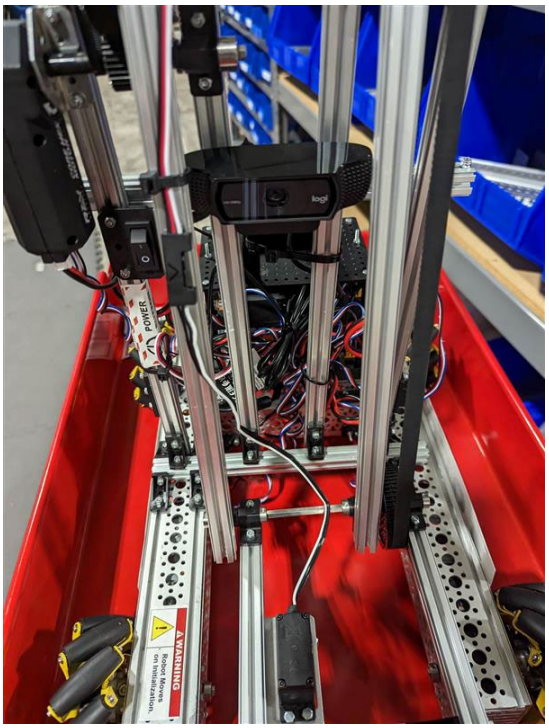
League Meets 3, 4, & 5 - Robot Iteration 3:

In this improvement, we addressed the problem of the wheels by adding larger wheels and made the intake active to increase speed and efficiency. Issues we had in this iteration was the camera shutting down for no reason and the camera being in a spot which made it hard for it to see the signal cone.

Improvements:

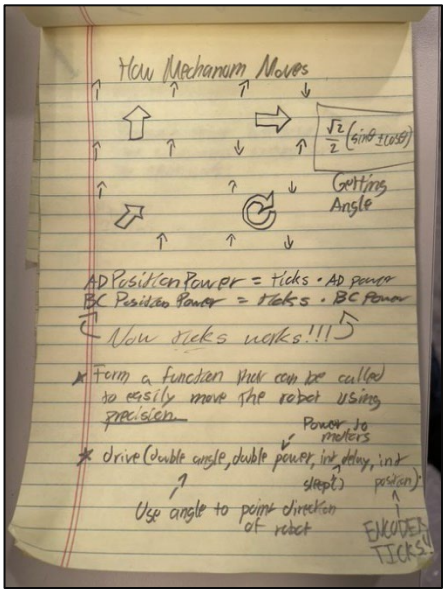
- Drivetrain
  - We replaced the 70mm (about 2.76 in) wheels with 95mm (about 3.74 in) wheels which allowed us to go over ground junctions easily.
  - Increased the height of the control hub tower to give more space and lessen the stress on the wire.
  - Added a much higher quality camera which can detect the signal sleeves much more efficiently.
- Arm
  - Put in even more stability beams and streamlined hex shafts and joints.
- Intake
  - Improved intake to an active one, which allowed us to pick up cones faster and more accurately than the passive intake.





SOFTWARE & PROGRAMMING

Autonomous Programming Goal 1: Move with accuracy using our new mecanum drivetrain.



This proved to be difficult as there were two options: manually code each of the four motors to move how we needed it to or create a method that would make the robot much easier to adjust once coding for autonomous was needed. In the interest of simplicity, we picked the second choice. Using resources such as "Team 6624's Software Guide" and the REV robotics motor encoder documentations, the first successful program was completed. It took a couple of weeks and many iterations, but we accomplished our first goal

Autonomous Programming Goal 2: Score autonomously.

With new methods to be able to code the robot with, our first programs were a simple park in either left or right terminal. This started us with 2 points, with 3 points being added once we set up the cone to the side of the robot.

Autonomous Programming Goal 3: Park according to the randomized signal.

After utilizing pre-trained TensorFlow data from FIRST, we were able to consistently score 10 points each game after parking in the correct target area.

```
if(signalSleeveValue == 1)
{
    //Rotate the arm up to medium junction height
    rotateArm(380,1,1000);
    //Drive forward (0 degrees in this case) at .5 power, for 2000mil secs at 3220 ticks
    drive(0,.5,2000,3220);
    //Drive right, going towards medium junction
    drive(90,.5,3000,1700);
    //Open the servo hand and score
    Hand_Servo.setPosition(0);
    //Drive left to align
    drive(270,.5,1000,1700);
    //Forward, slight adjustment
    drive(0,.5,500,300);

    //Forward, towards cone of towers
    drive(0,.5,1500,3400);
    //Turn to cone of towers, at -910 ticks, .2 power, and 2000 milsecs
    rotate(-910,.2,2000);
```

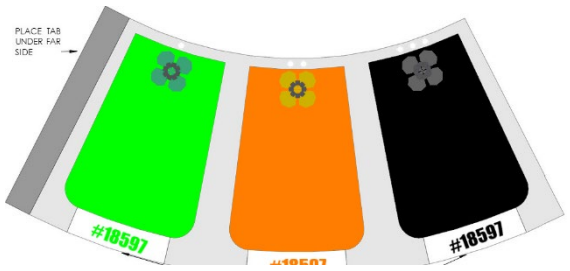
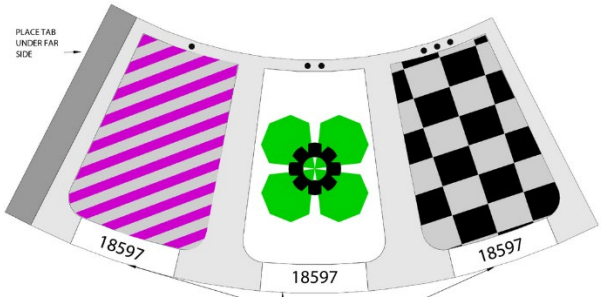
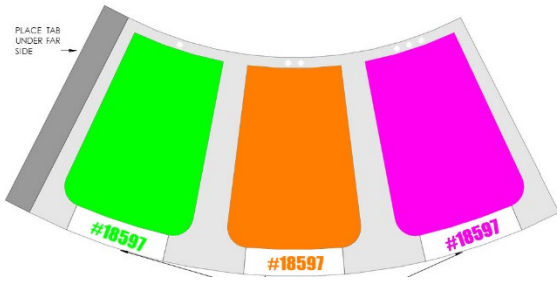
Autonomous Programming Goal 4: Score the preloaded cone on a junction and park in the randomized parking area.

We were able to combine coding elements from our successes in Goals 1- 3 to create a flexible autonomous program to meet this goal with 80+% accuracy regardless of the alliance color, side or randomization.

Autonomous Programming Goal 5: Use a custom sleeve.

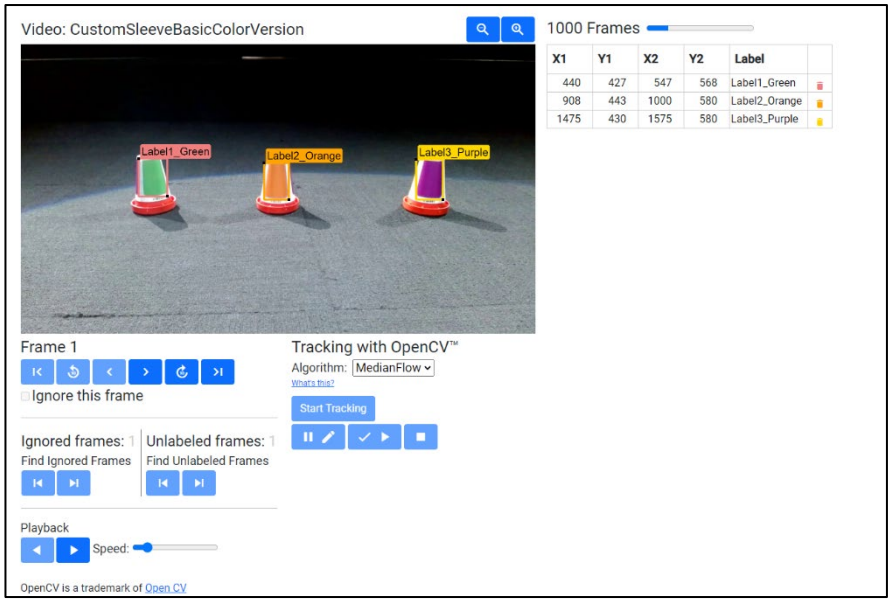
Our ongoing current goal is to consistently score 20 autonomous points rather than 10 for correctly parking using the standard signal. After our 4th league meet, our team realized that numerous teams in our league were tied with a 10-0 record. This had meant that autonomous scoring (TBP1) had become the key factor for league ranking.

Autonomous Programming Goal 5: Use a custom sleeve. (continued.)

Strategies Utilized	Custom Signal Sleeve Iterations
This design was made to work with using a color sensor that scans the RGB values of the image it sees, and those values align to a color. The assorted colors that the sensor picks up then goes into the program and would move to the corresponding parking zone during autonomous. This approach failed due to the range of the close proximity needed for the color sensor to be consistently accurate.	
The earlier strategic flaw that the color sensor could only pick up the color values from a close range required the bot to move then detect the color then run the correct program to move to the correct zone during autonomous. This design was our first attempt to use the webcam and incorporates 3 different images a checkered pattern, diagonal stripes, and a clover design.	
The second iteration was too complex for the machine learning to have a high enough confidence to detect the correct image for the camera. This third sleeve design was chosen after reaching out to team 17421's programing team who suggested that using solid colors may work better and not to use less training frames to make it less dependent on specific lighting.	

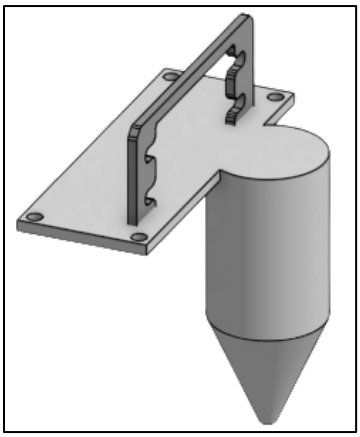
The FTC Machine Learning Toolchain

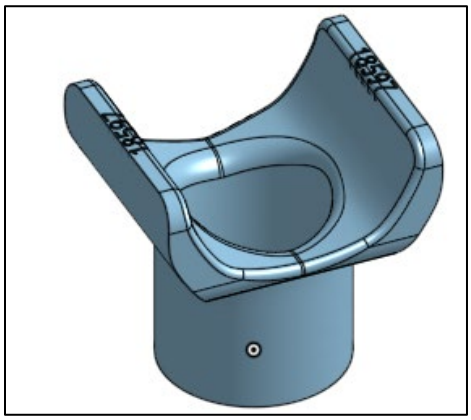
1. We label the section that we highlight and track in a video to generate a trained, labeled video.
2. After we have labeled the videos, then we create a dataset that uses the labeled frames to create the video that we choose how much of those frames are training and evaluation.
3. This then goes through and takes all the frames, trains a custom set, and evaluates those frames making a model that we insert into the program.



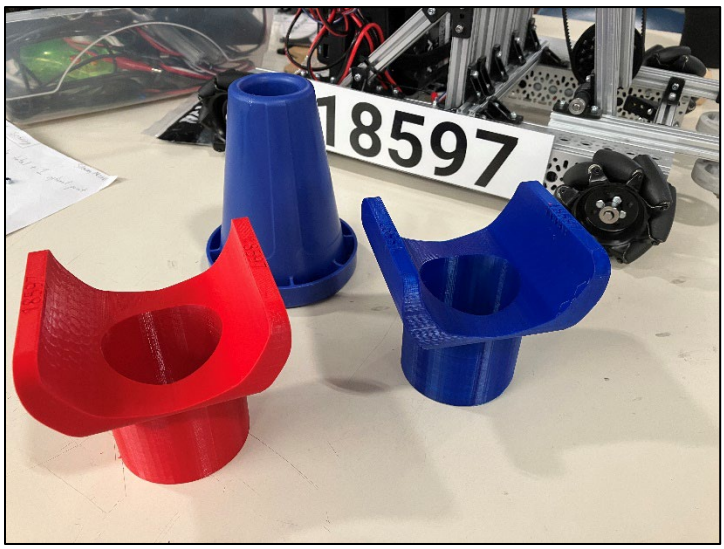
CAD & CUSTOM FABRICATION

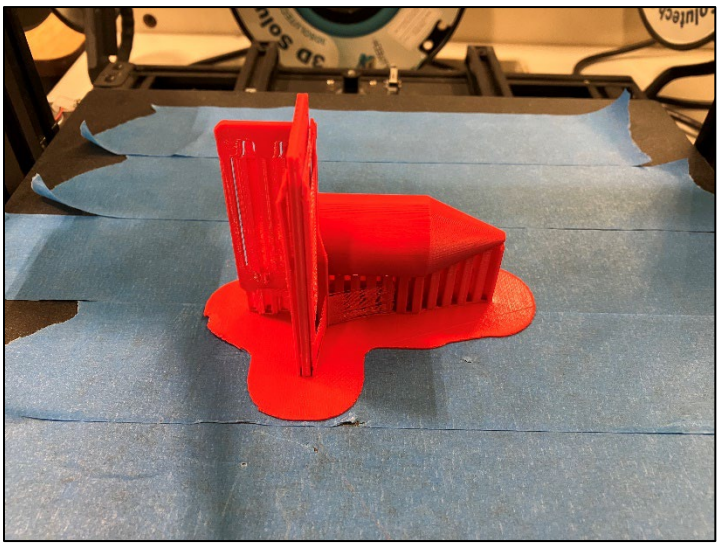
During the Research & Development part of the season, the build team experimented with various passive and active intake prototypes. Some of which were 3D printed for testing. At that point in the season, we were weighing the pros and cons of linear motion lifts and were seeking a quick, effective way to pick up the cones. Shane, a member of the Build team designed a prototype using Onshape. His idea was to go through the top of the cone and to clamp it inside using a servo. Despite never being used in competition due to inefficiency, it was a valuable prototype that ultimately made the robot better.





The beacon is a key element to score points in the endgame and to have complete control of a junction. The design of our team beacon is in the shape of a Lego hand in honor of the younger FLL Teams that we mentor. This first design has a sharp edge around the inside that would catch on the top of the junctions. A revision was made by adding a fillet around the inside around the center that is more forgiving when attempting to cap a junction pole. This was a very simple design change, that had a significant engineering performance impact.





LEAGUE MEETS

"Control hub's pins broke, catastrophic failure during operation to re-bend pins."
-- Nikolas, Coach during the first meeting. Excerpt from notepad

During the season, there were multiple events that occurred during our League Meets. Many of these events could be more accurately classified as incidents, as many of the events were disastrous.

Meet #1 & #2 (11/12/2022)
During our first meeting, one of the most notable events was the Control Hub being broken, by our own hands. This was due to one simple factor, poor structure design. Our robot uses a vertical system to stack all essential parts, like a server rack, to save space and keep everything important all together. Though, the problem with this was that…

A. each part was stacked too close to each other and
B. The Control Hub was on the very bottom, causing the power cables to be under extreme side pressure from the tension of the wire management.

The culmination of all this stress on the Control hub was it finally refused to power on just after passing inspection. During this event, our team was in a reasonable state of panic. We found the problem quickly, as we knew the problem had to stem from the Control hub. During the inspection, members of the team, most notably Logan, noticed how the *power pins had become bent*, therefore making the Control hub inoperable. The little time until our next qualification had led to a quick decision to bend the power pins back into place, an action we would instantly regret. As *shown to the right*, the botched operation resulted in the Control hub becoming broken and no longer useable.

Meet #3 & #4 (12/10/2022)
In the third meet, there showed signs of improvement compared to the first one, but once more we had difficulties. This time, one of the *e-clips* on the *back right* mecanum wheel popped off during a qualification, causing a roller axle to get jammed into a hole in the chassis of the robot. This caused the back right wheel to lock down the whole mobility of the robot. Despite this mechanical failure, we only lost that qualification by 5 points. We borrowed a spare wheel from another team, swapped it out, and got back to work.
In Meet 4 of the dual meet, while not as impactful as the mecanum failure, there was another incident. Right before our driver's meeting, our power switch, a requirement to let us compete in the meet, stopped working. With a spare in our parts tray, we swapped out another part in a hurry, and never missed a match.

Meet #5 (1/14/2022)
Considering the past meet events, our fifth meet was surprisingly uneventful. In fact, a separate team even asked us for help, team #18434 or the East Jackson Blue Eagles. They needed a servo extension cord, and from our lessons from earlier meets, we had packed more than extra just in case. Given the circumstances, we aided them, having known from experience how great it feels to experience Coopertition and Gracious Professionalism from a team that you are about to face off against in the next match. You pay it forward in FIRST.

OUTREACH

"Outreach."

-- Kaitlyn, Captain of Business and Communications

We expanded our outreach from last year to the max. This year we started a Junior Varsity FTC team for our County Robotics Program, mentored three FLL teams, hosted a FLL tournament, supported the FLL GA State tournament, and reached a total of 461 people though our social media.

We started FTC team #21721 (RoboClovers JV). Throughout this season, we mentored this rookie team of mostly 8th graders on how to make a functional robot, how to compile an engineering notebook, engineering portfolio, and everything else that goes with the FTC experience.

This year we mentored the three FLL teams that we practice with every day by refereeing their scrimmages, teaching them how to code, and supplying daily examples of gracious professionalism. With our mentoring all three FLL teams advanced to the Super-Regional tournament. At SuperRegional's we went to mentor them and help them throughout the competition. Having been through our own FIRST challenges, we were well prepared to assist them when their LEGO control hub blanked due to an unexpected firmware update. Our build team captain had to get rid of the current update so the code can work. While our business leader was livestreaming each table match for the parents and guardians that could not attend the tournament. At this tournament we spread the core value of fun. This year we also hosted the Northeast Georgia FLL Regional Tournament. This tournament had 23 teams and our Varsity team was spread out thought the tournament with some being referees, judges, or concession stand workers. This past offseason we had two members of the team supported the FLL state tournament by being referees and mentoring our own teams thought the tournament.

This year in funding, we had a Nintendo Switch OLED raffle and all the accessories. We sold over 1000 tickets and raised about $4000 towards our robotics program.

We reached out to our local stem community of Hard Rock Drilling as we took a tour of their facilities and connected them to tools in our shop. We reached out to our local Chamber of Commerce and told them about our program. We also reached out to the Barrow County School System Board of Education and educated them on our program and the benefits of FIRST. We also sent three team members to the Georgia FTC State Leadership conference where we spent a weekend at Camp John Hope in Fort Valley, GA. At this conference they took part in team building games, agility courses, and seminars.

During this season we had many sponsors that helped us grow as a team. Solvay Chemicals provided us with safety equipment (safety glasses are a must) for our Varsity and JV teams. Power Evans from SK Battery talked to us about working at SK Battery and their engineering processes manufacturing batteries for electric vehicles. Georgia Power provided us with lab equipment such as a horizontal metal bandsaw, mini mill, CNC router. Rehrig Pacific Company, a plastic fabrication company, gave us $500 to get the necessary equipment for our teams.

Though this year we have reached 461 people through TikTok, Instagram, and Facebook. We also reached 200 people and over 50 local industries and business in Barrow County though the Chamber of Commerce presentation.

MENTORS & ADVISORS

Purdue University

Benjamin Manning

Senior Instructional Lab Coordinator

Barrow Arts and Science Academy

Dylan Clark

STEM Instructor

Barrow Arts and Science Academy

Laurie Noles

Computer Science Instructor

Winder-Barrow High School

Kimberly Garren

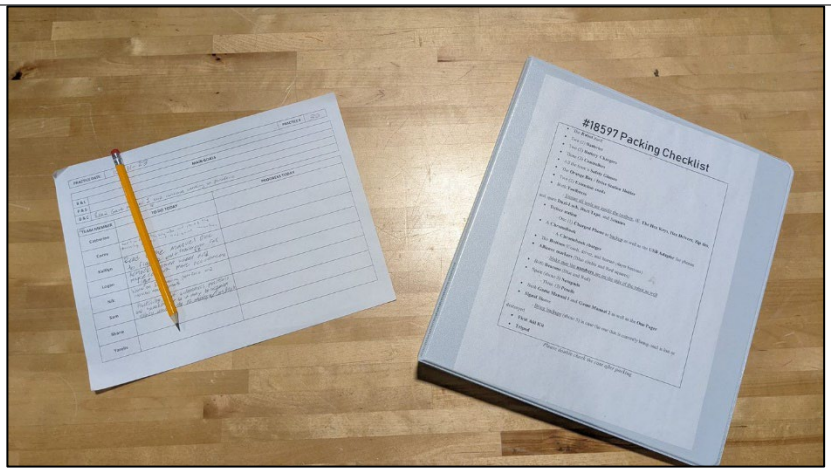
Engineering Instructor

DOCUMENTATION

"It's harder than you'd think."
-- Nikolas, Team Captain

Documentation this year had greatly improved by last year's standards, and it was surprisingly easy to do. This year's use of a simple, printed template in which each team member writes down what they will do during the practice at the beginning of the day and what they carried out by the end of the day had improved documentation efforts. Before this, we tried to use a virtual documentation system near the beginning of the year. This virtual system was proven to be completely ignored and forgotten by most, as most members did not want to go through the hassle of dealing with the poor mobile UI that Microsoft Teams has. Though, compared to last year's documentation system in which team members wrote down things as they happened on a notepad, which had proven inefficient as it disrupted work, there show obvious signs of better documentation systems.

On the **left**, the paper template in which team members have written down what they will do on practice 30.
On the **Right**, the binder which has all practice schedules and written plans from earlier practices.



Continuing, documentation during meetings has stayed the same, but there have been minor improvements. For instance, putting rough time stamps next to events, such as a qualification, has helped with being able to understand what happened linearly during the competition. In addition, an increased effort to talk to other teams to both learn and speak to them about their robot has allowed for better strategy planning for qualifications. There was the added information of learning their robot's limitations, which may have included what their robot could or could not do. Overall, an increased effort to document and communicate during meets was not only clearly beneficial to our documentation, but our strategy during qualifications too.