Team #6417

Power Play | 2022 - 2023

Engineering Portfolio

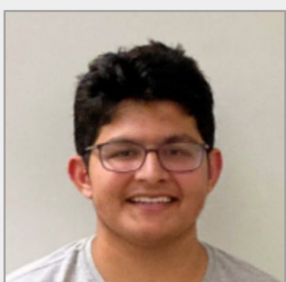
BLU CRU !!

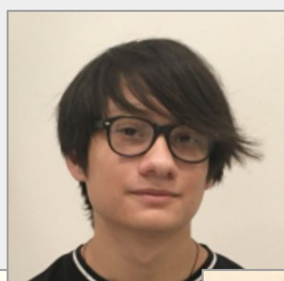
About The Blu Cru

- Part of the **Explorer Post 1010 organization**, based in **Rockville, Maryland** and founded by our mentor, Bob.
- The Blu Cru made its debut in the FIRST Tech Challenge in 2012.
- The team has returned every year since -
  - advancing to the state level of competition in a significant number of its past seasons
  - advancing to worlds in the 2021 - 2022 season.

Why "Blu Cru"?
Gratitude and teamwork.
We wear "blu" as a show of thanks to our sponsors, the Explorer Post 1010 & IBM. We embody our value of teamwork in every activity that our "cru" does together, working together respectfully and inclusively to achieve our goals.

"We are the Blu Cru, and we stick together like Glu!"


Jasnoor Lubana(12)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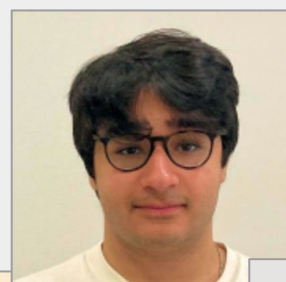
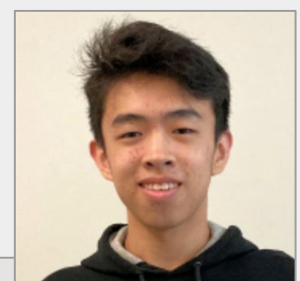
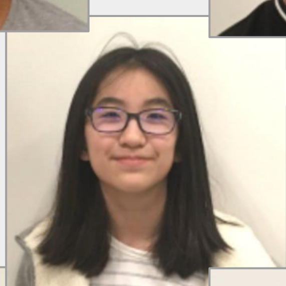
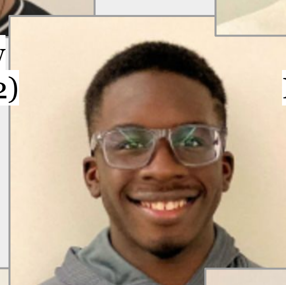
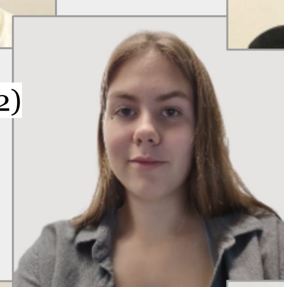
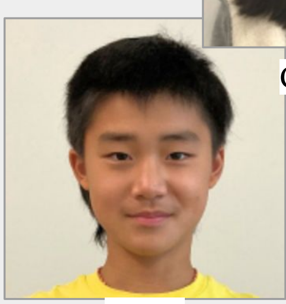

Shawn Pourifarsi(12)

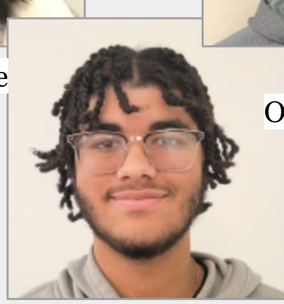

Kevin Dong(10)

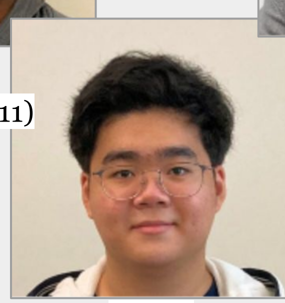

Catherine Qu(11)

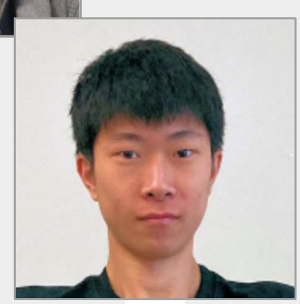

Siju Onadipe(11)


Emily Perkins (10)


Aaron Kulvatunyou(9)


Cyrus Adams(12)


Daniel Yeum(10)


Jake Li(10)

BLU CRU cont.

Team Relationships

Community:
Outreach focused on reaching out to youth to inspire the next generation of FIRST. We became heavily involved with the local libraries, middle/elementary schools, and FLL teams.

Other FIRST Teams:
The Blu Cru embodies the spirit of coopertition as we interact with other teams.

Sponsors:
We're sponsored through the umbrella organization of the Explorer Post 1010 by the Rockville Science Center (RSC) and IBM. We keep our sponsors aware of our activities to maintain a personal connection with the organizations.

Team Structure

We elect a captain and a head of each sub-cru to oversee activities. We divide into "sub-crus" to increase efficiency, some of our main sub-crus are programming, building, and team management.

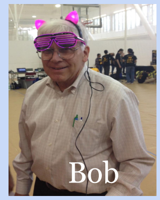
Thank you to our mentors and our sponsors!

IBM

TechAction

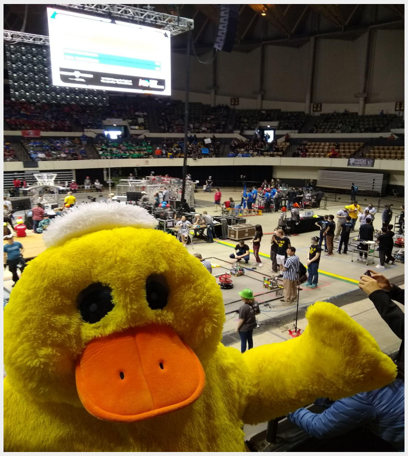
Explorer Post 1010 Future Engineers

Rockville Science Center



Team Mascot - DRU!!!

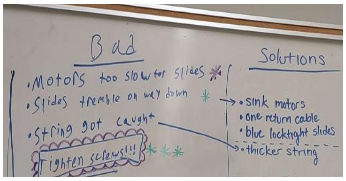
We found Dru at a Walmart in Virginia going to the 2022 season regionals competition. We immediately fell in love and he became the Blu Cru mascot.



Engineering Design Process

1. Define Problem(s)

- Discuss the problems as a team
- Develop a game strategy
- Break down problems into smaller problems
- Develop timeline



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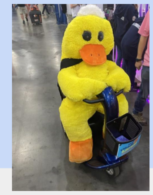
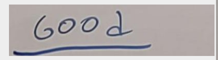
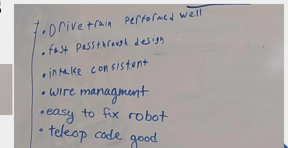
Travel with Dru the duck through Blu Cru's engineering design process



2. Brainstorm

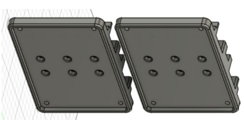
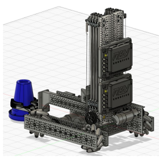
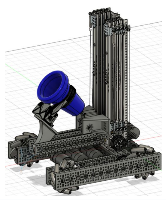
- Collaborate as a group, everyone participates
- Ideas ground in physics and math
- Make decisions as a group through -
    - pros and cons





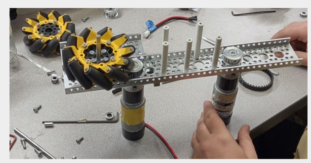
3. Plan Solutions & Prototypes

- Focus on the details of the design
- CAD designs
    - To determine if feasible + better visualize design
    - blueprint/framework for prototype + construction
- Prototype to test a simplified model of our design in a physical setting if appropriate

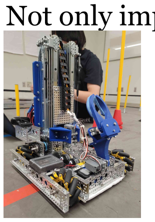
4. Build & Implement

- construct the design solutions to CAD + prototype
- Ideas for improvement and decisions
- Usually opt to test solution before implementing entirely, repeating prototyping and testing until a much improved robot is completed



5. Test

- Test in the order of:
    - Functionality
    - Accuracy
    - Consistency
    - Efficiency
- Further improvements can be made, steps repeated
- Not only improvements engineering-wise




6. Evaluate & Get Feedback

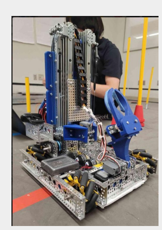
- Consider improvements to robot in key areas of accuracy, consistency/precision, efficiency
- Typically use outreach events to test robot "health"
- Consider alternative design solutions
- Get feedback from members and mentors
- If no feasible alternative solutions → move forward, else back to the brainstorming phase

7. Improve

- Implement brainstormed solutions
- Quantitatively and qualitatively evaluate improve compared to original solution
- Continuously get feedback

8. Finalize & Communicate

- finalize robot ~2 weeks before competition for practice
- Drivers practice tele-op period
- Coders improve autonomous code
- Document final robot in notebook



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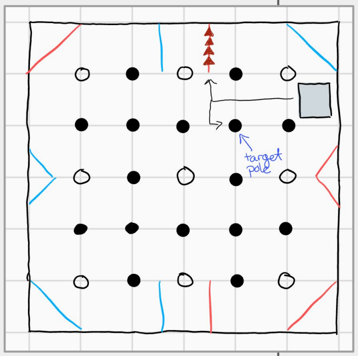
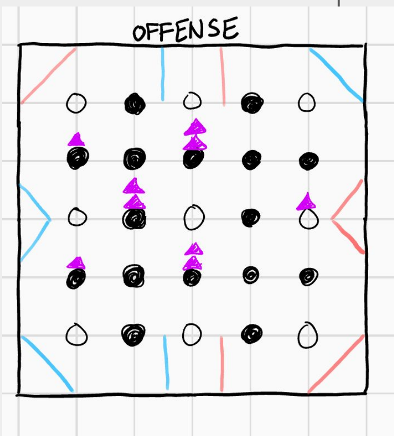
Autonomous
Game strategy

Our coding team was able to pull off an astonishing 1+5 on the low junction with our new and improved robot design. We decided to go with the low junction as we realized how crucial these small junctions are to completing a circuit, so obtaining these early in the match allows us more control of the field.



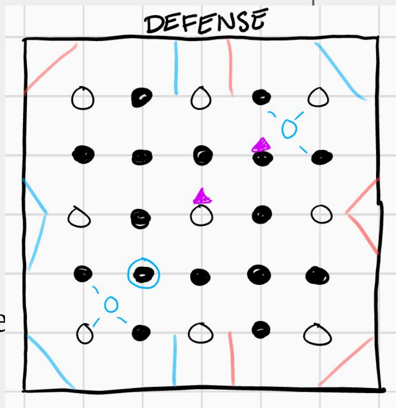
Driver Control
Game strategy

Our tele-op game strategy consists of some cycling to the high junction closest to us (~4-5) before switching fully to field coverage. We obtain the low, medium, and high junctions on our team's quarter of the field, then continue spreading out if there is still time before endgame starts.



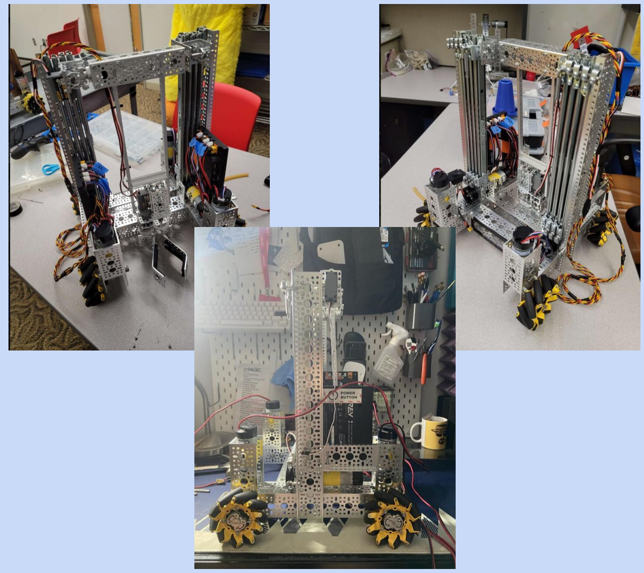
End Game
Game strategy

Our end game strategy is to continue field coverage, but focus on completing a circuit, as we see how valuable those 20 points can be. As soon as endgame starts, we grab our beacon and place that on the medium junction closest to our far alliance terminal. After placing our team beacon, we continue to place cones around the field to both complete our circuit and block the opponent's circuit.



Robot Evolution <> Beginning of season - Qualifier 1

Chassis - The back of the chassis is open so that we can pick up the cones from that area. Since we plan on swinging the cones through the robot having the back open will give us a bigger area to fit the cone. The drivetrain we are using had bevel gears to stick the motors vertically out of the way on the sides. We are using goBUILDA parts to build the chassis to make the building smoother instead of having to use tons of adapters and to allow us to adjust our robot quickly and easily.

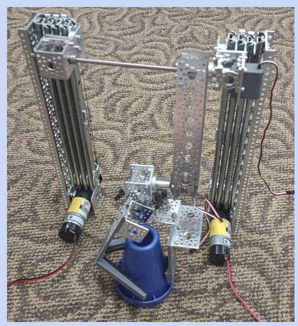


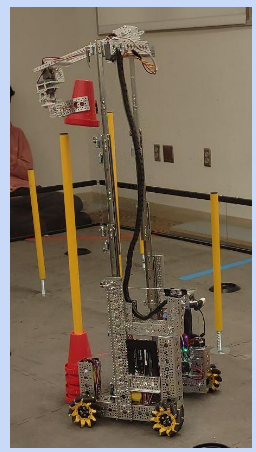
Sliders
- the use of sliders extends the arm
- fast and reliable way to get cones on junctions

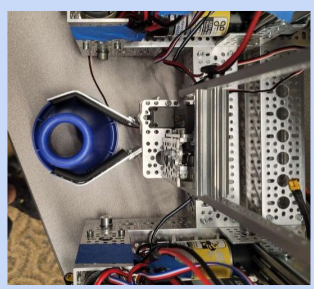
Arm
- arm swings through chassis
- without turning around, saves time

Wrist
- old design, very limited movement
- new design, bends in 2 places

Grabber
- originally grab from top
- new design grabs from middle

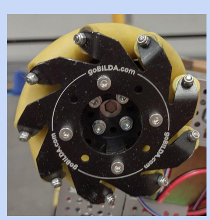


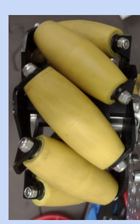




Wheels

We plan on using thinner mecanum wheels than we did last year. This is to try to thin out our robot so we can fit through the junctions easier and to prevent us from running into/over the junctions.



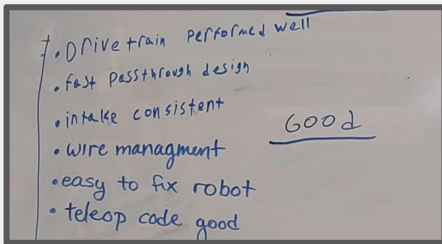


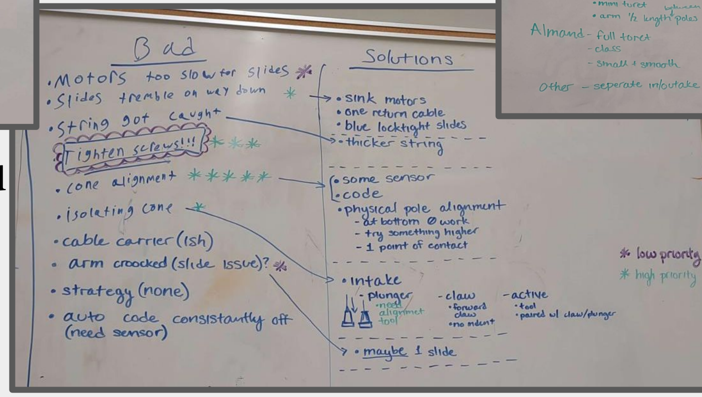
Old wheels

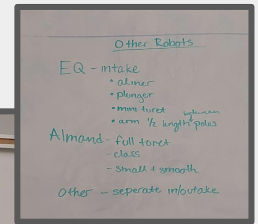
New wheels

Robot Evolution <> Qualifier 1 - Qualifier 2

BRAIN STORM ING



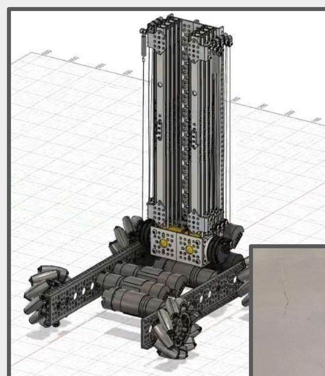


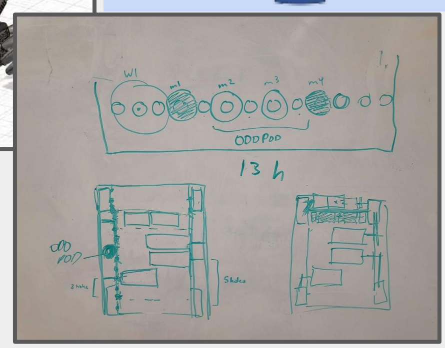


After Qualifier 1, we sat down as a team and analyzed our performance – both the positives and negatives. Together, we came up with a list of what we wanted to keep, as well as multiple solutions for each problem we faced. We then decided on the best one that we want to bring into the planning and design phase.

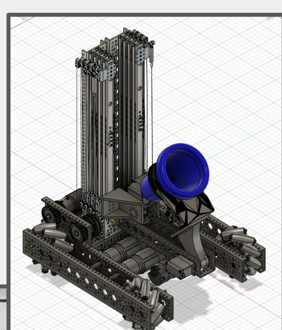
PLAN, DESIGN

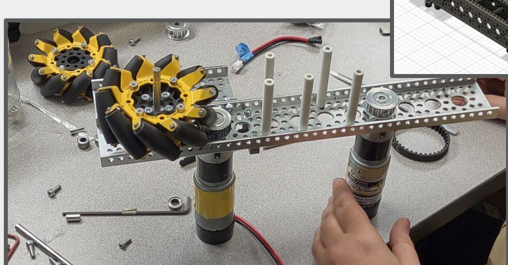
We saw success in our high maneuverability in aiding field coverage, so we redesigned our chassis to be even slimmer and more efficient. The versatility of our previous intake/outake system paired well with the small chassis, so we strived to amplify that versatility by implementing a mini turret system to allow us to outtake on 3 sides of the robot. We wanted the length of the arm to be half the length from one junction to another, allowing us to rotate the turret and score on our left and right side without moving the robot at all. We 3D modeled our designs before building and ordering parts to ensure we are being efficient with our time and resources.

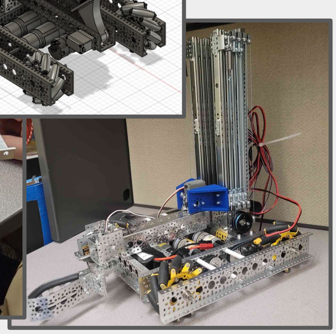




BUILDING + IMPROVE



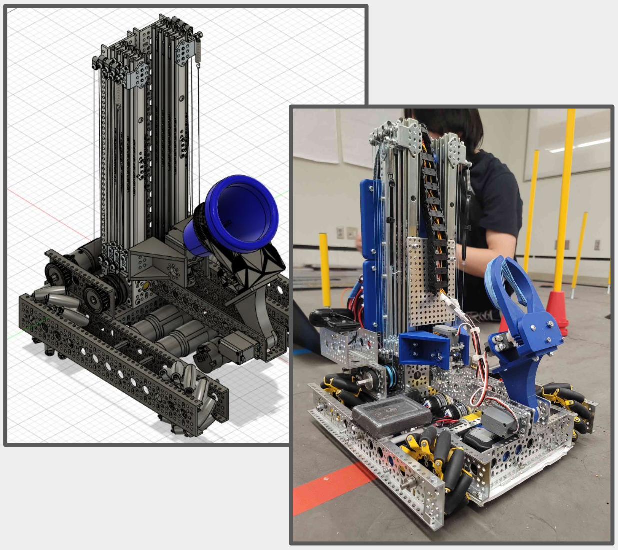


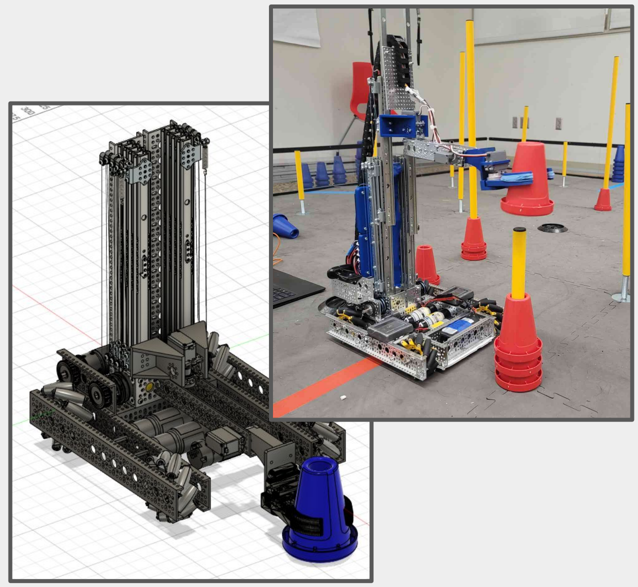


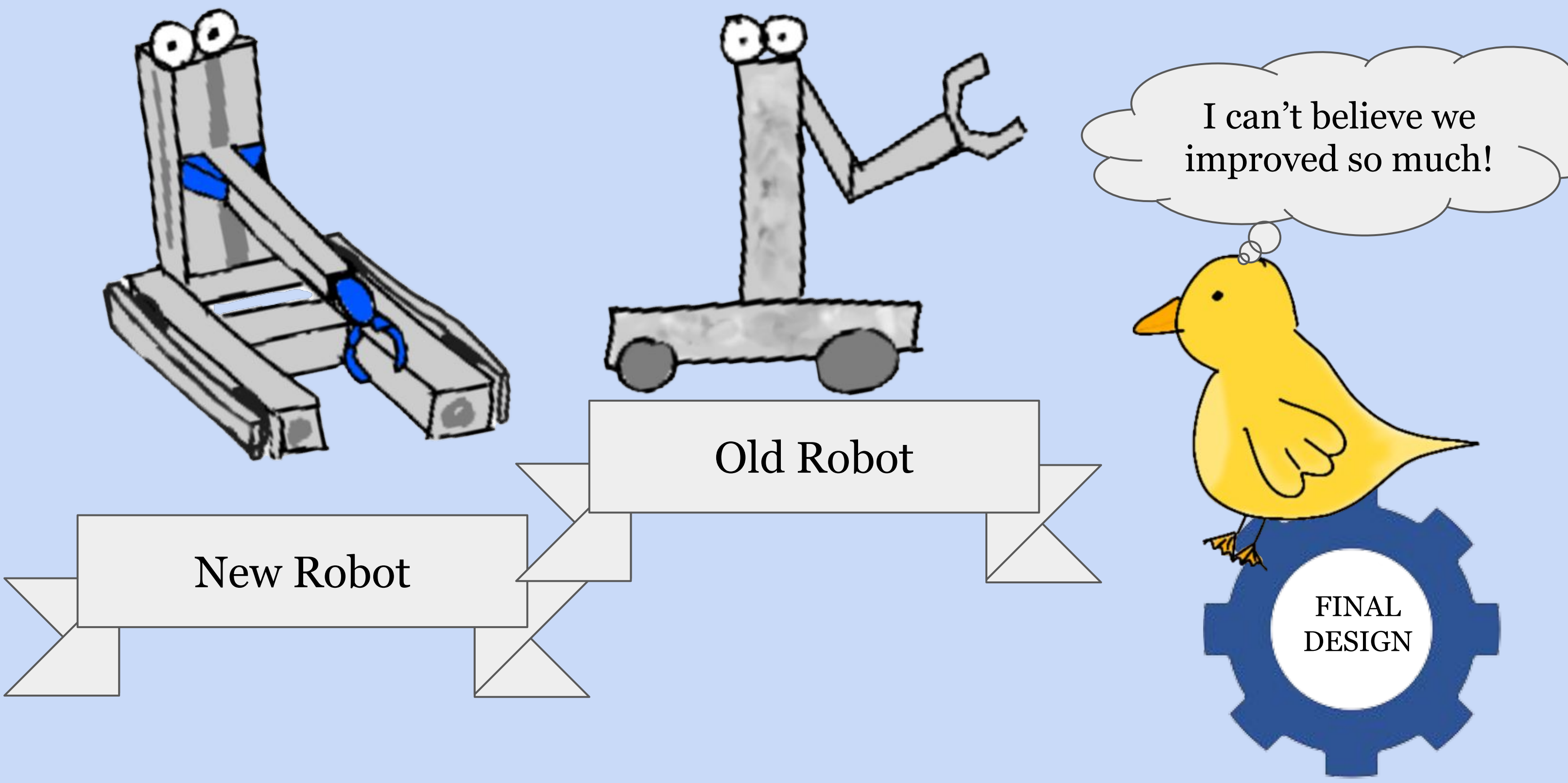
We changed our drivetrain to run on belts instead of bevel gears as we noticed belts give us smoother and more accurate driving. After constructing the first version of our robot based off our CAD, we realized the grabber stuck too far out the perimeter of the robot, risking breaking the grabber as we navigate around the junctions. To solve this, we decided to add a wrist design that will retract the grabber when we are not actively intaking or outtaking. Additionally, we redesigned our grabber to be 3D printed as to decrease the weight of the arm.

Robot Evolution <> Qualifier 1 - Qualifier 2

In the final design, we created a versatile and mobile robot. We have two vertical linear sliders to raise our arm up to the height for each junction. The arm itself is attached onto a servo that acts as a mini turret, allowing us to both intake and outtake from 3 sides of the robot. Our grabber is a 3D designed claw that is powered by a single servo, and is attached to another servo at the base, which acts as a wrist. This wrist allows the grabber to safely retract into the robot to prevent any damage to our grabber as we navigate the field.

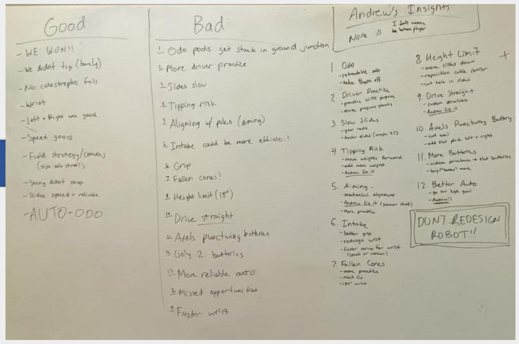






Robot Evolution <> Qualifier 2 - Chesapeake States

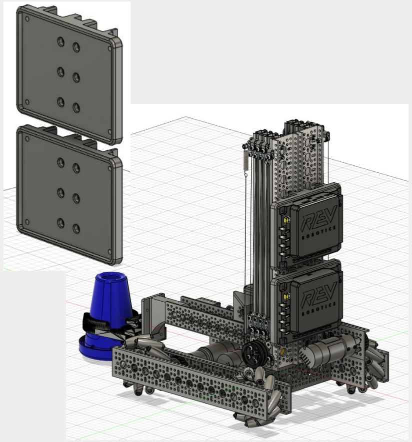
BRAIN STORM ING



Just like we did after the first qualifier, we brainstormed anything good, bad, and solutions for the bad. We found that our driving squad is very efficient when scoring cones quickly, our only problem is what happens when we miss cones. Our engineers brainstormed a design to be able to pick up cones that have fallen down.

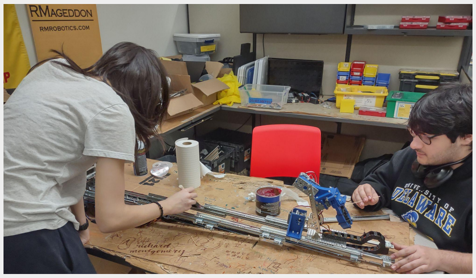
PLAN, DESIGN,

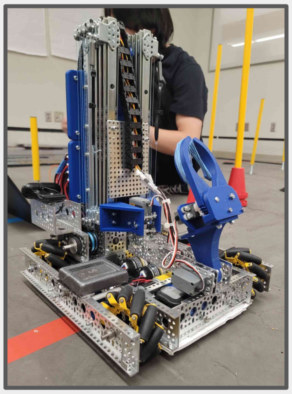
Our robot design does not need too much improvement, but it does need to be more reliable and more failsafe. We have had very good progress during our qualifier matches and end up using all the cones but we end up dropping some and 'wasting' them. We are trying to develop a way for the robot to flip cones that have been dropped in order to score more points and use all the cones to the maximum capacity.

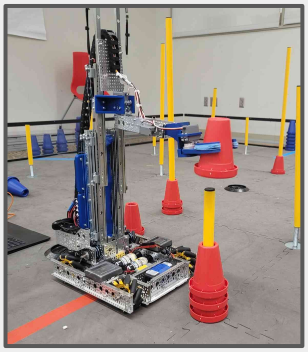


BUILDING + IMPROVE

We modified our arm/turret design, adding more stability and make it more failsafe. To help the slides move faster and more efficiently we changed the motor that controls said slides. This also helps with our intake and speeds up that process.







The robot can efficiently lift up fallen down cones and use them to score the maximum number of points. The slides are much more stable than when we started and can now move up and down at maximum speed.

FINAL DESIGN

Robot Evolution <> States - Worlds

BRAIN STORM ING

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PLAN, DESIGN,

BUILDING + IMPROVE

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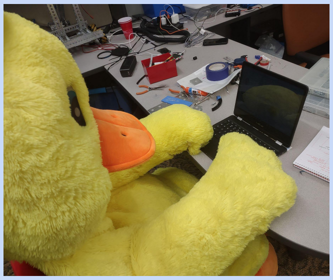
FINAL DESIGN



Dru helping code

Using **Java** in Android Studio to program our robot with **Object-Oriented Programming** language and 4 basic principles:

- **Encapsulation**: the Hardware Map contains all of the variables representing our robot's physical hardware and the methods to drive, strafe, rotate, and move servos.
- **Abstraction**: Our code uses a separate classes which defines methods for almost every action the robot can take
- **Inheritance:** Each OpMode module inherits from the tempalate class LinearOpMode, which provides a basic framework for both modules.
- **Polymorphism:** Our software treats all versions of our autonomous code as multiple "forms" of the same module, so that our Hardware Map is always compatible.

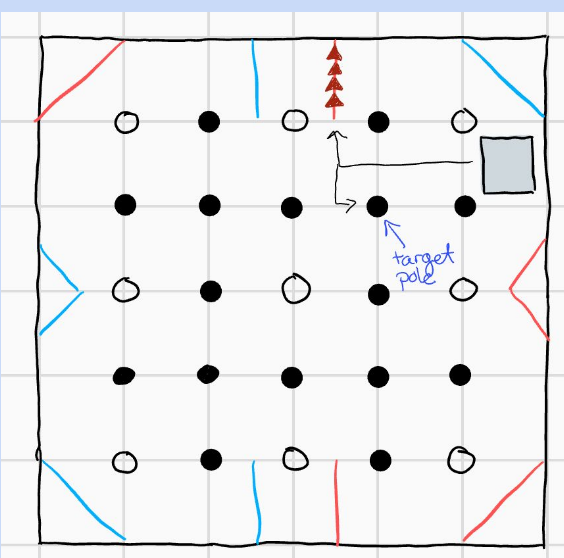
Sensing

The three main sensing techniques we use are:

- **Encoders:** Devices that detect the amount an axel has rotated. Using dead wheels an math, we can calculate the distance the robot has traveled in a certain direction.
- **Inertial Measurement Unit (IMU):** An internal gyroscope built into the robot's Control Hubs. We use the IMU to detect the current orientation of the robot and rotate specific distances.
- **Easy OpenCV image processing:** An image processing library tailored for FTC which we use to locate our custom marker piece by looking where on our camera feed has the most red, which is the color of out marker.

Autonomous Objectives:

1. Detecting custom signal sleeves
2. Stacking cones on low pole for speed and low error
3. Parking in correct space

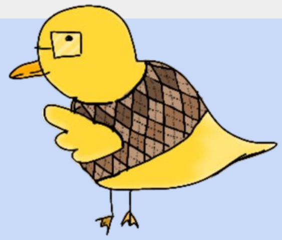


Autonomous Program Diagrams

O U T R E A C H

Rockville Science Center

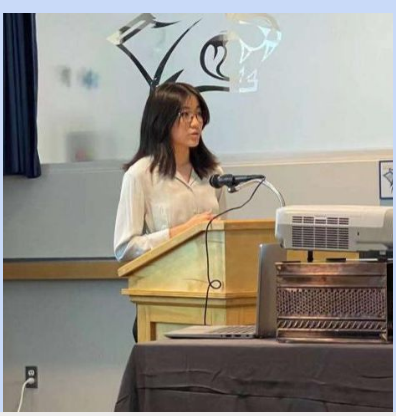
- Taught classes over the summer and weekends.
- Promoting STEM, Robotics, and FIRST.
- How to start/be a part of an FLL team
- Showing the benefits of robotics and teamwork

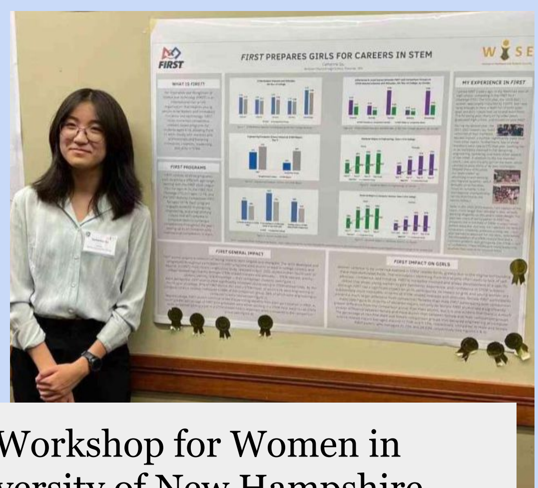


TWINBROOK ELEMENTARY SCHOOL
Rockville, Maryland

We created a free class for students at Twinbrook Elementary school. We emphasize and share our enthusiasm for different areas of STEM not just robotics. They are a tier one school with little funding for afterschool programs and extra learning opportunities.

WISE
Women in Hardware and Systems Security

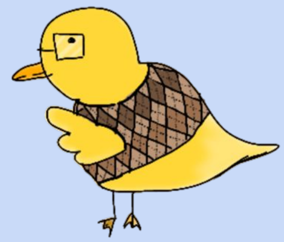


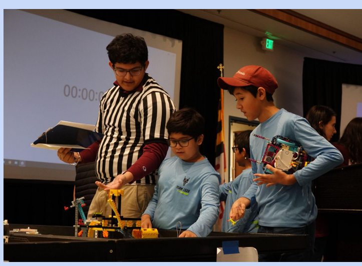


Our co-captain (Catherine) researched and spoke at the Workshop for Women in Hardware and Systems Security (WISE), held at the University of New Hampshire. She presented about how participation in FIRST impacts students' STEM careers, emphasizing its impact on girls, a traditionally underrepresented demographic in the field of STEM. She included personal experiences in FIRST and FTC, as well as information discovered through statistics from the FIRST website. Catherine also spoke on the student panel, sharing her experiences in STEM as a woman.

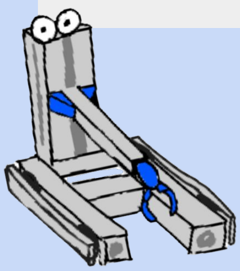
OUTREACH

The Hershey Company has sparked a wave of change with action grants. Launched in 2019, The Heartwarming Project's Action Grants Program supports young people who are advancing inclusion, empathy, kindness and connection in their schools and communities. Our team applied to the grant in hopes of funding that will help us continue to work hard and competitively in robotics, as well as enable us to endeavor more ambitious outreach opportunities to further spread the FIRST competitions and STEM as a whole.





Many of our teammates are volunteering at a FLL competition on January 14, 2023 as judges and score keepers. Many of our members have done FLL before competing in FTC, so this opportunity to return to the FLL field from a different perspective was one we could not pass up. FLL values, much the same as other FIRST organizations, are discovery, innovation, impact, teamwork, inclusion, and fun. Blu Cru strongly agrees that these values are very important to emphasize when working with youth. In addition to judging and keeping score at the FLL competition, we also demonstrated our robot as to display a possible future these kids can experience as they head into FTC.



The First Tech Challenge, Chesapeake, is recruiting at least 10 student ambassadors to be welcomed as visitors to the Chesapeake FTC Championship. Multiple of the Blu Cru teammates are applying to be a student ambassador to help bring the existence of Blu Cru to the community.

OUTREACH

BELLS MILL ELEMENTARY SCHOOL

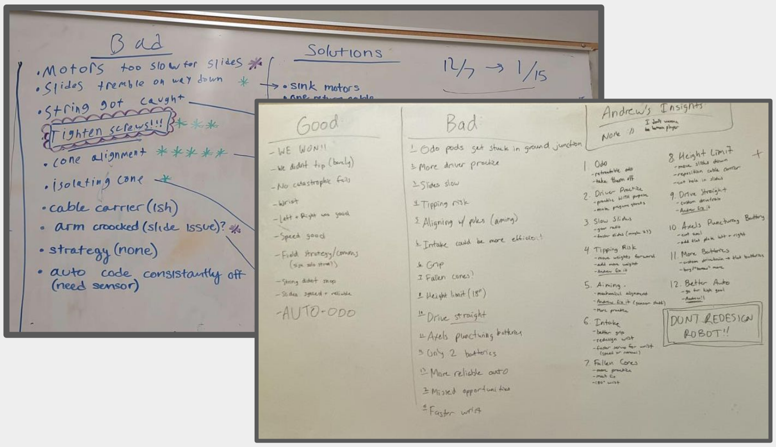
Science fair

Business and Sustainability Plan

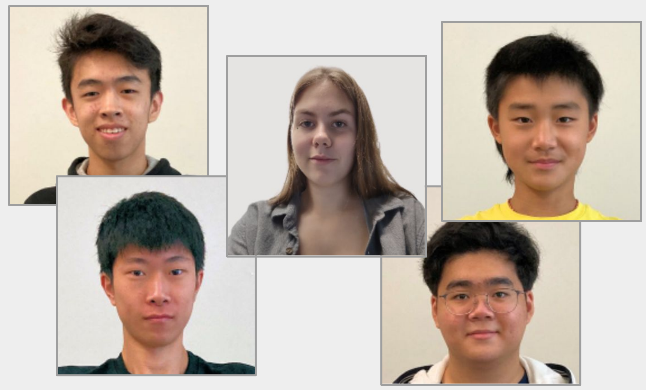
Overview

At the beginning of every season, the Cru gets together to define our goals for the season. We aim to make these goals as coherent and well-defined as possible, as we believe that specific, clear goals are most conducive to success. The Cru has a meeting to discuss our business agenda for the season every month. This meeting is attended by all team members and mentors.

DURING MEETINGS



PROMOTION/LEGACY



MEMBERS

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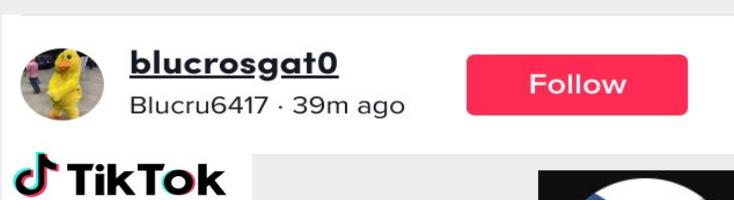
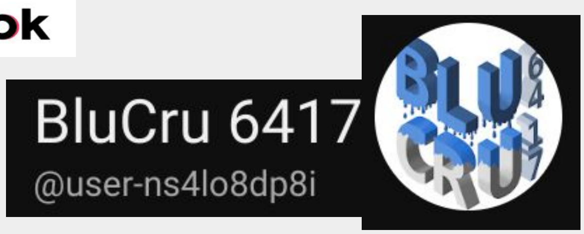
INCREASE PRESENCE

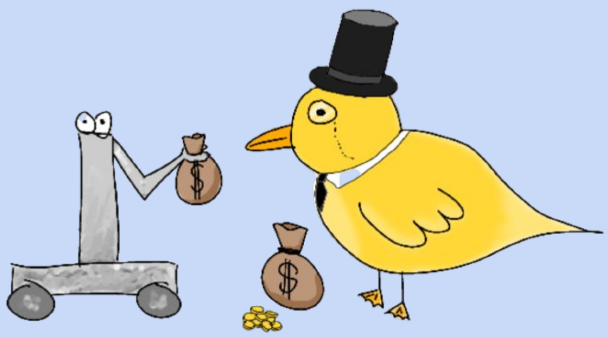




Finances

This year we decided to switch our parts to goBUILDA for an easier time. While it did help with the mechanics of the competition it was not cheap. We gained most of our budget from the member dues and spent most on the new robot parts and the game set.

BUDGET	Amount
Member Dues	$ 2,000 ($200/member)
Sponsors	$ 504
Total	**$ 2,504**



EXPENSES	Amount	Notes
FTC Registration	$ 295	Required expense
FIRST Chesapeake Composition	$ 300	Required expense
Game Set	$ 504	Required expense
Robot Parts	$ 678	Switched to goBUILDA
Additional Expenses	$ 356	
Total	**$ 2,133**	