Team #6417

Ultimate Goal | 2020-2021

Engineering Portfolio

About the Blu Cru

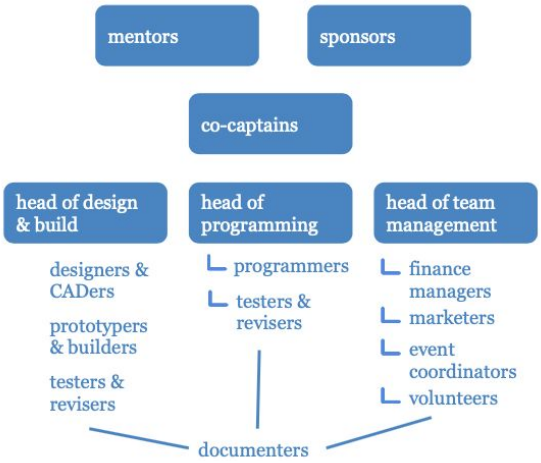
The Blu Cru is part of the **Explorer Post 1010 organization**, based in **Rockville, Maryland** and founded by our mentor, Bob. Explorer Post 1010 is dedicated to offering students exciting hands-on opportunities to learn about engineering and STEM.

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 almost all of its past seasons.

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 come together to make important, group-scale decisions, like when we decide on autonomous strategy and robot design. This season we've also decided that notebook should be done by the whole team, so that everyone informed of group activities and achievements.



Team Structure

To keep our team running efficiently every season, we elect a captain or two co-captains, a head of design & build, a head of programming, and a head of team management to oversee all sub-crus' activities and events. During the season, we divide into "sub-crus" to increase efficiency. Our main sub-crus are each focused on programming, building, and team management.

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

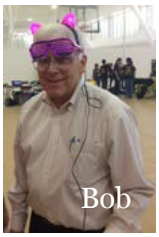
Team Relationships

Community: Our outreach is primarily focused on reaching out to the youth in the community because we want to inspire the next generation of FIRST, and future STEM workers and leaders. Over the seasons, we have also become heavily involved with the local libraries, middle and elementary schools, and FLL teams, even hosting scrimmages and tournaments.

Other FIRST Teams: The Blu Cru embodies the spirit of coopertition as we interact with other teams. Our relationships with other teams are friendly rivalries, but off-the-gameboard-alliances first.

Sponsors: We are sponsored through the umbrella organization of the Explorer Post 1010 by the Rockville Science Center (RSC) and IBM. This year, we have maintained a strong relationship with our sponsors, but in a distanced setting. We keep our sponsors aware of our activities to maintain a personal connection with the organizations. We also host outreach and volunteer under the RSC as a show of our appreciation.

Thank you to our mentors and our sponsors!



Explorer Post 1010 Future Engineers

IBM

Rockville Science Center

Engineering Design Process

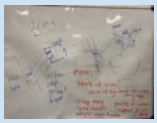
Though it will be outlined in chronological order, our engineering design process is anything but linear:

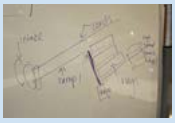
1. Define Problem(s)

- Discuss as a team
- Develop game strategy, considering point values, time constraints, feasibility, available resources
- Break down problems into parts
- Develop a coherent timeline and strategy
- Revisit constraints for robot and game field.

2. Brainstorm

- Collaboration! (a whole group effort)
- Combination of our own knowledge and research
- Ideas grounded in physics and math
- Make decisions as a group through pros and cons analysis, combining and improving solutions
- Sub-crus keep other sub-crus in check



3. Plan Solutions & Prototype

- More focus on details of design
- Hand-drawn diagrams at meetings → CAD at home through Discord
  - determine if feasible
  - better visualize ideas and proposed solutions.
  - allow all members to easily provide input
  - maximize efficiency and results.
  - Blueprint/framework for prototyping and construction
- Prototype to test a simplified model of our design in a physical setting if appropriate




4. Build (& Implement)

- Using our CAD design and prototype, our Cru constructs the design solution
- Collaborative effort
- Any changes made are documented in our notebook We also update our CAD design, but we do not erase our earlier iterations of the design
- Usually opt to test solution before implementing entirely

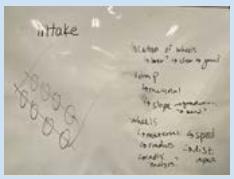

5. Test

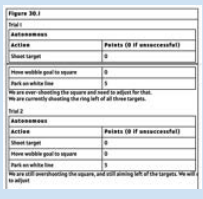
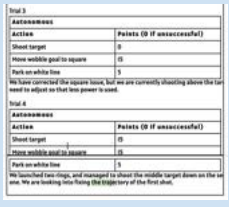
- Test in the order of:
  - Functionality (does it work?)
  - Accuracy (is it providing accurate results?)
  - Consistency (is it providing consistent results?)
  - Efficiency (could it work faster? using fewer parts? using simpler mechanisms? rely less on the human driver? etc.)
- Prefer quantifiable (objective, concrete, easily comparable) testing data
- Take science and math-related measurements to evaluate performance



6. Evaluate & Get Feedback

- Consider improvements to robot in key areas of accuracy, consistency/precision, efficiency
- Typically use outreach events to test robot "health"
- Also consider alternative design solutions
- Get feedback from all team members and mentors
- If no feasible alternative solutions → move forward, else back to the brainstorming phase
- Essentially the brainstorming phase take 2!



7. Improve

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

8. Finalize & Communicate

- Always room for improvement, but finalize robot ~2 weeks before competition for practice
- Drivers practice tele-op period
- Coders improve autonomous code
- Document final robot in notebook
- Display robot to other Explorer Post teams

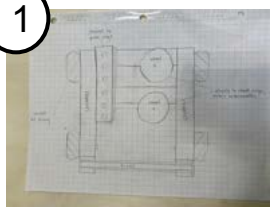
Game Strategy

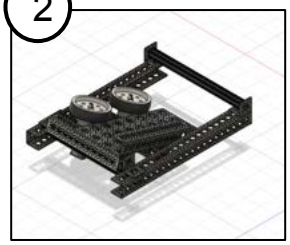
Below details our analysis of the points and our justifications for why or why not we don't plan to pursue them at competition. Point-scoring functions we're pursuing are indicated with a "✓" and those we're not with a "✗ ".

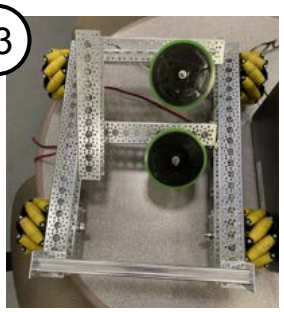
Activity	Pts	Qualifier 1	Qualifier 2
Autonomous			
Wobble to target zone	15 each	✓We combined this task with the task of transporting the wobble out of the field into one mechanism—an arm. This way, we were able to maximize our time and points.	
Rings into tower goal Low Middle High	 4 6 12	✓We aim to shoot two rings into the middle goal (for certain autonomous situations). Since the targets are roughly the same height as the middle goal, but shooting them earns significantly more points, we decided to build our non-adjustable ramp to aim for the middle goal and the target goals. Then, we can ensure more accuracy because the goal is larger.	✓We aim to shoot three rings into the top goal (for certain autonomous situations). This change occurred because we were able to develop a more consistent launching mechanism, so the matter of the top goal having a smaller area is no longer an issue. Since we can preload rings, this is not a majorly time-consuming activity for autonomous.
Park on white line	5	✓This is an easy way to score an extra 5 points, which can make a big difference when competing against evenly-matched teams.	
Targets	15 each	✓Since we were able to stay on schedule, we had enough time to fine-tune autonomous to be able to knock down the targets. In some versions of autonomous, we shoot down two rings.	✗ This ended up being fairly unreliable in our last qualifier (only working 2/6 times). So, we pivoted strategies and spent our time focusing on improving our launching system to be more consistent so we could launch into the top goal instead.
Driver-Controlled			
Rings into tower goal Low Mid High	 2 4 6	✓This is the only way to score points during tele-op. We knew we needed to build a mechanism to shoot rings, since in order to be a competitive team, we knew we'd need to at least score in the mid-high range. Since the area difference from the middle versus high goal is a factor of 2, we designed our robot to shoot into the middle goal to ensure accuracy and consistency with the larger target.	✓Since we've improved our launching system, we can now reliably shoot into the top goal. This is an additional 2 points per shot, which adds up over time significantly.
End Game			
Wobble to drop zone	20	✓This is the highest single point-scoring activity, so we wanted to pursue it. We use the arm from autonomous to accomplish this, saving time and materials by using one system to accomplish both.	
Wobble to starting line	5	✗ We prioritized delivering the wobble to the drop zone over this, since its 4x as many points.	
Wobble fully support ring	5 each	✗ We decided this isn't feasible, as it requires a time-consuming amount of precision that's not worth pursuing for 5 points each in a short 30-second time period.	
Targets	15 each	✓We aim to shoot down 2, as we have enough time during this period to try to aim before we deliver the wobble. Our drivers will be able to practice learning how to aim at the target, and we actually found a way to get consistent results by lining up our robot with the side wall.	✗ We had a consistency issue with the targets last qualifier, which is why we've decided not to pursue this activity this time. We would typically knock down only one target, if any, which totaled 15 points.
Rings into tower goal Low Mid High	 2 4 6	✗ Since shooting down the targets is more points and actually possible with the drivers being able to fine-tune the position of the robot before launching, we decided not to pursue this activity.	✓Our robot is now able to load three rings and hold them. Because launching into the top goal has more room for error than the target, and launching three is 18 points versus the 15 we were scoring at the last qualifier, we decided to pursue this activity instead.

Robot Evolution: The Beginning of the Season to Qualifier 1

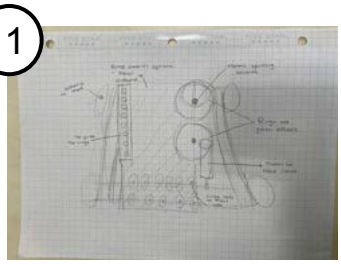
Our chassis has a higher center of mass than in previous years, which we chose to do to assist in launching rings to the higher goals. We used CAD to ensure that the appropriate launching angle we calculated was compatible with Actobotics parts. We have since attached more x-rails across the body of the chassis for support, as our chassis is very open. At the beginning, we planned on having the motors perpendicular to the Mecanum wheels, not needing bevel gears, but that would take up too much room within the chassis.

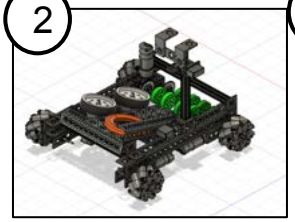
1


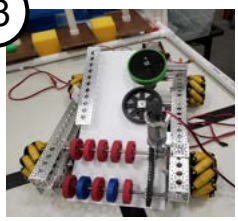
2


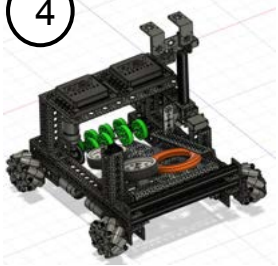
3


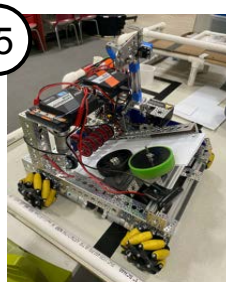
In our original plan, we planned on having 2 parallel sets of intake wheels and a conveyor belt that would bring the rings up to the shooter. As time went on we realized having a conveyor belt was unnecessarily complicated if we chose a low-friction ramp material instead, and would just be a waste of space, materials, and money. For the first qualifier, we settled on just having 2 sets of intake wheels, but after extensive testing found those could not reliably intake the rings. To counter this we added high-friction insulator strips to the wheels and a 3rd set of bigger wheels with more grip. This set can fold upwards so we are still within the size restrictions.

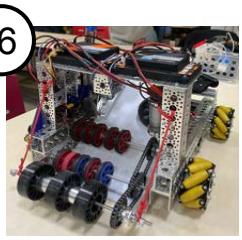
1


2


3


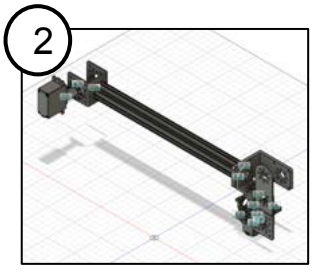
4


5


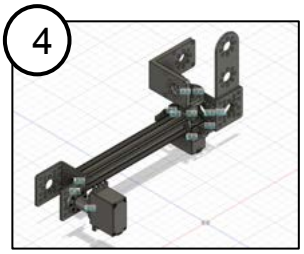
6


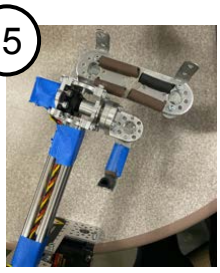
Originally we were planning on not having an arm. Our strategy was to just push the wobble goals into the zones in autonomous, without trying to lift the wobble goals over in endgame. After considering point values, however, we decided to add an arm so we could get the wobble goals over the walls in the endgame. Our first prototype for the arm could not lift up the wobble goal at all. Adding rubber bands helped a little, allowing us to slightly lift the wobble goal off the ground, but it was still nowhere near high enough. We then shortened the arm, replaced the rubber bands with a weight, and replaced the arm servo with a bigger, more powerful one. This allowed us to lift the wobble goal high enough to drop over the wall.

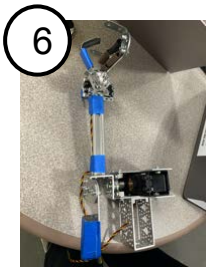
1


2


3


4


5


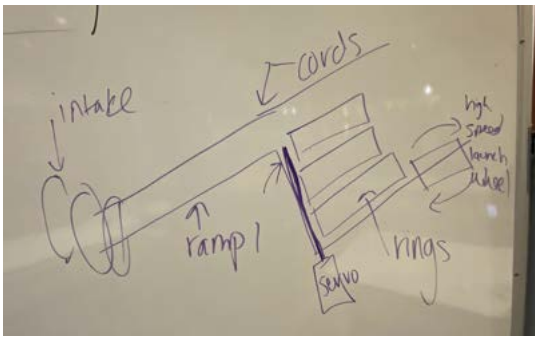
6


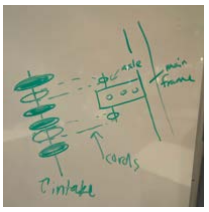
Robot Evolution: Qualifier 1 to Qualifier 2

Improving the Intake/Launching System for Qualifier 2

Brainstorming

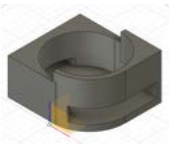
- Intake can be improved to hold 3 rings before launching
- Use some sort of vertical wheels at the start of the intake
- Either belts on top or bottom, or more vertical and sideways wheels in middle and end
- Launching has to be done by a 1-1 motor
- Two motors one after the other would be best, but one motor still works

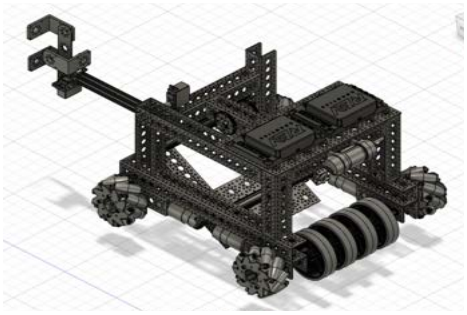




Planning Designs & Prototyping

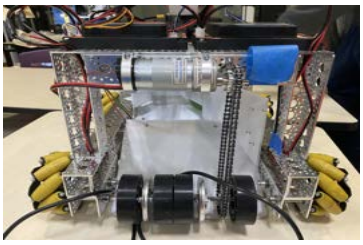
- Compliant wheels on a axle
  - Able to somewhat grip a ring for intake
- Launching prototype determined that two motors is most consistent
- CAD storage system for ring; prototype system on robot with cardboard material

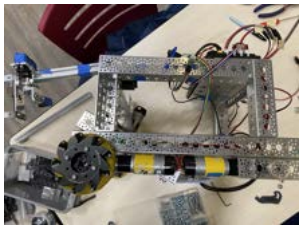




Building

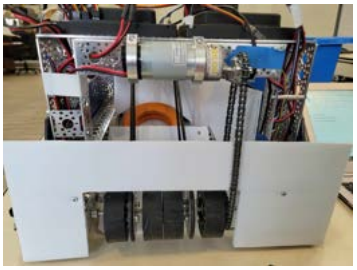
- Intake consists of multiple sets of vertically mounted small wheels
- Transitions to a big wheel, which moves it to the 1-1 motor with a green compliant wheel

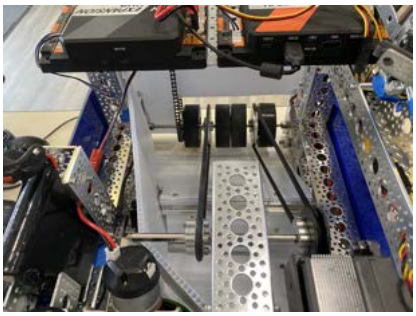




Improving

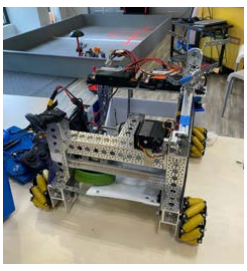
- Use makeshift ring storage system for competition, as not enough time to fine-tune 3D printed version
- Swap position of rightmost ring and gear so that wheels are in series next to each other to avoid issues with ring catching on gear
- Add rectangular cardboard piece so ring is guided to correct location

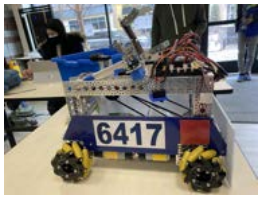




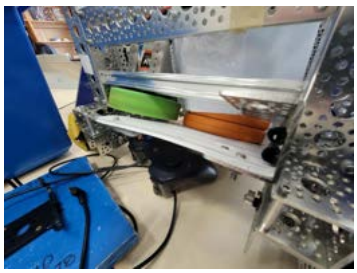
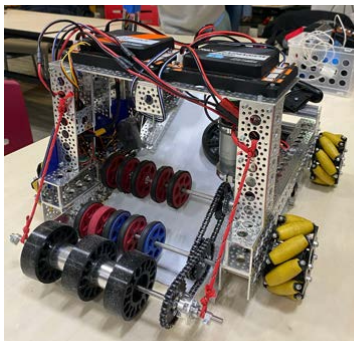
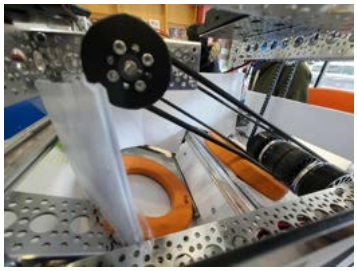
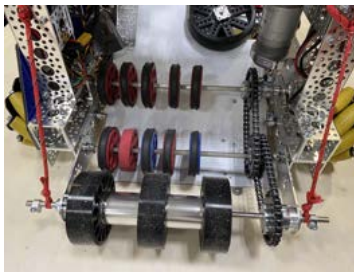
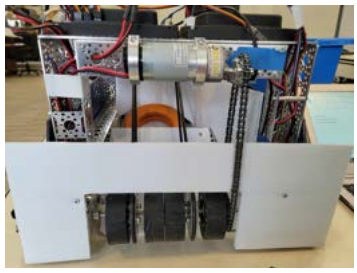
Final Design

- Intake consists of a set of 2 in. gecko wheels, with two belts
- Belts take rings into a three ring magazine
- Launcher is single 1-1 motor, and servo pushes rings into it





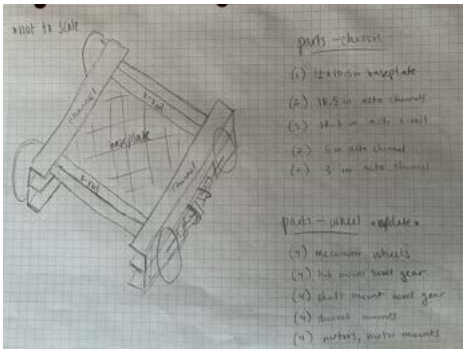
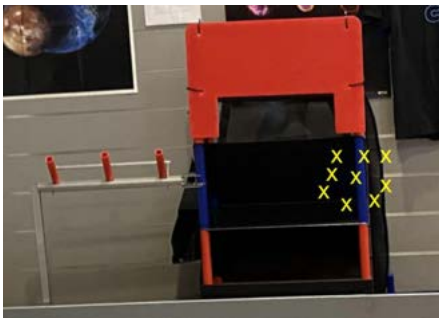
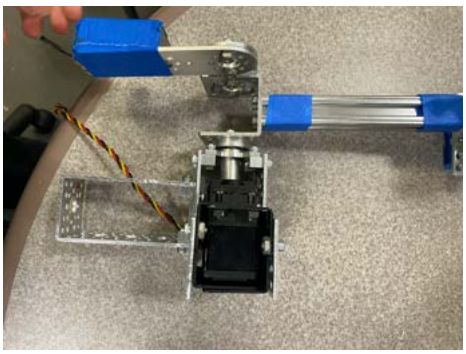
Robot Evolution: Qualifier 1 to Qualifier 2

<table>
<tr><td colspan="4">Robot Comparison: Key Similarities & Differences</td></tr>
<tr><td colspan="2">Qualifier 1</td><td colspan="2">Qualifier 2</td></tr>
<tr><td>Robot can store 2 rings without launching; prone to error because rings can be launched accidentally if moved up the ramp too far</td><td>  </td><td>Robot can store 3 rings without launching; not prone to error because ring launching requires a button, no need to gage distance to launch wheels</td><td>  </td></tr>
<tr><td colspan="2">Robot launching angle ~21° (according to CAD) to shoot into mid goal</td><td colspan="2">Robot launching angle ~30° (according to CAD) to shoot into high goal</td></tr>
<tr><td>Intake system is 3 parallel sets of vertical wheels; issues with friction of material, difficulty loading rings without ring getting stuck on “lip” of ramp, even with over-hanging set of black wheels</td><td>  </td><td>Intake system 1 parallel set of vertical wheels with cord/belts to assist passage up ramp; faster intake wheels with more reliable loading system due to improved ramp-to-ground gradient and guiding</td><td>  </td></tr>
<tr><td>Intake system has no feature to guide rings onto intake ramp; issue with getting caught on the ends of the ramp</td><td>  </td><td>Intake system has vertical cardboard feature to guide rings onto intake ramp; avoids issue with getting caught on the gear</td><td>  </td></tr>
<tr><td colspan="2">Large servo-powered arm with short stem and guiding alignment on grabber-portion; difference in mounting component & location, with qualifier 2 arm being mounted higher, but does not affect function or successfulness of picking up wobble</td><td colspan="2">  </td></tr>
</table>

Q1 average number of rings launched into middle goal for trial-runs: 4-5 (=16-20 points)
Q2 average number of rings launched into high goal for trial-runs: 8-9 (=48-54 points)

See “Game Strategy” and “Science & Math” sections for more comparisons of our qualifier 1 and qualifier 2 robots.

Engineering Meeting Extracts

Meeting #	Objective	Reflections	Pictures
Meeting #2	Draw out rudi-mentary chassis design	- A member of our team began to draw out a concept and a scaled model of our robot. It was helpful to be able to visualize the chassis as a team. - Because this item was completed during the meeting with restricted time, the hand-drawn model developed is basic and does not include all the parts necessary. It will serve as a concept design for when the team CADs remotely—it's helpful to have the model so that even separated, we can CAD effectively, in an organized fashion, and with a focused design in mind.	
Meeting #5	Finalize CAD model of chassis	- At home, we used Fusion 360 to finish the CAD model of our robot - Next week, we will begin building the chassis	
Meeting #16	Test shooters for function, then accuracy and consistency	- Now that the the team has replaced the broken motor with one of the other slower motors, the team placed rings into the shooter to see how well the system was working - The shooter seemed to be working but the results varied due to us not having a consistent intake speed/force - Since the launching system now functions properly, we could move on to test other things: accuracy and consistency - Overall, the shooter was pretty good and decently consistent considering the lack of intake— we manually fed the rings into the shooter - We couldn't do much other than test, as this meeting had to be short	
Meeting #22	Updates to arm: Attach large servos to arm Remove rubber bands	- We have developed another solution to address the problem of the wobble arm not being able to lift the wobble: - The team is switching out the small servos to the big servos so that the arm is able to withstand the weight of the wobble goal - Last meeting, we shortened the length of the level arm and made it so that the servo had 180 degree motion; we are optimistic that these changes in combo with a stronger servo will fix the issue	

Science & Math

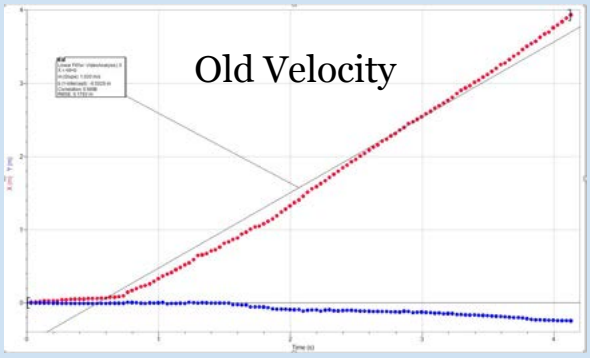
We use what we've learned from our science & math classes to improve the engineering process of our robot. Typically, we employ science & math concepts when designing our robot and when testing it or suggesting how to improve it. We take measurements to compare versions of our robot components in an objective, qualitative way.

Velocity Comparison

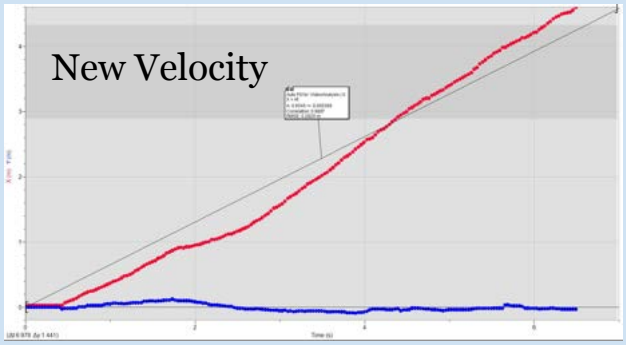
After qualifiers 1, our drivers requested for our robot to go quicker to score more points.

This calculation used video analysis of Logger Pro

Not only is the robot at a more consistent velocity(as indicated from the r^2 value), our robot is moving quicker making it easier for our drivers to score more points in tele-op



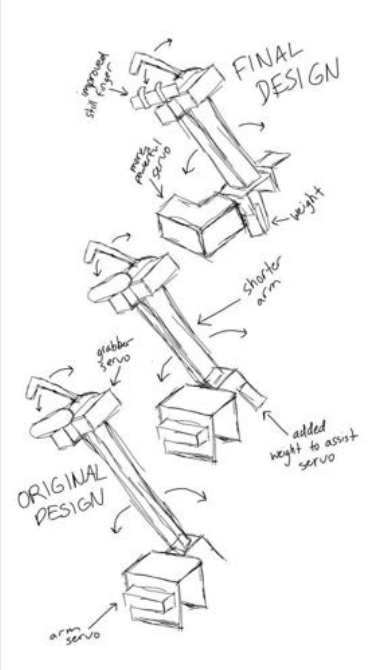
Auto Fit for: VideoAnalysis | X
X = At
A: 0.6545 +/- 0.005368
Correlation: 0.9807
RMSE: 0.2820 m



Linear Fit for: VideoAnalysis | X
X = mt+b
m (Slope): 1.030 +/- 0.01335 m/s
b (Y-Intercept): -0.5529 +/- 0.03188 m
Correlation: 0.9898
RMSE: 0.1793 m

Our Process:

Plan
↓
Experiment
↓
Record
↓
Calculate



Torque Comparison

Torque is an important calculation because this is a quantifiable measurement of the strain put on our servo from moving the arm up and down but also lifting the wobble goal up and down

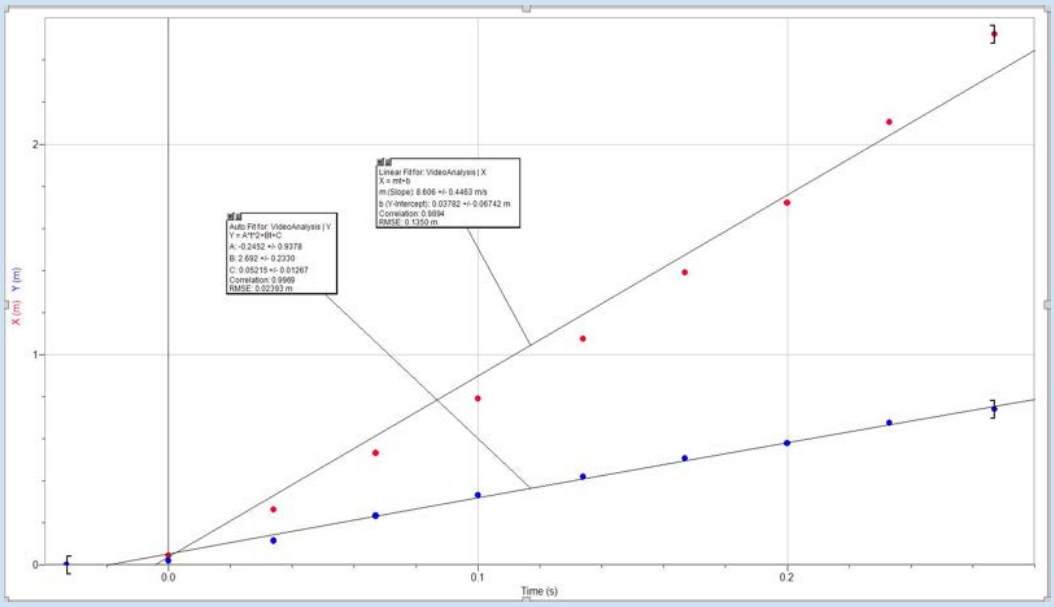
To calculate this we used the equation $\tau = r*f$.
Where τ is torque, r is the lever arm, and f is the force from the arm's weight & the weight of the wobble goal

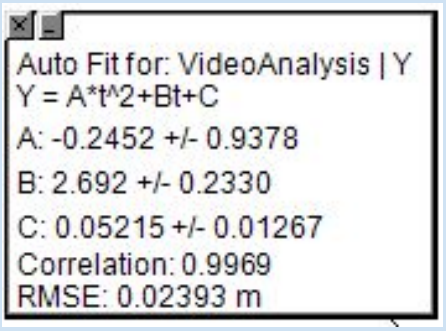
The old torque value was $\tau = 1.53 \pm 0.08$ N*m
The new torque value is $\tau = 1.74 \pm 0.08$ N*m

Although the strain put on the servo is now larger than it used to be, it is by a miniscule amount and since the servo has been handling this strain consistently through practices, the team doesn't have to worry too much about the longevity of the servo.

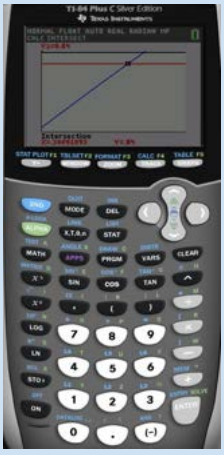
Science & Math

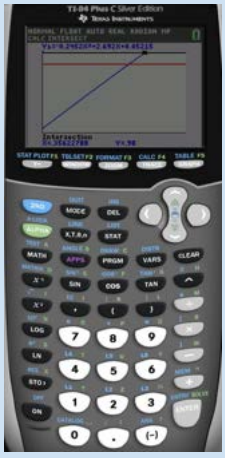
Projectile Motion





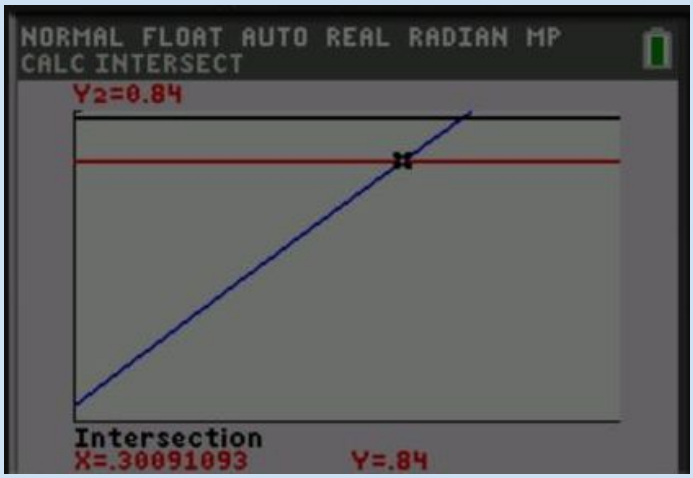
Through projectile motion, we can use this measurement to find the amount of time it took to reach the ideal height of the top goal.

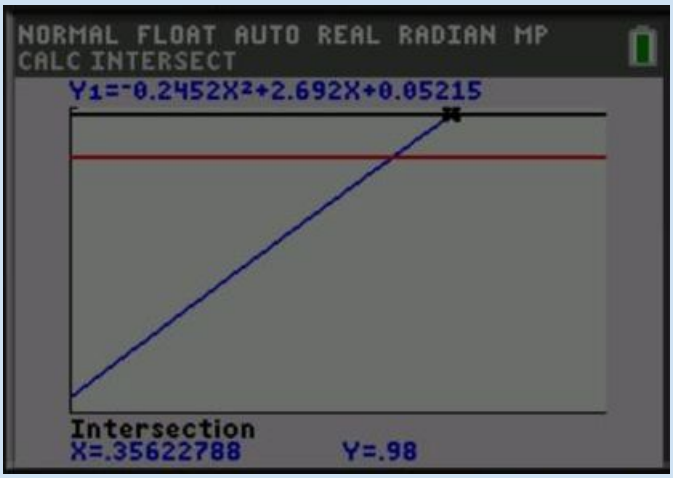




The top goal is between 33.125" and 38.625", or 0.84 to 0.98 meters off the ground, according to the game manual part 2 remote events pdf. Thus, the quadratic regression was plugged into y1, y=0.84 was plugged into y2 and y=0.98 was plugged into y3. The intersection between y1 and y2 and y1 and y3 was then found to be the time it took to shoot at that height.

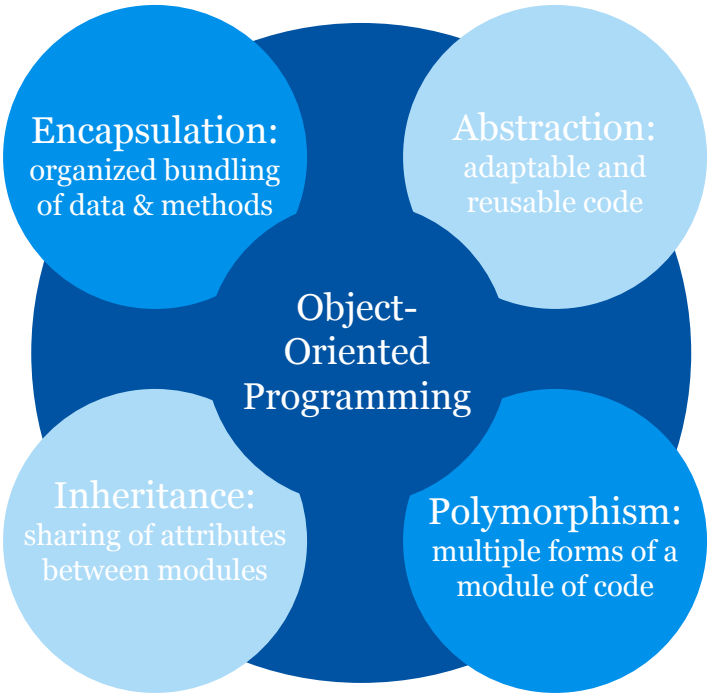
Overall, it takes 0.3 to 0.35 seconds to shoot into the high goal, showing our shooter system is not only accurate but quick, allowing our team to spend the majority of the time on picking up rings rather than launching them.





We were able to quantitatively determine how to make our robot more efficient for our second qualifier, and we're happy to see the results.

Code & Autonomous Development



We program our robot using Java in Android Studio. Through Java, we are able to take advantage of this **Object-Oriented Programming** (OOP) language and its four basic principles: **Encapsulation, Inheritance, Abstraction,** and **Polymorphism.**

- **Encapsulation**: in our code, the Hardware Map contains all of the variables representing our robot's physical hardware and the methods that operate on these variables, for instance, methods to drive, strafe, rotate, shoot rings, and move servos.
- **Abstraction**: In the autonomous phase, a single function that can carries out all three possible navigation paths using a matrix of distances to avoid repetitive code.
- **Inheritance:** Each OpMode module (Autonomous and TeleOp) 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 with them. This is very helpful during debugging.

Sensing

The three main sensing techniques we use are:

- **Encoders:** Sensing devices that detect the status of a motor based on electrical pulses. We can convert these pulses into revolutions of the wheel for our robot to travel specific distances on our field.
- **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.
- **TensorFlow Object Detection:** A machine learning library that uses a pre-trained image recognition model to recognize objects through the webcam. We use this library to detect the number of rings on the field to determine which target zone to drop the wobble goal.

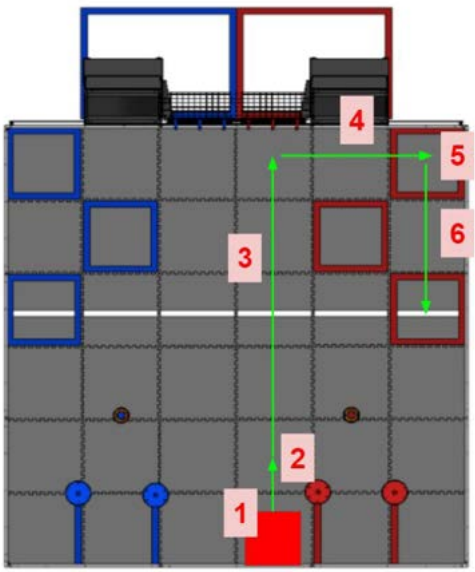
We've also experimented with **Vuforia Localization** to approximate the distances and angles of objects with respect to the webcam during testing, and **REV Color Sensor** to detect luminosity and sense the white line.

Autonomous Objectives:

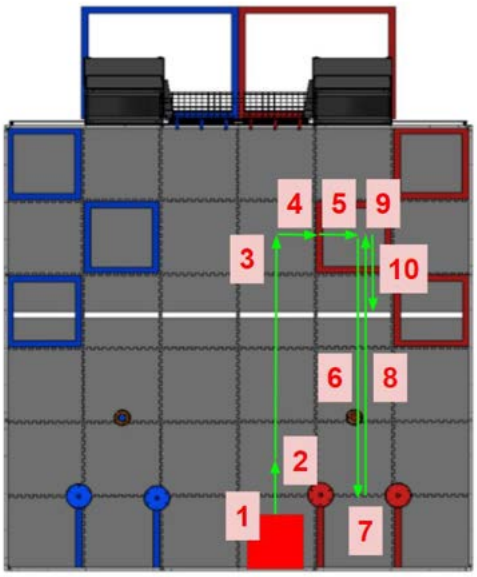
1. Determine no. rings on field
2. Shoot 3 rings into top goal (12 x 3 = 36)
3. Deposit Wobble Goals into target zone (Quad: 1 x 15 = +15; Single & None: 2 x 15 = +32)
4. Park on white line (+5)

Autonomous Program Diagrams

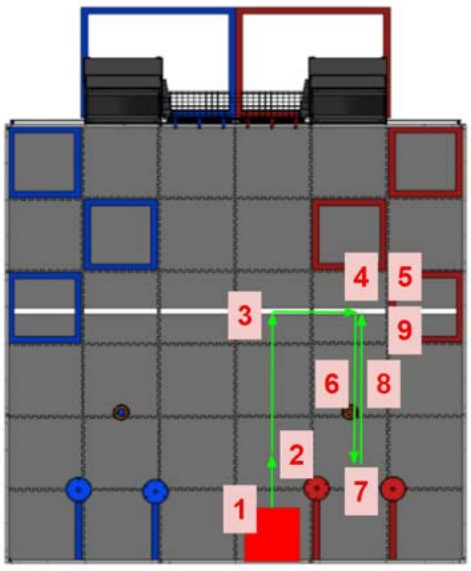
4 rings detected



1 ring detected



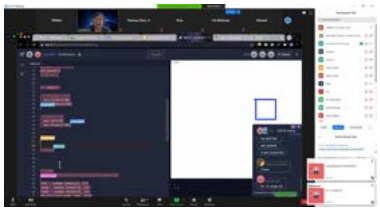
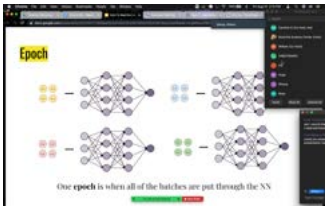
0 rings detected



Outreach

Remote Java Programming Workshop Series

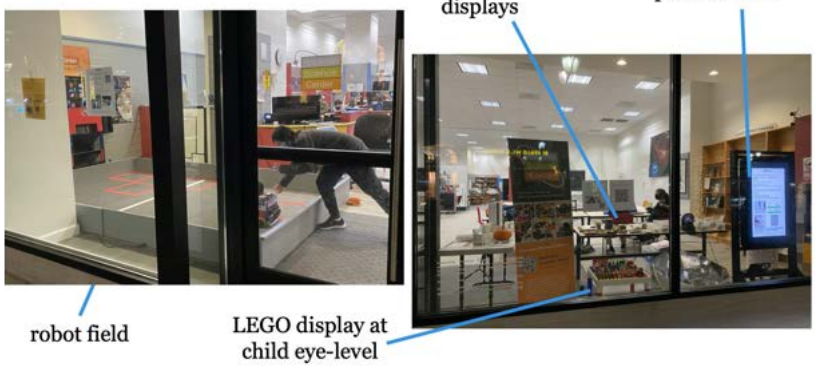
Our team recently conducted a series of Python programming workshops, led by our lead programmer Caroline. We virtually met with over 150 students over the course of five days, and our curriculum ranged from the basics of programming to complex interactive projects. Our cru was able to strike a balance between fun and informative by incorporating games and graphics as well as vocabulary and complex concepts. We made sure to guide our attendees through follow-up questions and helpful suggestions, rather than simply tell them what to do. We wanted to model our coaches' teaching style, as it has been very effective with us. Overall, we believe we achieved our goal of spreading the wealth of computer science throughout our community with the limited time that we had.

Rockville Science Center Activities

The Blu Cru has also been helping out with our sponsor, the Rockville Science Center, in setting up for virtual workshops and volunteering to help out at them. This is our way of saying thank you for their continued support.

Storefront Promotion



Remote STEM Interview Series

One thing some of our senior members pointed out about their high school experience was a lack of career-specific guidance. There are so many professions, particularly in STEM, that people either don't know about or only know about on a stereotypical surface-level. So, the team had the idea to host a series of remote interviews with local professionals in STEM. We plan to host these seminars during the second semester, when career day is scheduled in schools. We will invite local professionals to talk about what they do for a living, as well as why they like it and how they prepared themselves to take on the job. We have set up this outreach activity (see the interview questions), and we plan to recruit professionals soon.

Youtube Tutorial Series

We created a tutorial series covering all things FTC. Our goal in doing this was to a) create a resource for new members & future Blu Cru leaders to learn about how to run the team, and b) help new FTC teams, new members on other teams, and anyone looking for guidance on running a team. We published videos on the engineering and team plan-related activities teams need to complete during the year. We also created CAD tutorial with specifically cover creating FTC robot designs. We plan to create tutorial on building and code to expand our resource library in the future.

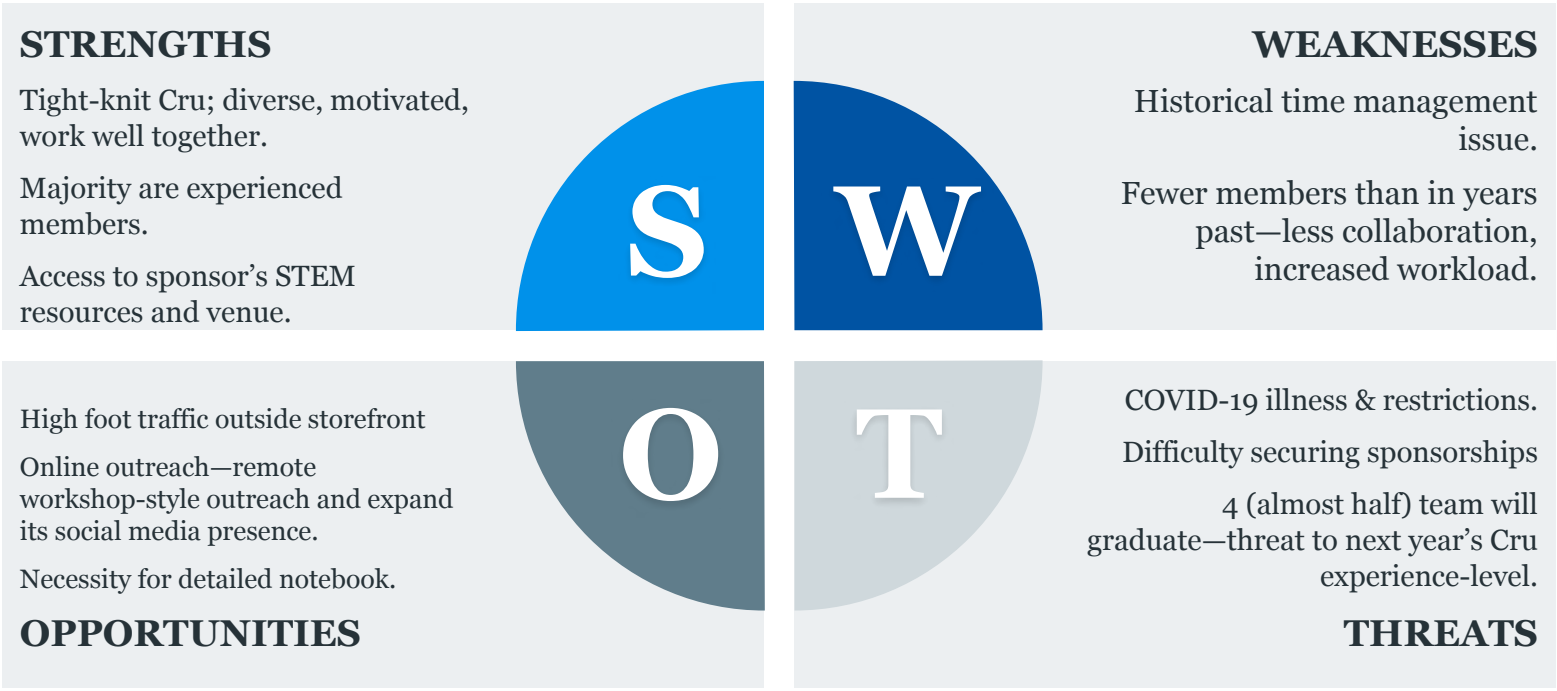

"Because someone has to inspire the next generation of engineers."

— Bob, our mentor, when asked *why outreach?*

Business & Sustainability Plan

Overview

At the beginning of every season, the Cru gets together to conduct a SWOT analysis (see below) and 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.



Every month, the Cru has a meeting to discuss our business agenda for the season. This meeting is attended by all team members and mentors. During the meetings, we...

- review our performance at past outreach activities, prepare for upcoming outreach activities, and canvass for new outreach opportunities.
- update team finance spreadsheets and approve purchases like robot parts and team competition expenses.
- discuss our fundraising opportunities and our sponsors.
- check in with our overall team progress, and each individual sub-cru.

Dually, these meetings teach our members to be more well-rounded; we aim to not only be technically skilled in robotics, but also to be business savvy, financially aware, and conscientious for our community.

The Blu Cru is committed to building long-lasting relationships with sponsors and mentors and maintaining positive connections to our community. Through efforts related to these goals, the Blu Cru has been able to sustain itself since its inception in 2012, and will hopefully be able to sustain itself in the future.

Our team actively engages with our sponsors during the season to keep them involved in our activities on a personal level. In a more typical year, we would attend multiple outreach events hosted by sponsors to showcase our progress and offer our services as volunteers as a thank-you. This year, we have hosted our online activities through our sponsor, the Rockville Science Center as a form of outreach to our community and our sponsor.

In this unprecedented time, we decided not to actively recruit new sponsors—not only are many businesses not in a financially stable enough situation to begin a relationship with our team, but we have managed to keep our expenses low so as to not require new sponsorships as a source of income. We plan to renew our plans to build connections with local businesses next season, or whenever circumstances become more appropriate to do so. In the meantime, we are using our STEM seminar outreach event as a way to canvass for new mentors. We are particularly looking for mentors with experience in coding and business, as our current mentors have experience with engineering.

Business & Sustainability Plan

Overview (cont.)

Because of our dedication to being positively engaged in our community, the Blu Cru has been able to grow and gain recognition. In the past, we have advertised our team activities in nearby schools, like in Rockville and Richard Montgomery High School, and promoted ourselves at local STEM fairs and events and in public spaces, like the library. This helped us gain community support and also attract new members to our team.

Without being able to interact with the public in a physical space, our location and the internet have become key in helping us reach our sustainability goals. We recently transitioned from the Makerspace in the Rockville Memorial Library to a property owned by the Rockville Science Center. This change allowed us to utilize the property's entirely glass storefront as a method of public-outreach.

The Blu Cru maintains its legacy through a coordinated effort to train new members. Our senior members usually transfer their knowledge and tips to the new members in training sessions. Our captains train our experienced members in learning how to coordinate all of the sub-crus on our team. In addition, our team mentors are a mix of alumni and community volunteers. This allows us to ensure continuity from year to year.

Goals & Actions | General Timeline

AUGUST / SEPTEMBER
Start meeting
Begin orientation for new members
Plan finances
Brainstorm ideas and plan
Build chassis
Create part list
Brainstorm outreach

OCTOBER/ NOVEMBER
Design & prototype intake and arm
Work on autonomous code

DECEMBER/ JANUARY
Plan outreach
Train members
Finalize robot
Practice!

Business

- Build sense of team comradery
- Keep all team members updated and aware of responsibilities
- Organize at least 2 online outreach events
- Coordinate volunteering positions at Rockville Science Center events
- Use storefront as form of team and STEM promotion
- Conserve and reuse robot parts to limit expenses

Sustainability

- Promote STEM and advertise Explorer Post 1010 Activities in the storefront
- Maintain strong relationship with our sponsor, the Rockville Science Center
- Increase presence on team social media accounts; increase number of teams that we are following to at least 40
- Gain a minimum of 1 new mentor through seminar outreach
- Gain a minimum of 2-3 new members
- Train new members in CAD, building, programming
- Prepare current members for passing-on of leadership roles for the next season

Robot & Competition

- Effectively use CAD software
- Improve approaches and strategies for solution testing (science & math)
- Document progress and details of design process thoroughly and extensively
- Outline comprehensive game strategy at beginning of season
- Allott drivers at least two weeks to practice for competition; score consistently

General

- Spread the spirit of FIRST and encourage involvement in STEM to community
- Inspire the next generation of FIRST members
- Improve teamwork and coopertition™ skills
- Demonstrate gracious professionalism at all times during competitions and events
- Maintain a fierce and lively competition spirit, but understand the greater goals for innovation, teamwork, and encouraging involvement in STEM

Goal	Action(s)
Build sense of comradery	• We have engaged in remote meetings over Discord, thus increasing the frequency of our meetings. • We developed a game to play using this year's theme where we try to toss rings onto the wobble goals—it's a source of competitive fun for the team!

Business & Sustainability Plan

Goal	Action(s)
Keep all members updated on progress & responsibilities	• We have held regularly-scheduled business meetings for every member of our team to check in on the Cru's progress as a whole and the individual sub-crus. • We have used our Discord server as a way to recap each meeting at its conclusion for those who weren't there. Absent members check our notebook for a more detailed account of each meeting's happenings.
Organize at least 2 online outreach events	• We hosted a series of Python programming workshops for beginners over the summer. Through the Rockville Science Center online seminar platform, we engaged over 50 attendees in how to program at a beginner level, and even guided them on creating their own games! • We are currently organizing a series of seminars with local STEM professionals. Not only will we use this event to canvas for new mentors or sponsors, but we will post the seminars on our social media pages to educate our followers on different STEM fields.
Coordinate volunteering positions at RSC events	• A series of Arduino circuit workshops takes place every Saturday at our meeting venue. We have been rotating members to help out at this seminar. • This task falls on any member with experience in circuit building and Arduino. It is an ongoing effort.
Use storefront as form of team and STEM promotion	• We set up our playing field in front of the windows to invite interested passersby to look into the store. • We have lego displays, block towers, and STEM posters (including informative COVID-19 posters) in front of our store. We loop a presentation with upcoming STEM events on a TV.
Increase presence on team social media accounts; increase number of teams we're following to ≥ 40	• We have created a team Twitter account. • We have followed 53 teams on Instagram, which have in turn followed us back. We have direct-messaged several teams to keep each other updated on our teams. • We have followed well-known and engaging STEM-focused accounts, like those of Bill Nye and Neil deGrasse Tyson. This provides us an alternative way of staying updated on science news. • We have learned about the activities of other teams, and they in turn have learned about ours. • We've created a team Youtube channel to post our matches and FTC tutorials for new members/teams
Gain a minimum of 1 new mentor through seminar outreach	• For the speakers whose professions line up with the FTC competition, we inquire about the possibility of a mentorship. • The idea is to suggest a flexible arrangement that can accommodate the availability of the potential mentor, as everyone has different circumstances during the COVID-19 pandemic.
Gain a minimum of 2-3 new members	• We believe 5 members is a good minimum number of experienced members for a team to successfully handle all the tasks that need to be completed. • We advertised FTC, the Cru, and our open team positions using the TV in the storefront to passersby. • We used an online "word-of-mouth" recruitment policy, in which our members informed people about our position openings using their social media accounts, like Instagram. • We used the Explorer Post 1010 and RSC email chains to inform people about the openings on the team. • We successfully recruited 2 new members!
Train new members in CAD, building, programming	• We took our new members on a "tour" around each of our sub crus, giving them an overview of each. • We held a CAD tutorial lesson for our new members using the Youtube tutorial developed by a Blu Cru alumnus. The new members learned the functions of CAD they would need for FTC, namely importing and using FIRST-specific parts and combining parts together to create an animated model for the robot. • We involved new members in each of our brainstorming, designing, and braining activities, encouraging them to give their input during these stages. • We created a series of tutorial videos to guide our new members on the FTC operations of a strong team. • We showed our new members our test robot, and allowed them to tinker around with the bot to get familiar with the tools and the FTC-specific parts.
Prepare current members for passing-on of leadership roles for the next season	• The heads of our sub-crus have allowed our members to take the initiative on specific tasks. For example, the design of our wobble-grabbing arm was coordinated by our less-experienced members, who collaborated to build, attach, and test the arm. It was a success! • Our captains prepare experienced members to learn how to manage the various sub-crus. These members learn about what the other Crus are doing by "swapping" jobs for a few meetings. • Our tutorial videos offer guidance from our older members on how to run a team; to be consulted in the future.

Finances

This year demanded an unprecedented financial plan. We were unable to carry out our typical fundraising initiatives, which involve in-person activities, such as the annual Explorer Post Laser Tag game and Post 1010 picnic. Our budget will have to be adjusted. It is very apparent that this season is not an appropriate time to inquire about sponsorships from local business, most of which are in no financial position to divert resources to a sponsorship. We also know that our fundraising activities, which in previous years were entirely in person, would not be possible this year. In addition, IBM has changed the way it allocates grants for this year, meaning our grant will be of a smaller amount than usual. Luckily, our loss in expenses will be accompanied with a reduction in competition and outreach expenditures.

2020-2021 Projected Income

Source	2019-2020 Amount	2020-2021 Projected Amount	Change from 2019-2020 season
Member dues	$2800	$1800	— $1000
Fundraisers/Community Donations • All-night laser tag • Post 1010 picnic • Bake sales at science events	$320 • $200 • $50 • $70	$0	— $320
Sponsors	$1500	$1500	—
IBM Grant	$500	$125	— $375
Total	$5120	$3425	— $1695

Expenses

Category of Expense	Amount	Notes
FTC registration	$275	This is a required expense
FIRST Chesapeake Competition Fee	$300	This is a required expense
Field Costs	$450	This is a required expense
Robot parts ULTRA PLANETARY GEARBOX KIT & HD HEX MOTOR (x2) EXTRAPLANETARY LONG REACH MOUNTING BRACKET - 2 PACK (x1) Stealth Wheels (x2) 5202 Series Yellow Jacket Planetary Gear Motor (x4) 1206 Series Pattern Adaptor (x4) 1.00" OD 0.500" ID Smooth Hub Pulley (x6) 6mm to 6mm Set Screw Shaft Coupler (x4) Control hub	$621 $72 $5 $14 $160 $14 $36 $20 $300	We reused parts from last year, and only bought parts which we could not find adequate substitutes for
Additional competition expenses	$0	We do not have to print our notebook or provide other materials to present at competition (all online).
Rental of venue & other Explorer Post 1010 umbrella costs	—	These are covered by a portion of our membership dues.
Total	$1646	We are happy to have stayed on track with our budget!

As a result, we paid extra attention to being deliberate and sustainably-minded when it came to making purchases. In some ways, this unusual season prompted us to become more aware financial decision-makers.