The next thing we had to do was tap the motors. We wanted to use hex axles for the intake wheels to go on, so we got a large hex axle that we wanted to screw onto the motor axle. This requires drilling and tapping the motors so a screw can thread through.

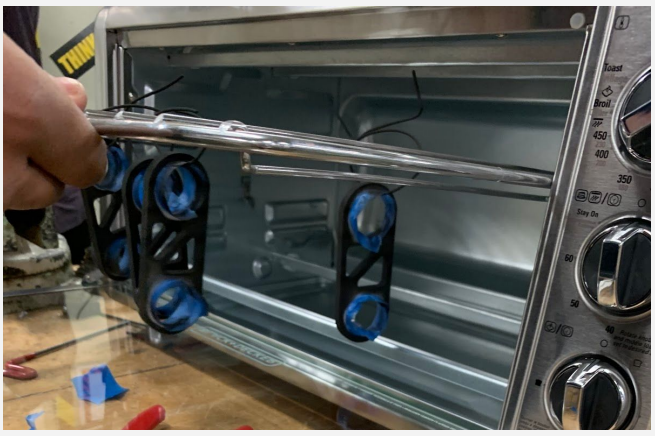
To fit our color scheme, we wanted to powder-coat the aluminum. We used black powder and taped the inside of the holes for the bearings to insure a better fit.

Before powder-coating it, we checked if the assembly fit together

To powder-coat, we needed to set up a stand to hold the intake plates as we are powder-coating them. Luckily, the styrofoam that came with the oven that we bought for powder-coating served as a perfect surface for a table. We quickly cut PVC pipes and pushed them into the styrofoam. With a little bit of duct tape, we had the perfect table for our powder-coating.

We covered all of the intake plates with black powder (covering the bearing holes with tape so they won't gain any extra thickness. Then we proceeded to put it in the oven for it to bake.

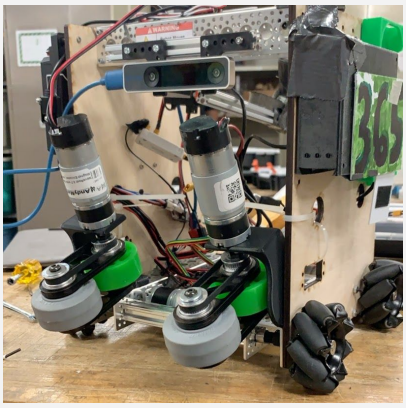
After baking the powder-coated mount, the tape got stuck and difficult to take out, but we used sandpaper, and then we arbor-pressed the bearings in.



This powder-coating resulted in very nice black aluminum plates for the intake.

FABRICATE AND INTEGRATE: INTAKE ASSEMBLY

We assembled the intake directly based off of the CAD. We also made custom sized spacers for the shorter (green) wheel to fit closer to the top intake plate. We used stock hex space and lathed off the size we needed.



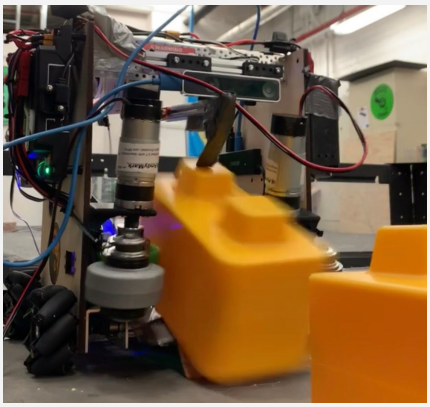
We tried to assemble it so that poorly-painted parts of the mount were facing down or inside of the robot, so it would look better.
We mounted the assembly onto the 3d-printed motor mount, and put the motor mount onto the robot.
We then used string to make a hard-stop for the spinning intake to prevent it from closing in on itself.

The string did not work perfectly, so we tried zip ties
Both solutions performed okay, but we will look into better solutions for hard-stopping it tomorrow.

TWEAK & EVALUATE: INTAKE PERFORMANCE

The intake does not grab blocks that are sideways that well, but it still has a good amount of compliance. We taped the intake ramp to the floor and saw a drastic increase in performance. This means a ramp that is close to the ground will intake the best, but it will not be able to go under the neutral bridge because of the half-inch lip.

We noted that the intake performs very well, but we do see room for improvement. It's alignment is not perfect, but it can still intake blocks that are not completely straight. This performance will be okay for the Delaware meet and we hope that the intake is competitive for the New Jersey Meet.



GENERATE CONCEPTS: INTAKE RAMP

We want an intake ramp that is close to the ground but will be able to go under the neutral bridge.

1) **Servo-powered Ramp**
    a) This ramp will only be down when intaking Stones, and it will be picked up when trying to go under the neutral bridge so it is not in the way.
2) **Passive Hinge Ramp (w/ Rollers)**
    a) This will not use a servo, but it will be a hinged-ramp that can rotate up and down. Gravity will bring it down, but it will be pushed up when trying to drive over the lip under the neutral bridge.

Option 2 is prefered if it works because it does not use an extra servo. The servo is another point of possible error. We do not know if the roller will ride up the ramp though, so tests need to be conducted later.

We will also test other materials and angles for the ramp to see if any of them will go over the neutral bridge and still pick on the stones.

Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	Fabricate and Integrate	**Tweak & Evaluate**

CHASSIS

TWEAK & EVALUATE: DRIVETRAIN PULLEY FIX

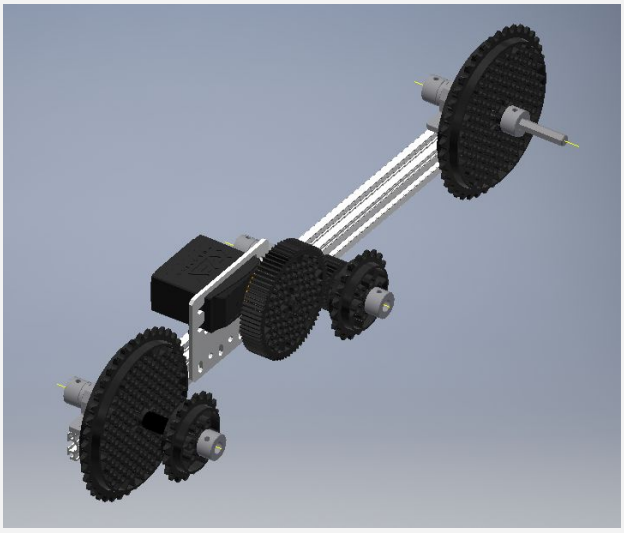
One of the pulleys of the drivetrain broke at the Oxford scrimmage, so the drivetrain does not drive properly. We have backups printed, but to prevent future problems with the pulley, we ordered the metal equivalent of the pulley. It has an axle hub that we do not need, so we will use the lathe to take it off. For the meet next week, we will use the printed back ups
No design *changes* were made to the chassis because it drove well at the Oxford scrimmage before breaking.

Define Problem	Generate Concepts	**Develop a Solution**	Construct & Test a Prototype	Fabricate and Integrate	Tweak & Evaluate

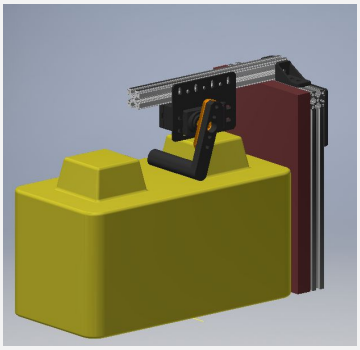
SCORING STONES

DEVELOP A SOLUTION: OUTTAKE CAD

We decided this outtake to be chain driven instead of string driven. First, running it off of chain means that it can actuate the extension and retraction. String does not do this unless there is a retractionstring. Next, we calculated the gear ratio so that it can be powered by 270 degrees of rotation for full extension. We did this because the Servo can stay in Servo Mode instead of Continuous Rotation (CR) Mode. In CR Mode, you set the power, but you do not have access to the positional data. In Servo mode, it runs at full power but you can set its position and it will hold it. This means that we will know the position of the outtake at all times. We also do not have to worry about strings falling off of pulleys/



DEVELOP A SOLUTION: GRABBER CAD



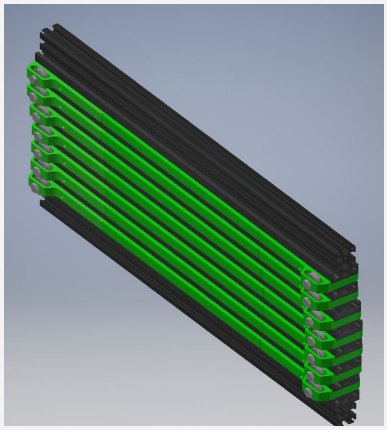
We CADed the grabber that holds the stone. It presses the stone against a grippy material using a 3D printed grabber part that pressed the nub of the stone.

Define Problem	Generate Concepts	**Develop a Solution**	Construct & Test a Prototype	Fabricate and Integrate	Tweak & Evaluate

STACKING STONES

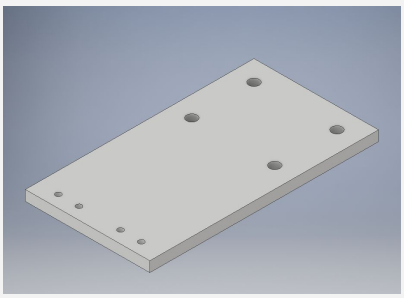
DEVELOP A SOLUTION: LINEAR SLIDE CAD

The team was decided whether to use REV Ultraslides or Misumi slides because teams were saying that the REV UltraSlides were prone to breaking. Also Misumi slides are well known and used by the top teams in FTC. While having this conversation, we saw the Long Robotics stocked up on their linear slides. We have been hearing wonderful reviews on the lightweight and slim design of the Long Robotics Slides. Also, they give CAD of the inserts on their storefront, so we will already have CAD for connecting the slides instead of making our own. Finally, they sell their slides in a black anodized version. This will look way better than the aluminum gray variants of any other slides we would have bought. We quickly bought as many slides as we needed in 6 packs, and we bought out their whole stock of 6 packs.
Then, using their inserts, we designed an 8 stage vertical lift with REV Extrusion on the bottom and top stage for mounting.



DEVELOP A SOLUTION: LINEAR SLIDE CAD

We CADed Slide plates for the Linear Slide to mount to. These Slide plates will use M3 Screws to mount to the REV extrusion of the lift and then we will use large screws through the plate to mount onto the side panels of the robot.



NON-TECHNICAL DISCUSSION

- We had an extra meeting to ensure we are competitive in the New Jersey Meet that is in 8 days. Because we want a good autonomous, we want the programmers to have the robot running as early as we can.
    - We prioritized things that the programmers required to have a good autonomous, such as a working intake and a working drivetrain.
    - We want to give the robot to the programmers early Saturday morning, and we can work on other mechanism off of the robot while they use it.

MEETING SUMMARY

- Intake Fabrication & Assembly
- Long Robotics Linear Slide CAD
- Outtake and Grabber CAD

SATURDAY, NOVEMBER 30, 2019 MEETING

DATE & TIME: 11/30/19 | 9:00 AM - 2:30 PM

STUDENTS: Katy, Helen, Jonas, Ian, Isha, Rohan, Suraj, Patrick, Bryan, Aidan, Paige

MENTORS: Mr. Prettyman, Arnav, Andrew

AGENDA
Fix and debug connection errors
Finish outreach presentation

TIMELINE REVIEW

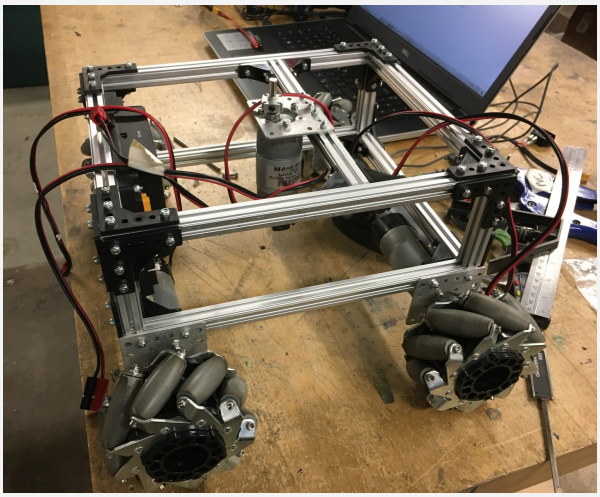
Upcoming Competitions	Towle meet (12/5), P'Town Throwdown VIII (12/7)

MECHANICAL ACCOMPLISHMENTS

Define Problem	Generate Concepts	Develop a Solution	**Construct & Test a Prototype**	Fabricate and Integrate	Tweak & Evaluate

NEW BATTERBOT

CONSTRUCT A PROTOTYPE: BATTERBOT



To teach and develop basic skills for robotics for the new team members, the mechanical team is creating a new, updated batterbot for MOE outreaches.

During this meeting, Isha, with the help of Jonas and Paige, worked on the new batterbot and created a base foundation and skeletal outline of the robot based off of the CAD designed during the previous meetings. The mechanical team cut some of the side panelling and plan on installing it after the two upcoming competitions.

Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	**Fabricate and Integrate**	Tweak & Evaluate

STACKING STONES

FABRICATE AND INTEGRATE: LIFT 3D PRINTED PARTS

Patrick and Bryan told Ian that they were using a linear slide for the stacking stones mechanism that need 3D printed inserts. These inserts are three pieces, a left insert piece, a right insert piece, and a center insert piece. So, he downloaded the for the website and put them in the PrusaSlicer Slicing software. For this print, he put 3 sets of each of the insert pieces. They finished printing before the end of the meeting and we think the green compliments the black very well.

Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	Fabricate and Integrate	**Tweak & Evaluate**

CONNECTION DEBUGGING

TWEAK AND EVALUATE: CONNECTION ERRORS

The mechanical team and the programming team worked together to solve the connection issues. We noticed that it doesn't matter how good our robot is if we are disconnecting every single match, so we dedicated a lot of time into solving this problem.

We did tests where we ran it across the field multiple times and then touched the metal bridge to see if it was electrostatic discharge problems. These tests were inconsistent.

We tried switching out phones and this also did not show any progress.

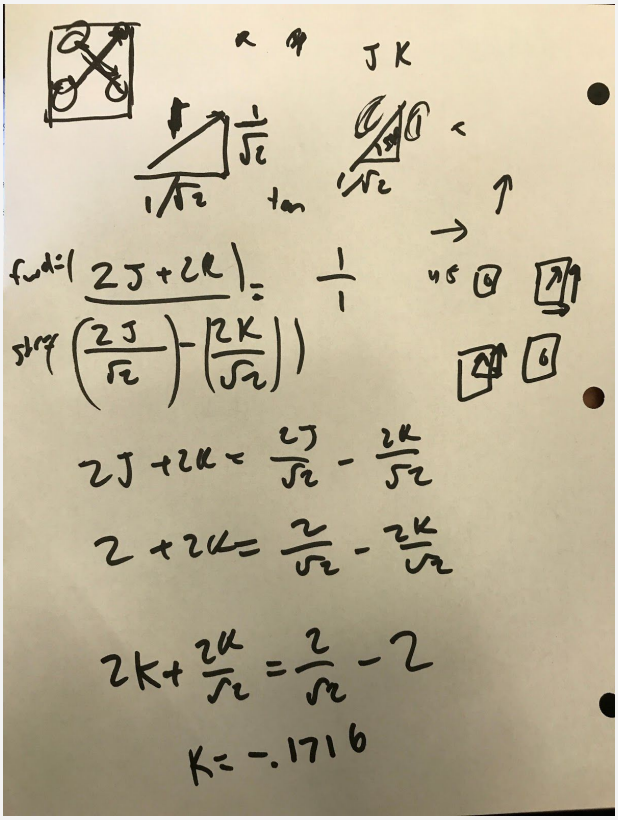
Our final decision was to make everything as basic as possible in code and electronically (we only kept the drive train plugged in) and then keep slowly adding on until we saw a problem.
We found that it was not the USB Hub or the Cameras causing the problem and neither was it any other motors. After changing the the phone mount to just being velcro, updating the REV firmware, and fixing some code (*read Connection Debugging under Programming Accomplishments)* the robot seemed to be running smoothly

PROGRAMMING ACCOMPLISHMENTS

Define Problem	Generate Concepts	**Develop a Solution**	Construct & Test a Prototype	Fabricate and Integrate	Tweak & Evaluate

TELEOP

DEVELOP A SOLUTION: MECANUM CALIBRATION



Theoretically, the robot would need to adjust its direction in order to travel in a specific angle. After strafing or traveling in a sideways direction, the x and y-axis of the robot will then be tilted in a different direction.

If the robot then wants to move in a specific direction with a specific angle, the robot has inconsistencies as the x-axis and y-axis are tilted in a direction that does not face forward. For example, if the input at this point is 45 degrees, the robot may not travel 45 degrees relative to the player/controller because the axis is tilted.

The calculation of k in the problem on the left addresses this difference. The value of k can be applied so the robot automatically calculates the angle that it should travel in the same direction as the input angle.

Once again, if the robot's axis is tilted with the positive x up and the input is 45 degrees, the robot would want to travel with a higher angle than expected. With this calculation, the robot will automatically calculate the angle that it should travel at (less than 45 degrees) so it would end up traveling 45 degrees overall.

This math will not be implemented until further testing is done. It is not a high priority—teams drive mecanum without this calibration without problems.

Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	Fabricate and Integrate	**Tweak & Evaluate**

CONNECTION DEBUGGING

TWEAK AND EVALUATE: CONNECTION ERRORS

Due to current errors with wire and phone connections of the robot, the programming team decided to switch the TeleOp code to our own loop from LinearOpModes (only run once). However, this created errors as the loops that the programming team wrote did not quit, so the robot continuously ran the loop, which led to some of the connection errors that we faced. Because of this error, the programming team decided to convert all of the code into OpMode code.

NON-TECHNICAL DISCUSSION

- **Helen and Katy created a presentation for outreaches.**

In order to become more organized and informative, MOE decided to use a slideshow and speech during outreaches to inspire students to participate in robotics. A FAQ session will also be implemented in the outreach presentation for more information for the parents.

- **The team set goals for the next week.**
    - Add a working foundation grabber
    - Fix connection errors and get a consistent drive
    - Tweak ramp (does not get caught on the tiles)

MEETING SUMMARY

- New Batterbot Fabrication
- Fixed Connection Errors

TUESDAY, DECEMBER 3, 2019 MEETING

DATE & TIME: 12/03/19 | 6:00 AM - 8:30 PM

STUDENTS: Bryan, Patrick, Helen, Ian, Marcus, Connor, Jonas, Aidan, Clare, Rohan

MENTORS: Nick, Andrew

AGENDA
Fix minor mechanical issues
Check phone and wire connections
Drive practice
Pack for Thursday and Saturday meets

TIMELINE REVIEW

Meets	Towle Meet - 12/5, P-Town Throwdown - 12/7
Lift	Build by 12/10-14
Harvester	Tested today

MECHANICAL ACCOMPLISHMENTS

MECHANICAL TO-DO LIST

MECHANICAL TO-DO LIST

Ahead of the meets later this week, the mechanical team was busy doing some quick repairs to make the robot perform more reliably and help solve the disconnect issues. They tried to move quickly so that the programmers could have the robot for the second half of the meeting to maximize our performance during the meets

To Do:

- check drive belts
- replace any broken drive pulleys
- secure (broken) harvester bracket with tons of tape or something (no time to reprint most likely)
- mount webcam with 3M tape & bent metal bracket
- mount foundation servos
- CLEAN UP WIRES
- strain relief on Robot Controller phone to stop disconnecting

Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	**Fabricate and Integrate**	Tweak & Evaluate

MOVING FOUNDATION

FABRICATE & INTEGRATE: FOUNDATION SERVO

Bryan and Patrick tested and rebuilt the servo mechanism designed to grab and move the Foundation during Autonomous and End Game. It is just two servos with REV Extrusion with angled REV plates. The servos are attached the the side panels with 3M double-sided Tape. The Rubber bands are added for extra grip. Also, we used two instead of one because when using one servo grabber at the Oxford Scrimmage, we saw that we had very little control of the foundation. This should improve how we well we grab the foundation

We put duct tape across so we can block Stones from going all the way through the robot when intaking. Then we put the foundation grabbers down and push the Stones with our outtake pusher.

Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	**Fabricate and Integrate**	**Tweak & Evaluate**

CHASSIS

TWEAK & EVALUATE: MOVEMENT ISSUES

When Rohan attempted to drive the robot prior to testing the autonomous code, the robot displayed irregular motion. As the robot drove straight forward, the line of motion turned rather than going directly straight. After examining the robot, Rohan and Andrew realized that one of the wheels on the robot made contact with the wooden side panelling of the robot. Because of this contact, the motion of the wheel is inhibited while the other parallel wheel's motion stays normal, resulting in curved movement instead of driving straight.

In order to overcome this unexpected issue, Patrick and Jonas adjusted the wheel's position by removing and reattaching the wheel and bearing. Patrick also brought the robot home to change the spacing of all the wheels so they don't touch the side panels.

FABRICATE AND INTEGRATE: CAMERA MOUNT

To mount the Logitech Camera, we just got a bent piece of aluminum and put two holes into it to mount onto the REV extrusion that already holds the SLAM Camera

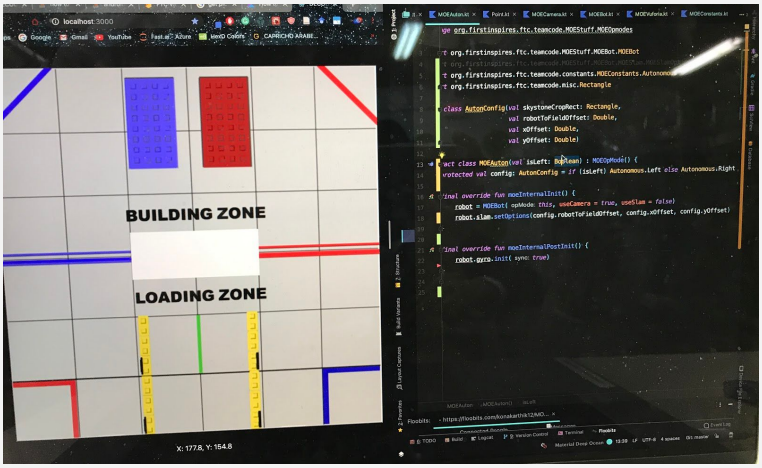
PROGRAMMING ACCOMPLISHMENTS

Define Problem	Generate Concepts	**Develop a Solution**	Construct & Test a Prototype	Fabricate and Integrate	Tweak & Evaluate

AUTONOMOUS

DEVELOP A SOLUTION: AUTONOMOUS POINTS

Prior to creating the autonomous code, Rohan utilized an online version of the game field to find specific points necessary for the robot to travel during the autonomous period. Using the coordinate system developed in past meetings, the online game field models the actual field and provides points that are adapted to fit the coordinate system of the game.



NON-TECHNICAL DISCUSSION

- **We went over a list of short-term priorities for the two upcoming meets.**

The main goal for today's meeting is to prepare for the meets on Thursday and Saturday. We want to have a basic autonomous and harvester/outtake prepared. After this weekend, we will have a significant period of time to make progress toward the final finished chassis design.

Mechanical:
- check drive belts (5m)
- replace any broken drive pulleys (10m)
- secure (broken) harvester bracket with tons of tape or something (no time to reprint most likely) (5m)
- mount webcam with 3M tape & bent metal bracket (15-20m?)
-mount foundation servos (10m)
- CLEAN UP WIRES (2m)
- strain relief on Robot Controller phone to stop disconnecting (1m)

Programming:
- make sure teleop is complete and tested (5m)
- basic auto- 1 stone delivered, move foundation, park, or something like that (1h) (can be done while packing tools / spares etc)

- **We reached out to a few organizations regarding outreaches.**

Helen and Clare reviewed the outreach presentation and contacted the Boys and Girls Club and Western YMCA about the possibility of hosting an outreach to introduce students to robotics in both locations.

- **Clare finished the first version of the Team Plan.**

Aside from a few details, the first version of the team plan is completed and ready for evaluation. I will present it to the team some point next week.

- **We packed for the meets later this week.**

Ian, Aidan, and Marcus referred to Ian's packing list from last year to gather all the parts and materials needed.

MEETING SUMMARY

- Preparation For Meets
- Autonomous Movement
- Chassis Fixes
- Foundation Grabber V2

TUESDAY, DECEMBER 10, 2019 MEETING

DATE & TIME: 12/10/19 | 6:00 PM - 8:30 PM

STUDENTS: Patrick, Bryan, Suraj, Clare, Aidan, Isha, Karthik, Helen, Marcus, Paige,

MENTORS: Andrew, Nick

AGENDA
Get well card for Mr. Prettyman
Discuss performance at P-Town Throwdown Meet and Delaware Towle Meet
Potential outreaches - Delaware Children's Museum
Scheduling for the next few weeks

TIMELINE REVIEW

Saturday 12/14	Kaizen Robotics Outreach
Lift and Intake Prints	Finish printing and assembling around 12/21

MECHANICAL ACCOMPLISHMENTS

Define Problem	Generate Concepts	**Develop a Solution**	Construct & Test a Prototype	Fabricate and Integrate	**Tweak & Evaluate**

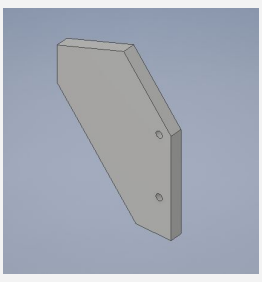
DELIVERING STONES

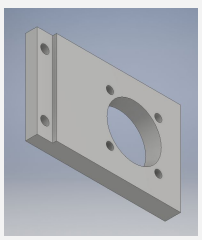
TWEAK & EVALUATE: PERFORMANCE AT MEETS

We were very happy with the performance of the intake in the two meets. Even though it was breaking, it grabbed blocks very quickly. One of the best teams in the New Jersey meet commented that we were the best intake bot there. To improve our intake, we want to have a more stable mount.

DEVELOP A SOLUTION: NEW INTAKE MOUNTING

Our idea is to make our intake mount out of aluminum. This also means that the shapes have to be more simple so that a CNC can mill it. For this to be possible, we need it to be a two part assembly: one that mounts to the side panel and then a motor mount on top of that. This way, any hits that the intake gets will be supported by aluminum mounts and the strong side panel.





Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	**Fabricate and Integrate**	**Tweak & Evaluate**

CHASSIS

TWEAK & EVALUATE: PERFORMANCE AT MEETS

We already knew that the plastic prints would possibly cause a problem, so we ordered metal ones before the meets. That being said, the meets held up our original opinion. One of the prints broke during the Delaware meet. For the New Jersey meet, because we did not bring spares, we had to zip tie the pulley together.

FABRICATE AND INTEGRATE: HEX BROACHED PULLEY

Our new metal pulleys came in. The plan is to lathe them if we have to (if they do not fit), but also hex broach them so they can fit on our hex axle. We also ordered a new hex broach. One of the FRC Mentors walked through how to correctly broach our new metal pulleys. We only got to finish one of the four pulleys today

DISCUSSION

CAD SPEED UP

The mentors noticed that we do not have many meetings in December because of holidays. This means that the CAD process needs to speed up. Bryan noted that his CAD Designs usually get critiqued too hard so they never pass the design stage. The mentors ensured that the CAD Designs will get passed the design stage if they pass a second look through by Arnav. In this look through, everything needs to be feasible, and it does not need to be perfect. The goal is to finish the CAD by Friday so it can get reviewed.

ODOMETRY

Currently, we plan to use the SLAM camera for our odometry system. Patrick and Bryan believe that dead-wheel odometry will perform much better, and it is worth designing. Nick believes that it will not be time-efficient because we are in a time crunch and we already have a solution for odometry. Patrick thinks that more reliable and consistent odometry would be efficient because the point breakdown for autonomous scores more points them stacking stones do. Also, the reliability of autonomous does not depend on the random alliance partner you have compared to tele-op because one partner does most of autonomous. Overall, they decided to not design dead wheel odometry right away, but plan space for it on the robot.

PROGRAMMING ACCOMPLISHMENTS

Define Problem	Generate Concepts	Develop a Solution	**Construct & Test a Prototype**	Fabricate and Integrate	Tweak & Evaluate

NEW PHONE

CONSTRUCT & TEST A PROTOTYPE: TEST NEW PHONES

MOE got two new phones that are both Moto E5 phones. The programming team wanted these phones because the new phones allowed for faster processing of code and programs while also staying in the MOE budget. After running the robot with these new phones, the programming team confirmed the faster processing speed of the phones and decided to keep them for the robot (especially during the competitions).

Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	Fabricate and Integrate	**Tweak & Evaluate**

SLAM TESTING

TWEAK & EVALUATE: PROPER TESTING

The programming team was told to conduct 30 trials regarding the SLAM camera to measure the accuracy (standard deviation, etc.) of the camera. These trials would involve driving the robot around different positions on the field and hand measuring the distance that the robot travelled. The hand measurements will then be compared to the distance measurements recorded by the Slam camera so the programming team can determine how accurate the measurements generated by the camera are. This will impact our decision on using the SLAM camera versus using odometry as our prime source of localization.

They did not conduct the tests this meeting.

Define the Problem	Generate Concepts	**Develop a Solution**	Construct & Test a Prototype	Fabricate and Integrate	Tweak & Evaluate

GAMEPAD DEVELOPMENT

DEFINE PROBLEM: TELE-OP CONTROLS

While at the December 7th New Jersey P-Town Throwdown, there was a need to quickly adapt and modify existing tele-op code. One of our drivers requested a toggle for a button, but due to the slightly convoluted logic behind the implementation of a toggle, lots of time were taken to debug and get the toggle working correctly. This time was wasted and should have been spent on more productive things.

Therefore, we needed to find a way to *efficiently develop tele-op controls* on the fly.

DEVELOP A SOLUTION: TELE-OP CONTROLS

A solution to the above problem was to create a Gamepad Manager class that acted as an abstraction between the raw gamepad class and the Tele-Op code we wrote.

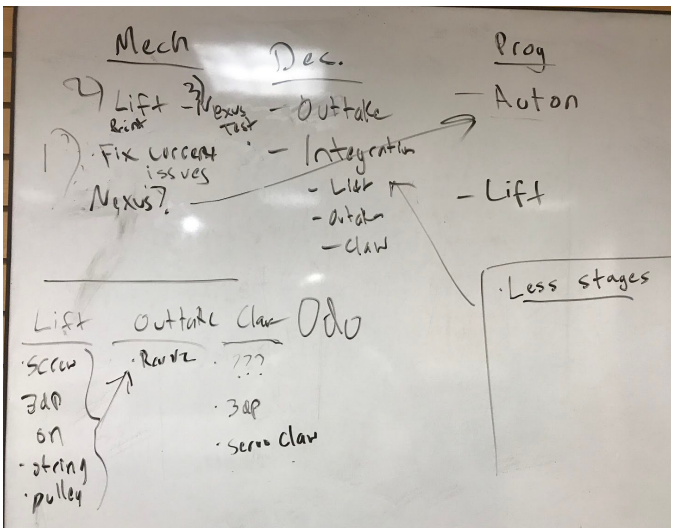
Essentially, for each button or possible input on the gamepad, this manager class would preprocess the input on each loop run. Instead of writing out a toggle everytime we needed one, this manager class would allow us to simply call “isToggled” or “isPressed” to access these states. The end result of this is that while developing novel Tele-Op controls, the logic behind toggles (or other similarly complex button input handling methods) would not need to be recalled, drastically speeding up the development of these gamepads.

NON-TECHNICAL DISCUSSION

1. Agenda/Discussion

- **a. Around the room discussion**
- **b. Printing is priority**
  1. Ian – Saturday to print 2 sets of 3
- **c. Notebook is behind**
  1. Undocumented outreaches, as well as competitions
  2. Mechanical and programming
- **d. Patrick is working on the Design Document**
  1. Showcases all of the designs
- **e. Drive Train is first priority**
  1. Replacement of pulleys
- **f. Arnav wants to look into Nexus wheels**
  1. Trade off discussions
- **g. Team Plan is done**
- **h. Mentor information for the team bios**
- **i. Schedule for the next two weeks**
- **j. Outreaches**
  1. Generation Tech opportunity (Helen)
  2. Delaware Children opportunities (Helen)
     1. Feb 22
        a. Because we need content for Judging
     2. March 20
        a. Because DE States is March 14

k. Batter bot (80%)



DE and NJ Meet Discussion

- Performance was very, very good!
- Intake worked better than expected
- We are in a better position than we thought we were in
- *More information on **E33** and **E36***

- **Upcoming Events:**

- Kaizen Robotics is meeting with us at 10:00 this Saturday
- We have a Dover Meet on January 10
- 12th January - NJ Meet
- 19th January - PA qualifier
- 20 January - STEMtastic Hagley Maker Fest
- 25 January - waitlisted for MD qualifier

Meeting Schedule
- 6 meetings

- **Priorities (image on right)**
  - Fix Nexus wheels
  - Print and assemble lift (while CADing claw, odometry, horizontal lift)
  - Bumpers

MEETING SUMMARY

- Review lessons learned at Towle and P'Town Throwdown meets
- Discuss priorities of the upcoming weeks
- Evaluate schedule from now through January
- Fix Drivetrain

SATURDAY, DECEMBER 14, 2019 MEETING

DATE & TIME: 12/14/19 | 9:00 AM - 2:30 PM

STUDENTS: Connor, Clare, Bryan, Patrick, Karthik, Jonas, Ian, Rohan, Isha, Paige, Suraj

MENTORS: Andrew, Arnav

AGENDA
Kaizen Robotics will visit today
Upcoming deadlines?
Outreach plans?
Meeting plan?

TIMELINE REVIEW

Lift	Fully prepared to build by Tuesday 12/17
Claw	Attached to horizontal lift today
Horizontal Lift	Built today

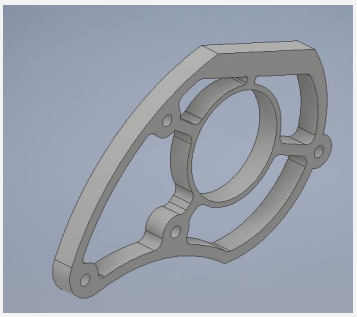
MECHANICAL ACCOMPLISHMENTS

Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	**Fabricate and Integrate**	Tweak & Evaluate

DELIVERING STONES

FABRICATE AND INTEGRATE: NEW INTAKE MOUNT

We updated the intake mount to include weight saving holes and to fit around the mecanum wheel diameter to make it a more sleek design.



Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	**Fabricate and Integrate**	Tweak & Evaluate

CHASSIS

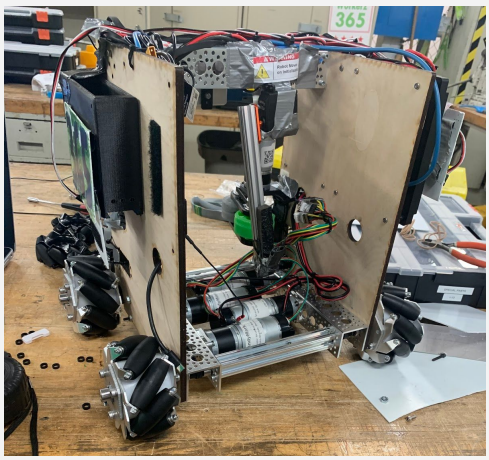
FABRICATE AND INTEGRATE: METAL PULLEYS

We had bought 16 teeth metal pulleys because our 3D printed ones were breaking and the chains were skipping teeth. We had to hex broach these metal ones to fit with our hex axles.

Unfortunately, upon testing, we found that these metal pulleys did not fix the problem. While they are likely more durable than our 3D printed ones, they were not incorrect size so the belts did not work on them.

FABRICATE AND INTEGRATE: NEXUS WHEELS

Patrick, Arnav, and Suraj switched the REV wheels to NEXUS ones. We made this decision because at the NJ meet, we had trouble moving over the central neutral bridge. These NEXUS mecanum wheels will allow us to move over this platform better because they are larger in diameter than the REV ones. They should also be faster, though this is not one of the primary reasons we chose to switch. Its size also means we will be more stable when moving.



Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	**Fabricate and Integrate**	**Tweak & Evaluate**

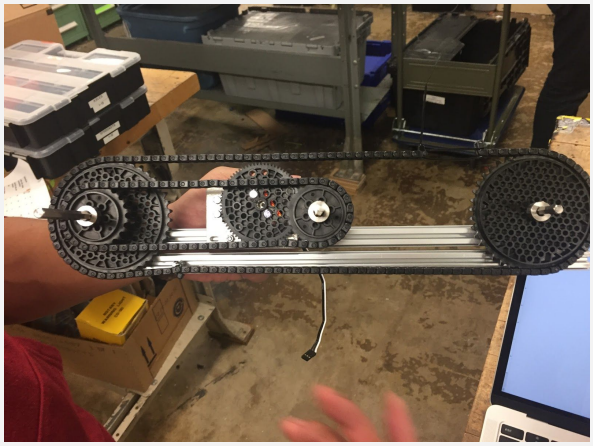
SCORING STONES

FABRICATE AND INTEGRATE: HORIZONTAL SLIDES

While waiting for the 3D prints for the vertical lift slides, Bryan and Jonas started assembling the horizontal lift. They followed Bryan's CAD and did not run into many issues.

We needed to achieve a horizontal extension that would transport the block far enough for a Stone to stack within a 270 degree rotation of a servo. The 270 degree number is important because the programmers need to be able to store positional data about the servo. We aimed to finish building it today.

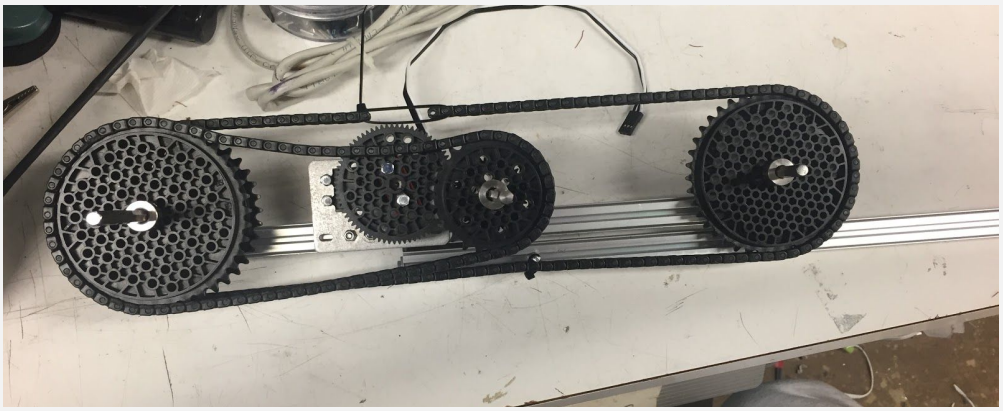
After completing the construction of the horizontal lift, we realized that we had made a mistake. Instead of completing the movement in 270 degrees, it took about 90 degrees. After considering our calculations, we realized that we had multiplied by the diameter of the last gear instead of the circumference. This meant that we were off by a factor of pi, which made sense with our observation of the servo turning ~90 instead of 270.



270 degrees/3.14 = 85.99 degrees

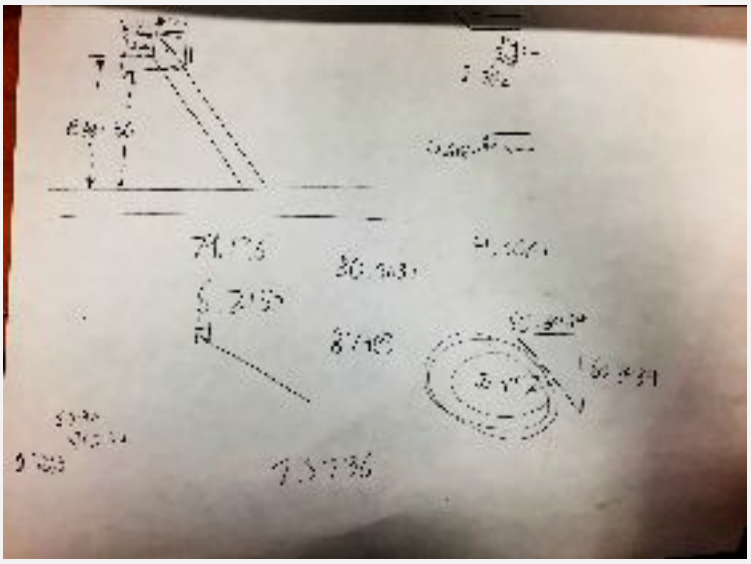
This meant that we had to alter the gear ratios by a factor of 3. Ideally we would be able to change them by exactly pi, but this is a close enough estimation.

After these fixes, the assembly is secure. However, the slides are very stiff when they are fully retracted. Wiping down the slides did not solve the problem.



PROS	CONS
-Reduces slipping (more accurate positional data) -By using hex shafts, which slip less than round shafts -Not relying on set screw to keep axle in same position -Chain - one complete loop (two strings can slip due to different tensions) -270 degrees will give us accurate positional data -Ease of building (all kit parts) -270 rotation is faster than having to use multiple rotations	-Very large, not compact due to sprockets rather than pulleys -REV slides aren't bearing based, so there is lots of friction (currently facing this problem) -Less durable because of plastic chains (metal are more durable) -Less torque because it is geared for speed

Jonas also calculated the angle of the extrusion needed to mount the horizontal lift. The horizontal lift needs to be mounted on the sides of the robot, so he needed to find the right values to keep the lift supported in the correct place.



**Contrast increased and brightness decreased to view numbers more easily*

Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	**Fabricate and Integrate**	Tweak & Evaluate

STACKING STONES

FABRICATE AND INTEGRATE: LIFT 3D PRINTED PARTS

Last meeting and between last meeting and this meeting, Patrick and Andrew printed 2 sets of the print set with 5 of each of the right, left and center inserts but both of them did not finish for some reason. It could have been that the filament sensor was not turned on, the filament got tangled and was not extruding or both. The second that did not finish and failed was on the print bed when Ian can to the meeting so he took them off the bed. Then, on boxed the Black Petg filament and put it on the spool rack.

After that, he made the same .gcode file with 5 of each of the right, left, and center insert pieces but with the temperature setting for the Petg filament. He set the temperature of the hotend and heated bed to get the temperatures for the Petg. Then, the printer calibrated the mesh bed level but something went wrong because when it was finding the points in the bed for mesh bed level with the p.i.n.d.a probe, the extruder was pushing down on the print bed, which is not supported to happen. I tried the test a few more times and it was doing the same thing so, I decide that the p.i.n.d.a probe was not at the right level so I made it height by making the height of a zip tie belt. This would solve the problem but when he did the first layer calibration, it changed the z height of the nozzle to the print bed to print the filament on the bed properly. So, he did the calibration until the extruder was printing the filament line at the right length. The z-height went from 0.610 to 0.275 m. While I was doing this calibration, I found out that the filament sensor was turned off for some reason and probably was the cause or part of the cause of why the other prints failed. Then, I start to print the print of the insert pieces.

While he got the Prusa ready and printing, he tried to print a set of the left, right, and center inserts with Black ABS on the Lulzbot Taz 3 because he did not think that the petg was enough to print a set. It is very hard to print with because if it is very environment temperature picky and warp or the bottom curves up from the print bed and usually need an encloser around the printer to be printed correctly, but this was the only filament the MOE FRC team had for their 3D printer. He started to print the print but while it continued

to do more layers of the print, the corners of the prints started to warp up, so he stopped. Then, he tried to print it again but the same thing happened. So, He stopped printing with the ABS and put the petg filament back in the printer.

PROGRAMMING ACCOMPLISHMENTS

Define Problem	**Generate Concepts**	Develop a Solution	Construct & Test a Prototype	Fabricate and Integrate	Tweak & Evaluate

ONLINE SIMULATIONS

GENERATE CONCEPTS: MECANUM DRIVE TRAIN

The programming team looked at programs such as Gazebo to run online simulations of different mecanum drive trains on robots as the mechanical team worked with the robot today.

NON-TECHNICAL DISCUSSION

- **Kaizen Robotics #16378 is visiting at 10:00.**

More information about this outreach can be found on page **E39.**

- **Priority List**
  - Mechanical
    - Pulleys for drive train
    - Nexus wheels
  - Programming
    - SLAM camera testing
  - CAD
    - continue printing lift parts
    - claw, odometry, horizontal lift, wire management, side panels, bumpers

- **Clare updated the website with recent competitions and outreaches.**

I added all of our events and photos onto the team's website Outreach page.

- **We finished writing the notebook entries for outreaches.**

We are now completely caught up with outreach documentation and prepared for the next outreaches we have scheduled for after the holidays.

MEETING SUMMARY

- Kaizen Robotics visit
- Fixing drivetrain
- Build horizontal lift

TUESDAY, DECEMBER 17, 2019 [EXTENDED] MEETING

DATE & TIME: 12/17/19 | 3:00 PM - 8:30 PM

STUDENTS: Patrick, Bryan, Helen, Karthik, Rohan, Clare, Connor, Aidan

MENTORS: Arnav, Nick, Andrew

AGENDA
One meeting before the holidays - Sat 12/21
Quickly finish drivetrain replacement pulleys and give chassis to programmers

TIMELINE REVIEW

Lift	Finish building by Saturday 12/21
Claw/Horizontal lift	Test assembly on Saturday 12/21

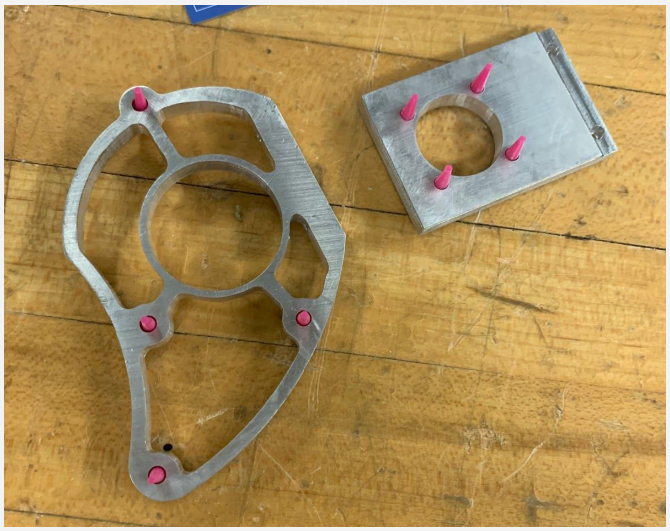
MECHANICAL ACCOMPLISHMENTS

Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	**Fabricate and Integrate**	Tweak & Evaluate

DELIVERING STONES

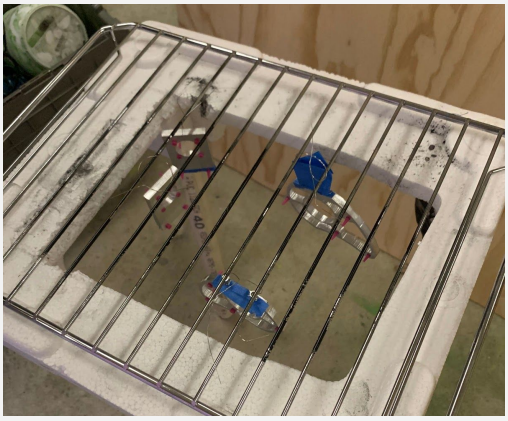
FABRICATE & INTEGRATE: CONSTRUCT INTAKE BRACKET

Using the CAD Design, we ran the intake bracket model through the CNC Mill at our lab. We programmed in weight-saving holes so it would not be too heavy. We also tapped the screw holes for the motor mount so screws can thread into them.

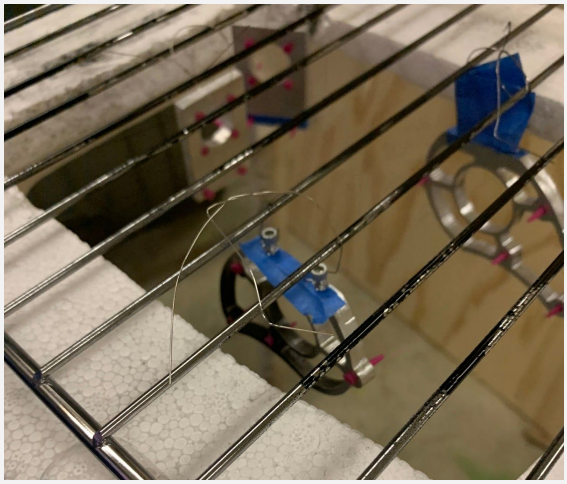


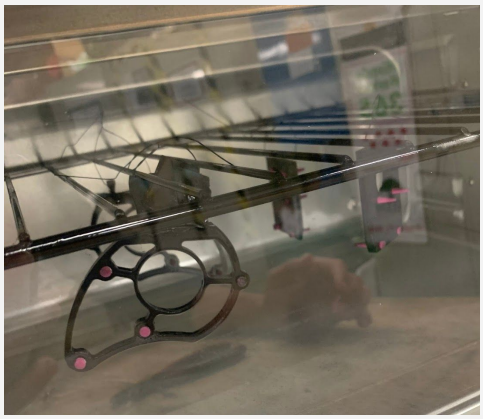
FABRICATE & INTEGRATE: POWDER COAT INTAKE BRACKET

To add some aesthetic, we wanted to powder coat the intake mounting bracket to match our color scheme. We used metal wire to suspend the parts on a rack. Also, we put in screws in the tapped holes to make sure the powder coat did not ruin the threading. Additionally, we taped the top so that the powdercoat would not add extra height to the design (which may cause problems). We used silicone plugs for the other holes because they are not tapped.



After powder coating, we put the rack in the oven to let the powder coat cure.





FABRICATE & INTEGRATE: ASSEMBLY INTAKE

After baking, we assembled the parts together and it came out very nicely!

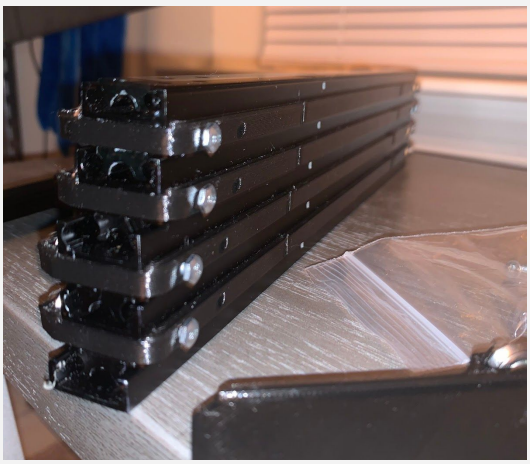
Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	**Fabricate and Integrate**	Tweak & Evaluate

STACKING STONES

FABRICATE & INTEGRATE: CONSTRUCT LIFT

The first batch of 5 slide insert sets was printed. Each insert set consists of a center, left, and right insert. We need 14 insert sets total, but only 5 fit on our printing bed. So, we printed the next batch of slide insert sets this meeting to keep on schedule. To make sure we stay on schedule, we started the assembly now, but we will add on as we get more prints.

Because we did not finish assembling all of the slides, Patrick took parts and tools home to finish.



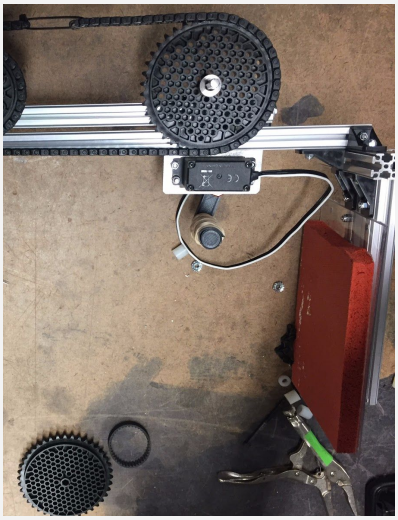
One of the slide inserts was not working well. Patrick thinks it's the center insert piece because changing the center insert piece out helped the assembly. Since we need 14 sets and we are printing in batches of 5, we will have to use the one extra print that we had planned for the last batch.

Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	**Fabricate and Integrate**	Tweak & Evaluate

SCORING STONES

FABRICATE & INTEGRATE: MOUNTING CLAW

Jonas brought the outtake slide and some REV parts home to assemble and mount the claw.



Define Problem	Generate Concepts	**Develop a Solution**	Construct & Test a Prototype	**Fabricate and Integrate**	**Tweak & Evaluate**

CHASSIS

TWEAK & EVALUATE: NEW DRIVETRAIN PULLEYS

We ordered new pulleys and belts from McMaster for the drivetrain because the last pulley we bought did not match the belts that we used. We chose XL timing pulleys because they are compatible with the imperial hole pattern of the actobotics channel.
We also used a belt calculator to get the correct belt to avoid using a tensioner.

We plan to use these pulleys for the wheel axle and the motor axle. This should improve the strength of the drivetrain because the old wheel axle pulleys was made out of 3D printed plastic, and it cracked several times.

TWEAK & EVALUATE: PULLEY HEX BROACH

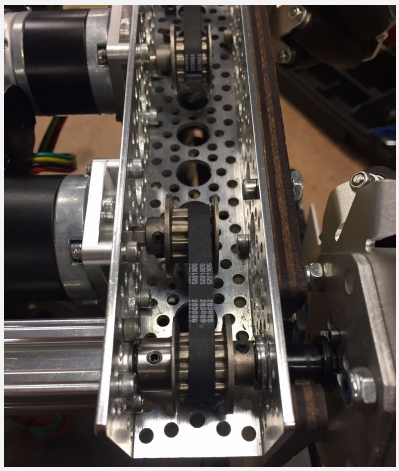
Since we use hex axles mounting the wheel, we used the REV Hex broach to create a hex hole in 4 of the pulleys. Conveniently, the axle hole on the pulley was already the perfect size so we did not need to drill into them before broaching them.

Unfortunately, the REV Hex broach snapped into two. This is not supposed to happen so we contacted REV about the problem. They gave us a coupon code for a replacement broach, and we answered some of their questions on how we used the broach. They thanked us for our information and said that they would contact their manufacturing engineers to potentially improve their product.

To continue the broaching process, we used a 5mm hex axle and sharpened the edges to use as a blade. Although this is not as good as using a broach, it worked to finish the rest of the pulleys.

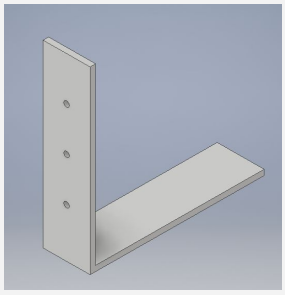
TWEAK & EVALUATE: MOUNT PULLEYS

After broaching the pulleys, we tried to put them on as fast as possible to the programmers would have some time with the robot. This took longer than we expected because the interior screws are difficult to access. We had to loosen the motor mount for the pulley to fit on the motor axle.In the end, the pulley and the belt worked very well. Because the belt is the correct size, we did not have to use tensioners like we did on the last design. Also there is space for a collar, and the pulley has its own set screw so we can use that to keep the bearings tight and reduce the wobble of the wheels.



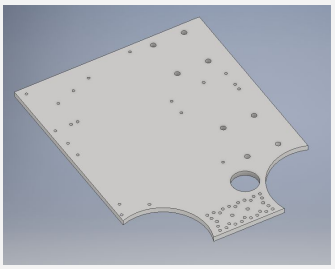
DEVELOP A SOLUTION: CAMERA MOUNT

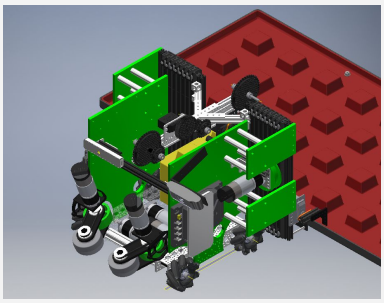
We created this simple L bracket in CAD for the logitech camera to mount on to. It



DEVELOP A SOLUTION: SIDE PANEL CAD

We got side panel CAD ready so we can outsource it to a University of Delaware CNC Machine and have Aluminum Side Panels. We needed to make sure we had screw holes for everything so most of the CAD was done at this point.





Define Problem	Generate Concepts	**Develop a Solution**	Construct & Test a Prototype	Fabricate and Integrate	Tweak & Evaluate

MOVING FOUNDATION

TWEAK & EVALUATE: FOUNDATION GRABBER

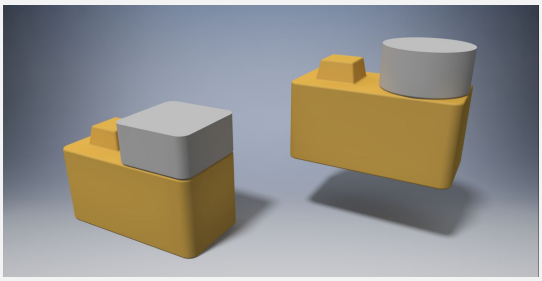
We CAD'ed a foundation grabber that mounts onto the REV extrusion that the linear slides mount to. It simply uses the servo horn with a small REV extrusion mounted to it and then an L bracket mounted onto that.

Define Problem	Generate Concepts	**Develop a Solution**	Construct & Test a Prototype	Fabricate and Integrate	Tweak & Evaluate

SCORING CAPSTONE

DEVELOP A SOLUTION: CAPSTONE PLANNING

We do not have a capstone mechanism designed yet, so we cannot design a capstone yet. However, Connor created rectangular and circular capstone bases that can have any design on it.



PROGRAMMING ACCOMPLISHMENTS

Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	Fabricate and Integrate	**Tweak & Evaluate**

DRIVETRAIN TESTING

TWEAK & EVALUATE: DRIVETRAIN EVALUATION

After receiving the chassis from the programmers, Rohan, Karthik, and Helen tested the new pulleys and wheels by driving the robot around with TeleOp controls. We noticed that the robot moved very smoothly and the larger wheels combined with the metal pulleys made significantly less noise than before. It was also able to move over the center ramp board much easier than before.
Another thing we noticed was that the right side of the robot appeared to be reacting slower than the left side, resulting in a slight sideways tilt when driving.
After conducting some tests, we concluded that it was not a programming issue but a mechanical one. The set screw was not tightened properly. Our old pulleys had a similar problem that was fixed with loctite, so we plan to loctite these set screws later.

NON-TECHNICAL DISCUSSION

- **Patrick completed some past notebook and outreach entries.**
- **Clare worked on the mentor bios for the notebook.**

MEETING SUMMARY

- Vertical Lift Assembly
- Intake Fabrication
- Drivetrain Pulleys' Fabrication and Integration

FRIDAY, DECEMBER 20, 2019 [EXTRA] MEETING

DATE & TIME: 12/20/19 | 12:15 PM - 7:30 PM

STUDENTS: Bryan, Patrick, Karthik, Rohan

MENTORS: Arnav

AGENDA
Powder coat side panels
Work on Vertical Slide

TIMELINE REVIEW

Mechanical	Finish Fabrication and Integration of Vertical Slides, Side Panels, Intake, and Outtake by Monday 12/23
Upcoming Competitions	Dover High School meet on January 10 and Pennsylvania Qualifier on January 19
Possible Competitions	Waitlisted for New Jersey Meet on January 12 and Maryland Qualifier on January 25
Upcoming Outreaches	Hagley STEMtastic Museum Maker Fest Outreach on January 20

MECHANICAL ACCOMPLISHMENTS

Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	**Fabricate and Integrate**	Tweak & Evaluate

CHASSIS

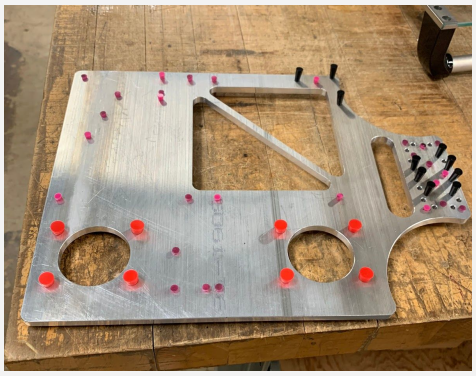
FABRICATE AND INTEGRATE: SIDE PANEL CNC

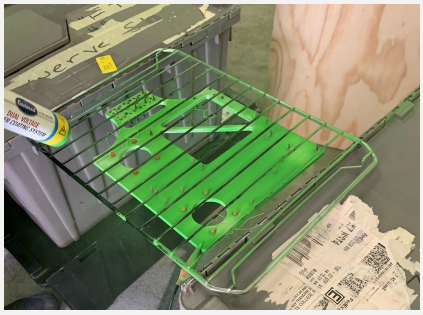
We sent our CAD Design to get CNC'd at a large CNC mill at UD because one of our mentors was able to get access to it. We added weight-saving holes so that the quarter-inch aluminum panels would not be too heavy for the drive base.

These side panels came out very nicely! They will definitely hold up better than our current wooden ones, but we want to powder coat them because we want them to fit our color scheme.

FABRICATE AND INTEGRATE: SIDE PANEL POWDER COATING

We used the silicone plugs to fill in the holes for powder coating. There are a lot of holes in the bottom section to match the actobotics channel but we did plug all of them because we knew we were not going to use all of the holes. We could only do one side panel at a time because the oven is not big enough to fit both of them.





We suspended one onto the rack, powder coated it, and baked it. The hole in our old styrofoam table did not fit the large side panel, so we used 4 crates on each side to support the rack when powder coating. It came out very nicely, but one side looked a lot nicer than the other. We made sure to completely mirror the process for the second side panel, so if the imperfections happen again, both side panels will have a good side that can face the outside of the robot.

We did not mount the new side panels, yet because we wanted the programmers to have more time with a working robot.

Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	**Fabricate and Integrate**	**Tweak & Evaluate**

STACKING STONES

TWEAK & EVALUATE: VERTICAL LIFT REV MOUNT

The next set of prints finished, but before continuing to print, we wanted to see how the slides would mount to REV extrusion. We saw that the only holes that we had access to were the bottom three instead of all 5. We first wanted to test if those three would be stable enough to support the slides before resorting to disassembling the slides.

FABRICATE & INTEGRATE: CUT HEX SCREWS

The smallest M3 Hex heads that we had were too long. We used a bench grinder to cut off the little that we need.

TWEAK & EVALUATE: MOUNTING SCREW STABILITY

We mounted the slides using the bottom 3 screw holes but saw that the slides were not mounted completely straight onto the REV Extrusion. This inaccuracy could cause possible binding problems when lifting two stages at once, so we saw that it was worth it to disassemble the slides to have access to the top screw hole.

This also means we cannot use hex heads because we need to be able to fit a driver for screwing. We opted for hex socket heads.

FABRICATE & INTEGRATE: CUT SOCKET HEAD SCREWS

We cut these screws using the same method as cutting the hex heads. We estimated the size when grinding because the overall length does not have to be exact.

TWEAK & EVALUATE: SOCKET HEAD SIZE

When we tested the socket heads on the bottom three screw holes, the slides had no problem clearing the head of the screw. After using the top, middle, and bottom holes, the slides struggled sliding up and down because it was hitting the head.

To solve this, we decided to use low-profile hex socket heads. Our team calls them “cheese” heads to differentiate between the normal size socket heads.

FABRICATE & INTEGRATE: CUT CHEESE HEAD SCREWS

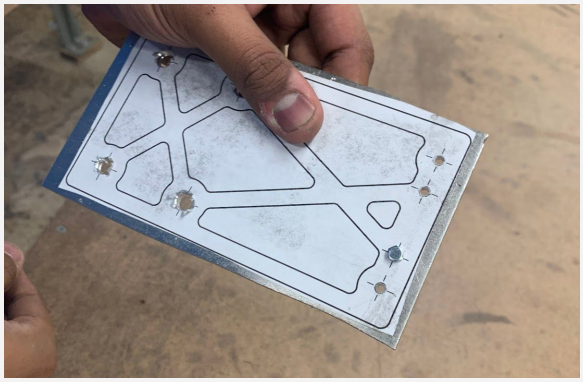
We cut these screws using the same method as cutting the hex heads and the other socket heads. We estimated the size when grinding because the overall length does not have to be exact.

FABRICATE & INTEGRATE: VERTICAL LIFT DISASSEMBLY & MOUNTING

While the new screws were being made, we were also working on disassembling the first set of slides so that we can mount it onto the REV Extrusion.
Because we did not completely finish disassembling, we got another slide and used the screws to mount it onto the REV extrusion. This proved to be a lot more stable than using the bottom three screws. Also, we were very happy with how well the anodized black REV extrusion matched the anodized black slide.

FABRICATE & INTEGRATE: SLIDE PLATE FABRICATION

We wanted to use the CNC Mill for fabricating the linear slide plates because they would give us more precision cuts and very nice weight-saving holes. Unfortunately, we could not get the CNC running, so we had to machine the plate by hand. We printed out a 2D drawing of the slide plate and stuck it to a piece of aluminum. We then punched the holes, and cut the aluminum to the size we wanted.



FABRICATE & INTEGRATE: SLIDE PLATE POWDER COATING

We wanted to powder coat the slide plates green to match the green side panels. Just like the other things that we powdercoated, we plugged in the holes using silicone plugs. Unfortunately, we did not have any extra holes to suspend the plates. We had to use two of the screw holes, but decided that we can just tap it again after it is powder coated.

FABRICATE & INTEGRATE: VERTICAL LIFT ASSEMBLY

The next batch of 5 sets finished printing so we could continue assembling the slides. Ian started the third and final batch of insert sets to be 3D print for the linear slide. They were printing well while Ian was at the meeting.

Instead of starting the second slide set, we wanted to finish the stack of 8 slides. We could not finish the whole set during the meeting so Patrick took the slides home to finish. He also started the next slide stack but there were only enough prints for 2 more stages. Again, one of the center pieces was not working. This is a problem because we will not have any extra center pieces. The last set of prints will be finished when we get there on Saturday morning, so we can make a special print that makes 2 center inserts, just in case this set also has a faulty center peice.

PROGRAMMING ACCOMPLISHMENTS

Define Problem	Generate Concepts	Develop a Solution	**Construct & Test a Prototype**	Fabricate and Integrate	Tweak & Evaluate

POSITIONAL PID

CONSTRUCT & TEST A PROTOTYPE: INDIVIDUAL PID COMPONENTS.

After successfully integrating the slam camera to our robot, Rohan and Karthik chose to use a positional PID for the motion of the robot across the field. A positional PID is a combination of three separate components: Forward/Backward movement, Left/Right movement, and Rotational Movement. For our robot, the goal is to remain at the same heading as the robot traverses the field. For example, assume the robot is to drive straight forward a 100 meters. If the robot starts turning left or right as it is moving, a rotational pid will proportionally correct this movement so that the robot continues to face straight forward. The Strafe component (Left/Right Movement) will make also make sure the robot does not move horizontally away from the center path. The Forward/Backwards component would then move the robot straight forward to its target.

Today, the programmers tested different P values for each of the individual components. However, due to

a few mechanical issues, were not able to properly combine

NON-TECHNICAL DISCUSSION

- We had this extra meeting to make sure we hit our mechanical deadlines by Monday 12/23/19 so there will be enough time for programming, drive practice, and any unforeseen mechanical problems.

MEETING SUMMARY

- Side Panel Fabrication
- Slide Plates Fabrication
- Vertical Lift Assembly
- Positional PID

SATURDAY, DECEMBER 21, 2019 MEETING

DATE & TIME: 12/21/19 | 9:00 AM - 3:00 PM

STUDENTS: Patrick, Bryan, Katy, Connor, Helen, Isha, Ian, Jonas, Karthik, Suraj, Paige

MENTORS: Andrew, Arnav, Zach

AGENDA
Tune PID
Mount new side panels
Mount slide brackets
Organize outreaches

TIMELINE REVIEW

Mechanical	Finish Fabrication and Integration of Vertical Slides, Side Panels, Intake, and Outtake by Monday 12/23
Upcoming Competitions	Dover High School meet on January 10 and Pennsylvania Qualifier on January 19
Possible Competitions	Waitlisted for New Jersey Meet on January 12 and Maryland Qualifier on January 25
Upcoming Outreaches	Hagley STEMtastic Museum Maker Fest Outreach on January 20

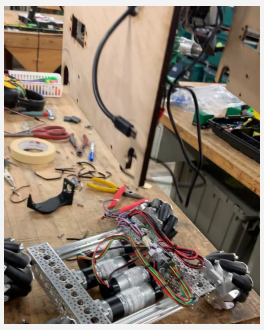
MECHANICAL ACCOMPLISHMENTS

Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	**Fabricate and Integrate**	Tweak & Evaluate

CHASSIS

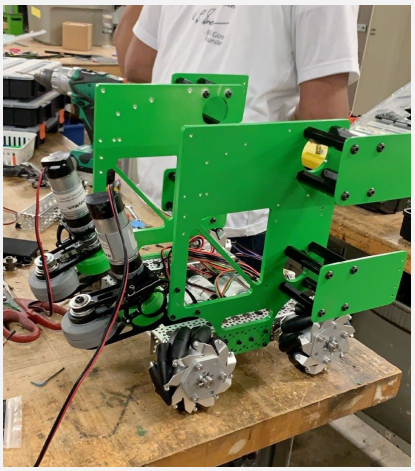
FABRICATE AND INTEGRATE: TAKE OFF OLD SIDE PANELS

To get the chassis ready for the new side panels, we unplugged everything and started unscrewing the old side panels. We also took off the old intake. Overall, we wanted to end with just the drive train.



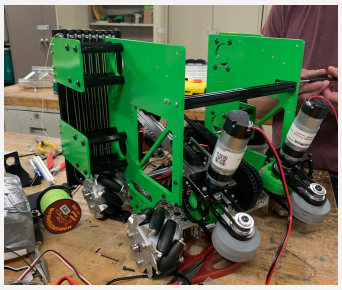
FABRICATE AND INTEGRATE: MOUNT NEW SIDE PANELS

After mounting the intake and the slide plates onto the side panels (see *Stacking Stones* and *Delivering Stones* below for more information), we mounted the side panels onto the drive train. We think the colors on the robot look amazing! It looks like an upgraded version of our old chassis.



FABRICATE AND INTEGRATE: MOUNT CROSS BEAM

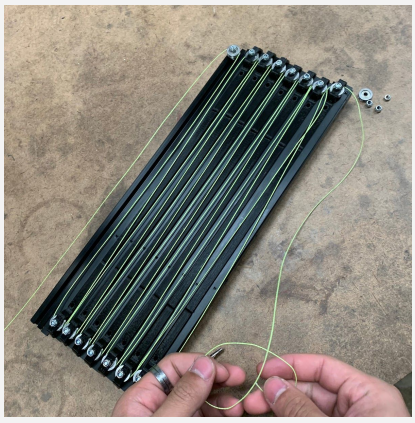
We mounted the REV cross beam to connect the two side panels from the top. This adds more rigidity as well as mounting space for the SLAM Camera.



Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	**Fabricate and Integrate**	Tweak & Evaluate

STACKING STONES

FABRICATE AND INTEGRATE: STRINGING SLIDES

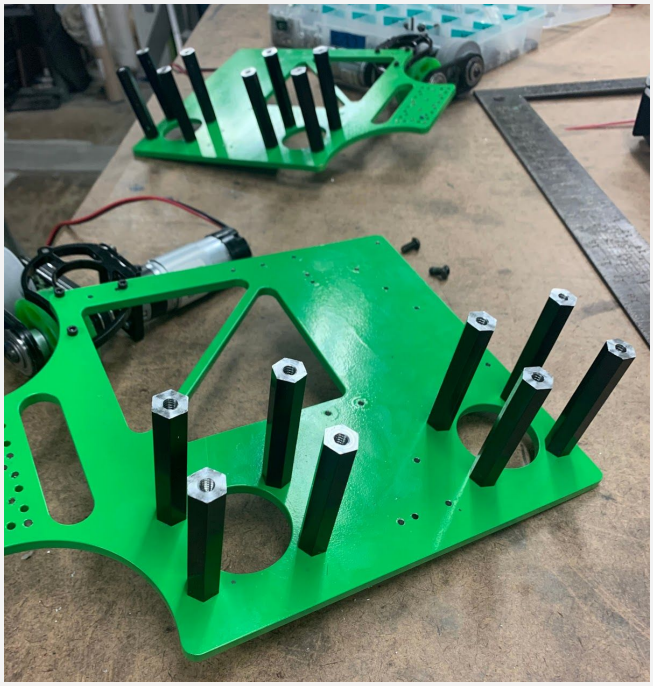


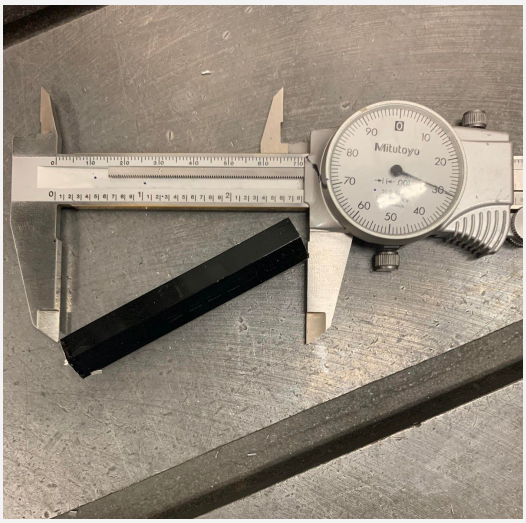
We used 90 lb fishing string to run the extension of the linear slide. This is very light and strong (but most importantly, its green!)
Unfortunately, the third batch of slide prints did not complete because the filament sensor found that the filament was not flowing through the extruder correctly and stopped the print in the middle of the night. So, when Ian can to this meeting, he resumed the print to finish the prints. This means that they will be done on Sunday, and we also need to print the extra center pieces.

While the print was continuing to print, Ian made a .gcode file for two center insert pieces to be printed because one center insert piece from each batch of 5 insert sets printed differently for the other center insert piece. After he made the .gcode file, he put in the team's shared drive for the other teammates to access because he could not put it on the 3D printer sd card while the 3D print is printing.

FABRICATE AND INTEGRATE: MOUNTING SLIDE PLATES

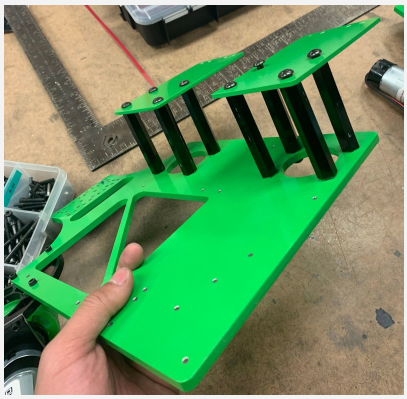
Originally we were going to us churros for spacing the slide plate from the side panel. Instead we decided to use black hex axle stock because we had a lot of it. We used a lathe to cut the axles to the correct size. Using the black axles also made them fit to our color scheme a lot nicer.





We then mounted the slide plates onto the spacers. All of the screw holes matched perfectly.

This slide mounting is very robust and should be able to support the weight of the vertical lift.



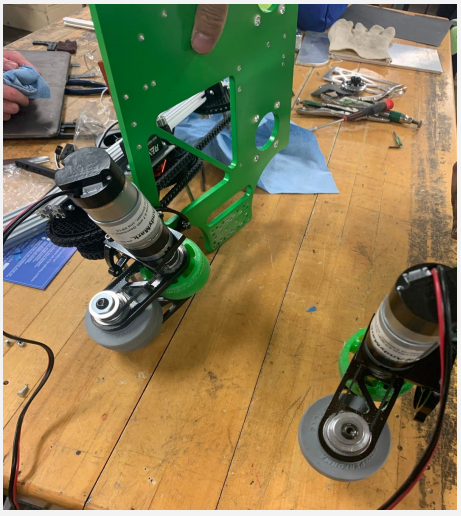
FABRICATE AND INTEGRATE: MOUNTING SLIDES

We mounted the completed set of slides onto the slide plate. Because we used REV extrusion, we can adjust the starting height to whatever we want. We chose to make the top 13.5" off the ground so that there is tolerance between that and the 14" Skybridge.
The bearings make the pulleys slide amazingly. It feels effortless. The problem is that the gravity retraction only works when going down fast. We mounted the outtake really quickly to do a weight test. It lifts very nicely, but it still does not want to retract all the way unless going faster.
We may look into other methods of retraction or just program the slides to move down quickly.


Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	**Fabricate and Integrate**	Tweak & Evaluate

DELIVERING STONES

FABRICATE AND INTEGRATE: MOUNTING INTAKE WHEELS



We mounted the intake modules on each side of the side panels. Because everything was CNC'd based off of the CAD, this mounting was very easy. All the screw holes were lined up.

PROGRAMMING ACCOMPLISHMENTS

Define Problem	Generate Concepts	Develop a Solution	**Construct & Test a Prototype**	Fabricate and Integrate	Tweak & Evaluate

PID TUNING

CONSTRUCT & TEST A PROTOTYPE: PID TUNING

Karthik continued testing and tuning the robot's PID using new values. At the same time, he checked the accuracy of the strafing of the robot after changing the motor names of the robot. Because the disorganization of the robot and motor names created problems with communication between the programming and mechanical teams last season, both subteams created a set list of motor names to make programming easier and more organized this year.

NON-TECHNICAL DISCUSSION

- **Mrs. Ho and Helen organized outreaches.**

MOE was invited to attend an outreach at the Walnut Street YMCA for a Black History Month presentation for young students. In addition, Helen found outreach opportunities at the Delaware Children's Museum.

- **Katy and Helen worked on designing a team shirt.**

In order to make the process easier for new members, we decided to create a generic design for the MOE team shirts rather than creating a new design every year. Andrew brought up the idea of using different patches for the team every year so we can exchange with other FTC teams.

MEETING SUMMARY

- Vertical Slide Assembly, Integration, and Testing
- Slide Plates Integration
- Side Panel Integration
- Intake Integration

SUNDAY, DECEMBER 22, 2019 [EXTRA] MEETING

DATE & TIME: 12/22/19 | 12:30 AM - 6:15 PM

STUDENTS: Patrick, Bryan, Jonas

MENTORS: Arnav

AGENDA
Finish Vertical Slides
Test Intake

TIMELINE REVIEW

Mechanical	Finish Fabrication and Integration of Vertical Slides, Side Panels, Intake, and Outtake by Monday 12/23
Upcoming Competitions	Dover High School meet on January 10 and Pennsylvania Qualifier on January 19
Possible Competitions	Waitlisted for New Jersey Meet on January 12 and Maryland Qualifier on January 25
Upcoming Outreaches	Hagley STEMtastic Museum Maker Fest Outreach on January 20

MECHANICAL ACCOMPLISHMENTS

Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	**Fabricate and Integrate**	Tweak & Evaluate

STACKING STONES

FABRICATE AND INTEGRATE: MOTOR FACE MOUNTS

To run the slides, we wanted to use a face mount to keep the motor in place. We thought he had some extra, but we could not find any. To solve this, we manufactured the face mount ourselves. We followed the same process as when we made the slide plates

1) Prints the 2D drawing to scale
2) Adhere it to aluminum
3) Punch the holes
4) Cut and Drill according to the drawing

Because we had extra time, we also powder coated these!

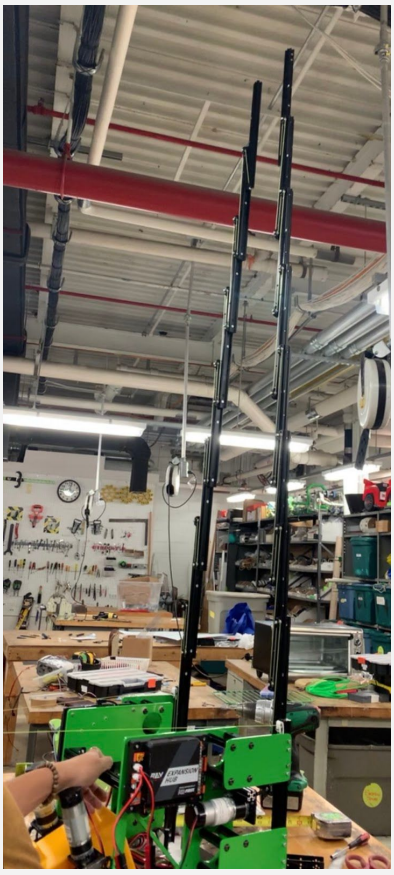
FABRICATE AND INTEGRATE: SECOND SET OF SLIDES

The third batch of five sets of prints finished! At the very start of the meeting, we ran a print of two center pieces because we knew we needed extra. Assembling the second set of slides took most of the meeting, but only one person was working on them, so we still were able to do other things.

Also, the mount in between the slides, we wanted to mount REV extrusion. We only had access to the top three screws (two high ones and one middle one) but we knew this would be okay because it would not bear as much load.

We followed the same process for grinding down cheese heads to make them fit. Unfortunately, *the shaved down cheese heads did not work because they go in different orientation than they did for the bottom REV extrusion. It turns out the normal size ones fit, but we did not have enough, so we got longer ones and shaved those down.*

FABRICATE AND INTEGRATE: TEST SLIDES



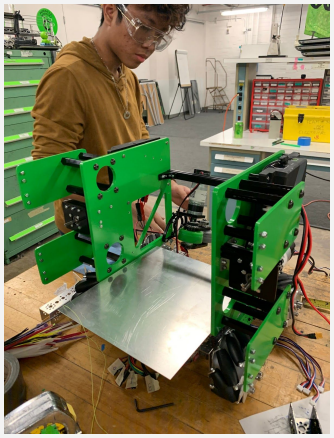
After stringing the second slides, we mounted them onto the other slide plates. We used a level to make sure the two slides were at the same height. Then we pulled the string to test its performance. We found that these slides were slightly worse at going down than the other set of slides… This may be problematic when using a gravity retract, but they go down evenly when they retract really fast.

Overall, we are happy with how it is performing right now. We do not have a spool to test it on a motor, but the motor is already mounted.

Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	**Fabricate and Integrate**	Tweak & Evaluate

DELIVERING STONES

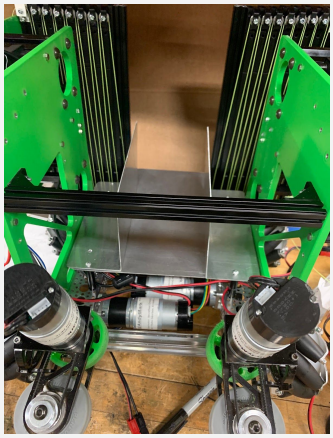
FABRICATE AND INTEGRATE: ALUMINUM TRAY



We need a place for the stone to hold the stone within the robot. We planned for an aluminum tray that is offset from the drivebase so we can fit wiring underneath the tray.

We used black spacer stock for standoffs. This will screw into the drivetrain and provide a place to mount the ramp.

We cut the aluminum to fit between the side panels. Next we got more aluminum and bent two L-shaped pieces. These will be the walls of the tray. We made holes for this mount on the standoffs as well. These holes were not perfectly aligned with the aluminum floor so we had to make the holes bigger and used washers



For the ramp, we want to use a PVC plastic because of how well it performed when in our original design, We found that it was able to guide Stones inside the chassis even when the ramp itself was a half inch off the ground. This means we are able to go through the Neutral Bridge, but still pick up the stones.

NON-TECHNICAL DISCUSSION

- We had this extra meeting to make sure we hit our mechanical deadlines by Monday 12/23/19 so there will be enough time for programming, drive practice, and any unforeseen mechanical problems.
- We told the programmers to not come to the extra meeting because we knew that they would not have time to use the robot.

MEETING SUMMARY

- Vertical Slide Assembly, Integration, and Testing
- Inner Tray Fabrication

MONDAY, DECEMBER 23, 2019 [EXTRA] MEETING

DATE & TIME: 12/23/19 | 2:15 PM - 10:50 PM

STUDENTS: Patrick, Bryan, Jonas, Karthik, Rohan

MENTORS: Arnav, Zach

AGENDA
Complete Mechanical Deadline

TIMELINE REVIEW

Mechanical	Finish Fabrication and Integration of Vertical Slides, Side Panels, Intake, and Outtake by TODAY
Upcoming Competitions	Dover High School meet on January 10 and Pennsylvania Qualifier on January 19
Possible Competitions	Waitlisted for New Jersey Meet on January 12 and Maryland Qualifier on January 25
Upcoming Outreaches	Hagley STEMtastic Museum Maker Fest Outreach on January 20

MECHANICAL ACCOMPLISHMENTS

Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	**Fabricate and Integrate**	**Tweak & Evaluate**

STACKING STONES

FABRICATE AND INTEGRATE: SLIDE PULLEY

We printed a two-part pulley print (a left half and a right half). Then, we screwed a motor axle hub onto it and directly mounted it onto the motor.

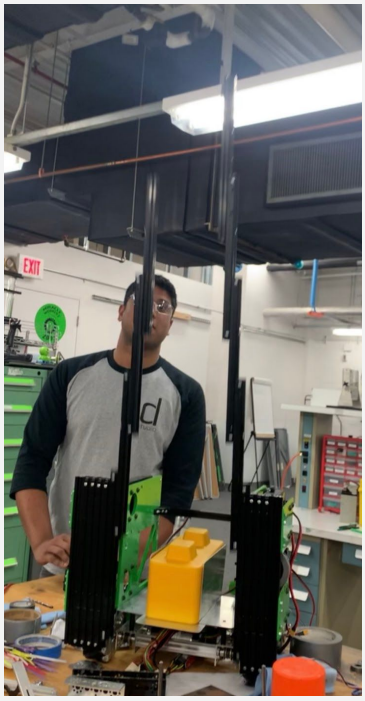
We did this for both sets for slides.

TWEAK & EVALUATE: SLIDE MOTOR TESTING

We wrapped the string from the slides around the pulley and tied a knot into it. We wanted to see if using a motor was just as good as pulling the string by hand. When running one slide, it performed very well. The speed was controlled yet swift at full power, so we are happy with the motor gear ratio and the pulley size.

When running both slides at once, not only did they run at different speeds, but they also were a bit jumpy. The strings were hopping off the pulley so it did not go up straight.

The problem is that the string keeps jumping off of the pulley. To fix this, we knew we had to guide the string better using multiple pulleys

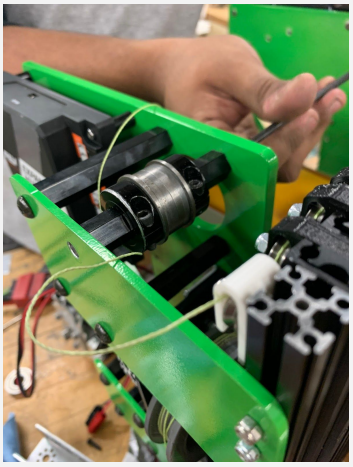


FABRICATE AND INTEGRATE: PULLEY BEARING GUIDE #1

One advantage of using hex axles as spacers is that now we have an axle to mount things on. We mounted a large pulley bearing onto the hex axle to guide string from the motor pulley to the lift.

When testing, this guide was still not good enough and the string continued falling off.

We saw that we could run the string along the slide plates but we were reluctant to drill into the plates unless it was the only solution we can do. Because there was no other places to mount, we decided that it was our best option.



FABRICATE AND INTEGRATE: PULLEY BEARING GUIDE #2

We measured the distances so that the string would follow tangent line of the lift, into to the 1st slide plate bearing, and then the 2nd slide plate bearing would be tangent to the pulley. This way everything is straight and the string can follow the bearings smoothly. We drilled the holes and mounted the pulley bearings.
‘

This seemed to run much smoother. One problem we see is that the inertia of going down sometimes causes the string to jump.

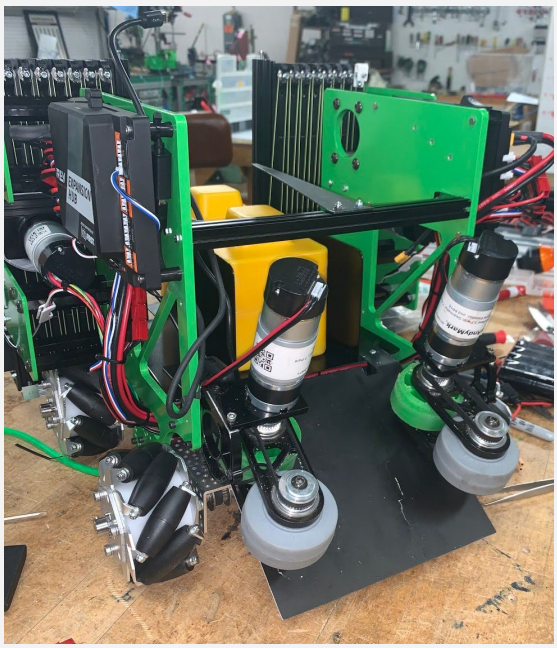
We plan on adding a pulley guard to prevent this from happening.

Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	**Fabricate and Integrate**	**Tweak & Evaluate**

DELIVERING STONES

FABRICATE AND INTEGRATE: RAMP AND TRAY PAINT

We spray painted the PVC Plastic Ramp and we powder coated the aluminum tray parts. We drilled extra holes onto the L parts so they can suspend onto the rack. Also, to make things easier, we did not suspend the floor because one side would not even be visible unless the robot is upside down. This coloring fits the robot very nicely.



Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	**Fabricate and Integrate**	Tweak & Evaluate

ELECTRONICS

FABRICATE AND INTEGRATE: WIRE MANAGEMENT

We mounted the REV hub on each side of the robot. Our plan was to plug in all the motors on the left half to the left hub and the same on the right hub. We used our cable management holes to control the wires.

Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	**Fabricate and Integrate**	Tweak & Evaluate

MOVING FOUNDATION

FABRICATE AND INTEGRATE: FOUNDATION GRABBERS

We mounted the servo directly onto the REV piece that the slides are mounted on. The holes did not fit all onto the REV piece so we needed to cut off one of the screw holes. Then we used an L bracket on the servo horn for grabbing the foundation.

PROGRAMMING ACCOMPLISHMENTS

Define Problem	**Generate Concepts**	Develop a Solution	Construct & Test a Prototype	Fabricate and Integrate	Tweak & Evaluate

SIMULATIONS

GENERATE CONCEPTS: SIMULATIONS

Since the programmers did not have time with the robot itself, we researched different ways to run simulations. This way, we can do some work by simulating robot movement and test different ideas without having the robot in front of us. Last year we had some 2D simulations to test Pure Pursuit, but we want our simulations to be more accurate of robot movement.

NON-TECHNICAL DISCUSSION

- We had this extra meeting to make sure we hit our mechanical deadlines by Monday 12/23/19 so there will be enough time for programming, drive practice, and any unforeseen mechanical problems.

MEETING SUMMARY

- Electronics and Wire Management
- Ramp Fabrication and Integration
- Vertical Lift Tweaks
- Foundation Grabber Fabrication and Integration

SATURDAY, DECEMBER 28, 2019 MEETING

DATE & TIME: 12/28/19 | 9:00 AM - 3:00 PM

STUDENTS: Karthik, Jonas, Ian, Connor, Helen, Aidan, Paige, Patrick, Bryan

MENTORS: Andrew, Zach

AGENDA
Mount cameras on robot
Test the installed slides/lift

TIMELINE REVIEW

Programming	Finish Autonomous for upcoming competitions
Upcoming Competitions	Dover High School meet on January 10 and Pennsylvania Qualifier on January 19
Possible Competitions	Waitlisted for New Jersey Meet on January 12 and Maryland Qualifier on January 25
Upcoming Outreaches	Hagley STEMtastic Museum Maker Fest Outreach on January 20

MECHANICAL ACCOMPLISHMENTS

Define Problem	Generate Concepts	Develop a Solution	Construct & Test a Prototype	**Fabricate and Integrate**	Tweak & Evaluate

ELECTRONICS

FABRICATE AND INTEGRATE: CAMERA MOUNT

The mechanical team mounted the Intel RealSense T265 camera on the redesigned robot so the programming team will be able to start localization and distance travelled for the robot. The mechanical team decided to mount the camera on the back of the robot in between the harvester motors in order to maintain a holistic, relatively centered view for the camera parallel to the ground. This will ensure that the robot will have a maximized view of its surroundings.