BROWNCOATS
Team 7842 Engineering Notebook

Date	Location	Start Time	End Time	Week #
September 13, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	2
Meeting Goals: Team discussion, tower height experiments being performed, POPs presented				
Team Members in Attendance:				
Becca, Ian, Jalynn, Joel H, Megan, Nathan				

Team Discussion
The team spent most of today finalizing discussions from Saturday and Sunday, as well as revising ideas and adding new ones. Additionally, they began discussing subsystem categories and names, as well as sub team assignments (software, hardware, and business).

Proposed Subsystems

Robot Hardware:

- Drive Train (Chassis & wheels)
- Collector (Picks up stones from front)
- Transfer (Drops stones out rear)
- Lift (Elevates stones vertically)
- Arm and Clamp (Move stones horizontally, place on skyscraper)
- Foundation Catch (Grabs foundation for move)
- Capstone Cradle (Capstone onboard storage)
- Capstone (Team scoring element)

Robot Software:

- Driver Control (Teleop)
- Autonomous
- Navigation
- Automation (Many opportunities)

Everything Else:

- Engineering Notebook
- Social Media
- Display Boards
- Pit Design
- Photography

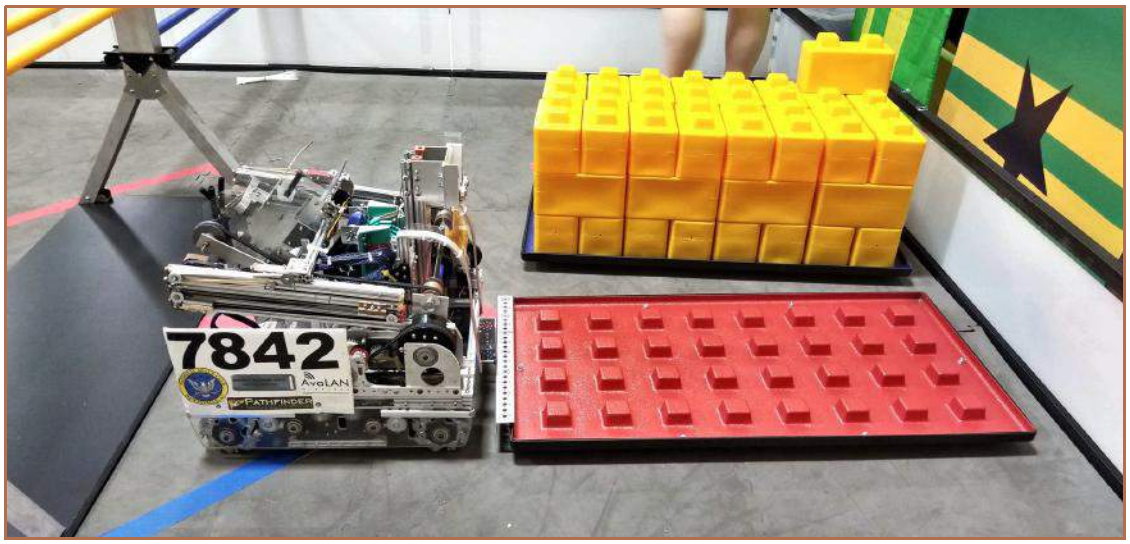
Proposed Assignments

Subteams	Subsystems/Responsibilities	Initial Assignments
Mechanical (Includes CAD)	Drive Train	Ian
	Collector	Megan, Ian, Nathan
	Transfer	Megan, Ian, Nathan
	Lift	Megan, Joel T.
	Arm & Clamp	Ian, Joel H.
	Foundation Catch	Joel T.
	Capstone Cradle	Megan, Brooklynn
	Capstone	Megan, Joel H., Joel T.
Software	Driver Control	n/a – Reused
	Autonomous	Ian
	Navigation	Ian
	Automation (Several Tasks)	Becca, John T., Joel T.
Business	Engineering Notebook, Social Media, Pit Design, Display Boards	Jalynn, Megan
	Photography	Joel H.
Drive	Primary Drive Team	Ian, Megan
	Backup Drive Team	Becca, Joel T.
	Primary Human Player	John T.
	Backup Human Player	Becca

Note: Throughout the Engineering Notebook, the collector is also referred to as the Intake.

Tower Height Experiments - Megan and Ian

After they finished discussions, they immediately went to look at the new set up field. Megan is going to be working on the lift subsystem, and therefore she needed to look at how tall the lift will potentially need to be. So, she stacked sixteen stones on top of each other (as she didn't think there will be any taller towers than that based on assumptions made at the initial brainstorming session), and if they want to be able to stack this tall, they will need a 70" lift to stack sixteen stones, and still be able to cap the capstone on top of all of them. They're not completely sure how they're going to stack stones yet or how tall, so this is likely to change, but these were Megan's initial observations. After this, Ian attached a Tetrix beam to the 2018-2019 robot and hooked it onto the foundation so he and Megan could test how moving it could affect stacking heights. They found, however, that while it would definitely be beneficial to have a clamp holding them in place, it's also not as big of a constraint as the team thought it would be. They will certainly need to slow the drive train down and use a jerk limiter, but between this and a clamp holding the stones in place, it shouldn't determine how high they end up stacking the skyscrapers. Tomorrow at the next meeting they're going to test how compliant wheels work for the intake.



Arm and Clamp - Ian and Nathan

Nathan's proof of principle idea was that the arm and clamp would swivel at the bottom so it could turn so that the robot doesn't have to turn. There is a clamp that holds the stones. He built it out of legos for his proof of principle.

Ian built a proof of principle for one of the arm and clamp ideas. This proof of principle was for a "virtual 4 bar linkage," which is a type of linkage that allows for continuous rotation of the mechanism while maintaining a constant orientation. A belt or chain is fixed at the pivot point of the bar, and the other end of the belt is connected to the shaft that the mechanism rotates on. This provides more freedom than a traditional four bar linkage, which has a limited range of motion. The implementation idea is to mount the pivot on the lift and connect the stone grabber to the upper shaft, keeping the stone parallel to the ground throughout the rotation of the arm.

Nathan's POP

Ian's POP

Date	Location	Start Time	End Time	Week #
September 14, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	2
Meeting Goals: POPs constructed and tested, tower height experiments being performed				
Team Members in Attendance:				
Ian, Megan, Joel T, Jalynn, Becca, Nathan, Joel H				

Intake - Megan and Ian

Megan and Ian worked on a simple intake proof of principle, consisting of two 35a (green) compliant wheels powered by two 3.7:1 motors with an external 2:1 reduction (for a final ratio of 7.4:1). The idea for this was to test the speed they might need for the wheeled intake, if they could pick up the stones in any orientation, and if they would need a separate subsystem to separate the quarry in autonomous, or if the intake would be able to do it by itself.

First they mounted the compliant wheel onto a Tetrix beam, and then they added a one flowered beam on top of the original beam and attached a geared pulley to it. The belt ran from this pulley to the pulley on the compliant wheel. Each wheel was mounted on its own beam, which could independently actuate. They did this to emulate spring-loaded intake arms. They then added two more three flowered beams on the side of the longest one to mount the motor on.

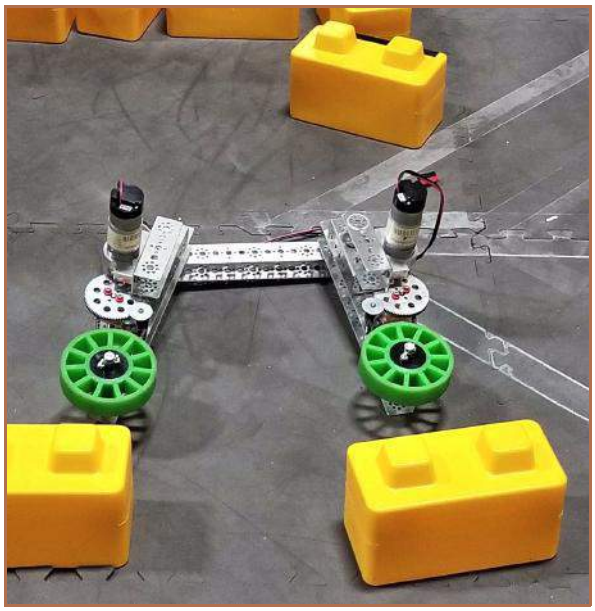
However, they soon noticed that their alignment was off slightly and needed to be adjusted before moving on and mounting the motor. Once they had everything aligned properly, they added another long Tetrix beam to connect both beams and add hinges so they could move it in and out if they need to, depending on how they needed to pick up the stones.

Then, they connected two batteries and a limit switch to the motors and tested it with the stones in a variety of orientations. The intake handled upright stones in every orientation extremely well (even with the long side orientation), and surprisingly was able to intake stones on their sides reasonably well (though it was unable to reorient them passively. However, they think some sort of angled plate might be able to force the element up). The compliant wheels easily picked up the stone from any standing position and righted it.

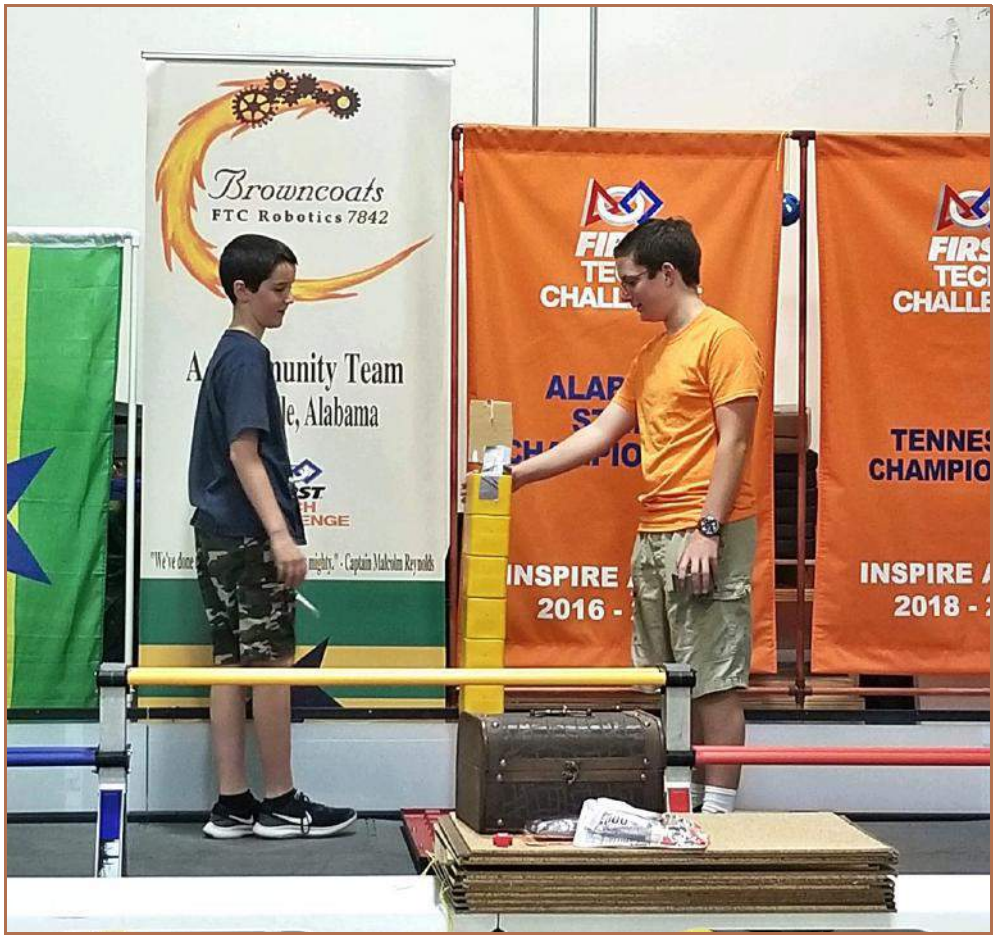
Intake - Megan and Ian - continued

Their final test was in the quarry. Everyone had been concerned that they wouldn't be able to intake the stones with a wheeled intake while they were positioned right next to each other, but to the team's delight, when they did test it, the stone was easily taken out of its place in the quarry.

This initial proof of principle answered a lot of their questions and they're very excited to move on from here.



Capstone - Joel H
Today, Joel H. tried out a tuned-mass damper model for the capstone that he assembled at home and attempted to prove that it might work by trying it out on skyscrapers of several different configurations and heights. There was no obvious improvement in stability observed (Mr. Jeff wondered if the damper could be tuned to better suit the skyscraper), but Joel did address some variables that could effect the overall POP such as the capstone falling off of the skyscraper, the capstone not being tall enough (the arm of the pendulum being too short), or the capstone being too difficult to lift and place on the skyscraper.



Tower Height Experiment - Becca, Nathan, Joel H
Becca, Nathan, and Joel H. experimented with how stable the towers are when moved. Becca also played with the different ways to stack the stones to see which way is most stable, while Nathan worked on calculating skyscraper heights.

Date	Location	Start Time	End Time	Week #
September 20, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	3
Meeting Goals: Continue to test POPs, Perform field tests				
Team Members in Attendance:				
Ian, Megan, Joel T, Jalynn, Becca, Nathan, Joel H, John				

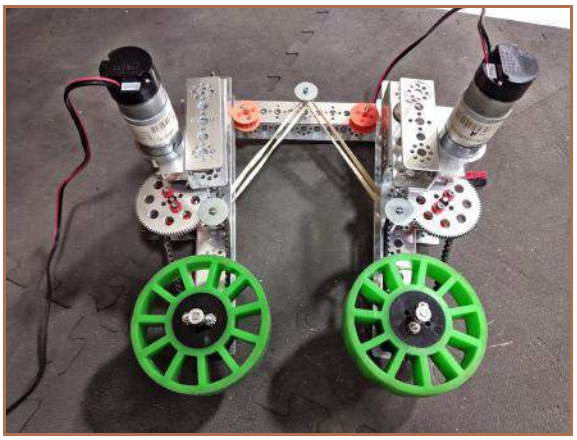
Intake - Megan and Ian

Megan and Ian went back to work on the intake proof of principle. There were a couple of things they still wanted to test. The first being, if it was spring-loaded, would they still be able to pick up the stones the same way, or would it change because of the different position the wheels are in? Megan added standoffs on both of the beams to wrap rubber bands around, and then she added a third standoff on the middle beam for the other ends of the rubber bands to wrap around. She put a washer on top of the standoff to keep the rubber bands from sliding off. These rubber bands would work as the spring-loaded mechanism.

Then, they needed a stop to keep the wheels from going past a certain point. Originally they had just wanted to use either another standoff or a screw with a spacer on it, however, because they were using Tetrix beams, the holes didn't line up enough for this to work. They tried using a one flowered Tetrix beam, but this kept the original beam from moving in either direction, so this didn't help at all. Finally, they used the only other thing they could think of, which was a 3D printed pulley. This definitely wouldn't work for an actual prototype, but because it was just a proof of principle, they figured it would work for now. They used one screw through the pulley, and then another screw on the side of it to keep it in place. They did this on both sides so that both beams with the wheels were in the same positions.

After this, it was ready to test. Unfortunately, they found that this did impact how the stones were collected. In the quarry, it was unable to intake the stones because it wasn't wide enough. When they collected one at a time, it actually stretched out the beams so that it was in the longer position instead of the shorter one, which is not what they want. What they decided from this was that when they spring load it in the prototype version, they need to have multiple sets of wheels, and the first two need to be spread a certain distance apart.

There is just one more thing they want to test, which they will begin work on tomorrow.



Foundation Catch - Joel T
Joel T. went to the field and got the dimensions of the foundation. He tested to see if torque would be a major problem when moving the platform from the top or bottom and his testing proved to show that torque could be a major problem in autonomous.

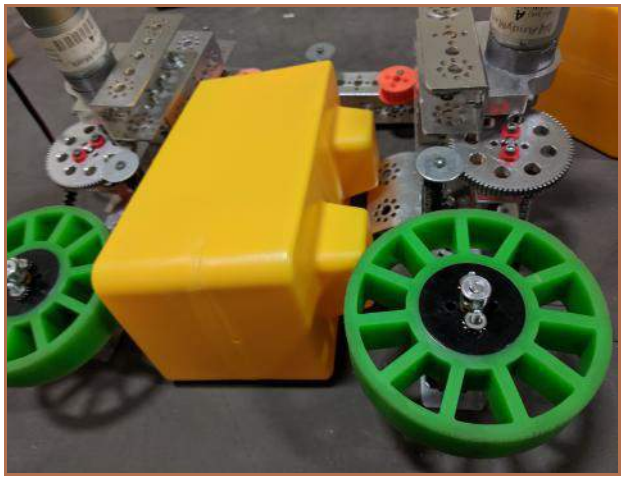
Date	Location	Start Time	End Time	Week #
September 21, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	3
Meeting Goals: Intake POP testing, Tower Stability Presentation, To-Do List made				
Team Members in Attendance:				
Ian, Megan, Jalynn, Becca, Nathan, John, Joel H				

Intake - Megan, Ian, and Nathan

Megan, Ian, and Nathan revisited the intake proof of principle, because there's one more thing that they wanted to test before they feel like they're ready to move on and begin modeling it in CAD. What they wanted to try now was adding a ramp of some sorts, so that when a stone that was collected on its side collides with it, the ramp would hopefully be able to right the stone back into its correct orientation.

Megan and Nathan grabbed a Tetrix plate that had been curved in the past and attached it to one of the beams with the wheels on it. Originally they planned to put it in the front towards the wheel, but they soon realized that the wheel would catch the stone and prevent it from being reoriented, so they moved it to the back of the beam instead. They also had the curve pointed upwards at first, but it was too high for it to catch the studs of the stone, and it probably would have stalled it anyway. So instead, they turned the point down so the stone would hit the curved slope and hopefully ride up it until it righted itself.

When they tested this, however, it simply did not work. It was very inconsistent in the way it didn't work, but it was clear that they would have to make adjustments in order for it to do what they wanted. They tried elevating one side of the slope, but this didn't help at all. They might try adding another ramp on the opposite beam to see if that helps at all. They ran out of time at this meeting before they could continue further, or make any conclusions, but at the next meeting, they 'll continue finding ways to tweak it and hopefully make a breakthrough.



Tower Stability - Joel H
Today, Joel H presented the main points of his tower stability data. He also wrote up POP's on the tuned mass damper prototype. Joel H, with the help from his father, calculated the average frequency for the swaying of the tower.

Optimizing Assumptions

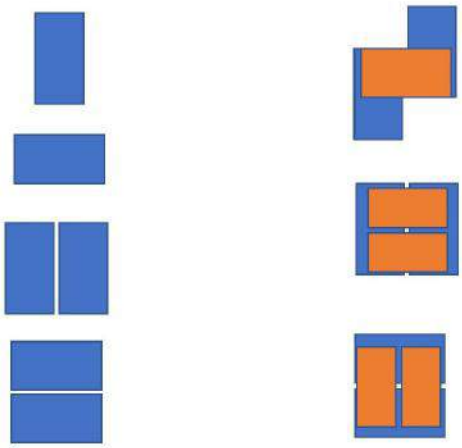
- Maximize Height
- Minimize # of stones
- Maximize lateral stability in direction of end game move

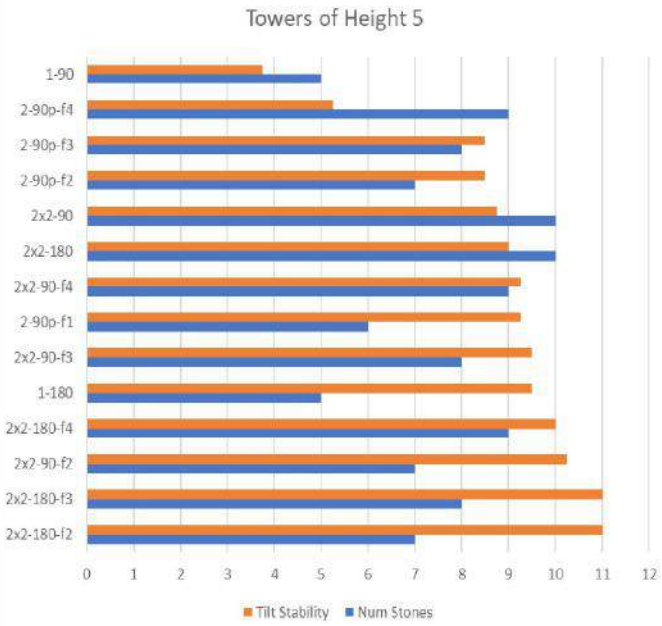
Tower Types

- 1-90
- 1-180
- 2x2-90
- 2x2-180

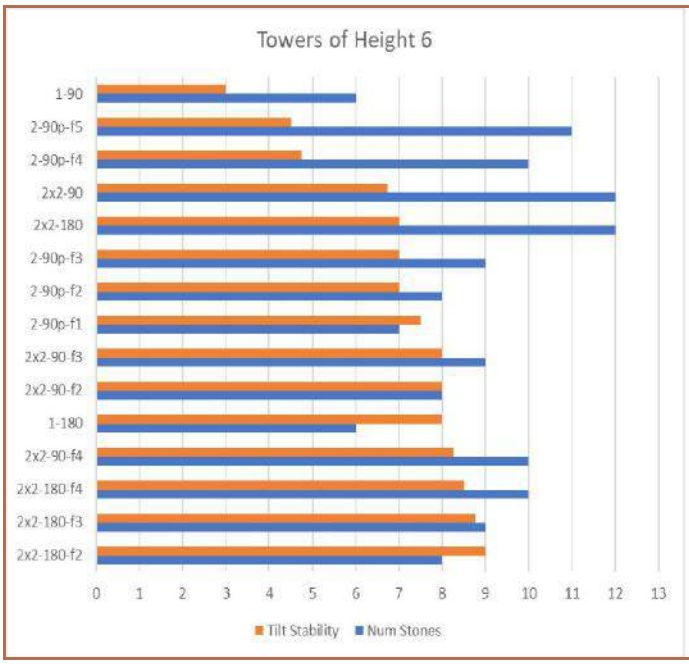
- 2-90p-fx
- 2x2-90-fx
- 2x2-180-fx

Maximizing laterally ←→

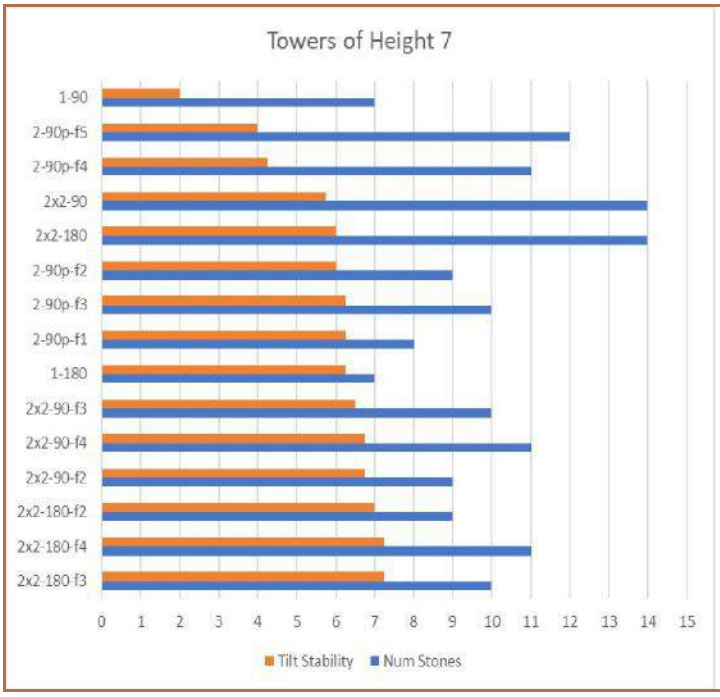




- 2-90p-fx is not a good design
- 1-180 is best for very few stones
- 180 first layer is better than 90
- 2 or 3 levels of foundation are better than 4

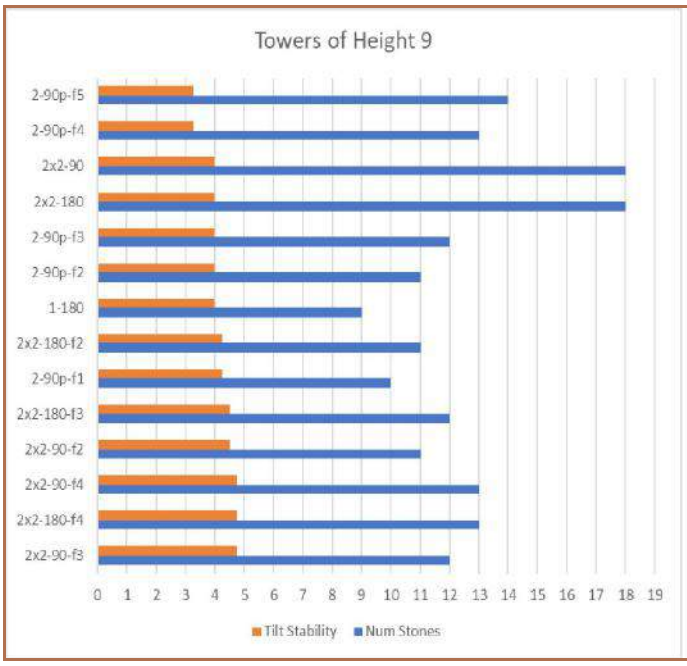


- 2-90p-fx is not a good design
- 1-180 is best for very few stones
- 180 first layer is better than 90
- 2 or 3 levels of foundation are better than 4

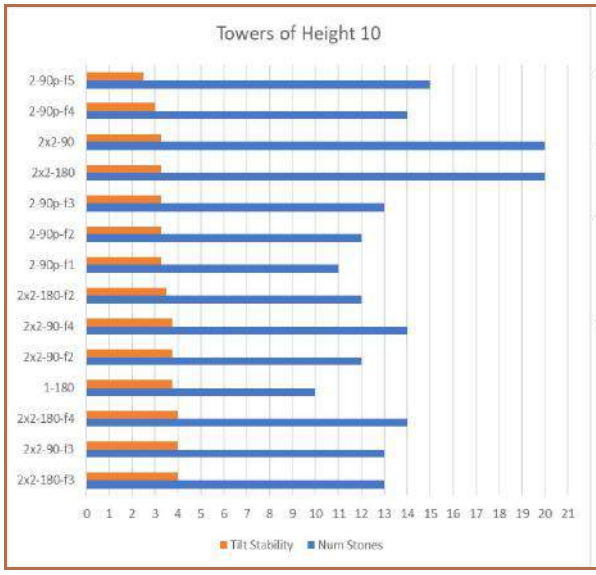


- 2-90p-fx is not a good design
- 1-180 is best for very few stones
- 180 first layer is better than 90
- 3 or 4 levels of foundation are better than 2

- 2-90p-fx is not a good design
- 1-180 is best for very few stones
- Unlike other charts 180 first layer is <u>worse</u> than 90 confirmed suspicion that data got switched here. May need to redo.☹



- 2-90p-fx is an ok design
- 1-180 is still ok for very few stones
- First layer orientation does not matter much here
- 3 or 4 levels of foundation are better than 2



- 2-90p-fx is not a good design
- 1-180 is still best for very few stones
- First layer orientation does not matter much here
- 3 or 4 levels of foundation are better than 2

- 2-90p-fx is not a good design
- 1-180 is still best for very few stones
- First layer orientation does not matter much here
- 3 or 4 levels of foundation are better than 2
- The 2 strongest here show advantage of seemingly useless extra foundation block

Conclusions

- 2x2-180-f3 seems the overall best choice if we are not sure how tall our tower will be due to time
- We need some testing to see what the stability rating needs to be

BROWNCOATS
Team 7842 Engineering Notebook

Date	Location	Start Time	End Time	Week #
September 24 & 26, 2019	Joel H.'s House		6:00 p.m.	4
Meeting Goals: Tuned Mass Damper Capstone				
Team Members in Attendance:				
Joel H				

Capstone - Joel H

On September 24th, Joel H and his dad tested the average resonance frequency of several representative skyscrapers, and they found that the tuned mass damper idea might be doable (thanks to an online resource called Omni simple pendulum calculator at Omnicalculator.com). They can support pendulum periods as slow as 0.6 seconds or so. They went to The Home Depot and bought strips of aluminum, weights and other objects to build the tuned mass damper proof of principle model. They attempted to solder the pieces of aluminum together, except it did not work.

They learned that they cannot solder aluminum. The process they tried was simple: apply plenty of flux, apply solder, done. But this (simple) process turned out to be much more complicated than they anticipated. First, they tried lead-free solder trying to make it stick to flux, but this did not work at all. First reason, they applied the flux before the solder and therefore, it did not stick. Second reason, lead-free solder won't stick to aluminum, and lead solder is VERY weak. They learned that one would have to actually weld the pieces together to get a strong bond. But until supplies needed to do simple welding are bought, they are at a standstill.

On the 26th, Joel and his dad tried welding the pieces together using a blow torch and brazing rod but this did not even work! They eventually used wood for the base instead of metal. They used a pendulum weight of 6 oz., a pendulum length of 3.75 inches from hinge point to the bottom, and a total weight of the pendulum and frame of 8 2/3 oz. The pendulum was made in the shape shown to prevent it from bumping into the "studs" of the stone it was sitting on. Things were looking good!

Date	Location	Start Time	End Time	Week #
September 27, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	4
Meeting Goals: POPs finalized and continued testing, Tower Design plan				
Team Members in Attendance:				
Ian, Megan, Joel T, Jalynn, Becca, Nathan, Joel H, John				

Intake - Megan and Nathan

On September 27th, Megan and Nathan returned to the proof of principle intake in hopes of getting the ramp to reorient the fallen stones working. First, they took the ramp and moved it as far as they could towards the end of the beam it's attached to. Last week they'd noticed it was getting caught on the compliant wheel, which might have been keeping it from righting itself. When Megan tested this, it still didn't work. It seemed to start to, but there wasn't enough momentum, and the ramp just wasn't in the correct position. Unfortunately, because they were using Tetrix and this is a rather complicated system, it seems to need to be more custom than Tetrix allows. So, once they go to the next step with the intake, they'll begin looking at some different ways to do it and how to customize it more.

Despite the fact that not everything worked the way Megan wanted it to, she's still very happy with the data received from the entire POP. They learned that compliant wheels will almost certainly be the way to collect the stones, however they have to make sure they keep them at a certain width or else the wheels won't be able to easily pick up the stones within the quarry. Now, they're ready to move onto the next step, which Ian's going to CAD first, and then they'll start assembling it.

Capstone - Joel H
Today Joel H. brought the pendulum proof of principle that is different then the last one he described. He was disappointed because the pendulum did not work well with the most stable 11 stone high tower design. The hope was that, when the foundation was jolted in the 180 degree direction, it would absorb some energy and prevent it from falling. However, the tower seemed to fall in the 90 degree direction (not the direction of motion). On the other hand, for smaller, single column 1x2 towers up to 9 stones high, it seemed to help some. For the stronger tower design, it might help to move the pendulum off-center to help prevent the tower falling to the side. More testing is needed.

Programming and CAD Organization - Ian, Joel T., Becca, and John
Today Ian introduced the plans for project management and version control to the rest of the software team (Joel T., Becca, and John). Their plan is to use Git for version control. They will use Bitbucket for repository hosting. This will allow each user to fork the primary repository and work on their own fork while retaining the private status of the main repository. Each student will use separate branches for individual features to reduce merging conflicts. After a feature has been completed within its branch, a pull request will be submitted to the main repository with the changes relevant to that feature. The pull request will be reviewed by the head programmer to ensure consistency between programmers and to catch potential bugs.

Programming and CAD Organization - Ian, Joel T., Becca, and John - continued

If accepted, the pull request will be merged into the main repository, allowing each programmer to pull those changes to their own fork. Additionally, they discussed their CAD version control. They will be using GrabCAD Workbench for design version control. Each user will download from the workbench repository before working to ensure up to date and consistent models. After working, changes will be uploaded to the workbench. This will reduce points of failure (they will always have a cloud-based backup as well as multiple physical backups) and increase efficiency within the design team.

Tower Design Plan - John

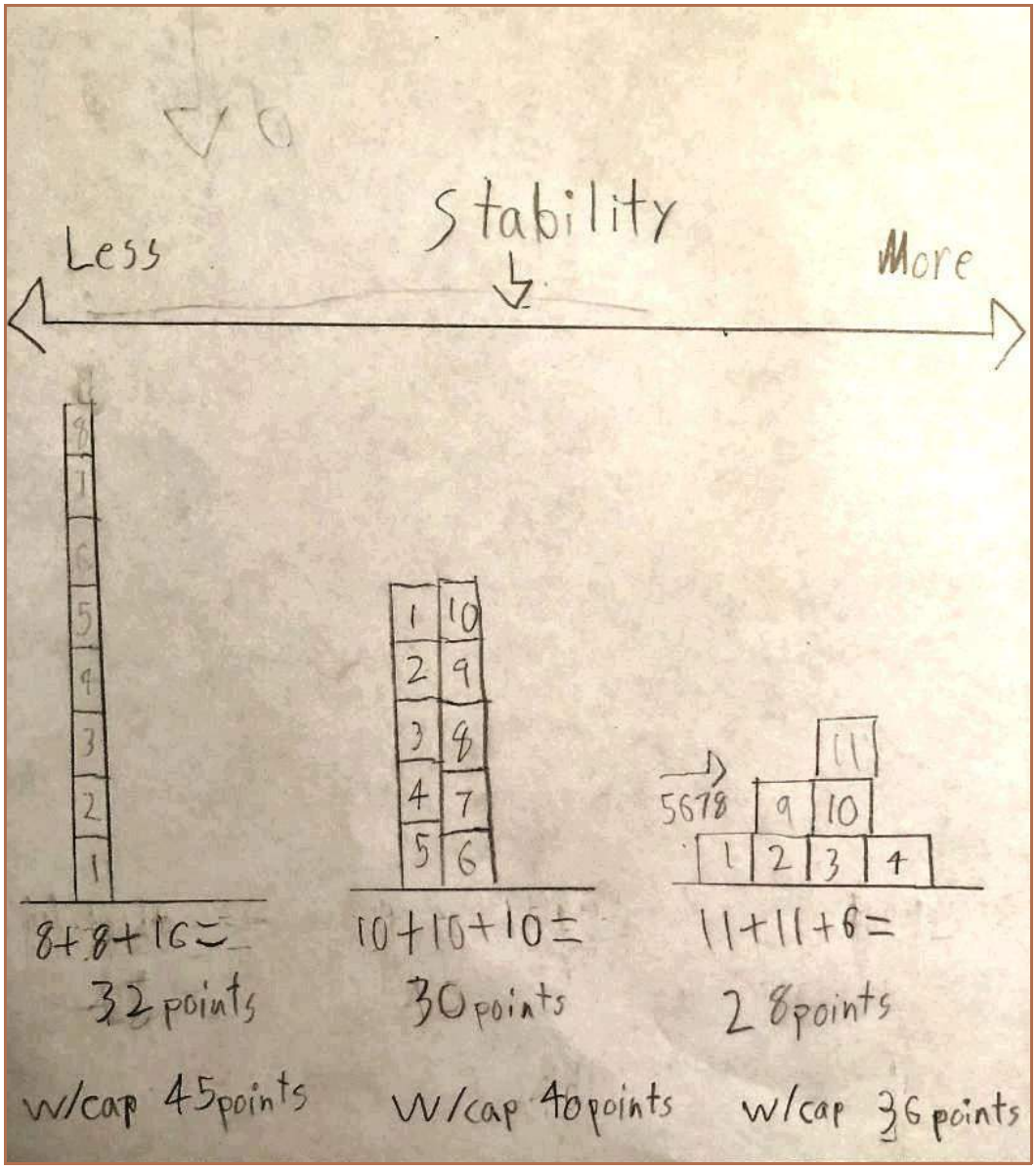
John's original idea was that the team could focus on building a robot that could get stones quickly so that they could build a shorter tower with a lot of stones. As shown in his spreadsheet below, number three, instead of building a robot with a big lift to build high. His reason behind this is the fact that this design would be nearly worth the same amount of points, more stable, and it would be easier to build, again no big lift.

Ian explained to John that his design would not get enough points and that the team will build a robot that does not need to focus on one thing, like getting stones quickly, and that it would not be hard to build a tall tower with the lift. After that, Ian showed him his tower idea, which was sturdy and tall so it got them more points.

Ian's design is a tower that has two stones next to each other. These stones turn 90 degrees each level. This makes the stones link together more stable. With this design you get stability and height, to max out points.

Tower Hight	Block Delivery	Block Placing	Tower Level Multiple	Capping	Total Points
1	1	1	2	6	10
2	2	2	4	7	15
3	3	3	6	8	20
4	4	4	8	9	25
5	5	5	10	10	30
6	6	6	12	11	35
7	7	7	14	12	40
8	8	8	16	13	45

Tower Hight
Points
Total Points per level (single block tower)


Stability
Less
More
8+8+16=
32 points
w/cap 45points
10+10+10=
30 points
w/cap 40points
5678
11+11+8=
28points
w/cap 36 points

Date	Location	Start Time	End Time	Week #
October 4, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	5
Meeting Goals: Assembly of drive train components, Continued testing of pendulum Capstone POP				
Team Members in Attendance:				
Ian, Megan, Joel T, Jalynn, Becca, Nathan, Joel H, John T				

Drive Train - Ian and Megan

Today Ian and Megan began assembling components for the drive train. Parts had come in during the week, so they started by organizing them. After organizing, they began measuring the 3D printed parts. They found that many of the parts came out undersized (primarily on counterbores and shaft bores). They attempted to file these parts to make them fit, but they found that it took too much time to do so. Instead, they're going reprint these parts with larger modeled dimensions. After this, they drilled out 4 of the #6-32 tapped 0.5" hex hubs they purchased. They drilled for the smallest #6 clearance they could (due to a lack of material near those holes). After drilling these, they assembled them onto the mecanum hubs and slid them onto the drive shafts.

Capstone - Joel H and John

Joel H and John started collecting tuned mass damper information to see if it would help the overall tower stability. During this time, it occurred to Joel that frequency is not the same as stability and tests were showing (like last meeting) that it may not be as helpful as he originally thought.

Date	Location	Start Time	End Time	Week #
October 11, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	6
Meeting Goals: Team Discussion, Slide parts arrive and are assembled, Preparation for Build Day				
Team Members in Attendance:				
Ian, Megan, Joel T, Jalynn, Becca, Brooklynn, Nathan, Joel H, John				

Lift - Megan

Megan looked at the new slides the team had ordered for the lift. In the past, they'd used REV slides for their lifts and extension arms, but this year she wanted to try something new to get the best result.

These slides have bearings in them, which help them move much more smoothly than other options. Unfortunately, she didn't have the right parts to attach the slides, so they're going to 3D print them for the next meeting, but looking at the slides in person and looking at the size really helped her think about what she wants to do with them in the future. Currently, she's positive they'll have at least five stages on either side of the robot, however, they may increase this to six, but this is something they'll have to think about and test. Next week she's going to make a proof of principle for rigging options.

Drive Train - Ian and Becca
Today was primarily spent organizing the drive train parts. The major components of the drive train (the two drive tubes and one of the cross tubes) were completed over the week, and they will powder coat them before the build day tomorrow. Additionally, they discussed their plans for the build day. Becca helped put O rings on components of the odometry wheels.

Date	Location	Start Time	End Time	Week #
October 18, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	7
Meeting Goals: Drive train assembly begins, Foundation catch POP designed				
Team Members in Attendance:				
Ian, Megan, Joel T, Jalynn, Becca, Nathan, Joel H, John				

Drive Train - Ian and Megan

Over the week, the rest of the drive train parts were cut (the cross tube gussets, motor mounting plates, custom washers for the wheels, and encoder mounts for the odometry pods) and powder coated, and the team began assembly of the drive train. Early into the meeting, they realized that the flathead screws they bought were too short to provide adequate thread engagement into the motors. As such, they instead counter-bored the drive tubes and instead used standard M3 socket head screws. They then worked on filing out the bearing bores, as most of them had come out a few thousandths undersized. They also worked on assembly of the odometry wheels.

Foundation Catch - Joel T
Joel started to doubt the latch design he had made so decided to check what it would look like in real life. He made a cardboard model of it by cutting a few boxes into 2x(1x7) and 1(1X17). He duct taped the pieces together and was not surprised to see that the model was HUGE. This was important because this was when he decided to go in a different direction with the latch.

BROWNCOATS
Team 7842 Engineering Notebook

Date	Location	Start Time	End Time	Week #
October 19, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	7
Meeting Goals: Drive train assembly continues, Slide POP being built				
Team Members in Attendance:				
Ian, Megan, Joel T, Jalynn, Becca, Nathan, Joel H, John				

Drive Train - Ian and Megan
The team continued the drive train assembly today. They finished filing the bearing bores and completed assembly of the mecanum and odometry wheels. Additionally, they assembled the belt tensioners in the tubes. Finally, they attached the two sides with a cross tube and its associated gussets, resulting in a nearly finished frame.

Lift - Megan

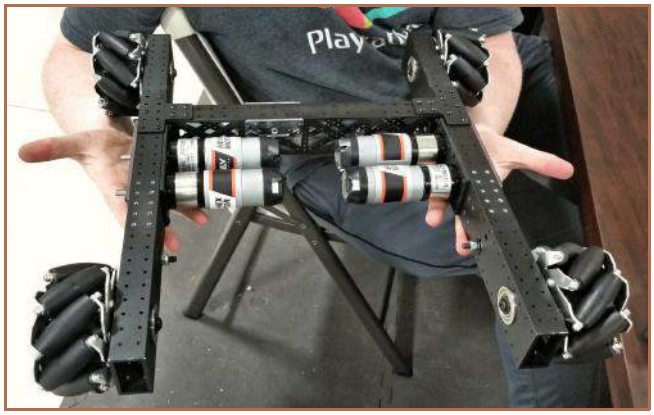
Megan got to work on her lift slide proof of principle. Something the team has done in the past is rig their lifts with the cascading effect, so all the slides move at the same time, however, this time she wanted to try rigging the lift continuously. After doing some research, she'd found that many teams preferred this method over cascading, especially if using belts (which is what they did last year and she wants to do again this year), so she wanted to try it. The first thing she did was take the 3D printed parts to connect each stage and assembled them on the back of the first slide. There are three parts to each slide, and they all connect with each other. The only problem she found with this was that some of the holes didn't align properly from the 3D printed part to the slide, so she had to drill the holes out to get them to fit. After that, she added the other three parts to the second slide and connected both slides together.

She added four V-bearings for the string to loop through, and she added two screws as anchor points for the string to tie off on. Finally, she strung it. Originally she used the orange REV string, however, it wasn't long enough and they didn't have a long enough piece, so she used temporary string to test. Once it was all strung together and tied off, she was able to show how it extends and retracts. It all worked very well, and the slides were very smooth, which she was happy about. From all that she learned, she's decided continuous will almost definitely be the rigging option to go with.

Date	Location	Start Time	End Time	Week #
October 25, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	8
Meeting Goals: Drive train assembly continues, Foundation catch POP built				
Team Members in Attendance:				
Ian, Megan, Joel T, Jalynn, Becca, Nathan, Joel H, John				

Drive Train - Ian and Megan

The team finished assembly of the drive train today. They inserted all of the belts into the tubes and mounted the motors without much trouble, and they're going to make a temporary electronics mounting plate tomorrow. Once all of this was finished, the team decided to weigh Vera for the first time. They placed the REV hub, phone, and the battery on top of the drive train. The weight came out to about 15 pounds, which gives them plenty to work with for the other subsystems.

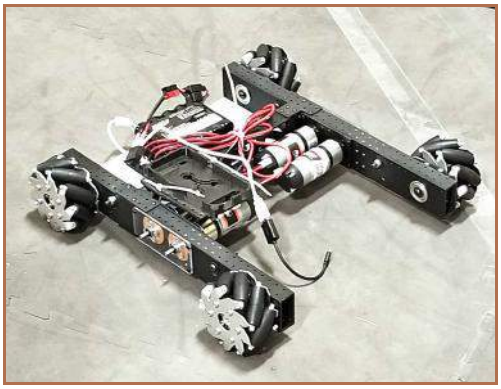


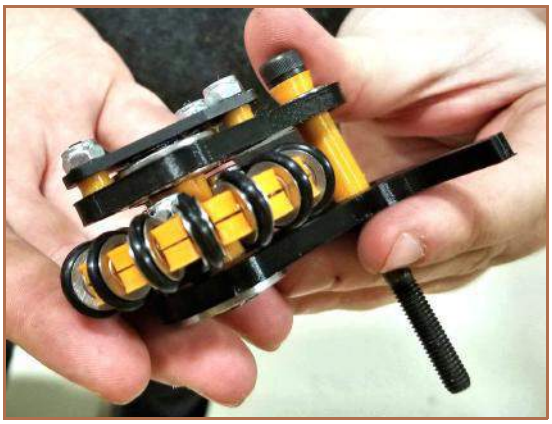
Foundation Catch - Joel T
After realizing that the HUGE latch design he came up with was not going to work, he decided to scrap it and start on a new latch over the week. This latch consisted of a 2.5x3x1.5in 3d printed block that sat above the wheel of the robot, there were two of these. Then, he put a 5x5 L bracket (which was cut down to a 3x3) on top, this would act as the part that would catch the foundation. Then, the plan was to have a servo on a long shaft connected to the brackets which would control their movement. This idea was meant to sit on either the left or right side of the robot because we planned on moving the foundation from the bottom.

Date	Location	Start Time	End Time	Week #
October 26, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	8
Meeting Goals: Drive train assembly continues, Foundation catch POP built				
Team Members in Attendance:				
Ian, Megan, Joel T, Becca, Nathan, Joel H, John				

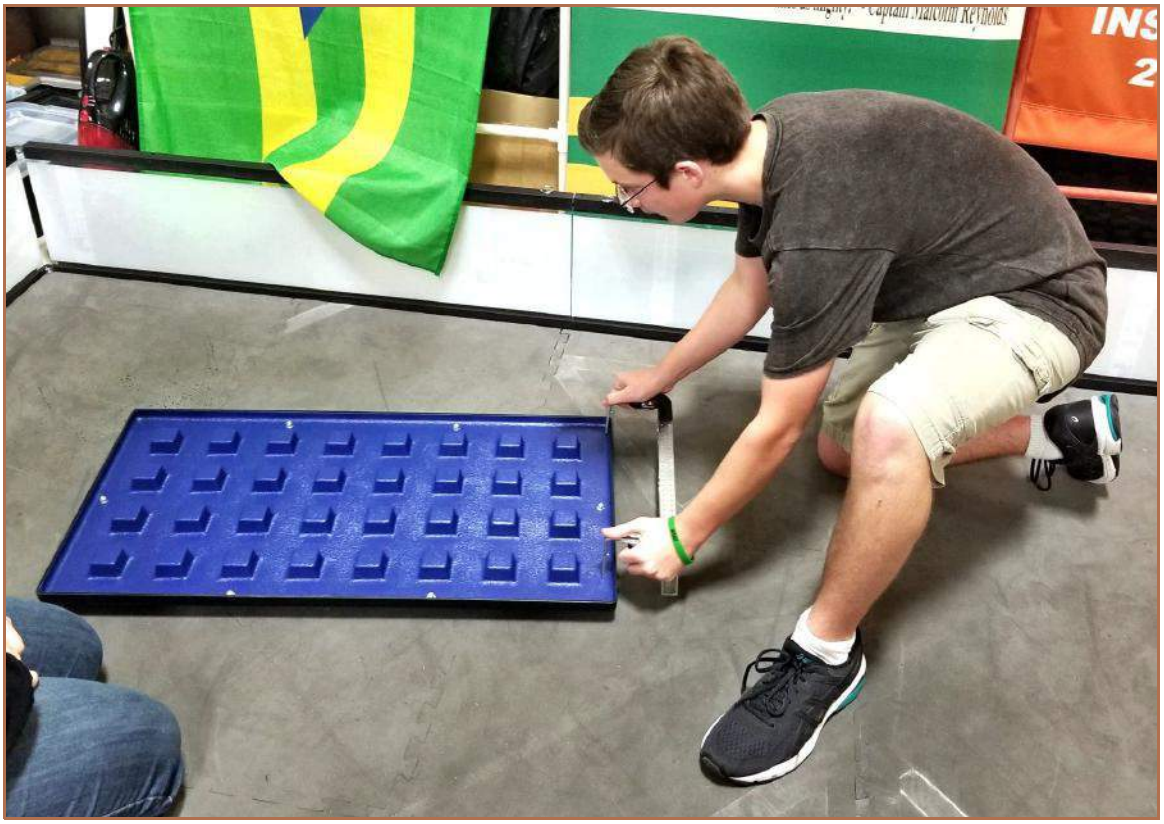
Drive Train - Ian and Megan

Today the team assembled the odometry pods and an electronics mounting plate, which they custom made out of Lexan to temporarily mount the REV hubs. This allowed them to test the drive train. The drive train performed far better than they had hoped, and they noticed very little drift while translating.



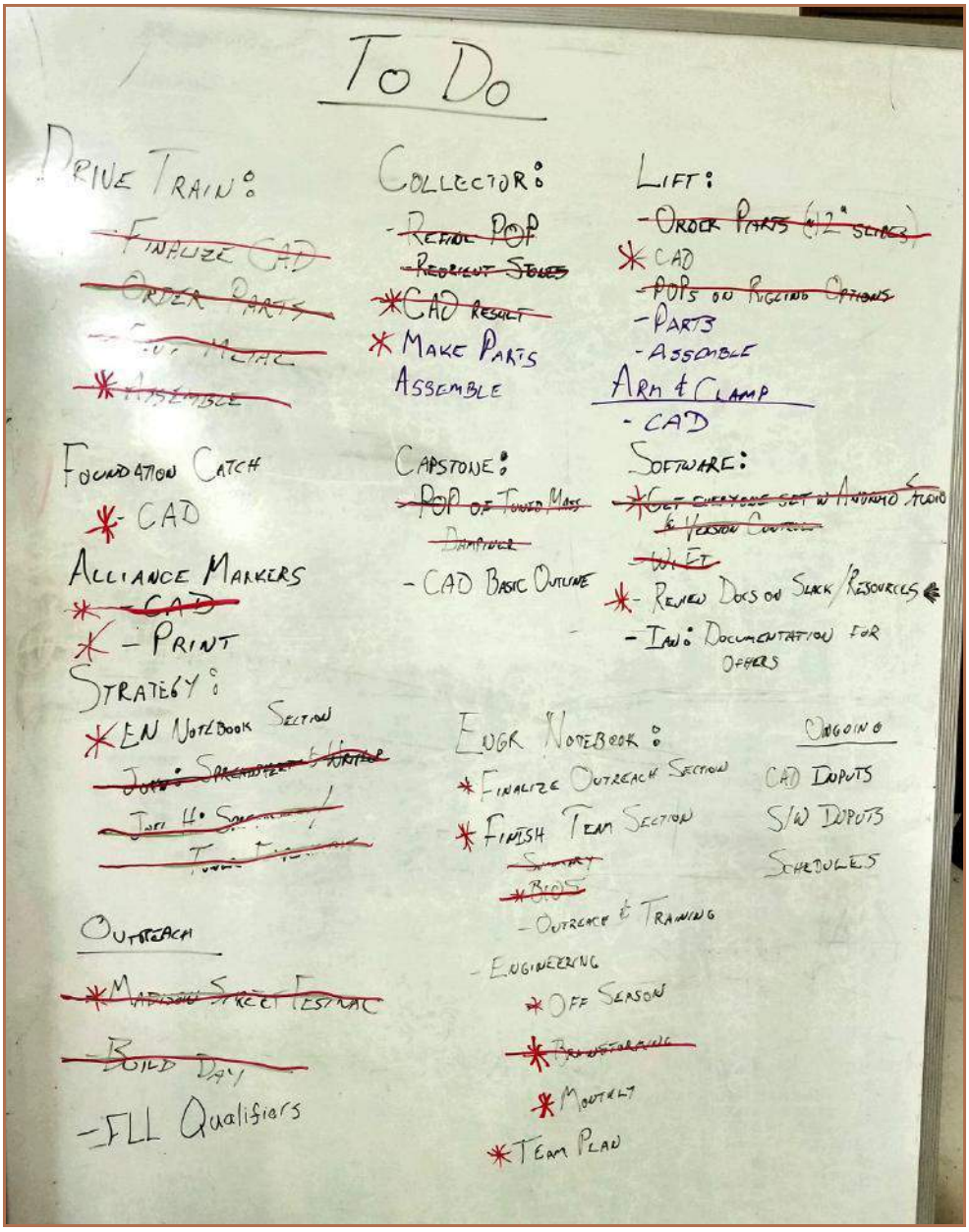


Foundation Catch - Joel T
Joel had the plan for the foundation catch mostly designed and ready to be tested. He attached it to a backup drive train tube. In the process, he learned how to tap holes with a special tool. He tapped the tube and then filed out some crud that was on the 3D printed part and then attached it to the tube. Once all that was done he tested it, and it worked! And it worked better than he thought it would. But due to changes in plans, the foundation latch was to be moved to the back of the robot. So this idea became a failsafe in case the idea didn't work.



Date	Location	Start Time	End Time	Week #
November 1, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	9
Meeting Goals: Mount odometry wheels on drive train				
Team Members in Attendance:				
Ian, Megan, Joel T, Jalynn, Nathan				

Drive Train - Ian and Megan
Today, Ian and Megan mounted the odometry wheels and made a temporary solution for spring-loading them. They then tested how well the wheels were able to handle the bump under the neutral skybridge and were pleasantly surprised. Even at higher speeds, all three wheels were able to go over the bump. They were particularly concerned about the perpendicular wheel, but it seemed to be able to handle it fine. They are, however, going to reinforce that assembly with a standoff to ensure strength throughout the season.

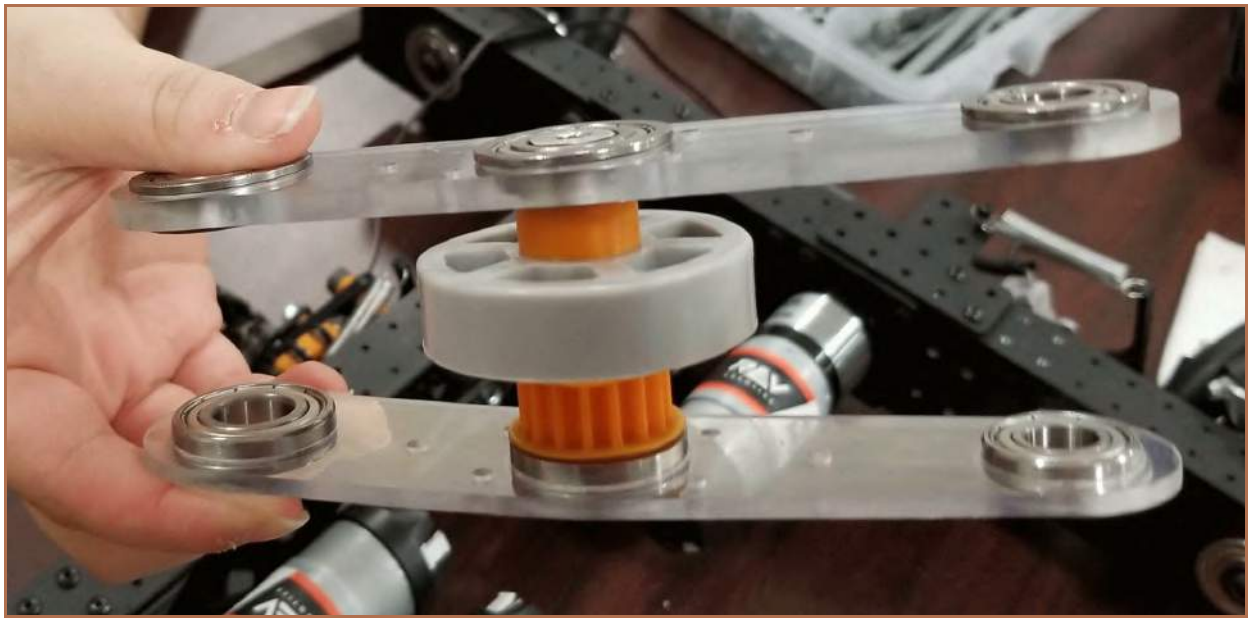


The to-do list as of November 1st

Date	Location	Start Time	End Time	Week #
November 8, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	10
Meeting Goals: Begin Intake assembly				
Team Members in Attendance:				
Ian, Megan, Joel T, Jalynn, Becca, Nathan, Joel H, John				

Intake - Ian and Megan

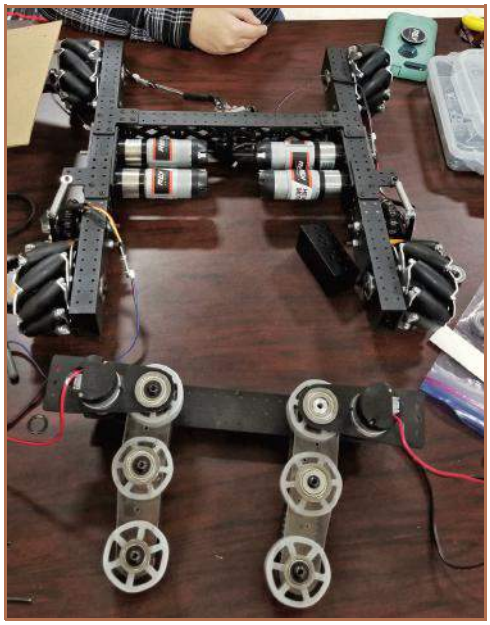
On November 8th, Ian and Megan began the intake assembly. Most of the intake parts had been completed over the week, so Megan took the polycarbonate plates where the wheels will be housed and filed out the holes for the bearings, which were machined a little too small. It took her a couple of tries with some of them, but finally she'd filed them to the correct size and all the bearings were pressed into the polycarbonate. The aluminum parts needed to be powder coated, so they didn't do any assembly with those.



Date	Location	Start Time	End Time	Week #
November 9, 2019	AvaLAN Wireless	12:30 p.m.	5:00 p.m.	10
Meeting Goals: Complete Intake Assembly, Design Review for Foundation Catch				
Team Members in Attendance:				
Ian, Megan, Joel T, Joel H, John				

Intake - Ian and Megan

The team completed the majority of the intake assembly today. The system still needs to be mounted to the robot and they need to design an element ramp for the stones. They did find that their original plan for the intake belt run resulted in far too much friction in the system. They intended to use 4 tensioners to maintain wrap on the middle pulley, but the sharp bends didn't allow the belt to run smoothly. They removed 2 of the tensioners, which let the belt run smoother. This did reduce the amount of wrap on the pulley, however, which means that the middle wheels on the intake are capable of skipping under stall loads. However, this is acceptable because the middle wheels do not make contact with the stone under normal operation (they're only used for reorienting the stone if necessary). While Ian assembled the first arm, Megan filed out the bearing holes on the metal plates that mount the motors to the drive train. The area for the bearings were too small, so she had to file them out until they were able to be pressed in. Once she was finished with that, and once Ian had finished his arm of the intake, Megan began assembling the other one. She added two screws to the polycarbonate plate and added a locknut, a bushing, and then another locknut so they could trim the screws. These screws would act as tensioners for the belts. Then, she added the thunder hex axles and added pulleys to them for the belt, which she put on next. After that, it was time to add the wheels and a couple more spacers, and finally, the second polycarbonate plate to sandwich everything together. Then, she took the metal plate that connects the motor and the wheels, and added a pulley, then the motor, and then a belt to connect everything. Once all of this was finished, she and Ian connected the two arms of the intake with a long plate. The next step would be mounting it onto the robot, but they still needed one more part, and they ran out of time, so at the next meeting, they will finish that.

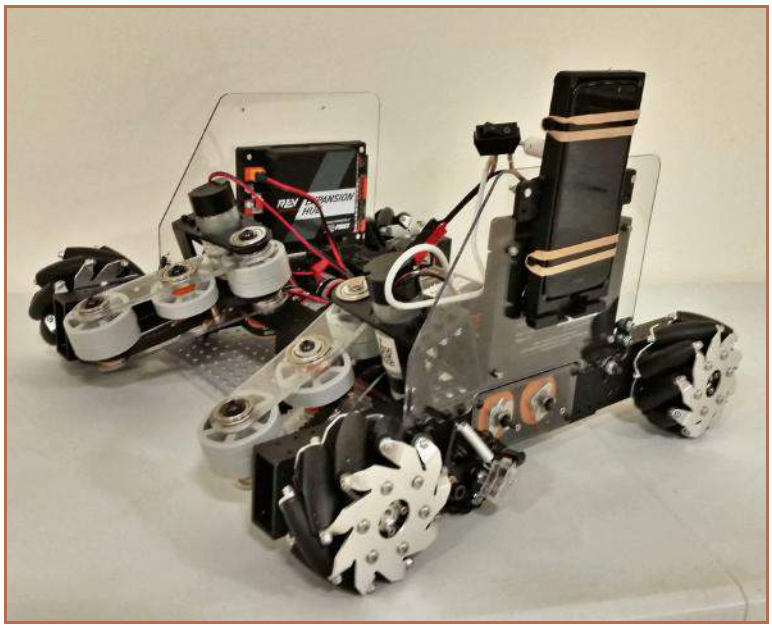


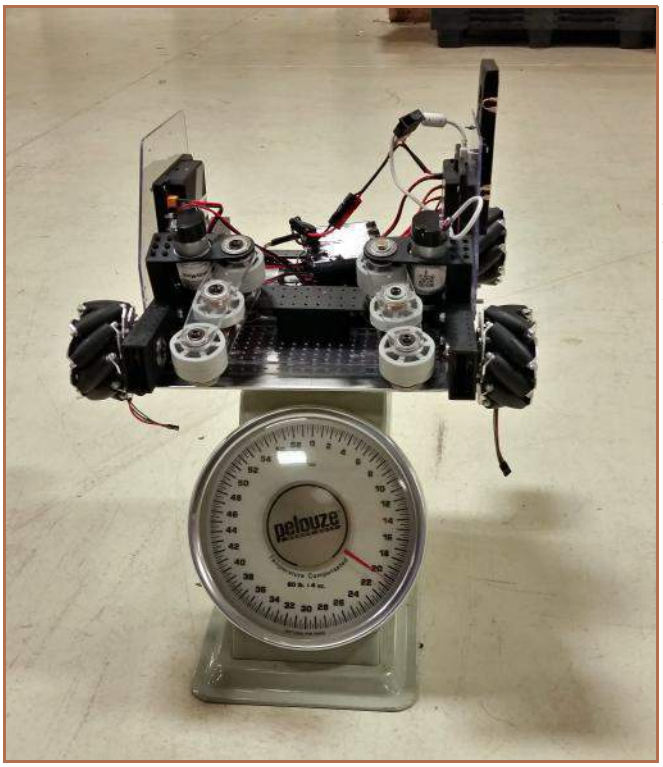
Foundation Catch - Joel T
After the old foundation idea was put in a box, Joel came up with one more design that he presented to the team today. It consists of a 1 x 1 x 6 3D printed block that runs across the back of the robot. A shaft runs through the block and two fingers are connected to the ends of the shaft. A servo that is either on the side or in the back (the exact position of the servo mount is TBD) will rotate the shaft.

Date	Location	Start Time	End Time	Week #
November 10, 2019	AvaLAN Wireless	12:30 p.m.	4:00 p.m.	10
Meeting Goals: Mounting Intake to Robot, Testing of Intake				
Team Members in Attendance:				
Ian, Megan				

Intake - Ian and Megan

Today, Ian and Megan mounted the intake to the robot, began testing stone ramps, and mounted the REV Expansion Hubs to the robot with some polycarbonate plates that were designed in Solidworks. They found that the element ramp needed an additional, sharp bend downwards for the stones to go up smoothly. They had originally intended to use polycarbonate for this, but they couldn't get a tight enough bend radius (via heat bending) to accomplish this. Instead, they're going to model a 1/16" 6061 aluminum plate for the intake, which they will cut over the week. They will then bend the plate, which will hold a much tighter radius than the polycarbonate.

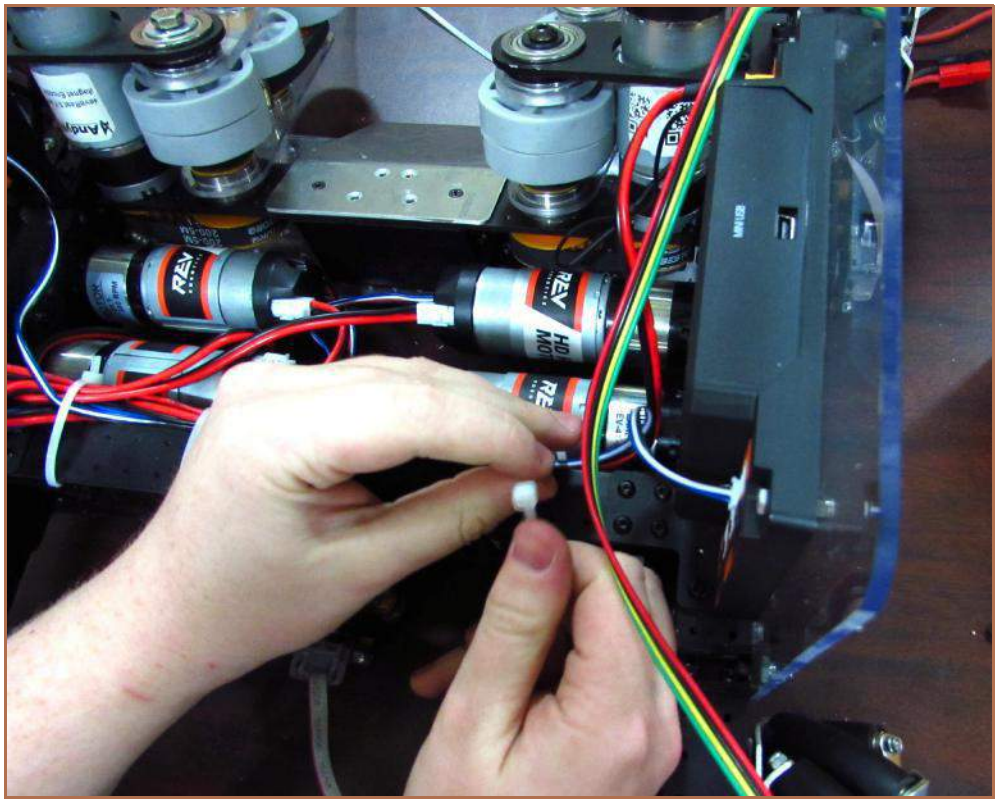




WEIGHT CHECK
Vera is up to about
21 pounds on November 10th

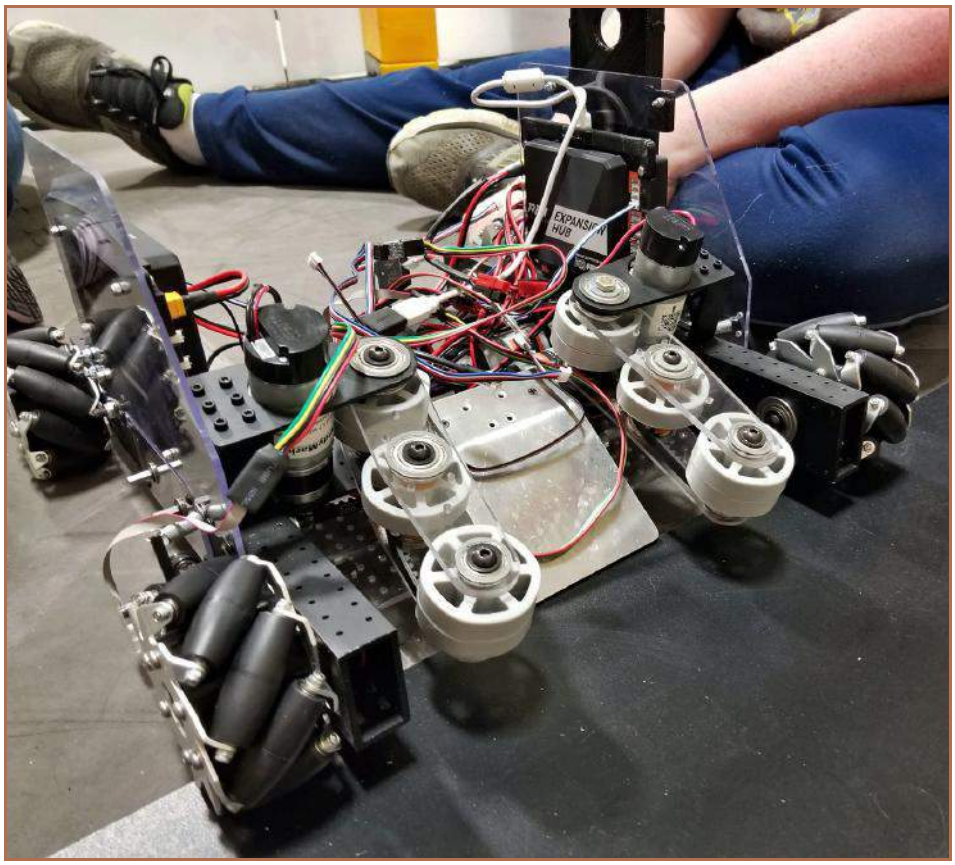
Date	Location	Start Time	End Time	Week #
November 15, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	11
Meeting Goals: Wiring the Robot, Adjusting Element Ramp on Intake				
Team Members in Attendance:				
Ian, Megan, Jalynn, Becca, Nathan, Joel H, John				

Wiring - Ian
Ian spent most of today wiring the robot and bundling the cables neatly. He finished the wiring of the odometry wheels, drive motors, and the intake motors.



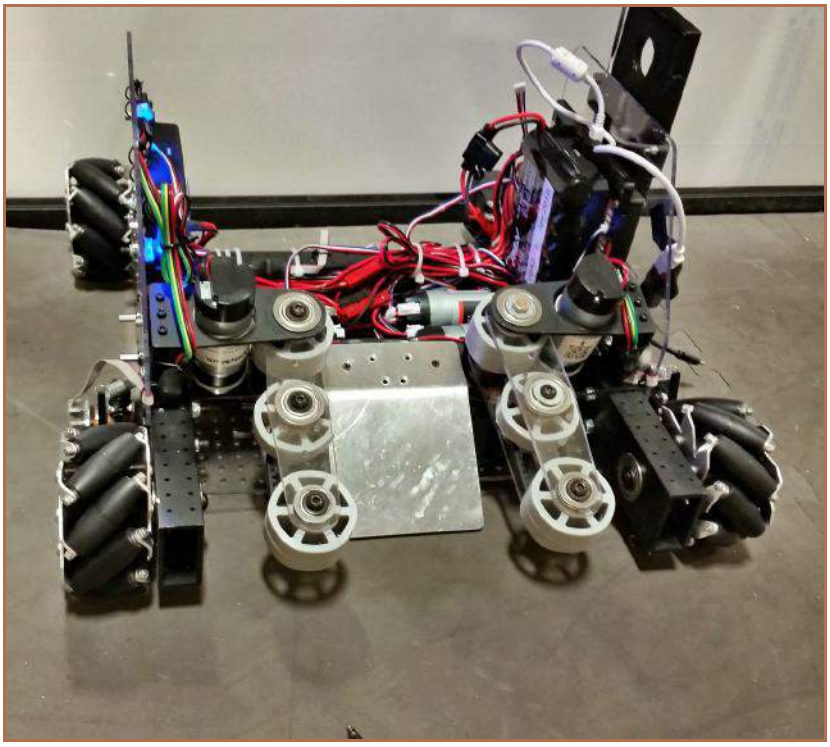
Intake - Ian

Ian also worked on the element ramp for the intake, which was modeled and cut over the week. He mounted and bent the part multiple times throughout the day, and he cut the part shorter a few times. He did this while trying to optimize both the ease of intaking and the ability to drive over the bump under the neutral skybridge. He ended up reducing the length of the part by about 0.5", and the final angle of the part was 36 degrees, resulting in an additional 17.3 degrees from the intake angle. The team is going to design a part to support the end of this plate. This part will be 3D printed and will double as the stop for the intake arms.



Date	Location	Start Time	End Time	Week #
November 16, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	11
Meeting Goals: Continued Adjustments of Element Ramp, Testing of Intake, Software, Foundation Catch Attached and Tested				
Team Members in Attendance:				
Ian, Megan, Joel T				

Intake - Ian and Megan
Ian and Megan mounted the element ramp support block today, which allowed them to test the intake with stops. They were very happy with how well the intake was able to reorient stones in any upright orientation, and the intake speed seems very good.

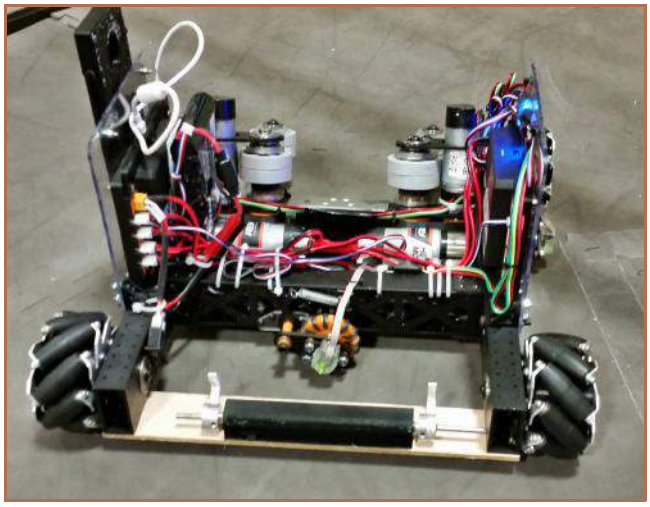


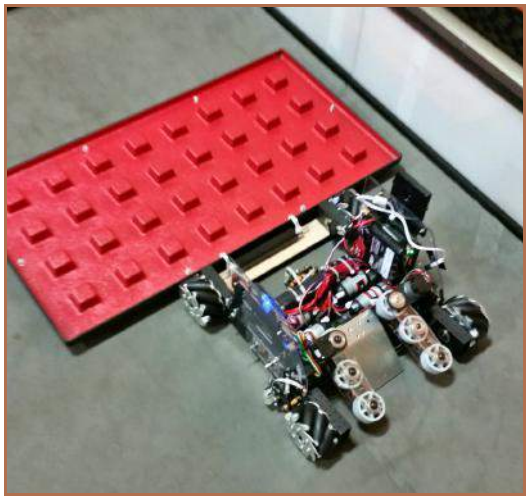
Software- Ian

Ian then began doing some software work. He started by implementing the control software for the intake into the teleop program, which allowed him to test the intake while driving. He was very encouraged by its performance. He then began to work on preliminary autonomous tuning. This involved tuning the feedback controllers in the system, as well as measuring and applying certain drive constants (such as the track width).

Foundation Catch - Joel T

After the catch was printed and cut, Joel put it all together and, just for the sake of time, he took a piece of plywood and cut it down to size, bored a few holes, and attached it to the robot. Then, since he had not attached the servo yet, he just used his hands to test it. It seemed to work very well.

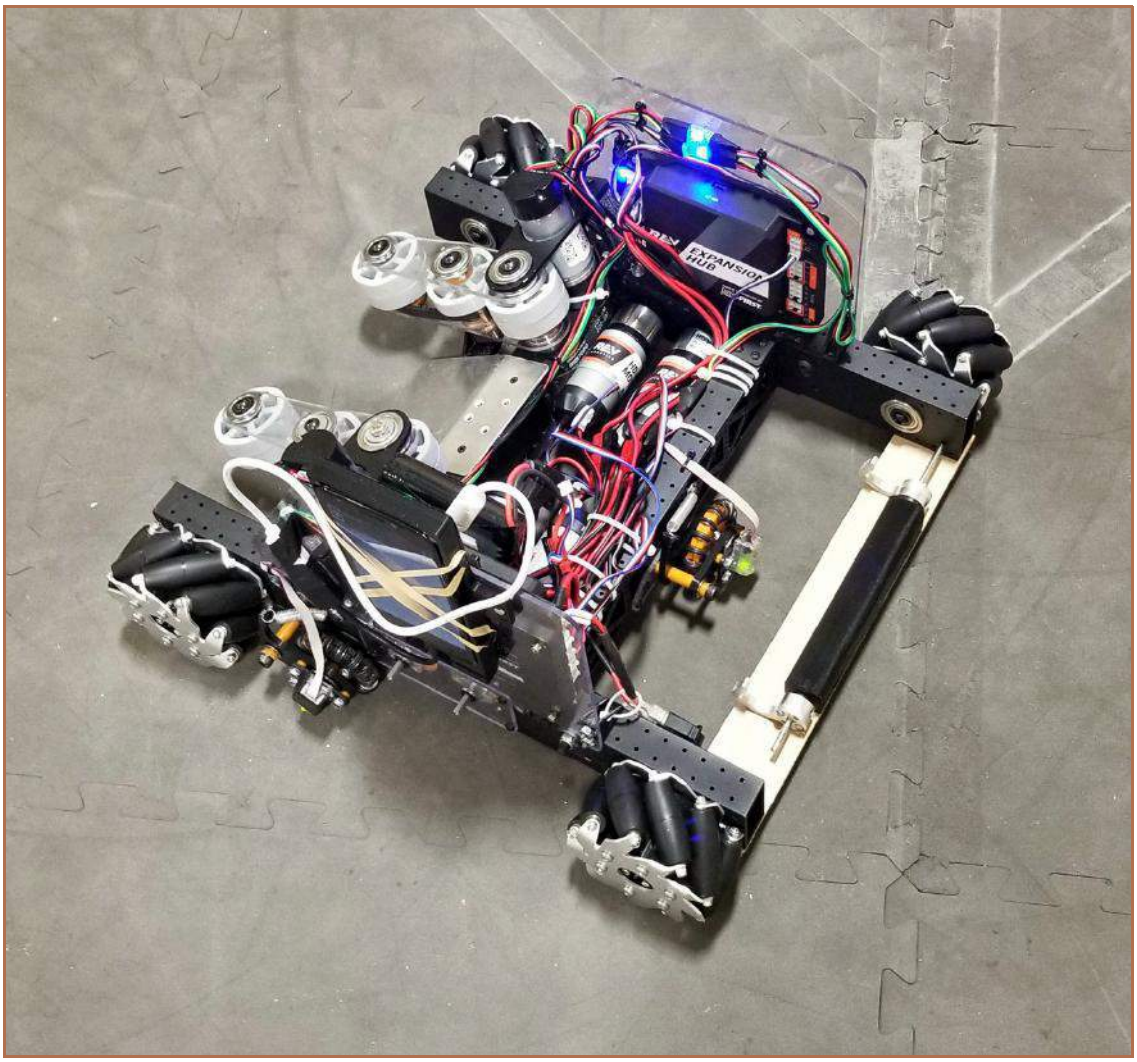




Date	Location	Start Time	End Time	Week #
November 17, 2019	AvaLAN Wireless	12:00 p.m.	4:00 p.m.	11
Meeting Goals: Software				
Team Members in Attendance:				
Ian, Megan				

Software - Ian

Ian continued autonomous programming today. He ran into some issues with the odometry localization, which he realized were caused by an improperly secured encoder case, encoders plugged into the wrong ports, and constants about the odometry wheel positions being negative. After resolving these issues, he was very encouraged by the accuracy of the odometry wheels over short distances (less than an inch of linear deviation, and less than a degree of angulardeviation). Ian then began testing small path segments (such as line segments and point turns) and tuned the drive constants to be more consistent. He found that the robot was able to turn within a half degree very consistently, and it was able to execute line segments with under an inch of deviation, but the localization for spline following was less accurate. He's going to retune the feedback controllers while following splines later on to try and resolve this issue.


EXPANSION HUB

Date	Location	Start Time	End Time	Week #
November 22, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	12

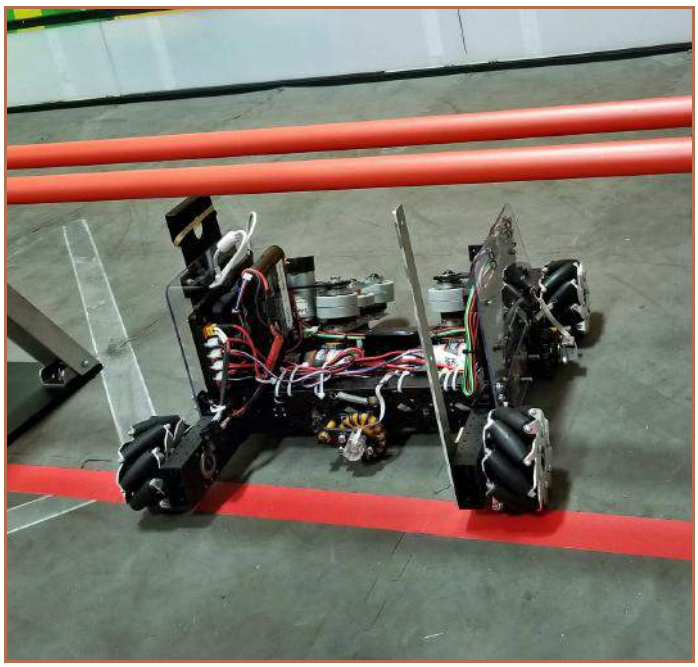
Meeting Goals: Assembly of Arm and Clamp, Foundation Catch POP, Software Programming

Team Members in Attendance:

Ian, Megan, Joel T, Jalynn, Becca, Nathan, Joel H, John

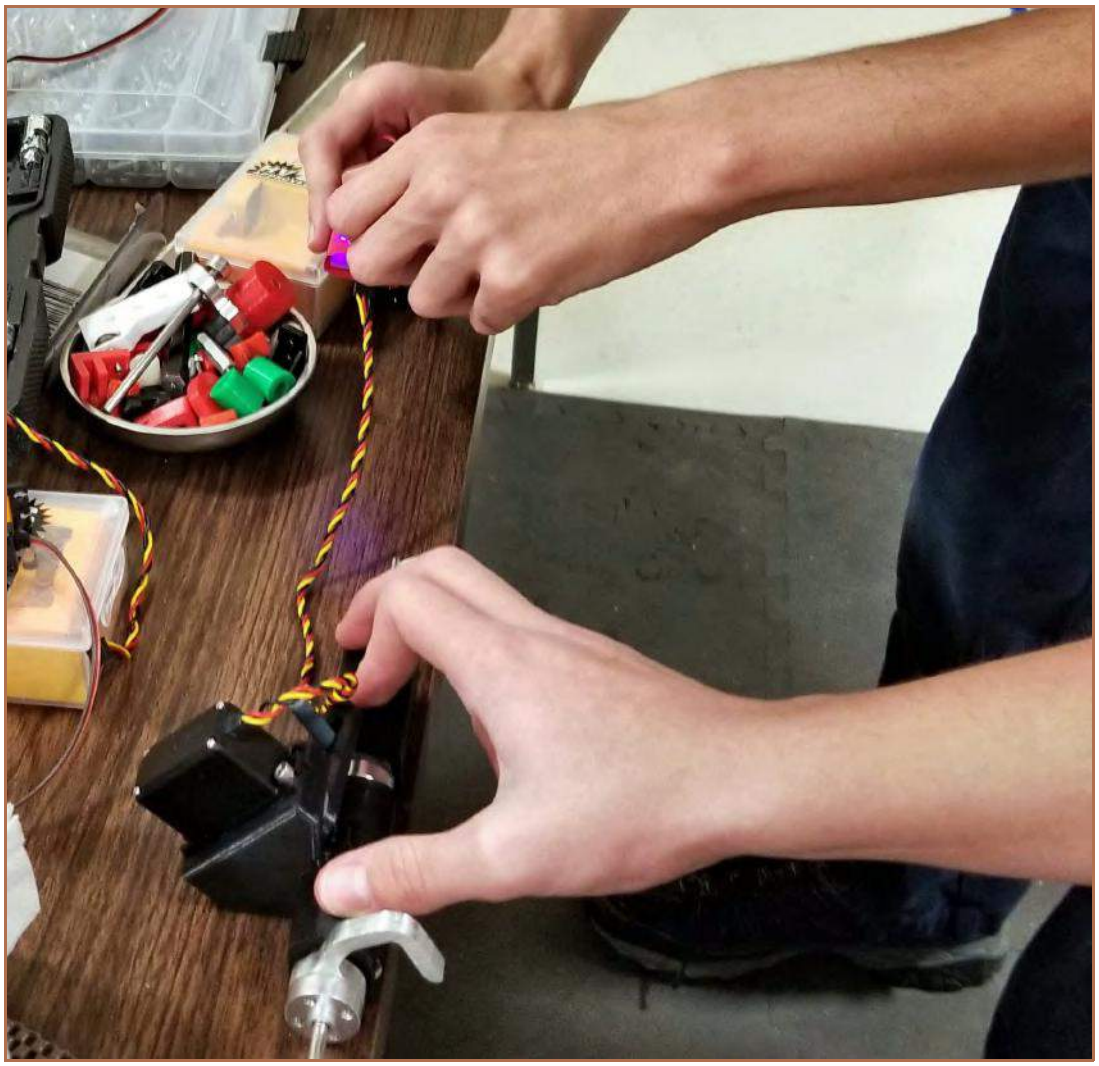
Arm and Clamp - Ian, Megan, and Nathan

On November 22nd, the team started pulling together the parts they currently had for the arm and clamp. The work was divided between them to try and get as much done as possible. Megan was tasked with drilling out and tapping the holes of five bearing blocks for the lift subsystem. The job went smoothly and she didn't have any problems with tapping them. Now they just needed to be powder coated. Nathan was tasked with assembling a servo block.



Foundation Catch - Joel T

Joel T brought in an improved prototype model of his foundation catch. The catch is made of two 1 x 1 x 3 inch block that an axle runs through. A servo was mounted forward which drove a slotted linkage to the axle and lowered the fingers to the foundation. The fingers are an aluminum hook. This catch's hinge point was horizontal to its latching point, so there were no back-driven stresses placed upon the servo.



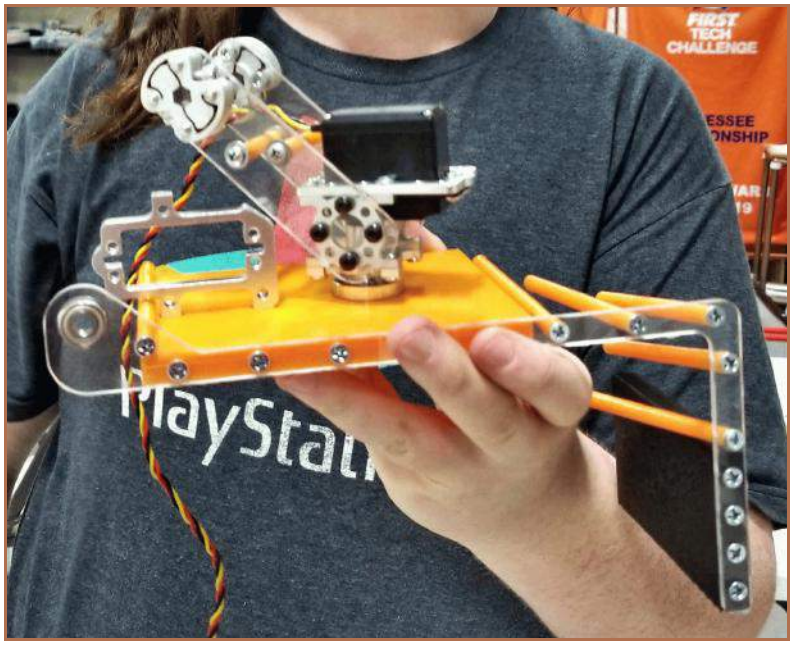
Software - Ian

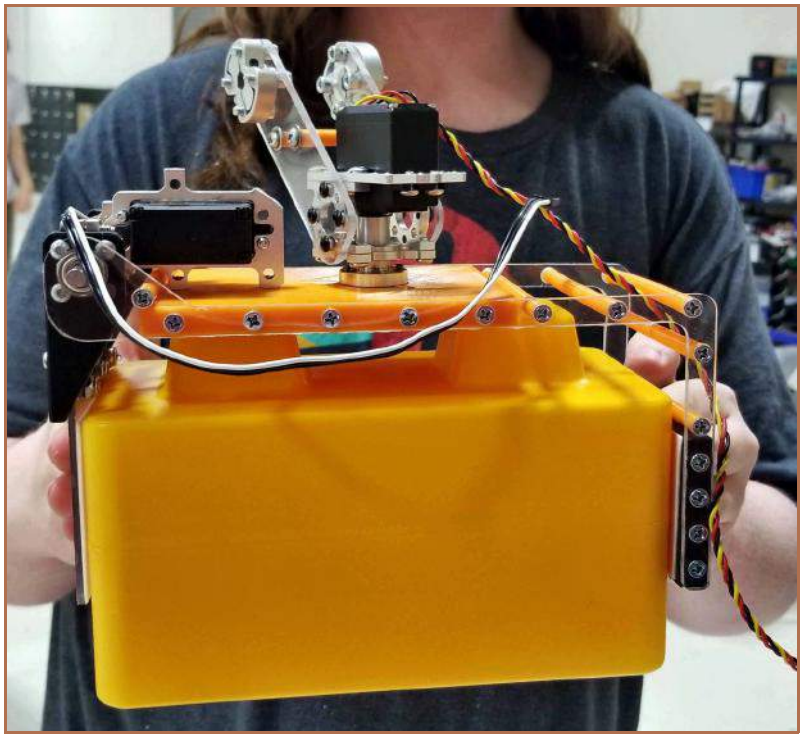
Today Ian worked on computer vision, with the intent to quickly detect a Skystone in a line of regular stones (such as the quarry). He began testing the use of a different color space, YCrCb. This color space works very well for differentiating between blueish and reddish objects. This is because the "Cr" and "Cb" channels work by measuring the difference from red and the difference from blue. Yellow has virtually no blue, while black (such as the sticker on the Skystone) has plenty of blue. This results in a very clear difference between Skystones and Stones when looking at the channel representing difference from blue.

Date	Location	Start Time	End Time	Week #
November 23, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	12
Meeting Goals: Assembly of Stone Clamp Completed				
Team Members in Attendance:				
Ian, Megan, John				

Arm and Clamp - Ian and Megan

Today Ian and Megan finished assembly of the stone clamp, which is part of the Arm and Clamp subsystem. This clamp attaches to the end of the arm – which is powered by a servo and a "virtual 4 bar" linkage to maintain the orientation of the clamp – and moves a collected stone out of the robot and onto the foundation. The front of the clamp system is powered by a servo (and is the component that actually clamps the stone), and the back is fixed. They chose to grab onto the front of the stone rather than the stud because it allowed them to eliminate a separate transfer mechanism, which reduces complexity. Furthermore, the clamp is mounted to the arm with a servo, so the clamp is able to rotate once outside of the robot. This allows them to place stones in both a parallel and perpendicular orientation, relative to the sides of the robot. During assembly, they had to manually countersink many of the holes on the custom parts for it (to reduce the amount of CAM work required to machine these parts, two identical parts were made and the countersinks would be added on opposite sides later.), and they accidentally countersunk the two plates on the same face, relative to each other. This meant that they had to cut a new plate (which was fortunately fairly quick to do) to continue assembly. Once that issue was resolved, the assembly went smoothly.

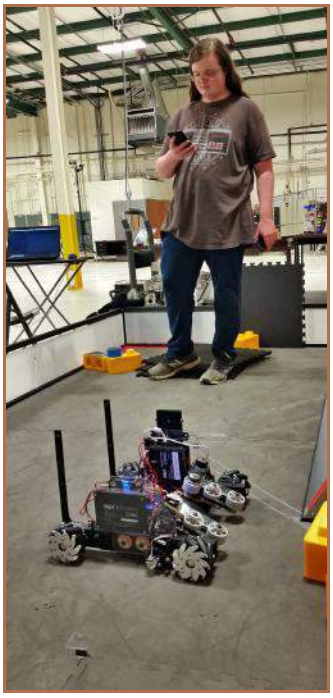

FIRST
TECH
CHALLENGE

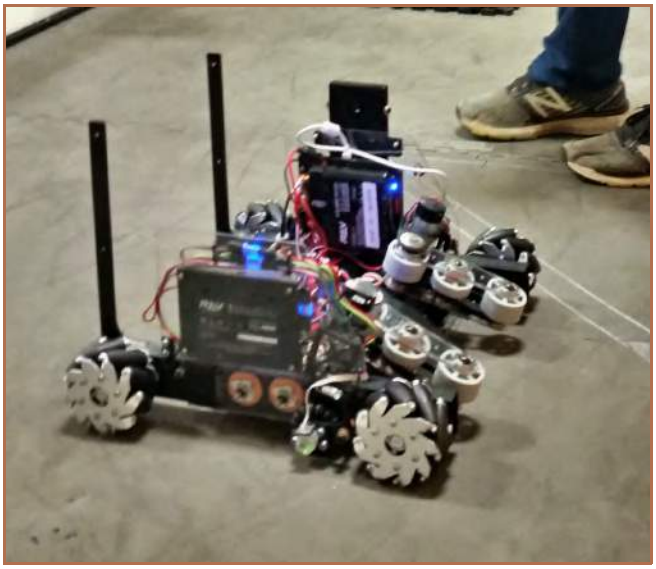


Date	Location	Start Time	End Time	Week #
November 25, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	13
Meeting Goals: Software, Discussion of Foundation Catch				
Team Members in Attendance:				
Ian, Joel T				

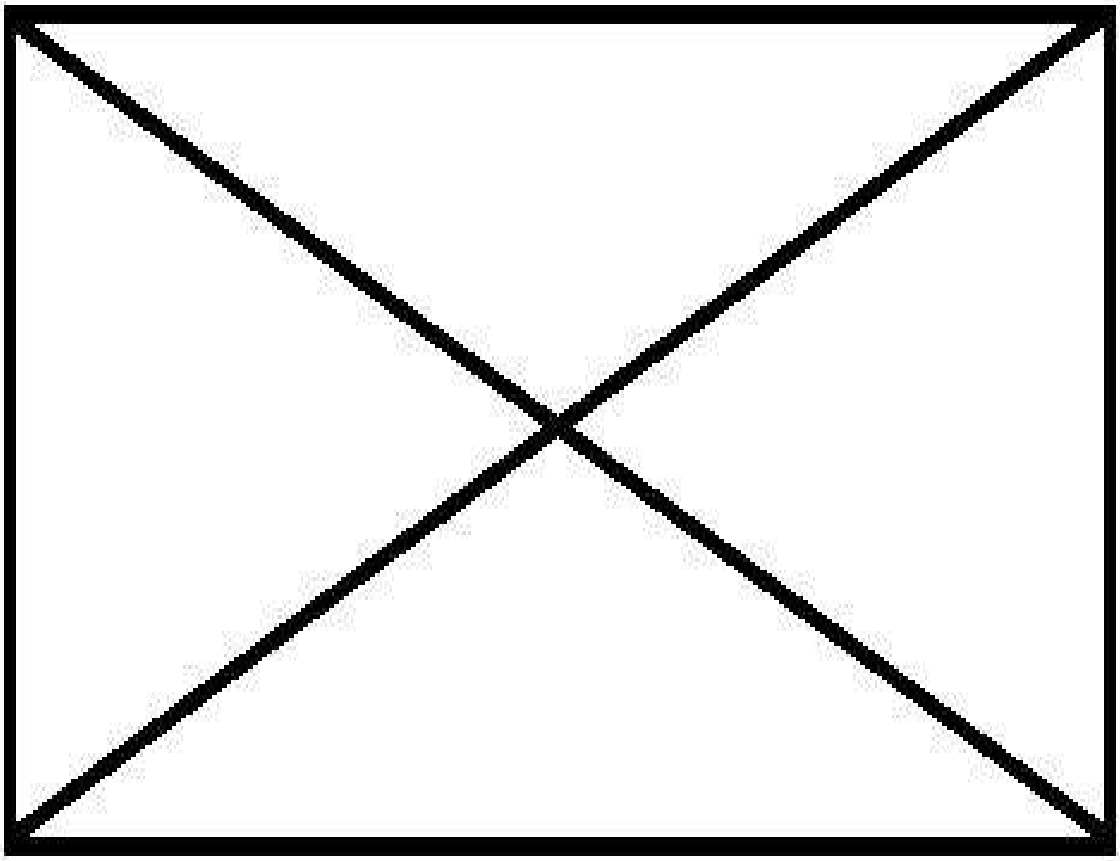
Software - Ian

The team chose not to meet yesterday, and they instead opted to finish the remaining manufacturing so that they could quickly assemble everything at a later date. Ian worked on software for the majority of the day and attempted to fix the issues he previously encountered with spline following and its associated feedback errors. He was not able to solve the issue but has a hypothesis that it has to do with the alternative control method (rather than using a motor velocity PID, due to the bad motor encoder) and its acceleration control.





Foundation Catch - Ian and Joel T.
Ian and Joel discussed plans for the foundation catch, because the previous design would interfere with the lift. They were also having a difference of opinion on where the catch would go, so they discussed several options. The catch would have no room in the middle rear of the robot, so they agreed to put it on the back of the drive tubes.



Date	Location	Start Time	End Time	Week #
November 27, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	13

Meeting Goals: Maintenance of Intake, Lift Slides Assembled, Lift and Hopper Assembled

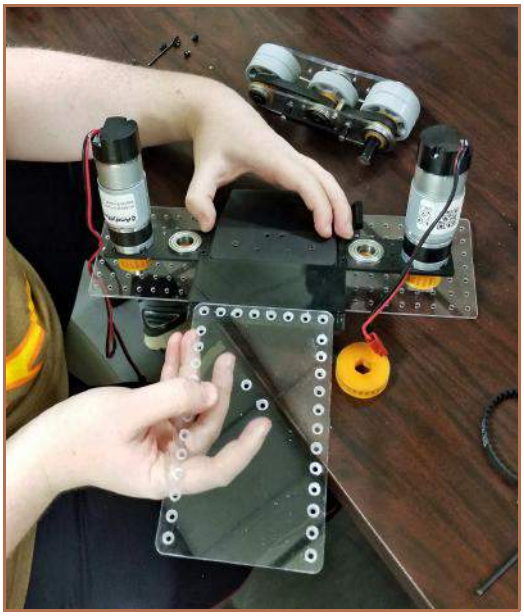
Team Members in Attendance:

Ian, Megan

Intake - Ian and Megan

The team met at AvaLAN after their outreach event to get some extra work done on the robot, since their December 7th qualifier was quickly approaching. Ian had to take the intake off of the robot; so while he was working on fixing the tensioners on the arms of the intake, Megan took the clamping hubs off of the motors and made sure all of the motor screws were fastened tightly, then when she put the clamping hubs back on, she made sure to apply Loctite to the screws so they would be sure to stay put.

Ian began assembling the hopper for the intake. He temporarily removed the intake to tap holes for the hopper to mount to, and he removed the intake arms so that he could replace the tensioners. Originally, the intake used bronze tensioners (which were bored out from 0.25" diameter bronze stock on Ian's lathe) running on M3 bolts. However, due to the tension of the belt, the threads of the bolt wore down the bore of the tensioner and spread bronze dust across the robot and field. To prevent this, he decided to use shoulder bolts and oil-embedded bushings. However, these bushings were too short to cover the whole belt, which resulted in excess friction in the system. As such, he's investigating ways to use bearings as tensioners instead (which he had initially avoided due to space constraints).



Lift - Megan

At their last meeting, they realized that the delron inserts for the slides for the lift were too thick, and were cut too narrow. So, they decided to simply 3D print them and see how that worked. To their delight, the slides fit perfectly in the inserts! So, Megan got to work on putting them together. The first thing she did was connect the individual slides to the individual inserts. At first she was having trouble getting the screws through the plastic, but once they drilled out the holes in the 3D printed parts, it made the job much easier. Once all of the inserts were mounted to the slides, she took the lift mounts off of the drive train and mounted a bare slide to the beam. After that, she mounted five of the slides with the backs, and then she repeated for the other beam. That was all she had time for during this meeting, but she's going to continue with it at the next one.

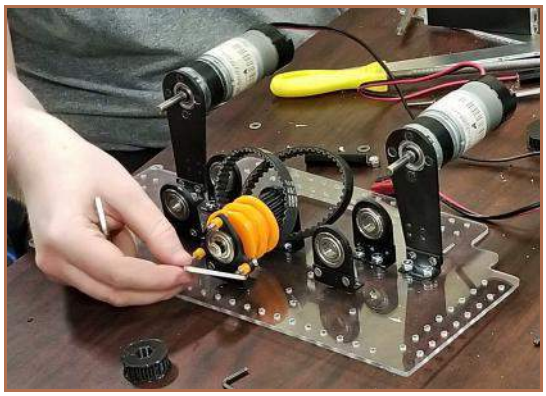
Date	Location	Start Time	End Time	Week #
November 29, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	13
Meeting Goals: Lift Assembly Continues, Lift Drive Assembled, New Catch Design				
Team Members in Attendance:				
Ian, Megan, Joel T, Jalynn, Becca, Joel H				

Lift - Megan

On November 29th, Megan went back to the lift assembly. Unfortunately, she realized she had to take apart the slides she'd put together at the previous meeting so they could add a 3D printed part to the first stage which will hold V-bearings for the string. Once she took it apart, she added the 3D printed part, and then she put it all back together again, stage by stage. Once she was done with that, she added all of the V-bearings to their respective places using 3mm screws to keep them in place, but not tight enough to keep the bearings from spinning. After all of this was finished, she was able to mount the slides onto the robot. They all moved smoothly, even more than she expected. Yesterday there had been some binding on some stages, but today she didn't tighten the screws quite as tightly, and this seemed to take away that binding completely. Once all this was done, she took two angled brackets and mounted them onto each final stage of the lift, which will act as a mounting point for the deposit.

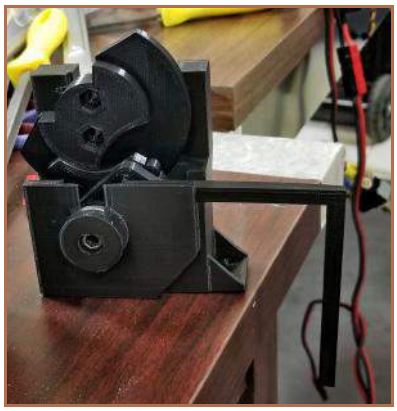
Lift - Ian

Today the team worked on assembly of the lift drive system, which includes the motors, spools, belts, and encoder. These are mounted to a Lexan belly pan, which itself mounts to the underside of the drive train. They also began work on assembly of the arm system to move the clamp in and out of the robot, which mostly consisted of pressing bearings into various parts.



Foundation Catch - Joel T.

Joel T brought in a newly designed foundation catch. This catch was made to mount on the top of the drive tube. It made use of a Geneva drive mechanism so that the catch could not be backdriven and damage the servo. This became necessary because from its new position on the top of the drive tube, the hinge point of the mechanism could not be lowered and aligned with the edge of the foundation. But sadly this catch was in the way of another piece on the lift assembly, so they had to set aside this design and, in the interest of time, go with a temporary, more direct design that consisted of a finger directly mounted to a servo.



Date	Location	Start Time	End Time	Week #
November 30, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	13

Meeting Goals: Lift Assembly Continues, Intake and Deposit Testing, Lift Testing, Weight Check, Finite Element Analysis of Lift Triple V Block

Team Members in Attendance:

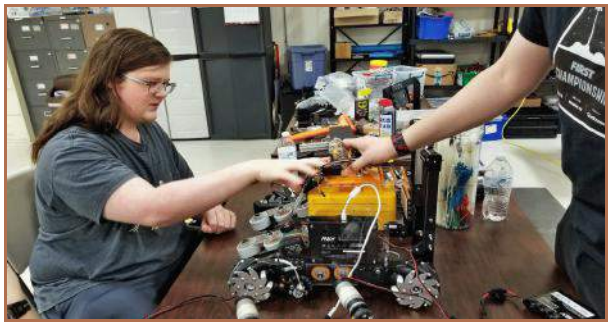
Ian, Megan, Joel T, Jalynn

Lift - Megan

Megan continued putting together the lift. Currently, she was focused on the belly pan that housed the motor mounts, the motors, and spool for the lift. She finished putting together the shaft mounts and the pulleys that ran the belts from the spool to the motor. It took a couple of tries to get the belts just so, but once she got them in place and she connected a battery to the motors to test them, the belts ran just fine. Then, she started putting together the 3D printed parts for the V-bearings for the string. She got two of them together, and they both seemed fine, but when she started on the other two, which were slightly different from the first two parts in the fact that they housed two bearings instead of one, they both cracked while she was tightening the screws. And because their December 7th qualifier was quickly approaching, they didn't have time to fix it in CAD and cut it out of metal. So, after a bunch of ideas were thrown around, they decided on using metal brackets in place of the 3D printed parts and manually drilling holes through them for the screws to mount to the belly pan and the V-bearings. And while this solution wasn't what they originally intended, it should work once they string it all together, and on the plus side, it'll be much sturdier than the original plan.

Intake - Megan, Ian, and Joel T

While they waited for parts to be printed, Megan, Ian, and Joel T. decided to test the intake and hopper to make sure it worked well. They fed a stone into the intake, and immediately the stone shot through the hopper and out the back, because they didn't have a stop on the hopper yet. At first, they used their hands to test, and to their delight, there was no rebound on the stone and it settled into the hopper perfectly. Then, they used a plate to test just to make sure, and they had the same result. They were very pleased by these results, and decided to test the clamp as best they could without it being attached. They held it in the approximate position it will be mounted, and then once a stone was collected, they brought the clamp down, secured the stone, and mimicked scoring it. Because of the carpet tape they have on the clamp, and paired with the servo power, it was able to hold the stones in place very well, and they were very happy with the result.



They tested the clamp's position...

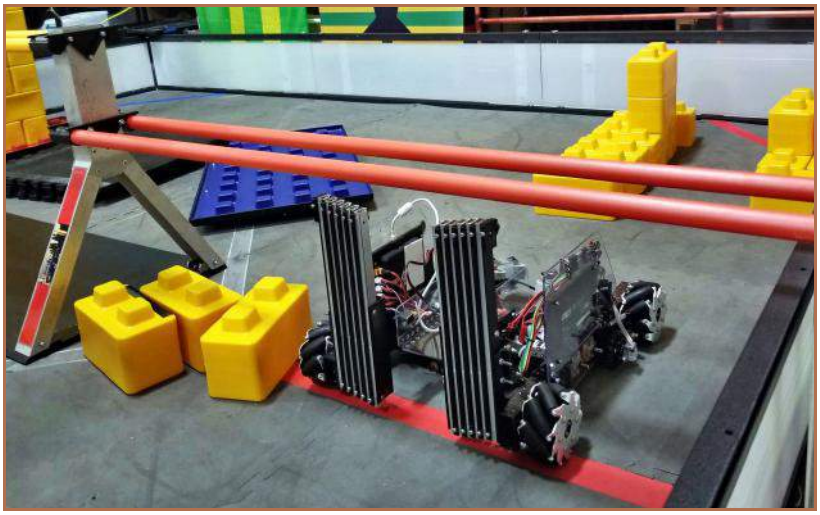
... as well as mimicked the scoring process

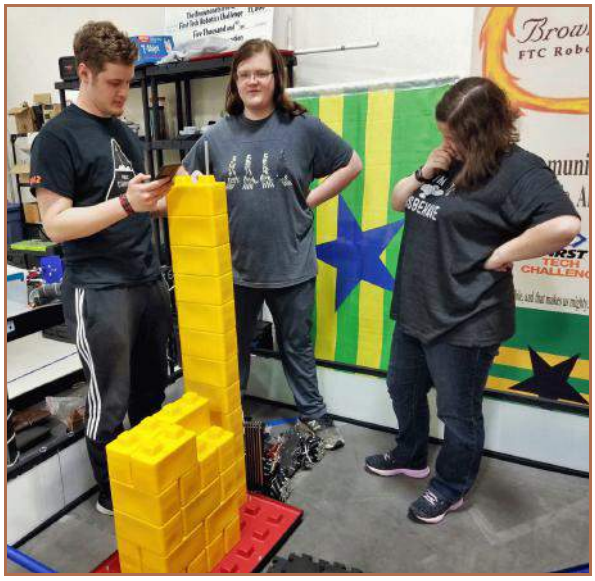
Lift - Ian, Megan, and Joel T

Megan, Ian, and Joel T. were all pretty certain the lift would be short enough to go under the skybridge, but they wanted to make sure, so once it was mounted to the robot, they brought the robot onto the field and pushed it under the skybridge. To their delight, there was plenty of clearance! This will certainly make up for the tolerance differences from field to field.
After that, they extended the lift all the way to see approximately how many stones they'll be able to score based on the height of their lift. They ended up going with six stages instead of seven due to size constraints, so they weren't sure how many they would end up stacking in the end. While Ian held the lift at full extension, Megan and Joel stacked as many stones as the height of it would allow, and they found they would be able to score either eleven or twelve

Lift - Ian, Megan, and Joel T (continued)

high and then the capstone. Megan's initial assumptions after kickoff was sixteen, but due to the fact that they had one less stage, they were not surprised by this. In fact, it was one or two stones more than they were expecting, which they were very excited about.



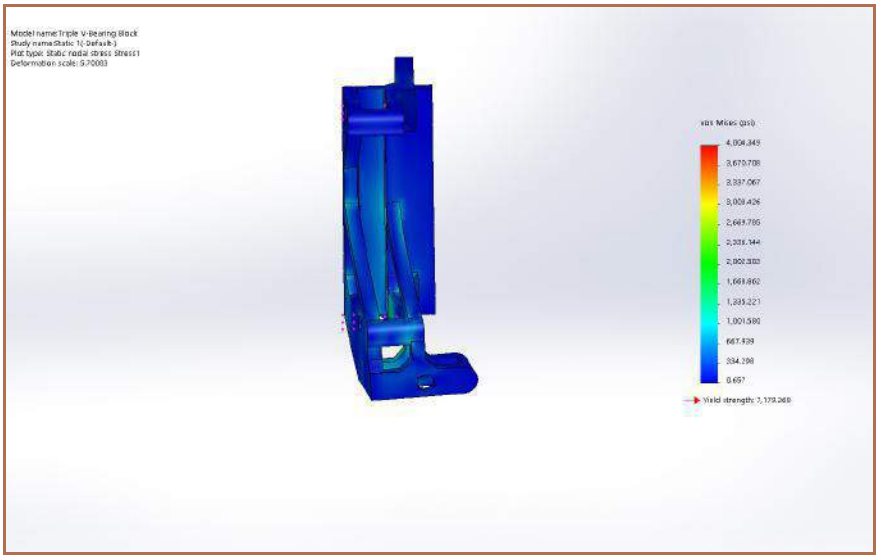


Weight Check- Ian, Megan, and Joel T

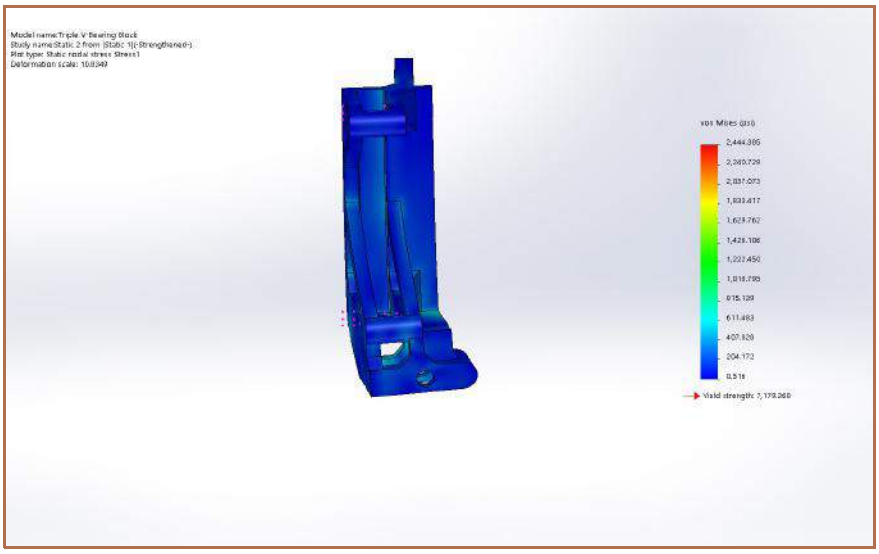
Towards the end of the meeting, they all decided to weigh the robot to see where they were with weight currently. They weighed the robot with all of the components it currently had, and they placed the clamp onto it to try and get a more accurate reading. It came out to 24 pounds, and because they didn't have the belly pan with the motors for the lift, or the battery and phone, and a couple of other things, they're estimating Vera will come in around thirty pounds or a little bit above that, which they're satisfied with. Last year they came very close to the weight limit, and their goal this year was to steer clear of it, and it seems they'll be able to do that.

Finite Element Analysis of Lift Triple V Block - Joel T

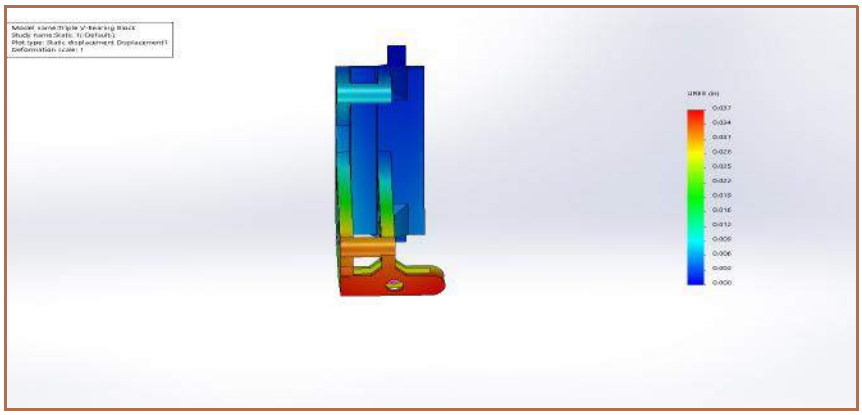
Joel ran an FEA (Finite Element Analysis) using SolidWorks on the Triple V Block from the lift and concluded that as designed, the part would likely not hold up to the stresses that it would be subjected to by the lift string. A reinforced, alternative design was provided which SolidWorks showed would increase the Factor of Safety from 1.7 to 3.



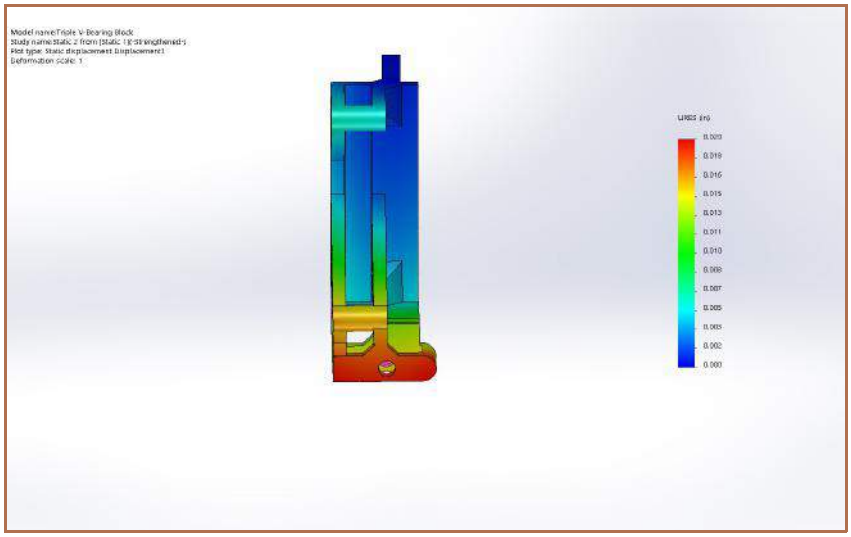
Triple V-Bearing Block
Original Stress



Triple V-Bearing Block
Redesign Stress



Triple V-Bearing Block
Original Displacement



Triple V-Bearing Block
Redesin Displacement

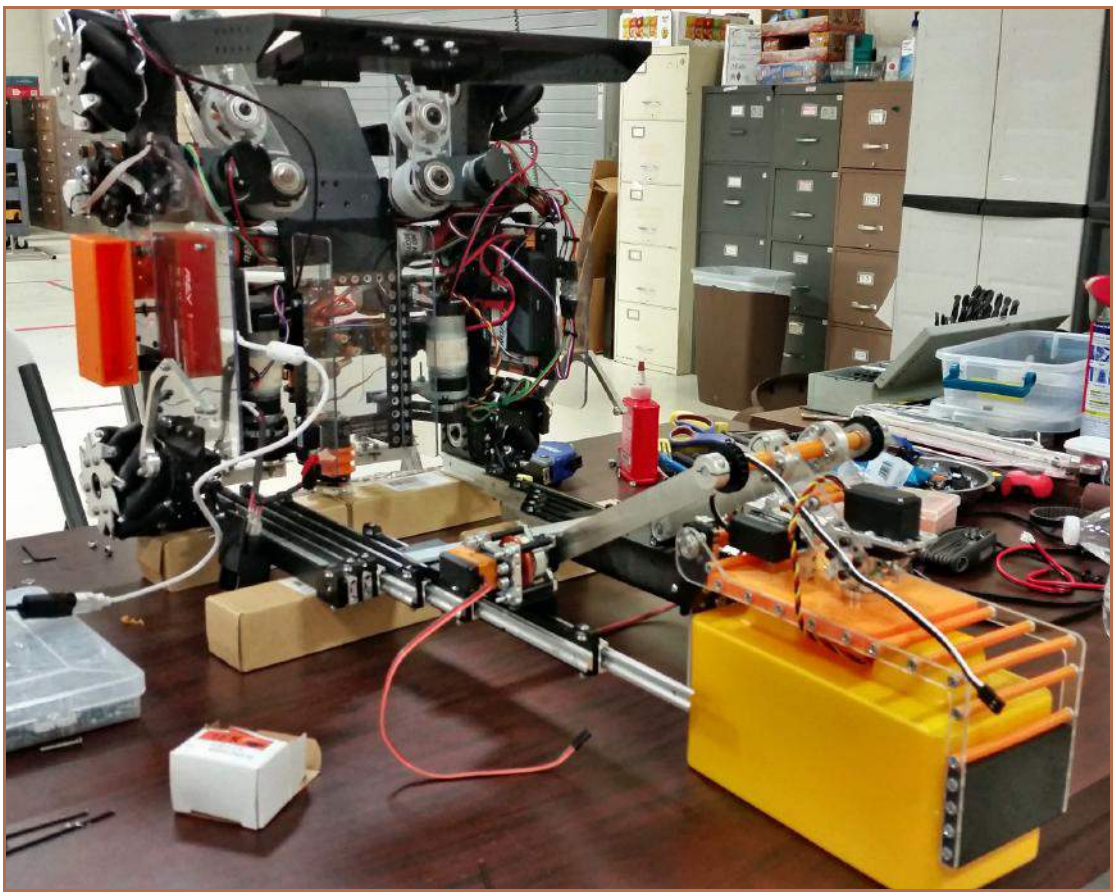
Date	Location	Start Time	End Time	Week #
December 1, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	13
Meeting Goals: Work on Various Hardware, Rigging the Lift				
Team Members in Attendance:				
Ian, Megan				

Lift - Ian and Megan

Megan and Ian worked on rigging the lift today. The rigging consists of two very long UHMWPE Kite strings that anchor on both sides of the lift. These are wound onto a single spool, and the strings run through the center of rotation of the spool. The up string went on rather smoothly and quickly, threading through all of the V-bearings easily. When it came to the downstring, they had to readjust which mounting hole they used to tie off the string, so they could insert a pair of tensioning springs. After rigging, they realized that they didn't provide adequate string on the spool for the lift to completely travel up and down, which prevented the lift from retracting. They are going to restring it tomorrow to resolve this issue.

Hardware - Ian and Megan

Ian and Megan met with the intentions of finishing the hardware subsystems, so that Ian could spend the rest of the week working on autonomous. Unfortunately, they were unable to complete everything, though they were close. Towards the end of the meeting, all they had left to do was put on the skirt to protect the odometry wheels, mount the alliance marker holders, and finish stringing the lift.



Date	Location	Start Time	End Time	Week #
December 2, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	14
Meeting Goals: Work on Lift and the Deposit hardware and software				
Team Members in Attendance:				
Ian, Megan				

Lift - Megan and Ian

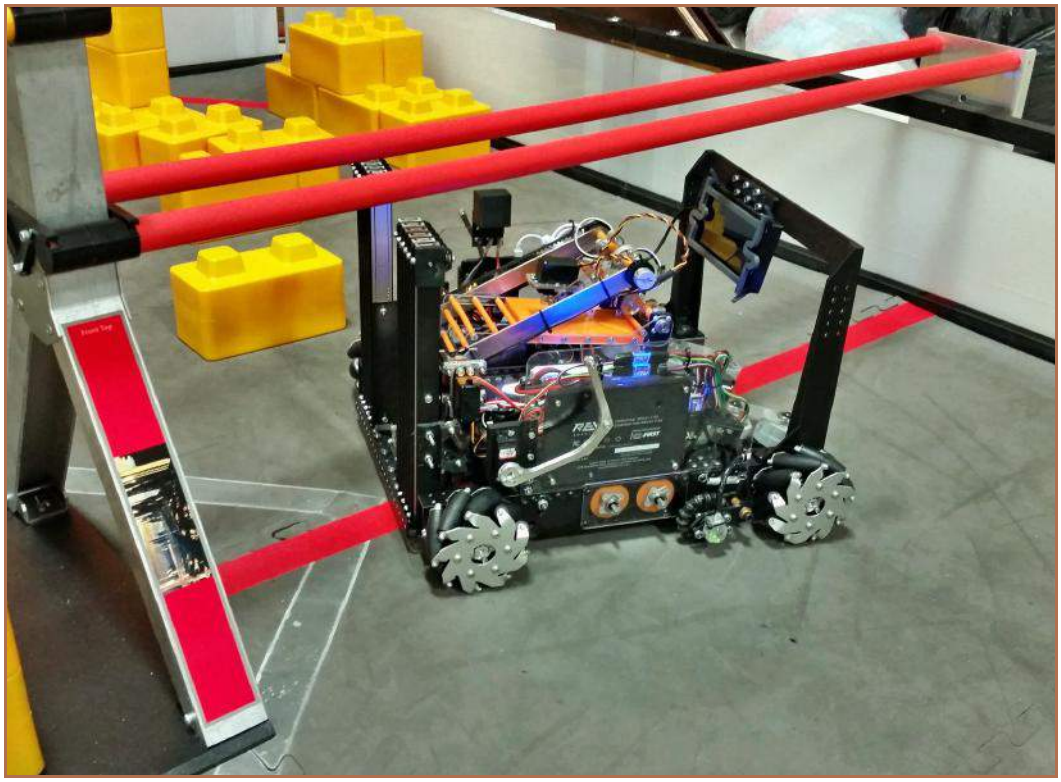
Megan and Ian took off all of the string they'd put on the lift at the last meeting so the lift would be able to retract again, and then they began restringing it. Everything was going really well until one of the 3D printed parts that houses three V-bearings snapped. This part served to shift the string closer to the lift and was an essential component to its operation. This potential failure had been predicted a few days prior when doing a stress analysis on that very part in SolidWorks. Unfortunately, the part had already been mounted to the lift (and the current design of the lift prevents easy replacement and would require a full disassembly to access). While this is a minor problem, they just didn't have enough time to come up with a solution when they still needed to work on the autonomous program for their upcoming qualifier. With this development, they decided to continue forward with other subsystems (in the hope of being able to field a robot at their qualifier on the 7th), which could technically work without the lift functioning (thus, the lift would be entirely disabled for this first competition).

Testing of Hardware Subsystems - Megan and Ian

Once Ian and Megan had finished all of the hardware changes they could make that day, Ian started working on software so they could begin testing their subsystems and then he could work on autonomous. They knew the intake and hopper worked the way they wanted to, and they couldn't test the lift because it wasn't strung yet, so they started with the foundation catch. It works really well for moving forward and backwards, however, it's unable to move sideways because the servo mount is very flexible and the foundation slips out from underneath the catch fingers rather easily. This version of the catch was a temporary solution for the Arkansas qualifier, so it will need some modification in its next iteration.

Arm and Clamp - Megan and Ian

After making the decision to not fix the lift, Ian and Megan worked on the deposit. Because of the deposit system they were using (the linkage and clamp), this would allow for them to stack one or two stones, so during matches, they could stack one or two all around the foundation to try and get as many points as stacking a tall tower. The hardware for it was mostly complete, so they began software testing on the servos. They quickly discovered that the deposit didn't have consistent clearance between the lift stages. They had initially thought that the clearance would be adequate with six lift stages, but that was not the case. Furthermore, they realized that the front right drive train wheel wasn't turning in one direction. They spent a while debugging this issue and traced it to the expansion hub motor port. The hub was defective, possibly due to an electrostatic discharge event (ESD). With all of these issues in mind, and in consideration of the travel cost and time commitments a recommendation was made to the team to withdraw from the December 7th qualifier so that these issues could be properly addressed. The entire team unanimously voted, even though disappointed, to withdraw.



Date	Location	Start Time	End Time	Week #
December 6, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	14

Meeting Goals: Team Discussion About Issues and Solutions, Design Review, Triboelectric Scale Materials

Team Members in Attendance:

Ian, Megan, Jalynn, Becca, Nathan, Joel, John

Team Discussion About Issues and Solutions - Everyone

While the robot's subsystems showed a lot of promise, some of them needed to be revised due to failure. That, and also everything that needs to be done before the qualifier in January was discussed.

First, they considered the lift. While not the most desirable option, they decided to remove a stage and go with five instead of six. This would allow them to stack approximately ten stones instead of twelve, but it would give them the room needed to fix the clearance problems with the clamp. As for the part that broke on the lift, a reinforced a reinforced version had already been created in CAD. It was also decided to drill through the first stage of the slide so that they would be able to access the part and easily take it off or put it back on in case they ever needed to change it out again.

As for the clamp, not much will change to the current design, but Ian is going to revise it in CAD to help address the clearance issue. The initial belt tensioning method (zip ties on an open loop belt) was suboptimal, so they are looking into using a continuous loop belt and a tensioner.

The next item discussed was the REV Hub. A major concern for the reasoning behind the dead port was static discharge. The team had major static issues last year, and it was starting to look like they were back again this year, only slightly worse, which was concerning. There are a few things they can do to combat this, but they'll need to be careful, especially with wiring, which requires more thought than has currently been given.

One idea that was proposed was building a second drive train out of the spare parts to make a testing robot. The team has done this in the past. The robot is usually named Binky and is mainly used for software testing, however, they decided they wanted to build her for both

Team Discussion About Issues and Solutions - Everyone (continued)

software and hardware reasons. This would give the newer and younger team members a chance to work on the drive train and learn from the experience, and also, the team would be able to test different mechanisms without taking the competition robot out-of-service. For instance, while the five stage lift may work for their qualifiers and state competitions, it may not be competitive after that. So, what they're planning on doing is focusing on Vera as a main priority, but when they have spare time, they can design and build different ideas and test them. If they decide one of those is better or more reliable, they'll switch out the one on Vera for the one on Binky and integrate it. All in all, this will be a great way to test different solutions and it will be a great learning experience for all of team members.

Design Review - Everyone

At the beginning of the meeting, the team had a design review of the robot. In their haste to prepare for their early qualifier, they'd missed some of the important design reviews they'd set out at the beginning of the season, so they were catching up now. Ian and Megan went through every subsystem with the team and explained what each does, how it works, or why it didn't work, and what the problems are.

Currently the subsystems are: the drive train, the collector (which intakes the stones), the arm and clamp (this deposits the stones), the foundation catch (the fingers latch onto the foundation and moves it in autonomous and endgame), and the lift (Which raises the arm and clamp).

Triboelectric Scale Materials - Joel T

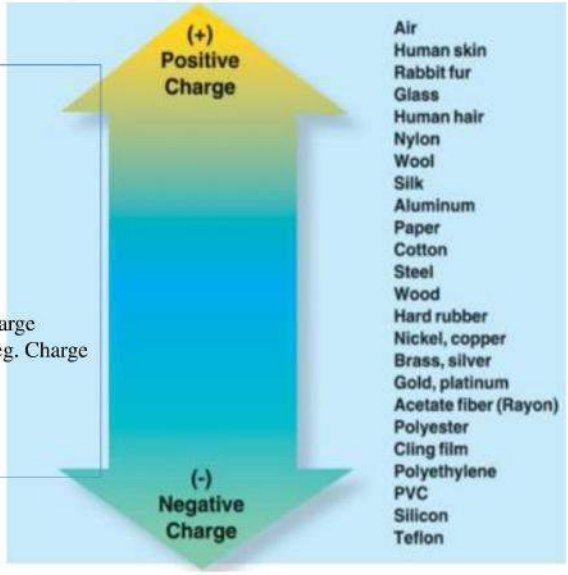
Joel T found a small list of Triboelectric Series of materials. When plastic slides on plastic, picking materials close to each other on these lists reduces static charge levels. Found in plastic film industry that using polyurathane rollers instead of silicon rollers helps. Apparently, this list was compiled by someone in the plastic film industry, where they found that static electricity is reduced when polycarbinate rollers are substituted for rollers made of silicon.

Triboelectric Scale/Charging – is a type of contact electrification on which certain materials Become electrically charged after they come into contact with other materials

Cause?
The contact causes an exchange of electrons between various type of materials will cause an electrostatic attraction between the molecules that holds them together.

A deficit of electron = Pos. Charge
An attraction of electrons = Neg. Charge

The two materials only have to come into contact for the electrons to be exchanged.

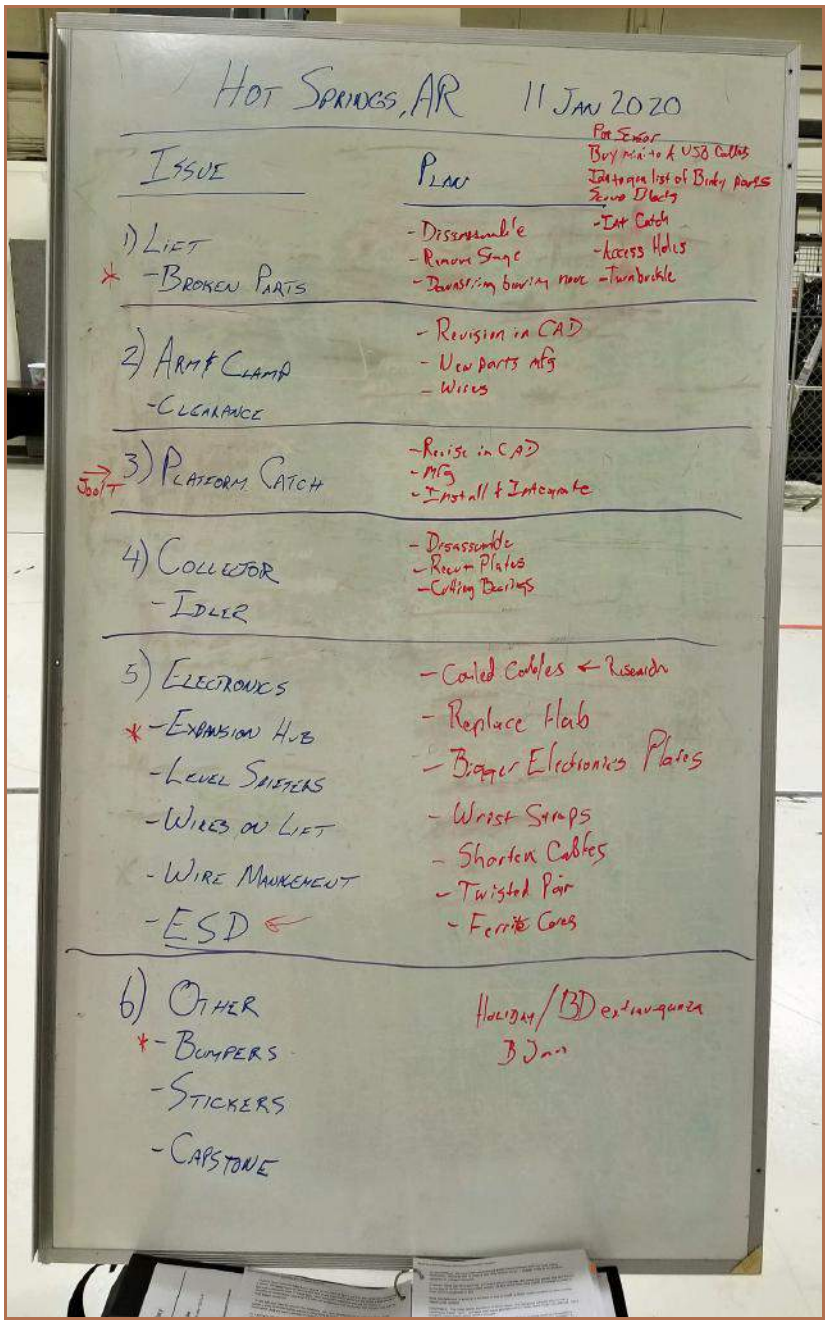


The Triboelectric Series

Common FTC Materials

+ Positive Ve +
Nylon
PLA
Polycarbonate
PETG
EVA Foam - Floor
Delrin
Latex
Acrylic
Neoprene
HDPE - Blocks
Silicone Tubing, cast silicone
PVC
– Negative Ve –

Select materials that are close together on this list to reduce static charge build up when parts are sliding or rubbing against each other.



To-do list was revised to list all the items to be fixed

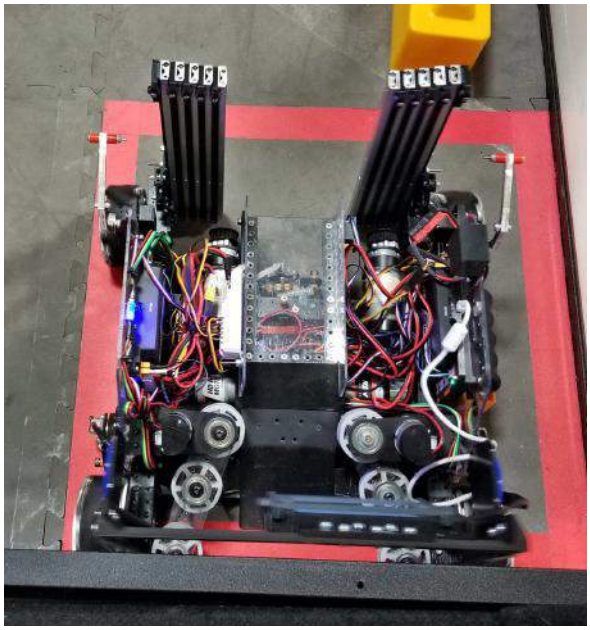
Date	Location	Start Time	End Time	Week #
December 7, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	14
Meeting Goals: Work on Lift				
Team Members in Attendance:				
Ian, Megan, Jalynn, Nathan, Joel, John				

Lift - Megan and Ian
Megan began taking the lift off of the robot. She had some difficulties doing so because of the belly pan that was now mounted on the bottom, so she took that off to make things easier and go faster. Once she took the lift off, she removed a stage from each side to bring them down to five slides. Then, she realized she didn't have to take the entire lift apart to remove the broken part. All she had to do was extend the lift so she had access to two of the three screws in the drawer slide of the first stage. Once she took those out, she was able to twist the lift enough that she had access to the screws mounting the broken part. After disassembly, Ian and Megan removed the broken printed parts and replaced them with strengthened ones (using stress analysis data). They drilled new access holes in the first stage slides to make access easier, and then mounted the new, reinforced part. Once all of that was done, they put the lift back on the robot.

Date	Location	Start Time	End Time	Week #
December 13, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	15
Meeting Goals: Work on Lift, Team Vote on Capstone Design				
Team Members in Attendance:				
Ian, Megan, Jalynn, Becca, Nathan, Joel, John				

Lift - Ian and Megan

Megan and Ian remounted the lift stacks to the drive train today, though they haven't mounted the belly pan yet, because they're going to redesign the spacers that support the motor mounts for the lift so that they're more rigidly mounted, and keeping the belly pan off will provide easier access. We also tested the drive train and intake after replacing the bad expansion hub, and it functioned as expected. Additionally, the team briefly discussed the revisions to the deposit, which were being worked on in CAD. These revisions include the use of 6mm wide closed loop belts with slot tensioners, rather than an open loop belt. This should increase reliability of the system, and will reduce the number of points for the deposit to get caught on during rotation.



Capstone - Everyone

Today, the team voted on the capstone. From kickoff, they knew they wanted to do something sized similarly to a stone so that the intake would pick it up and that the arm and clamp could place it. They also wanted transparent sides to show off a Serenity model inside. There were a couple of options to choose from: the first Serenity was 3D printed, which everyone liked, but it also didn't stand out super well. The second was a stuffed Serenity, and while everyone really liked this option, it was slightly too big for the capstone and had to be squished to fit. The third option was a silver metallic Christmas ornament, which everyone was immediately drawn to. They could see all of the details of Serenity, and it contrasted well with the orange 3D printed materials that supported the Lexan plates. This was the clear winner. Now all that's left to do is secure it in the capstone, and then it will be ready to go.

Date	Location	Start Time	End Time	Week #
December 14, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	15
Meeting Goals: Remove Hopper from Intake, Modifying Drive Train				
Team Members in Attendance:				
Ian, Megan				

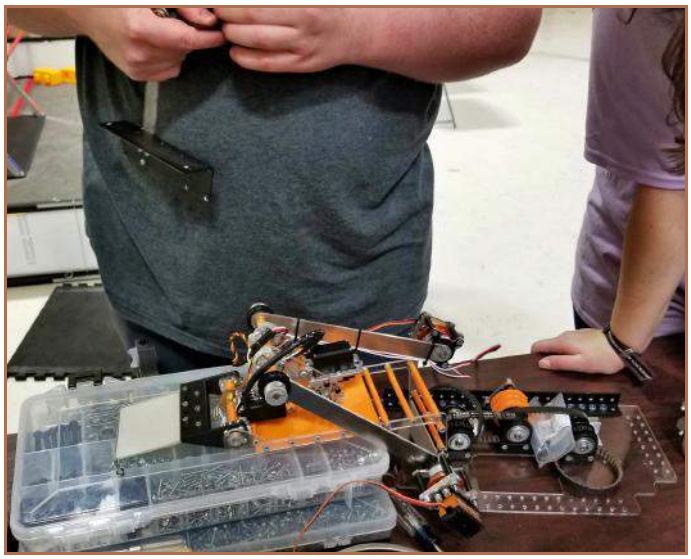
Intake - Megan
On December 14th, the team met after the FLL qualifier they volunteered at to grab a couple of things they needed from AvaLAN, and to get a little bit done if they could. In the next couple of meetings, they want to manage the wiring better than it currently is now, so Megan took the hopper off of the robot, so they would easily be able to access the wires and bundle them.

Drive Train - Ian

Furthermore, they began working on modifying one of REV Robotics' 60mm omni wheels for the odometry system, because they had discovered some inaccuracies with their old, custom omnis (which they believe were caused by the sharp points of those rollers, which caused the wheels to sink in the mat more, thus allowing the effective diameter of the wheel to vary drastically over the course of a revolution). These modifications required a printed template that was designed to fit over the existing geometry of the omni wheel. This template was bolted on via the existing bolt pattern, and a new, larger pattern was drilled using the template. After this step, the center of the wheel will need to be drilled out to accept a printed hub, which will allow them to use these omni wheels with 3/8" hex shafts (which will allow the team to simply drop them into their existing odometry pods with no modifications required), instead of the stock 5mm hex bore.

Arm and Clamp- Ian

The team was unable to meet for an extended period of time today, so they began work on smaller components, including the disassembly of the arm to prepare for revisions.



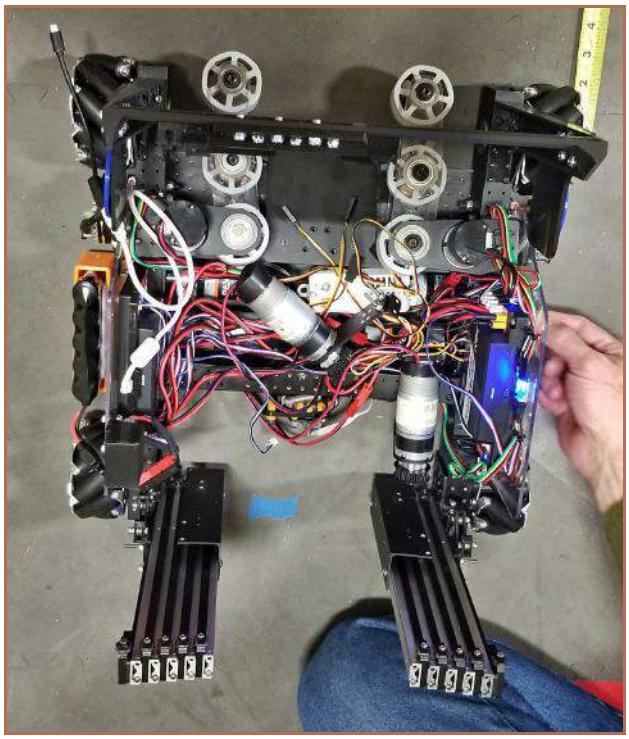
Date	Location	Start Time	End Time	Week #
December 15, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	15
Meeting Goals: Work on Lift, Removal of Temporary Foundation Catch, Drive Train Modifications Completed				
Team Members in Attendance:				
Ian, Megan, Nathan, Joel				

Lift - Megan

On December 15th, Megan took the two motors that will power the lift off of the robot. They're going to be printing new spacers, so they took them off now, so they could fix the mounting holes that they'd messed up a bit while putting on the motors last time. She drilled through the holes on one of the motor plates so they'd easily be able to get the screws through, and then she re-tapped the mounting holes on the box tube to clean up the holes. Once the new part was printed for the first motor, she mounted the motor back on the robot. The difference between the new one and the old one is that the old one was two 3D printed standoffs for each motor, whereas the new part is one block that can be mounted with four screws, which helped to provide a lot more rigidity.

Foundation Catch- Megan
Megan also took off the foundation catch they'd temporarily made for their first qualifier. The second version was currently being designed, so she wanted to make sure there was room on the robot for when they got the part made.

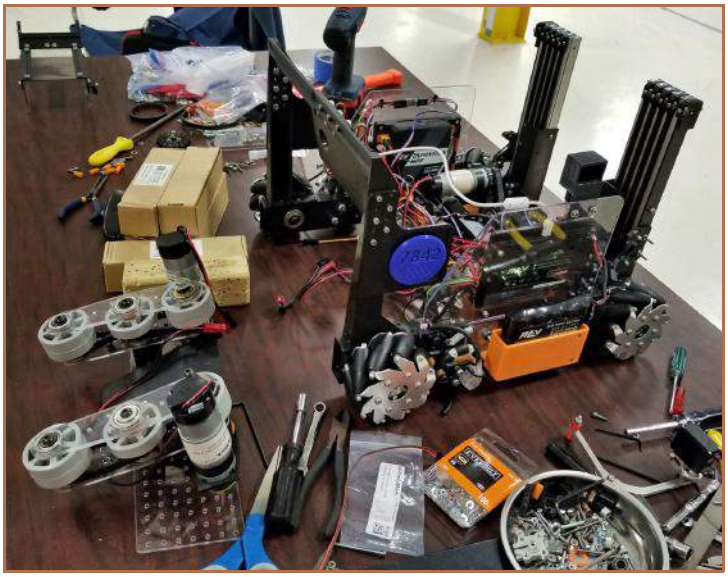
Drive Train - Ian
The team completed the modification of one of the REV omnis today and mounted it into one of the odometry pods. The hub for the wheel required multiple revisions to strengthen the part, and they ended up having to bore the wheel out for a larger diameter than initially expected. After completing this, they tested the accuracy on the field and compared it to the old omni (which was still mounted in the other odometry pod) and observed a significant increase in accuracy. After seeing this increase, they began work on modifying a second wheel, which they were unable to complete by the end of the meeting.



Date	Location	Start Time	End Time	Week #
December 18, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	16
Meeting Goals: Remounted Lift Belly Pan				
Team Members in Attendance:				
Ian, Megan, Joel				

Lift - Ian and Megan

Ian and Megan remounted the lift belly pan today and added the new cross bar for the lift stages (which is similar to the old one and still serves to hold the two sides together. It was just simply widened to accommodate the removal of one stage from each side). Additionally, they removed the intake from the robot to prepare for the minor tensioner revisions. They're recutting the lower intake plates to adjust the spacing of the tensioners (which should translate to approximately equal tension to the current one) to accommodate the idler pulleys. These idler pulleys are simple belt idlers with bearings in them, and they're grinding the flanges off with a disk sander. Bearings will handle the high speeds better and will wear less, which was a very big problem with the bushing tensioners.




SHOP

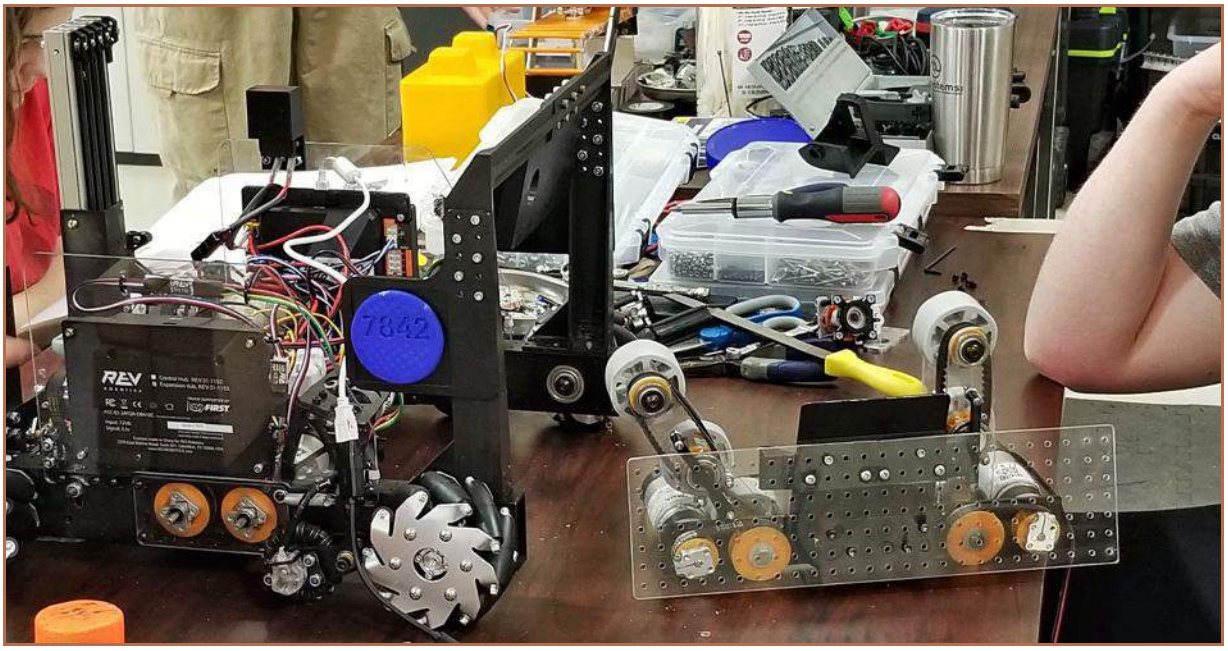
BROWNCOATS
Team 7842 Engineering Notebook

Date	Location	Start Time	End Time	Week #
December 20, 2019	AvaLAN Wireless	1:00 p.m.	6:40 p.m.	16
Meeting Goals: Work on Lift, Work on Intake, Testing Intake				
Team Members in Attendance:				
Ian, Megan, Jalynn, Joel, John				

Lift- Ian and Megan

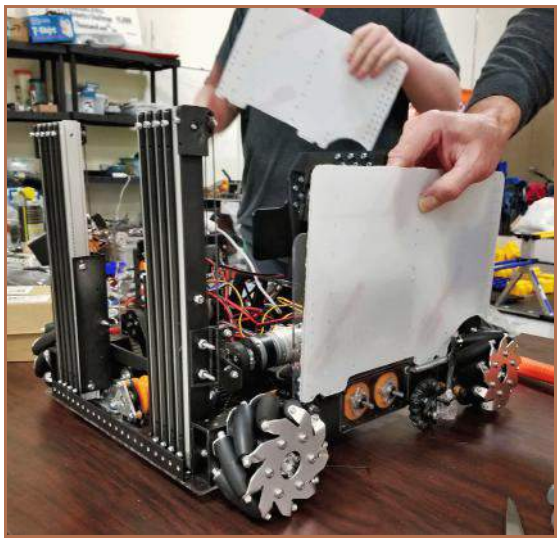
On Friday, December 20th, Megan and Ian worked on the lift rigging. Now that everything was mounted, they were able to begin work with the string. First, they pulled the up string through every V-bearing, and then they strung it through the spool, and then they strung the other side. They kept having trouble with slack in the string and finding the correct balance between tension and too much tension. When they tried to work on the down string, everything kept getting tangled because they hadn't anchored off both ends of the up string, so they took off all the down string and completed the up rigging. They ran out of time to do the rest, but they're going to finish it at the next meeting.

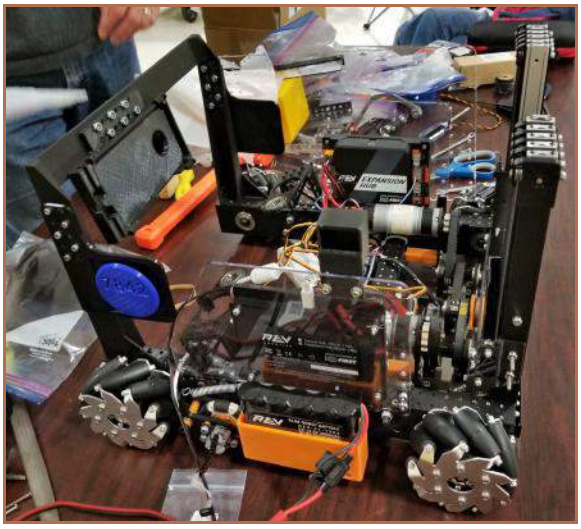
Intake - Ian
Today was spent primarily replacing the intake tensioners with bearings. The new plates were cut between meetings, and they had to partially disassemble the individual intake "arms" to replace them. After installation, the intake ran immediately much smoother (the bearings introduced far less friction into the system), which is simultaneously a good thing in that the system efficiency is higher, and a bad thing in that the arms will have less inward pressure on the block now. They are somewhat concerned about this, and they're going to investigate it further once the intake is remounted to the robot.



Date	Location	Start Time	End Time	Week #
December 21, 2019	AvaLAN Wireless	11:00 a.m.	6:00 p.m.	16
Meeting Goals: Replaced Electronics Panels, Tested Lift, Tested Intake, Mounted Foundation Catch				
Team Members in Attendance:				
Ian				

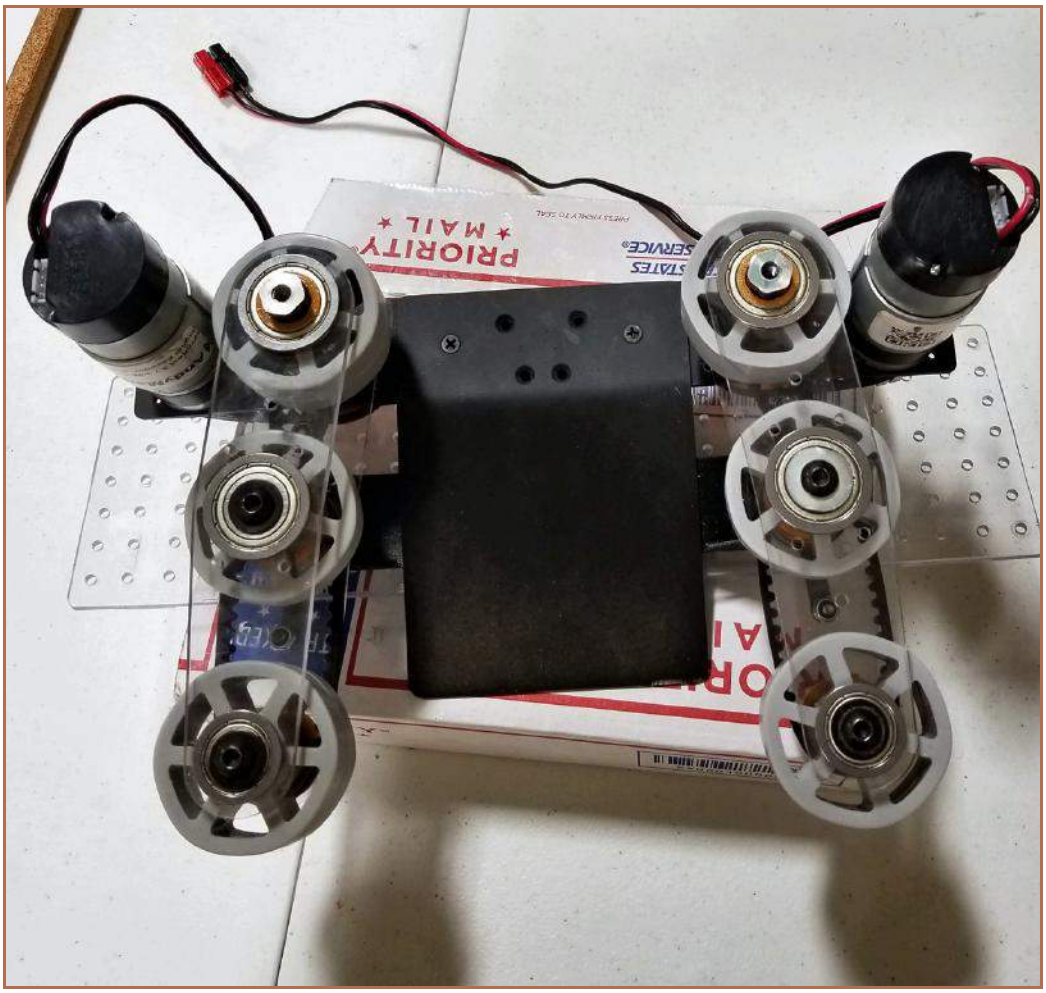
Drive Train- Ian
Ian made a lot of progress on many subsystems today. He began by replacing the electronics panels with new, larger ones that had been designed and cut between meetings. These panels provide more mounting options for the electronics, and they are reinforced by mounting to the printed phone bracket.





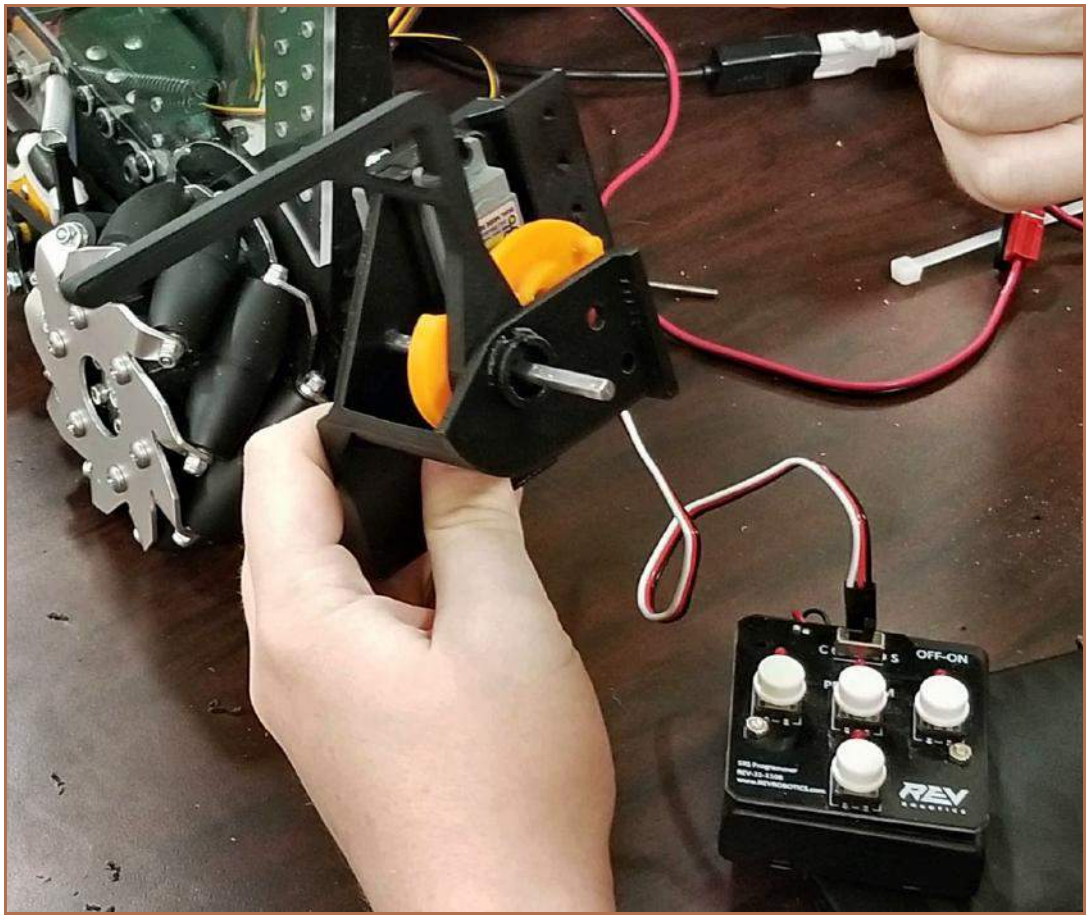
Lift- Ian
Ian also strung the lift today and he ran it with the motors. It does move, though it requires a lot of current and potentially more torque than the system can provide once the lift is fully loaded. He's going to investigate ways to make minor reduction changes without major modifications to the system, primarily by "trading" teeth on one pulley to another to change the ratio from 1:1 to any torque reduction that is reasonably feasible.

Intake- Ian
Ian also remounted the intake today and verified its functionality. He believes that the concern over inward pressure due to the reduced friction is relatively minimal after testing, because it still appeared to handle stones very well.



Foundation Catch- Ian

Furthermore, Ian mounted the revised geneva drive-based foundation catch. This system uses a geneva drive with two pegs, as opposed to the original idea with just one. This allows them to recess the "fingers" fully into the robot. He began testing it with the servos and discovered that the geneva system had too much backlash in it in the locked position, so he's going to reprint that part with a slightly larger diameter on that component, which should reduce that.

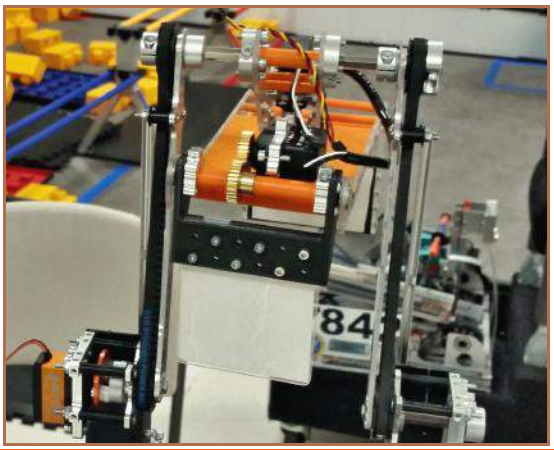


BROWNCOATS
Team 7842 Engineering Notebook

Date	Location	Start Time	End Time	Week #
December 22, 2019	AvaLAN Wireless	11:00 a.m.	6:00 p.m.	16
Meeting Goals: Arm and Clamp Assembled, Mounted, and Tested; Lift Repairs				
Team Members in Attendance:				
Ian, Megan				

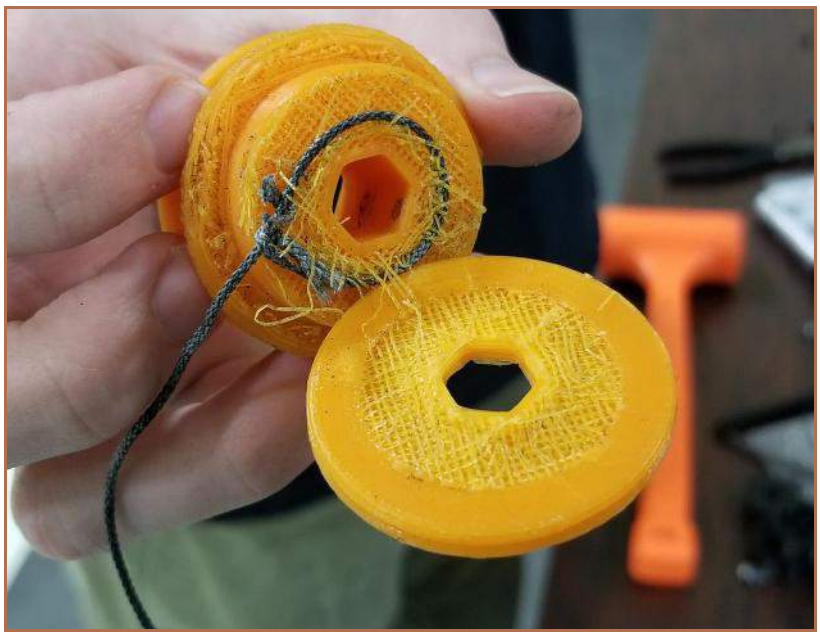
Arm and Clamp- Ian and Megan

On December 22nd, Ian and Megan worked on the assembly of the second iteration of the arm for the arm and clamp. Most of it went together relatively smoothly, until it was time to mount the arms to the clamp. The two spacers they'd printed were sized too small, and when they tried to file them out, the spacers broke, so they had to improvise and use some hubs instead. Unfortunately, they were supposed to use these somewhere else, so they had to change one out for a different hub as a temporary solution until they could reprint the spacers. Once they'd mounted the clamp onto the robot, everything seemed to be working well until they tried testing moving it through the lift. They found there wasn't enough clearance between the tensioners for the belts and the first stage of the lift. At first they contemplated cutting off a tiny part of the lift, but they realized when the lift was completely retracted, it would collide with the drawer slide anyway, so they abandoned that idea, and instead changed out the current tensioners with pulleys they'd used on their extension arm last year. There was just barely clearance when they tried it out, but it worked. They're unsure how they'll be able to fix this for a future solution. If they raise the flaps in which the tensioners are mounted to, it'll start pinching the belt at the edge of the pulley it's on, which won't be good. They're going to investigate more solutions and use this one for now.



Lift- Ian and Megan

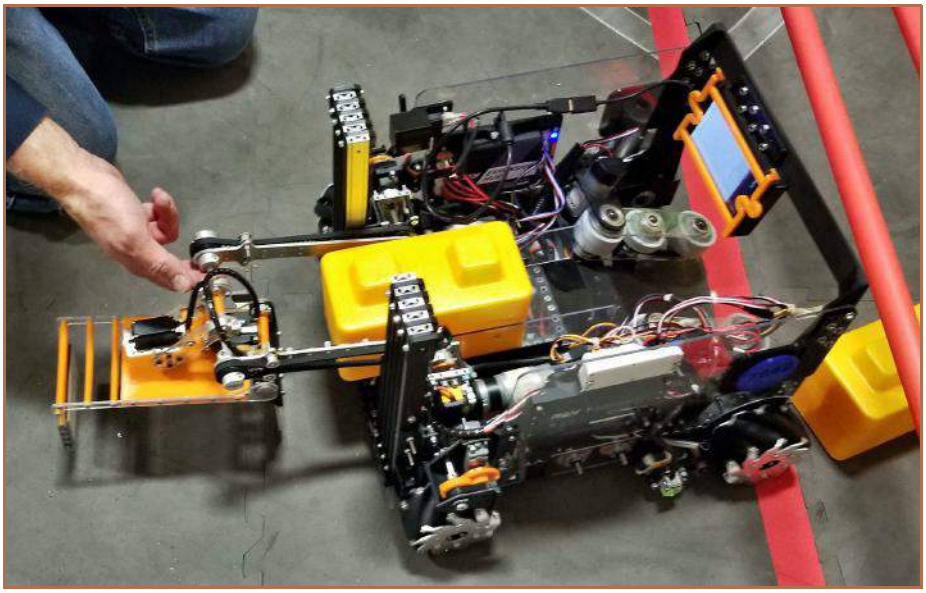
After the clamp had been mounted, Ian and Megan noticed that the string on the down rigging was suddenly very slack again, so they re-tensioned it by making it pull tighter on the springs, but this only made the tension incredibly tight when it was towards the top, and really loose at the bottom, which was weird, as it had been working fine the day before. After examining it more closely, they soon realized why it was doing this. The string had broken the spool. It had been digging into it so much that it had completely sheared through it. So, they began discussing different ways to fix it. Reprinting another 3D part wasn't going to work, they decided, as it would just do it again. Machining it was possible, or creating two metal tubes essentially, and sandwiching them between three 3D printed plates so that the string was riding on metal, but the entire thing didn't have to be machined. They still needed to think about it some more, but they had lots of ideas to discuss.

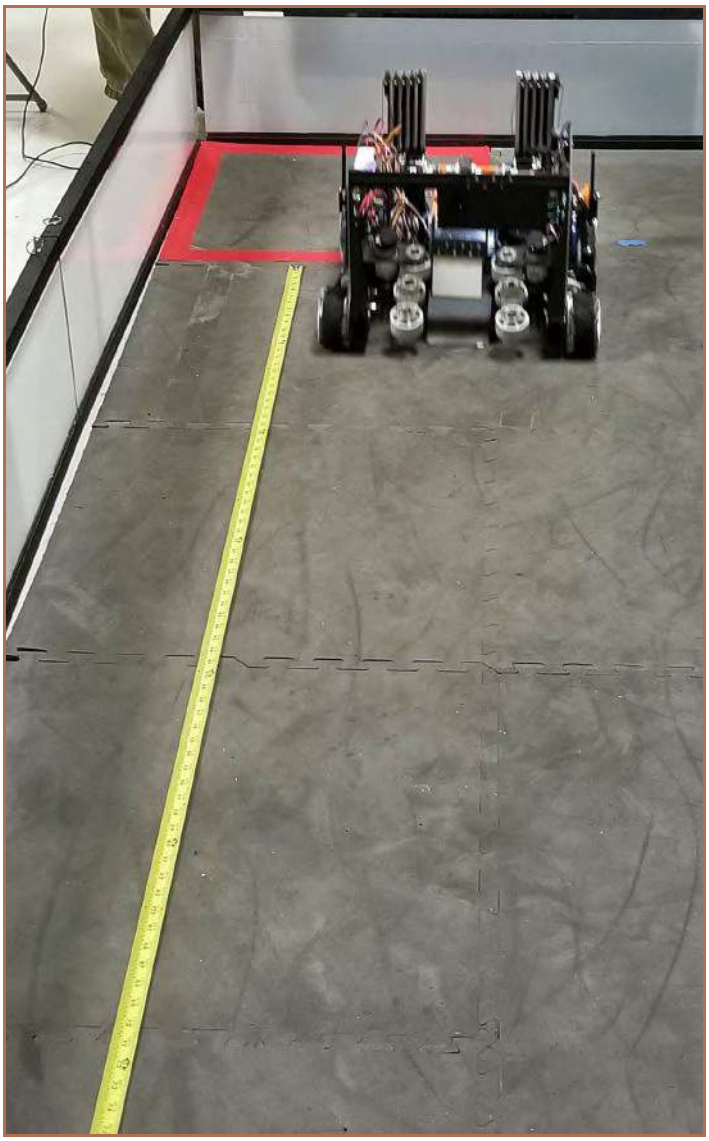


Date	Location	Start Time	End Time	Week #
December 26, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	17
Meeting Goals: Software				
Team Members in Attendance:				
Ian, Megan				

Software- Ian

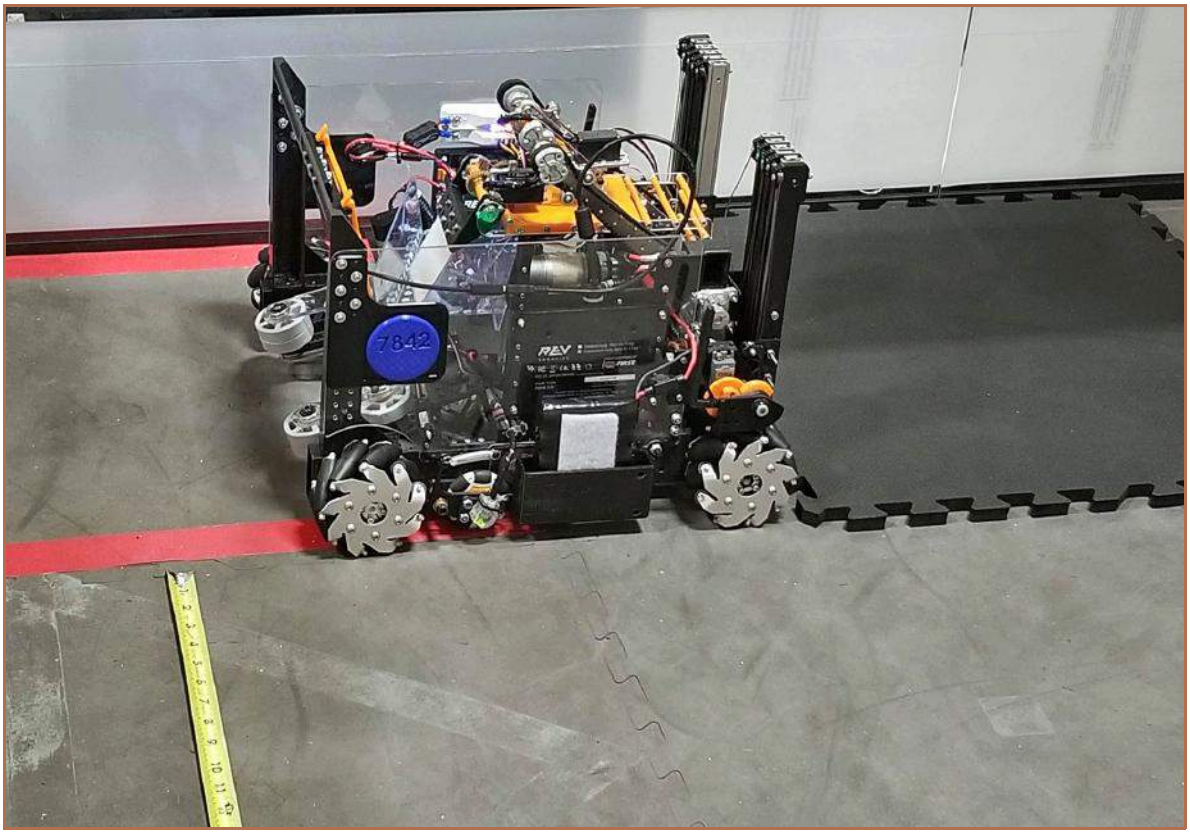
Today Ian primarily worked on software (as well as buttoning up wiring) due to the broken lift spool. He began by verifying the odometry system's accuracy after the omni swap. While the individual omnis were reading very accurately, the estimated position (which is calculated with standard systems of equations, which are defined with known position and behavioral data of the odometry system) was inaccurate. He spent most of the day attempting to diagnose this issue, and narrowed it down to something relating to those linear systems, though he's not sure exactly what would be causing it.





Date	Location	Start Time	End Time	Week #
December 27, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	17
Meeting Goals: Software				
Team Members in Attendance:				
Ian, Megan, Joel				

Software- Ian
Ian spent the day continuing the debugging from yesterday. After stepping back for a while and then reanalyzing the software, he discovered a couple minor issues with the wheel placements and signs (which are necessary to model the position). However, after correcting these issues, he still saw significant (though lessened) error in the position calculation. He found better results using only two wheels and an IMU for heading, rather than using three wheels. This has a few disadvantages (primarily that the IMU refreshes far slower than the quadrature-based encoders do) over a three wheel system, but he decided to make that sacrifice for the moment in the interest of getting navigation working.


7842
REV

BROWNCOATS
Team 7842 Engineering Notebook

Date	Location	Start Time	End Time	Week #
December 28, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	17

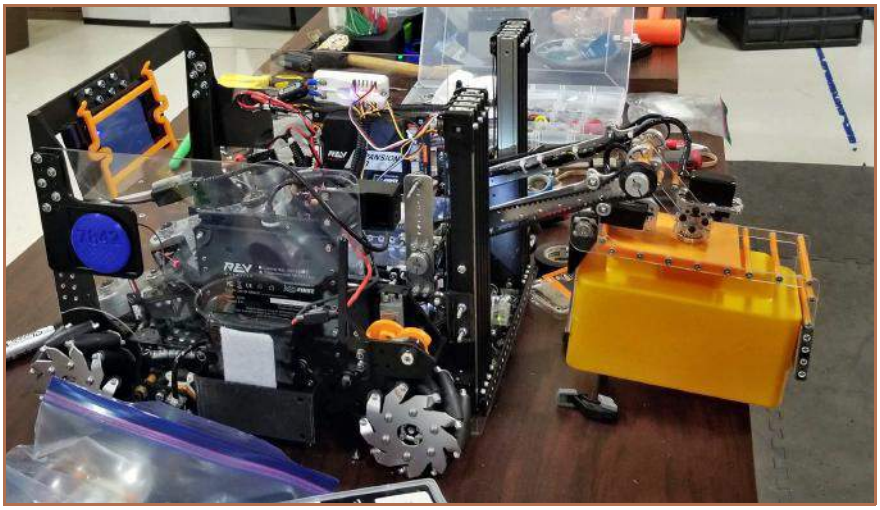
Meeting Goals: Deposit Modifications, Testing of Foundation Catch, Spool Revision Discussion

Team Members in Attendance:

Ian, Megan, Jalynn

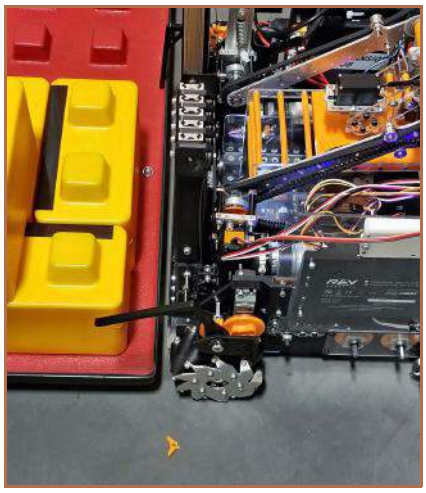
Arm and Clamp- Ian and Megan

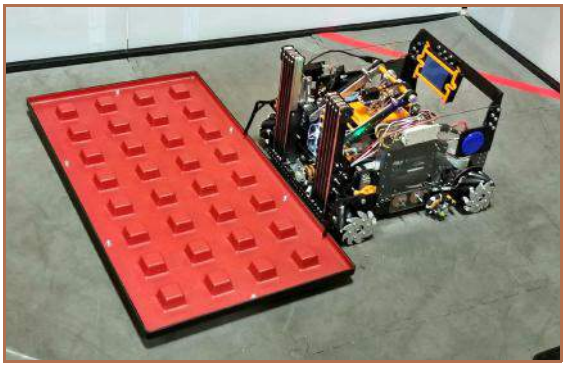
Today was primarily spent doing hardware modifications and revisions. They found a while ago that the deposit wasn't able to rotate under its own power with just one servo (they had removed the other due to synchronization issues as well as weight concerns), so they experimented with ways to springload it, and decided upon using a very strong spring connected to a hub on one of the rotation shafts. This is less than optimal because it provides only a very short moment arm for the spring, which requires a very strong spring to counteract. However, they were able to make this work, and the deposit is now capable of moving quickly. Furthermore, springloading the deposit should dampen the system when it reaches a setpoint, which will extend the life of the servo.



Foundation Catch- Ian

Additionally, Ian tested geneva-based foundation catch today, and it promptly broke. He found that the "fingers" on the catch swing out (following a circle) rather than down, which causes the fingers to collide with blocks if there are any. This is less than ideal in the best of circumstances, where a tower may simply be knocked over. However, in this case, the system was jammed due to the stones, which caused the geneva mechanism to fail catastrophically. The team is going to investigate some linkage based alternatives instead, because they will provide similar resistance to back-driving as well as a more linear travel.





Lift- Ian

Finally, the team discussed spool revisions today, which involve using metal drums with milled 3/8" hex bores and plastic flanges that are secured with screws that tap into the aluminum.

BROWNCOATS
Team 7842 Engineering Notebook

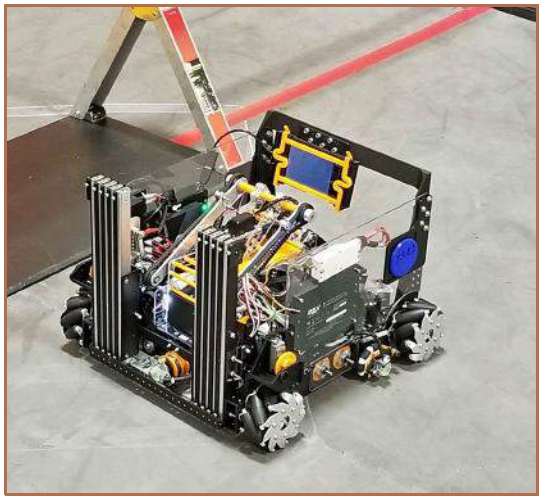
Date	Location	Start Time	End Time	Week #
December 29, 2019	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	17
Meeting Goals: New Spool Parts, Deposit Upgraded, Software				
Team Members in Attendance:				
Ian, Megan, Joel				
December was a rough month for the Browncoats. Unfortunately, due to their respective school commitments, Becca, Brooklynn, and Joel T have had to resign from their positions on the team. We wish them all the best in their future endeavors and hope that they will consider rejoining the team in the future, if they are able.				

Lift- Ian
Between meetings, Ian modeled and cut spool parts based on the revisions the team discussed. However, he found that the printed parts were simply too small to print well, and the metal parts were prone to breaking tooling during manufacturing. As such, he designed a new, entirely plastic spool. This spool has small chamfers on the internal corners to slightly reduce shear forces, and it has 4 metal wood screws (2 in each direction, parallel to the axis of rotation) running through it to reinforce it.

Arm and Clamp- Ian
Ian also upgraded the deposit springloading mechanism today. Initially they had used a zip tie to connect the spring to the hub (which was always intended to be temporary), which they replaced with a metal s-hook.

Ian spring-loaded the deposit

Software- Ian
Additionally, Ian continued software work today. He noticed some issues with turning accuracy and controller sensitivity as he were tuning the feedback controllers, so Ian is going to take the robot home over New Year's and continue working on the controllers to diagnose those issues.



Date	Location	Start Time	End Time	Week #
January 3, 2020	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	18
Meeting Goals: Restring Lift, Install Springs, Mount Spool				
Team Members in Attendance:				
Ian, Megan, Jalynn, Joel, Nathan				

Lift - Megan, Ian

Today Megan and Ian restrung the lift with a new printed spool. This spool has metal wood screws running through it in alternating directions and was coated with super glue (and then cured) prior to use, which should minimize the string's ability to cut between layers. They also used new, lighter springs with more travel for the down string tensioner. This should reduce the stress in the system significantly. Once the lift was rigged, they discovered that it required far too much current to raise. The motors were able to do it, but they would be near stall current while doing so, even with the new spool (which was reduced in diameter). To resolve this, they're going to investigate a few possibilities. First, they're going to see if they can reduce the pulley diameter on the motors and increase the pulley diameters on the shafts. This would result in a reduction, increasing the torque (and therefore decreasing current). A second option that was proposed was to instead swap the motors to slower motors and reverse the pulleys (so that the large one is on the motor, and the small one is on the shaft). This would speed it up, while still being slower than before.

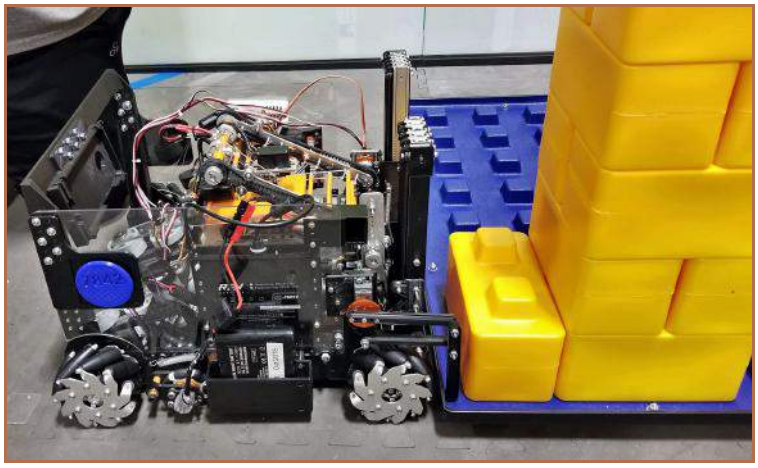
Date	Location	Start Time	End Time	Week #
January 4, 2020	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	18
Meeting Goals: Work on Autonomous, Install Foundation Catch				
Team Members in Attendance:				
Ian, Megan, Jalynn, Nathan, Joel				

Software - Ian

Today was spent primarily on software. They saw significant progress in regards to the autonomous paths, but they were experiencing major inconsistencies in the navigation system. They were unable to investigate this further before the meeting ended, however.

Foundation Catch - Ian, Megan

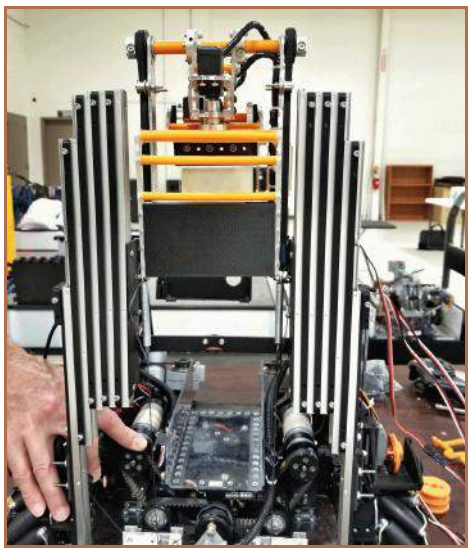
A new foundation catch mechanism was designed between meetings and was printed. This mechanism utilizes a four-bar linkage to grab the foundation. This results in a more linear motion of the catch, which eliminates the concern of contacting stones on the foundation. After mounting the first one to the robot (the second set of parts were being printed and were completed near the end of the meeting), they began autonomous work.



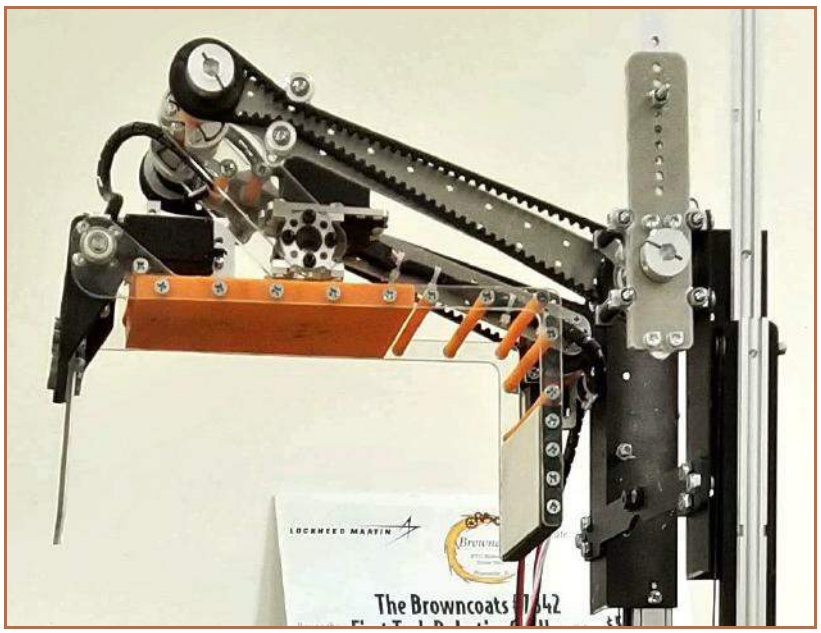
Date	Location	Start Time	End Time	Week #
January 5, 2020	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	18
Meeting Goals: Switch Out Motors				
Team Members in Attendance:				
Ian, Megan				

Lift - Megan, Ian

Between meetings, Megan and Ian investigated possibilities for revising the lift gearing to reduce the current draw. Simply adding a gear reduction on the first stage without a motor swap was not possible due to the size of the smaller pulley (which would need a hub to attach to the motor shaft). To circumvent this, they swapped the 3.7:1 motors to 19.2:1, and put the small pulleys on the shafts, and the large pulleys on the motors. This resulted in a final ratio of 12.8:1, which they felt was too slow. To speed it up, they slightly increased the pulley diameter from its original 1.25” diameter (which had since been decreased to 1.125” in an attempt to reduce current draw). When swapping the parts, they removed the lift belly pan from the robot. In doing so, they discovered a multitude of cracks forming in the polycarbonate. To delay those cracks from propagating (until they have time to recut it out of a different material and/or redesign it), they super glued them and the surrounding areas and left the part to cure overnight.



Arm & Clamp - Ian
They'd also found that one of their servos on the arm and clamp wasn't working. When they investigated, they learned it wasn't the servo itself that was malfunctioning, but the servo horn. The teeth on the horn had stripped. Luckily, they had a spare that they were able to put on, and they made sure to put Loctite on it so that hopefully won't happen again. They also decided to leave this to cure over night for the best result.



Date	Location	Start Time	End Time	Week #
January 6, 2020	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	19
Meeting Goals: Remount Belly Pan, Wire Management				
Team Members in Attendance:				
Ian, Megan				

Lift - Ian, Megan

Today Megan and Ian remounted the lift belly pan to the robot and rigged the lift again. After doing so, they discovered that the belts were skipping on the motors. This is likely because the path length of the system should have changed slightly (to be slightly larger) when they changed the pulley sizes, but they were unable to accommodate that due to the constraints of the current design. As such, they're going to print pulleys that are one tooth larger on the motors, which will take up the slack (as well as speed the lift up a tiny amount). They're also investigating ways to support the motors other than just the face, which should reduce the flex in the system (which is part of the cause of the belt skipping).

Wire Management - Ian, Megan

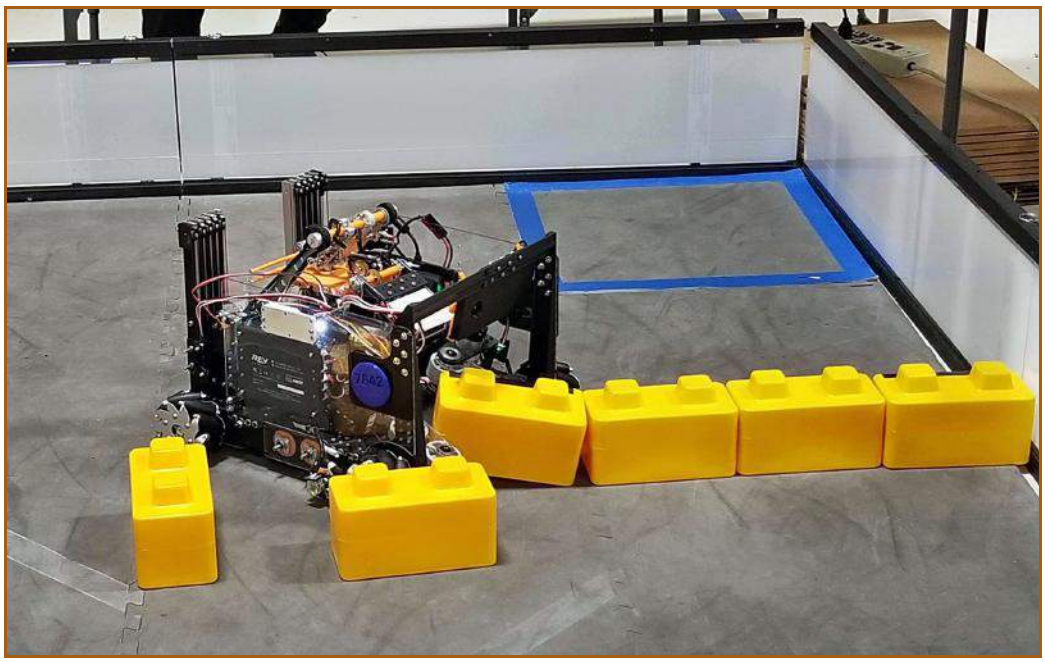
A solution to the wire management had been modeled in CAD and was printed today. It's multiple 3D printed parts with ribs in them that will zip tie the wire bundle to the parts, and then each section of the 3D printed parts will stack on each other until the lift is raised, then it will extend, and when the lift lowers, the parts will return to their stack, sort of like an accordion. The team has had issues with wires interfering with lift movement in the past, and they wanted to make sure they didn't have to worry about that in matches this year.

BROWNCOATS
Team 7842 Engineering Notebook

Date	Location	Start Time	End Time	Week #
January 7, 2020	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	19
Meeting Goals: Swap Pulleys, Continue Autonomous Work				
Team Members in Attendance:				
Ian, Megan				

Lift - Ian, Megan
Today Ian and Megan began by swapping the pulleys on the motors to slightly larger ones, which did reduce the skipping problem, though it was not entirely eliminated. They also designed and printed support pieces for the motors, but they were unable to use them due to time constraints. After these swaps, they continued work on autonomous.

Software - Ian
Soon after beginning, Ian realized the source of inconsistency. The drive motors were not using the encoders for velocity control, which was a simple oversight. The call for the method to bulk set the drive motor modes was commented out because of a prior issue that was debugged, and then it was never uncommented. After making this change, the controllers had to be retuned, which was nearly done by the end of the day.

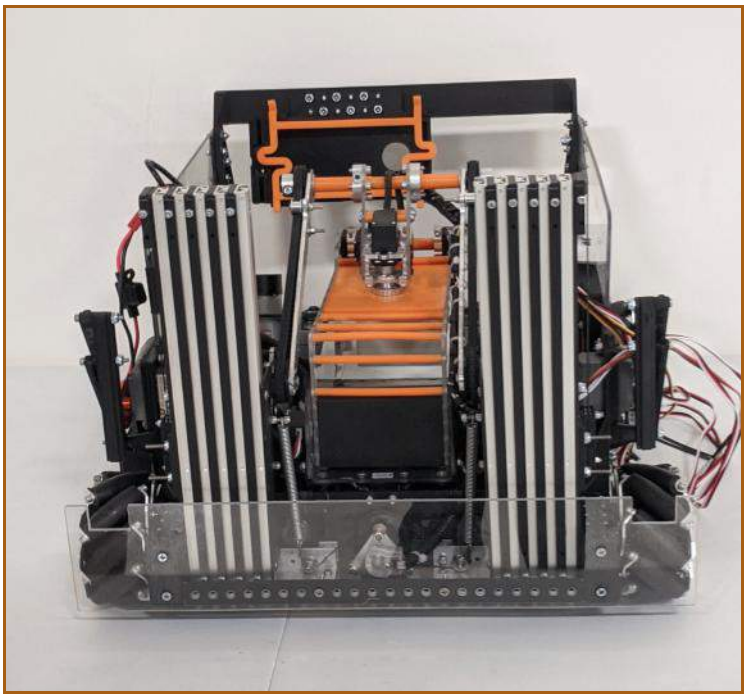


BROWNCOATS
Team 7842 Engineering Notebook

Date	Location	Start Time	End Time	Week #
January 8, 2020	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	19
Meeting Goals: Finish Autonomous Routes				
Team Members in Attendance:				
Ian, Megan				

Lift - Ian, Megan

Ian was working on some of his autonomous routes when one of the springs on the down string bent and snapped off of the screw, causing the string to get caught in the spool. Megan and Ian tried to save it, but there was no feasible way to do so. Instead, they cut off all the down string and re-strung that part of the lift. Because they didn't want the springs to ever do that again, they bent them slightly so it would tie around the second loop of the spring, so that way if the first loop bent, the string would still be tied to the spring. Once all of this was finished, autonomous work continued.

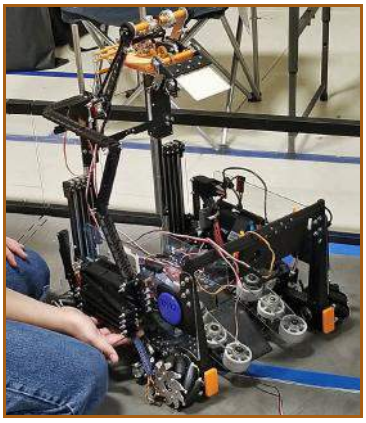


Software - Ian

Ian finished tuning the drive and worked on modifying the autonomous paths. The paths needed to be retuned because the drive was behaving more accurately. He unfortunately didn't finish this, but one of the three skystone positions was working decently well with one stone.

Wire Management - Ian, Megan

Ian and Megan finished mounting the wire management accordian today and plugged everything in. When they tested it, it worked very well! They raised and lowered the lift several times and it never got caught and it always retracted the way it was supposed to.



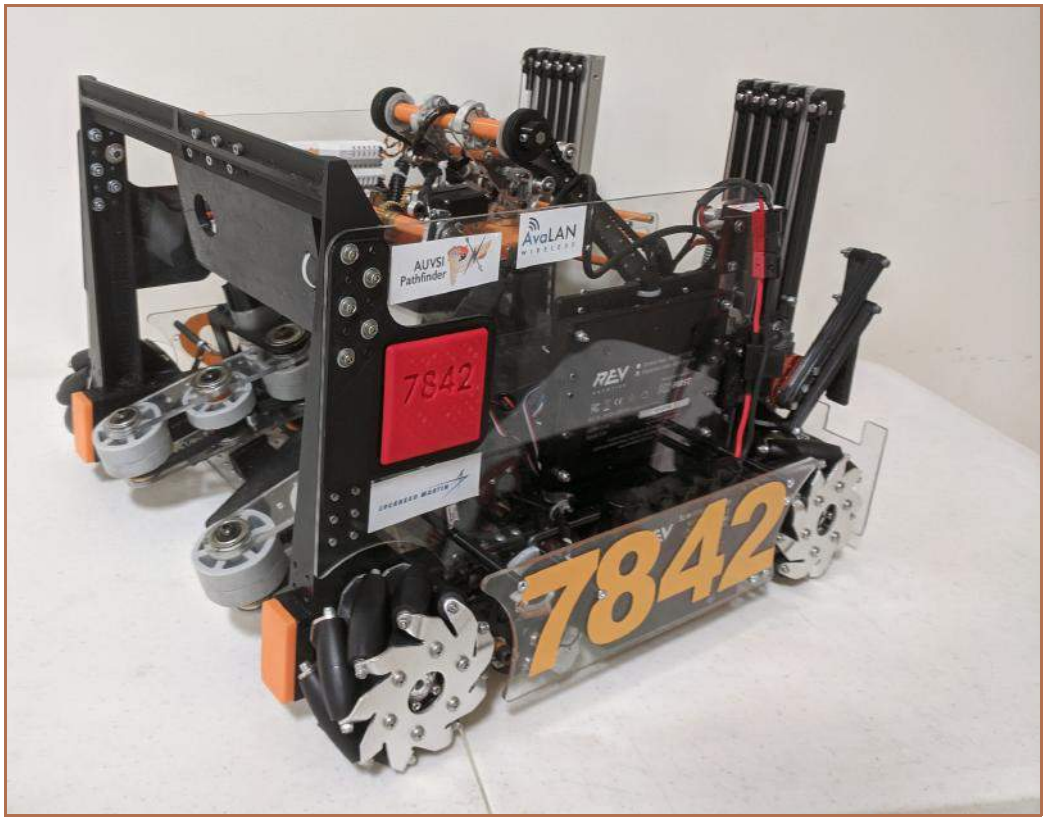
Date	Location	Start Time	End Time	Week #
January 9, 2020	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	19
Meeting Goals: Finish Autonomous, Mount Side Plates				
Team Members in Attendance:				
Ian, Megan				

Drive Train - Megan

As there was only one day until the team left for their qualifier in Arkansas, Megan took the Lexan side panels for their team numbers and counter sunk the holes for the screws so they could mount the panels to the robot. After Ian finished some of his program, she tapped all of the required holes and then put the side panels on.

Software - Ian

The team spent most of the day working on autonomous. They were seeing significant accuracy issues near the end of the run (as the robot goes to collect the second skystone) even after much tuning, so they decided to target just one skystone instead. By the end of the day, they had it working decently in one position, and they had preliminary paths for the other two. Unfortunately, that was all they were able to accomplish before they had to pack for their qualifier. Additionally, they damaged their arm servo during an autonomous testing, which they had to replace before leaving.


AUVSI
Pathfinder
AvoLAN
7842
REV
7842

BROWNCOATS
Team 7842 Engineering Notebook

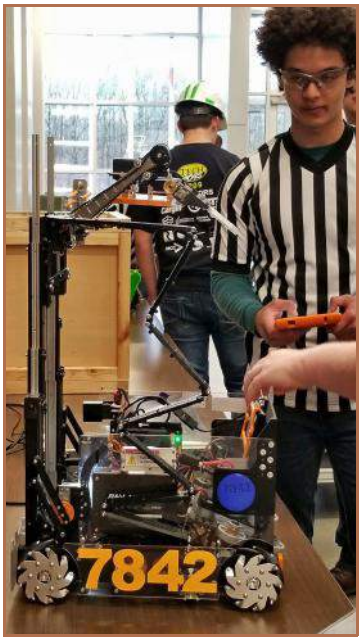
Date	Location	Start Time	End Time	Week #
January 11, 2020	Hot Springs, Arkansas	7:00 a.m.	6:00 p.m.	19
Goals: Arkansas Qualifier				
Team Members in Attendance:				
Ian, Megan, Jalynn, Joel, John, Nathan				

General Overview

On January 11th, our team competed in the Hot Springs, Arkansas Qualifier, our first competition of the year. We hadn't had a lot of driver practice and our autonomous wasn't completely working yet, so we weren't sure how the day was going to go, but we were excited to get to compete with other teams and learn from them! We spent most of our free time on the practice field tuning our autonomous to the best of our ability, and to our delight, we got it working for our qualification matches! Parking under the skybridge was a little inconsistent, so we're planning on fixing that once we get home. During our qualification matches, we had one problem with disconnecting (it turned out the battery came unplugged), but other than that, everything ran relatively smoothly and we went undefeated. We chose Team 7572 Lights On to be our alliance partner, and together we won both of our Semi-Finals and Finals matches. For judged awards, we were nominated for the Motivate Award, the Connect Award, the Design Award, the Innovate Award, and the Inspire Award. It was a fantastic day, and we can't wait for our next qualifier!

Technical Overview

We began working on the practice field almost immediately after completing our robot and field inspections. During the car ride to Hot Springs (and in the hotel the night before the competition), we mirrored the red autonomous paths and implemented those paths into the blue autonomous program. We also wrote a very simple parking autonomous with an adjustable delay, which gave us more flexibility in regards to alliance strategy. We spent a significant amount of time tuning these new routes, as well as our single skystone red autonomous. We weren't able to reliably collect the stone closest to the skybridge in practice, so we forced the program to default to one of the other positions if the skystone was close to the bridge. Our delivery points were reduced, but it was far better than the other possibility (if we hadn't defaulted it) of a complete autonomous failure. We also spent some time between matches doing tuning in the blue (recently created) side, because it wasn't quite as accurate as the red side. Nonetheless, we were able to get autonomous working reasonably consistently in 2 of the 3 skystone positions, which helped us significantly in our matches. We also practiced driving a little prior to our first match, which we hadn't been able to do much before then. By the end of the day, we had stacked one or two 6-high towers, which we were very happy with, especially with our lack of driver practice. Our biggest takeaway from this competition is how strong autonomous is and will continue to be. A significant amount of a match's score comes from autonomous, so we're going to focus more on our autonomous strategies and programs for future competitions.



Lessons Learned

After the qualifier, the team went to get ice cream to celebrate and discuss what they learned from the competition. They talked about what went right throughout the day, what they could have done better, and what they planned to improve before the next competition. Everyone had lots of suggestions and comments that were compiled into a list. The Browncoats also took a moment to commend each member on the role they played at the qualifier, as everyone did something throughout the day that helped the team and even the overall qualifier.

Lessons Learned:

- Driver practice is essential
- Autonomous points are extremely valuable
- Having one partner delivering stones while the other scores is the fastest strategy we've found so far
- Communication is a key part of this game–always get with alliance partners to discuss before matches
- Have fun! Going in with little stress leads to the best performance


7842


AUVSI Pathfinder
AvoLAN
7842
REV
7842


7842
7572

Date	Location	Start Time	End Time	Week #
January 13-16, 2020	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	20
Meeting Goals: Software				
Team Members in Attendance:				
Ian, Megan				

Software - Ian

This week was spent almost entirely on autonomous work, though a small amount of driver practice did occur the day before the team left for Springdale.

Ian's initial goal was to complete a reliable two Skystone autonomous. Ideally, this autonomous would deliver and place both Skystones, and move the foundation into the Building Site, and then park under the Alliance Skybridge. He made some steady progress towards this goal over the first couple days. However, they began to see very prominent accuracy issues towards the end of the program. He didn't have enough time to fix these issues, so he instead reverted his focus to a single Skystone autonomous. He started with the paths from last week and tuned them to be more accurate and precise. In addition, he also wrote and finished a new path that would allow the drivers to collect and deliver the Skystone if it landed in the near position. By the end of Thursday, the autonomous was working reasonably consistently in all 6 Skystone positions (3 blue and 3 red). As such, Ian and Megan spent the rest of the meeting time working on driver practice, with a specific focus on capping the tower in endgame.


NASA

BROWNCOATS
Team 7842 Engineering Notebook

Date	Location	Start Time	End Time	Week #
January 18, 2020	Springdale, Arkansas	7:00 a.m.	6:00 p.m.	20
Goals: Arkansas Qualifier				
Team Members in Attendance:				
Ian, Megan, Nathan				

General Overview

On January 18th, our team competed in our second qualifier of the season in Springdale, Arkansas. During our first qualification match, our servo on the arm for the arm and clamp broke, and we didn't have a spare. We were able to loosen the screws just enough that the servo would still move, and it worked for all of the qualification matches, but it broke again during the semi-finals matches, this time for good. Our autonomous, on the other hand, ran consistently in every single match which we were excited about! We finished our qualification matches in 1st place with four wins and one loss, and we chose team 9879 Root Negative One to be our Final Alliance partner. We won both of our semi-finals matches, but lost both of our Finals matches. We had a great time playing with them! For judged awards, we were the 3rd Place Design Award Winner and we won the Inspire Award! We all had a great day and we all learned a lot!

Technical Overview

We began the event with robot and field inspection, as usual. However, during robot inspection, our autonomous didn't work. The robot seemingly had trouble with navigation, and it ran into the Skybridge pillar as it was going to deliver the Skystone. Initially, we were concerned that it was because of the field. Our practice field's tiles are fairly old, whereas these field tiles were brand new. However, shortly before judging, we noticed that our lateral odometry wheel's module had jammed (due to a design flaw with the pivot bearing retention, which we're going to correct) and the wheel couldn't turn. Thus, we attributed the odd behavior of the autonomous routes to that. After judging, we ran one of the Skystone positions on one of the practice fields, and it ran correctly, with no major errors. However, we had to move to the other practice field to try our other paths because of field demand. None of our auto paths worked on that field. We initially tuned the autonomous paths to try and correct for these errors on this field, but we were unable to see much consistency. The tiles on that field were very worn and were somewhat out of square, so we hoped that those issues were the source of our error and reverted all of our changes. During autonomous in our first match, our arm didn't stow properly, which caused it to get caught on the alliance skybridge as we drove under it. This bent one of the shafts in the servo, which limited its performance. We were able to continue using the servo throughout the day though, and it performed well enough until semis one, when the same issue reoccurred. This irreparably damaged the servo, and we were unable to stack for the rest of the competition. In the future, we're going to investigate ways to either isolate our virtual 4 bar arm servos, or move to a less demanding mechanism, such as a horizontal linear slide.

Lessons Learned

The Friday after the qualifier, the Browncoats gathered to discuss the outcome of the qualifier, what went well, and what needs improvement.

Lessons Learned:

- Everyone needs to practice as the human player. We gained an appreciation of how difficult the job can be, and everyone needs to be prepared to jump in
- Though judging went well during both qualifiers, there is still room for improvement. More practice is needed.
- A foundation only autonomous path would have been helpful during one of our matches–to investigate before states
- Automation on the lift would have been helpful during matches
- Idea: figure out how to use sensors to detect when systems are broken to help prevent further damage

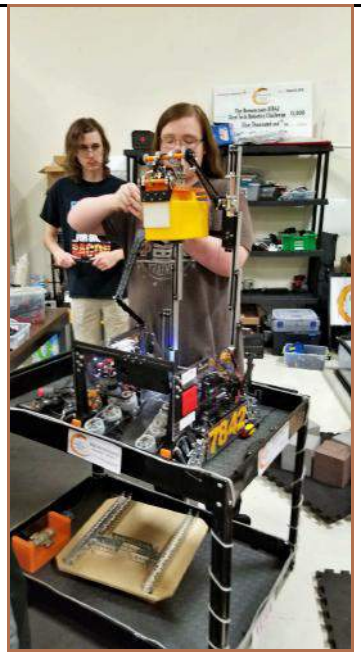

7842

BROWNCOATS
Team 7842 Engineering Notebook

Date	Location	Start Time	End Time	Week #
January 24, 2020	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	21
Meeting Goals: Repairing Servo				
Team Members in Attendance:				
Ian, Megan, Jalynn, Joel, Nathan, John				

Arm & Clamp - Ian, Megan

Today was spent replacing the servo on the deposit arm. They ordered new servos over the week, which allowed them to completely swap the broken one out. After swapping it and recalibrating the arm, they disassembled the old servo to inspect it. The first gear in the servo's gearbox had separated. Normally, the first gear is made up of a thin aluminum gear, and a taller brass gear pressed into a bore in the aluminum one. These two parts had separated, which meant that torque couldn't be transferred through the gearbox. Furthermore, the shaft that this gear (and one other gear) rotated on had bent very significantly, to the point that the servo's case was damaged. They're likely going to retire that servo, because they're concerned about the health of the motor.




7842

BROWNCOATS
Team 7842 Engineering Notebook

Date	Location	Start Time	End Time	Week #
January 30-31, 2020	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	22
Meeting Goals: Software				
Team Members in Attendance:				
Ian, Megan, Jalynn, Joel, Nathan				

Software - Ian

The team met Thursday to do some basic robot maintenance and prep work for their St. Jude demo the next morning. After the demo, they continued working on the robot. Most of the day was consumed by a mix of training everyone for the human player role, driver practice, and swapping the robot's side panels. The new side panels use darker orange for the stickers, which maintains consistency with the rest of the robot much better than the previous panels. Furthermore, the new stickers are attached to the inside of the panels, rather than the outside. They did this because the stickers on the old panels were significantly scratched after just two competitions.


FIRST
TECH
CHALLENGE
ALABAMA
STATE
CHAMPIONSHIP
INSPIRE AWARD
2016 - 2017

BROWNCOATS
Team 7842 Engineering Notebook

Date	Location	Start Time	End Time	Week #
February 7-8, 2020	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	23
Meeting Goals: Foundation Catch Maintenance, Software				
Team Members in Attendance:				
Ian, Megan, Jalynn, Joel, Nathan, John				

Foundation Catch - Megan

On Friday, February 7th, Megan changed out the foundation catch fingers for new ones. They were almost completely the same as the previous ones, however, these had rubber on the ends of them, so that they could grip the foundation better, as the previous fingers slid around a lot when moving it, which caused for lots of inconsistencies in autonomous. Once she'd changed them out, they tested the fingers and found that they worked well! They still slipped a little, but not nearly as much as the other ones.

Software - Ian

These meetings were primarily spent retuning the autonomous controllers for the drive train. The team noticed in the past that their motor velocity controller seemed less than stellar, so they were trying to improve upon it as much as possible. However, during the tuning, they noticed that the control loop's update rate was abysmal (in the neighborhood of 6Hz). Ian suspected that this was due to an oversight when moving over to the new SDK version (5.4)'s bulk read interface. After some investigation, this did appear to be the case. That problem was resolved, which increased their refresh rate to a still dismal 12Hz. After that, they did some further investigation and realized that their hopper's color sensor was being polled continuously throughout an opmode from two different sources. I2C sensors are much slower to poll than any other type on the REV Expansion Hub, so they eliminated both polls to see how much it would improve. This increased the refresh rate to a much better 50Hz. If they also eliminated the IMU polls (which could be done with a properly tuned 3-wheel odometry setup, but theirs still needs a bit more work), the refresh rate reached near 100Hz. After these optimizations, they continued tuning the velocity PID, which went relatively quickly. They then began working on the positional PID controllers, and noticed quite a bit of inconsistency in their position estimate. They had a number of hypotheses for why this might be the case, and they're going to test them tomorrow.

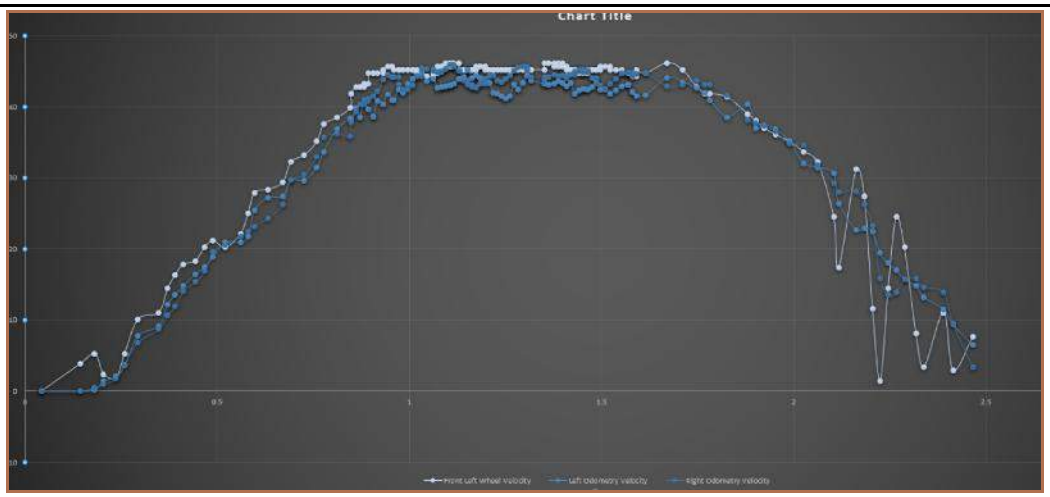
Date	Location	Start Time	End Time	Week #
February 9-13, 2020	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	23-24
Meeting Goals: Software				
Team Members in Attendance:				
Ian, Megan				

Software- Ian

Between meetings, Ian wrote a simple program to drive a specific distance in one axis. This was done purely through a motion profile; no paths or trajectories were involved. This allowed the team to directly expose their instantaneous target acceleration and velocity, and they were going to use this to compare the odometry wheel velocities to the target drive velocity. However, they realized how complex it would be to quickly graph all of that data, so they instead used this program to drive an accurate distance. They then recorded data from the odometry wheels (such as inches traveled and ticks rotated, as well as heading and the actual distance traveled, which was measured by a tape measure) and analyzed it, hoping to find a consistent pattern. Unfortunately, the errors they were seeing appeared entirely arbitrary, and they couldn't find any sort of pattern. As such, they investigated ways to log the robot's wheel and odometry velocities to a spreadsheet. They were unable to finish this before the meeting ended, but Ian brought the robot home and continued working on it. He was able to log the wheel velocities, the odometry wheel velocities, and the timestamp over the course of a simple 64" long profile. These were exported to a .CSV, which was then imported to Excel and filtered for unique entries (this was done because the opmode loop time is much quicker than the hardware thread loop time – due to their multithreaded approach. As such, there were around 7000 entries, most of which only varied in the time stamp. The filtering step shortened this to just under 200 entries). The filtered spreadsheet was then graphed, which allowed them to visibly compare the results. They noticed a very consistent trend under the target velocity, though the more prominent issue was that the left wheel's velocity appeared much noisier and trended further under the target. They're not entirely sure why this might be the case, but something they noted is that the odometry velocities seemed rather erratic, rather than cyclical. Their initial hypothesis was that the changing wheel diameter impacted accuracy, but if that was the case, that would've been reflected in this data, and it wasn't (at least not visibly). Based on this data, they decided that it was potentially a hardware issue, rather than a software one. This new spacer fixes an issue with the old pod design, where the pod sides can pop off of the bearings, which jams the wheels.

Software - Ian (continued)

After modeling and printing that, they completely disassembled the odometry pods and tried to make them perform similarly. Earlier in the week, they noticed that one wheel had far more resistance when turning. They weren't sure if this was contributing to the error, but they wanted to eliminate it for the sake of consistency. Once the pods were reassembled, they began positional controller tuning again. However, they still noticed some error. After some further investigation, they noticed that the parallel wheels weren't tensioned against the ground enough, and they were capable of slipping relatively easily. Between meetings, they bought new, stronger springs to hopefully resolve this issue. They tested them the next day, and the new springs seemed to resolve a lot of their accuracy issues, though not all of them. However, because they were running out of time at this point, they decided to finish the PID tuning. After finishing it, they began working on autonomous. However, they noticed a lot of accuracy issues with more complex maneuvers. As such, they researched some other odometry solutions and discovered a different way to calculate position. This solution uses arcs to approximate the robot's motion, rather than lines. They experimented with this solution some, but they were unable to achieve sufficient accuracy within their time constraints. This forced them back to the line-based approach, and they simply had to plan their autonomous paths around that constraint. They tried to avoid very tight spline maneuvers, and they zeroed the position about halfway through the route. This allowed them to achieve sufficient enough accuracy to complete a somewhat consistent two skystone autonomous in most of the red positions. Unfortunately, they ran out of time, and they're going to have to tune the last red position (as well as the blue ones) on the practice fields at the competition.



Blue= odmetry White= motor velocity inches per second

BROWNCOATS
Team 7842 Engineering Notebook

Date	Location	Start Time	End Time	Week #
February 15, 2020	Springdale, Arkansas	7:00 a.m.	6:00 p.m.	24
Goals: Arkansas State Championship				
Team Members in Attendance:				
Ian, Megan, Jalynn, Joel, Nathan, John				

General Overview

On February 15th, we competed in our first state competition, which was held in Sprindale, Arkansas. We went in for early inspection the night before the competition so we could also make use of the practice fields and finish our autonomous paths. We'd been trying all week to get the two Skystone paths working, but we hadn't been fully successful until Thursday, the day before we left, and we didn't have time to finish all of the paths, so we spent a majority of Friday night and Saturday morning doing that. Once it was time for matches to start, we still didn't have it working the way we wanted it to, but it was well enough that we felt comfortable fielding it. In our first couple of matches, however, it didn't work because we hit our alliance partner as we were going to deliver our first Skystone and it messed up the rest of the route. Once we get home, we're going to make it so we don't come close to our partner.

We went undefeated in our qualifications matches and finished in 2nd Place. For our partners, we chose teams 10391 Lynx Robotics and 17179 DevilBots to join our alliance. We won both of our semi-finals and finals matches. In the first semi-final match, we scored the highest we've ever scored this season, with 115 points. We successfully scored both of our Skystones in autonomous, moved the foundation, and parked. In tele-op, we stacked seven stones, and in endgame we capped and parked. In our next semi-finals match, we stacked eight stones in tele-op and capped in endgame, which is the highest our lift can score, and that was the first time we'd been able to do that in competition.

Our team finished the day out as the Winning Alliance Captain and received an invitation to attend the Maryland Tech Invitational in June. We won the Innovate Award, we were a finalist for the Promote Award, and were 2nd Place Inspire.

It was such a fun day for all of us and an incredible learning experience! We're so glad we've gotten to connect with the Arkansas teams and learn from them!

Technical Overview

Ian mirrored the red paths onto the blue side during the drive up to Springdale. The team went through robot and field inspection the day before the event, and then we spent a while working on the practice field. We made decent progress on tuning the autonomous routes the night before, though they weren't quite ready. The next morning, we immediately continued work on path tuning. Throughout the morning, we made somewhat steady progress. However, at one point during working on the blue side, the robot ran into the skybridge, and a printed part on our intake broke. This part served as the stop for the arm, which prevents it from moving into the path of the stone. We fixed this problem with a bolt and duct tape. The bolt acted as a splint, and the duct tape secured it to the part. It wasn't a perfect fix, but it worked well enough. By the time matches started, most of our autonomous routes were working. We were somewhat worried about one of the blue routes, so we added a default route for that one which would instead follow our most consistent route. However, we were unable to test this before our first match. During the first match, our autonomous program didn't work (it simply didn't move and immediately ended the program). This was due to a bug in our default statement, which we didn't catch because we were unable to test it. In teleop, we began to move the foundation into the building site when one of our foundation catch linkage bars broke. We were still able to move the foundation in and out of the building site without it, but it resulted in an incredibly close match. Fortunately, we had printed spares of those parts, so it was a relatively simple swap to repair it. Throughout the rest of the day, autonomous worked some of the time. It had a tendency to hit our partners when going under the bridge, which would end the route. Nonetheless, we were able to win all of our qualification matches and seed second. In the elimination matches, autonomous was somewhat consistent, and it was enough to win the elimination matches. In the future, we want to further investigate our odometry accuracy so that we can increase our autonomous reliability. Additionally, we want to reinforce the printed parts that broke.

Lessons Learned
•Mitigated problems with REV Hub by observing a correlation between REV Hub behavior and long power on times of the robot, so we powered down the robot between matches •Discussing strategy with final alliance partners instead of running our robots on the field before final matches resulted in a clear game strategy as elimination matches progressed •Don't leave autonomous to the last minute - consistency is key •When drivers stay calm, matches go much smoother •We observed that after we replaced the hub on the arm, the arm set position was wrong in tele-op - needs to be fixed before Alabama State •Autonomous needs to be tuned to consistency before Alabama State •Capping points are very valuable - need to aim to cap in every match


Maryland
Tech
Invitational


As the Blue and Gold Still Wave.
Maryland
Tech
Invitational

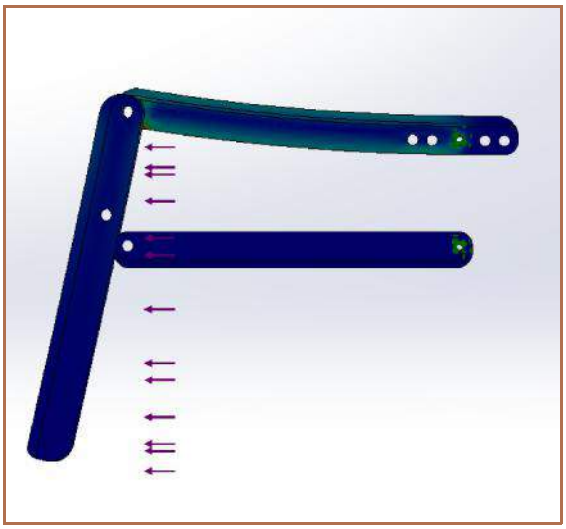
Date	Location	Start Time	End Time	Week #
February 17-20, 2020	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	25
Meeting Goals: Software				
Team Members in Attendance:				
Ian, Megan				

Software - Ian

The team began the week by revisiting the other (arc-based) option for odometry calculations. After traveling home from Springdale on the 16th, Ian spent some time working out the differences between the two approaches and compared them. The arc-based system uses arbitrary coefficients for converting ticks to linear units, whereas the line-based system uses actual measurements about the odometry system (such as location in relation to the robot's center and the wheel radii). However, in theory, the two should reach the same result, at least in simple line segments. Using this fact allowed him to solve for what these arbitrary coefficients should be. There is a reason that these coefficients are empirically tuned, however. Empirically tuning them allows the user to adjust for the differences between theoretical and real-world performance. As such, these calculated coefficients were simply used as starting points, and ended up being fairly accurate ones. After dialing everything in, the arc-based system seemed far more accurate than the previous line-based one. However, the largest issue with both of these systems is that they can't handle holonomic maneuvers (such as rotating along a linear segment) very well, because the math assumes that the robot's direction of travel is tangential (or normal) to the motion. This is a reasonable assumption for non-holonomic drives, but it falls apart with mecanum drives. In the future they're going to investigate ways to calculate the resultant direction of travel based on the odometry wheel velocities (which would separate heading from direction) and use that angle to calculate displacement in each axis. For now, however, they're simply going to stick with this system, and they'll avoid holonomic maneuvers. The next day, they did a lot of hardware maintenance. Between meetings, a revised intake stop bar was designed, based on how the previous one broke. The part was made a bit thicker, and a large rib was added on the trailing edge of the part. This should significantly improve the robustness of this part – particularly because of the rib. They also did some general maintenance like tightening up bolts, and they replaced a cracked printed part on the hopper.

Software/Hardware - Ian (continued)

They also swapped the second REV Expansion Hub, because they were having issues with it dropping connection last weekend. Furthermore, they took some measurements of the foundation on the foam tiles. Their goal was to determine the angle at which it begins to slip on the tiles. Once that has been determined, they can calculate the foundation's coefficient of static friction with the field tiles, and they can use that (along with the foundation's mass, which they measured) to determine the maximum force that the foundation catch will have to withstand when moving an unloaded foundation. They'll add a generous factor of safety on top of that, and they'll use Solidworks' simulation suite to optimize the part geometry. Over the next two meetings, they worked on autonomous. They used their Arkansas Championship paths as a base, and tuned them for the new, more accurate odometry localization system. They were able to finish the red paths, and most of the blue paths are done as well. They have about 6 seconds left at the end of the route, so they're going to investigate collecting and placing more stones in the future, but they're targeting a very consistent 2 Skystone autonomous first because of how much it's worth. Additionally, after the meeting on Thursday, Ian determined the foundation's coefficient of static friction and maximum force of friction. Using these forces, he simulated the system in Solidworks, and the results of that simulation correlated well with where the part broke last weekend. Thus, they optimized the part around that region to reduce the load at that point.



Solidworks FEA Analysis of the foundation catch at 100 N

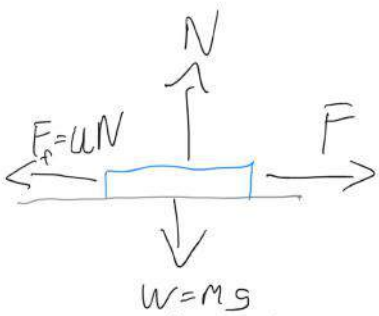
$$\theta_{avg} = \frac{(25.8+22+23+24+27+23+24+25+25)}{9}$$

$$\theta_{avg} = 24.311^\circ = 24.3^\circ$$

$$\mu_s = \tan(\theta_{avg}) = \tan(24.3) = 0.452$$

$$M_F = 2.513\ kg = 2.51\ kg$$

Computation of coefficient of static friction between the foundation and the foam field tiles



$$\Sigma F_y = N - W = N - mg$$
$$N = mg$$
$$N = 2.51(9.8)$$
$$N = 24.6N$$

Free body diagram and computation of normal force required to move the foundation on the foam field tiles

$$F_f = 0.452(24.6N)$$
$$= 11.1\ N$$