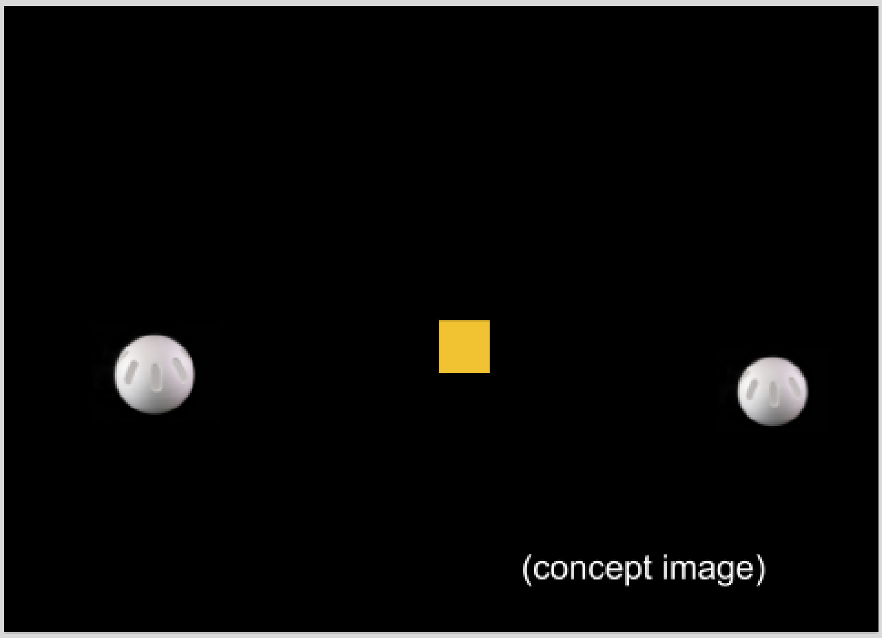
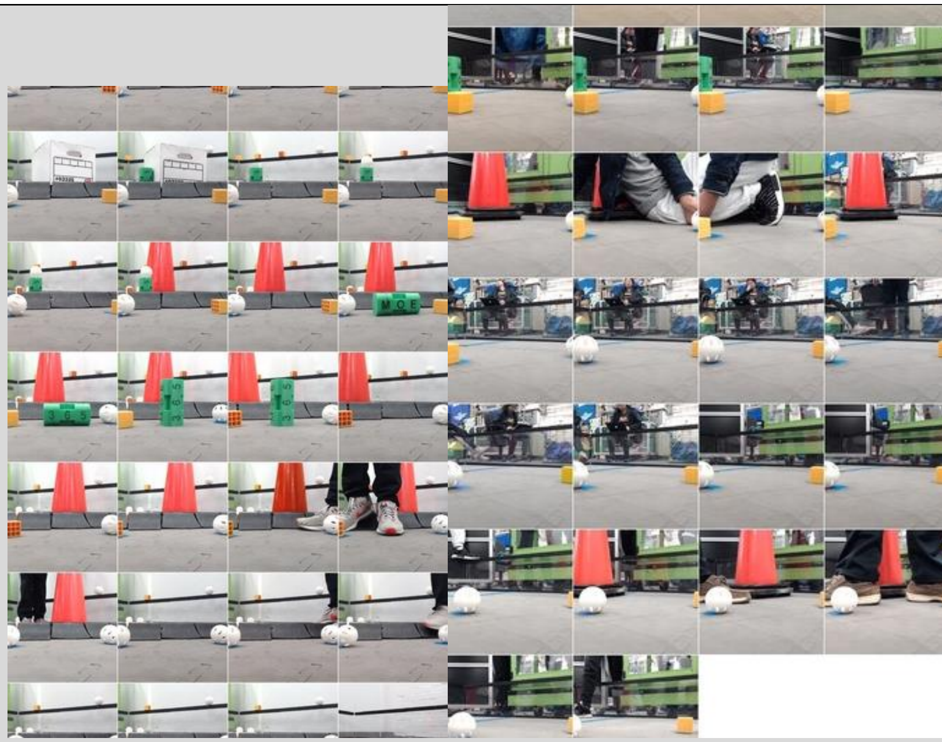
	• Yellow/gold colors present in attire worn by those standing in front of the camera • Yellow/gold colors in a gym or wooden floor • Pieces of red tape sticking out from under the silver, sphere shaped minerals For the Silver Mineral - • White/light colors present in attire worn by those standing in front of the camera • White walls
Tweak: Mineral Identification	In order to fix this, we decided to use a different kind of image recognition, as described below. 

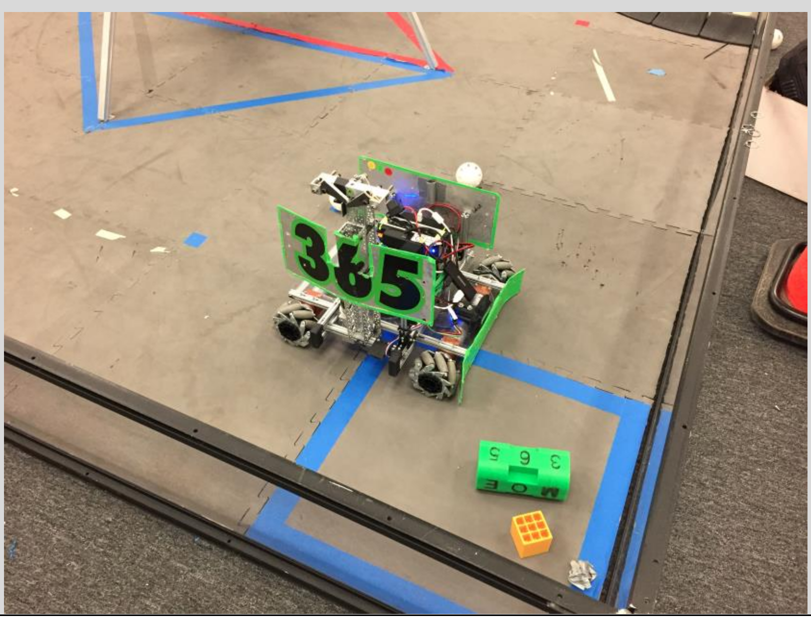


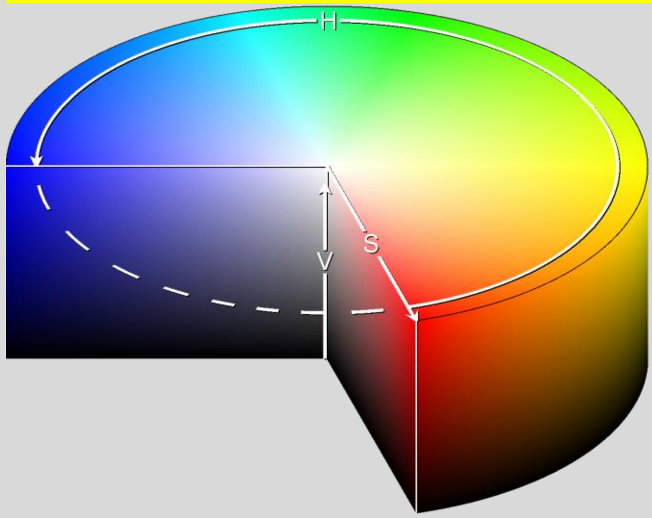
Actual images taken by robot

In this system, the robot would take the following steps:

1. Take an image of the minerals.
2. Convert this to a low-resolution image.
3. Identify only the pixels that are "mineral pixels", or included a clear amount of gold or white clumped together in a group.
4. Change all pixels that are not "mineral pixels" to black.
5. Use our neural network on this new, edited image to identify the position of the minerals.

After writing this program, we began some early stages of testing and ran into several errors, which required some troubleshooting to fix.



	After overcoming these initial hurdles, we tested the program multiple times. The first results showed promise, but we need to undergo further trials before deciding if this is a plausible solution.
Develop A Solution: Mineral Identification	We realized that algorithms are always going to work while neural networks still have a chance of error, even in relatively perfect conditions. The difference is that algorithms are not as good at accounting for differences that may matter We decided that using an algorithm was a better approach because we can easily decrease the possibilities of error by only focusing on the gold To do this, we realized that HSV would be more valuable then RGB  *Depiction of the HSV cylinder* This is because we are only looking for a certain gold HUE (which is the H in HSV) We also realized that a lower Value and Saturation makes the HUE not as prominent (lower saturation makes it lose its color, lower value blocks out the color with black) This could create a problem because when it looks at white Silver minerals, t**he HSV value could be anything,** as long as the Value is high and the saturation is low. We used this to ignore anything without "prominent hue" (meaning that, its either not colorful enough, or too dark) We tested out different threshold values for Hue and Saturation We got the colors that passed the threshold and maximized their hue to better see what Hue the program would read

We realized that the Hue of the Gold block is pretty high, so we can get away with a high threshold for hue.

Just for fun, we wanted to see what it would look like with no threshold

This picture actually perfectly demonstrates why the saturation and value thresholds are needed!

	The areas with low saturation, like the white background and the gray floor have red-orange (even green at one point!) hue values, which would skew the readings.

Non-Technical/Discussion:

Key Learnings from Meet:

- **Camera mount needed (messed up one of our autons)**
- **Pack the controllers**
- **Phone mount**
- **Fix Depot -> Crater -> Depot**
- **Red autonomous**

We want a:

- **Pit Display**
- **Promote Video**

Promote Video Planning

Prompt: "If every student participated in FIRST, the world would be... "

- **Have multiple answers to prompts with corresponding clips**
  - **Smarter**
  - **Kinder**
  - **More inclusive/ connected**
  - **More creative**
  - **More gracious**
  - **More enthusiastic**
  - **More respectful**
  - **More motivated**
- **RAP/SONG?**
- **From a spaceship – Press a button that goes into an alternate dimension with all FIRST Students**
- **Video Layout Concept #1:**
  - **From a spaceship -> Clips from like competitions and stuff ->**
  - **Lyrics on the bottom**
  - **2 Line chorus with different adj. that goes into verse about the chorus**
  - **1st chorus introducing the prompt goes into chorus**
  - **Cut Time – 70 BPM - allows for 35 measures in 1 minute**

  - **2 measures intro -> 1 measure chorus -> 8 measure verse -> 1 chorus – 8 verse -> 1 chorus -> 8 verse 1 chorus -> 4 bridge -> 1 measure conclusion**
- **Music for promote**
  - **Minor key sounds too ominous**
  - **Choose Bb major and it was pretty good**
  - **Trap beat would not be very “FIRST”-y so the content wouldn’t match the beat**
  - **KYLE happy rap-style is pretty good**

- **After the Camera mount block was finished printing, Ian and Marcus put new blue painters' tape of the print bed.**
- **Then, Marcus cleaned the extruder with a towel and water to get the dried filament and dirt of the extruder**
- **After that, Marcus and Ian organized Cabinet A and cleaned of the table where the 3d printer is.**

Date: 12/18/18

Duration: 6:00PM – 8:30PM & 12:00 PM – 4 PM

Tuesday and Wednesday, December 18-19, 2018 Meeting

***some students had a giant research project due on Wednesday and could not make it to the scheduled Tuesday meeting, so they went to a separate Wednesday meeting**

Students:	Rohan	Karthik	Jonas	Ian	Clare	Patrick	Bryan
Mentors:	**Mr. Prettyman**	**Zach**	**Arnav**	**Mr. Szeto**	**Mr. Price**		

Agenda
Discuss Previous Meeting

Tasks:	
MMS	**Programming**
	Test and improve mineral identification.

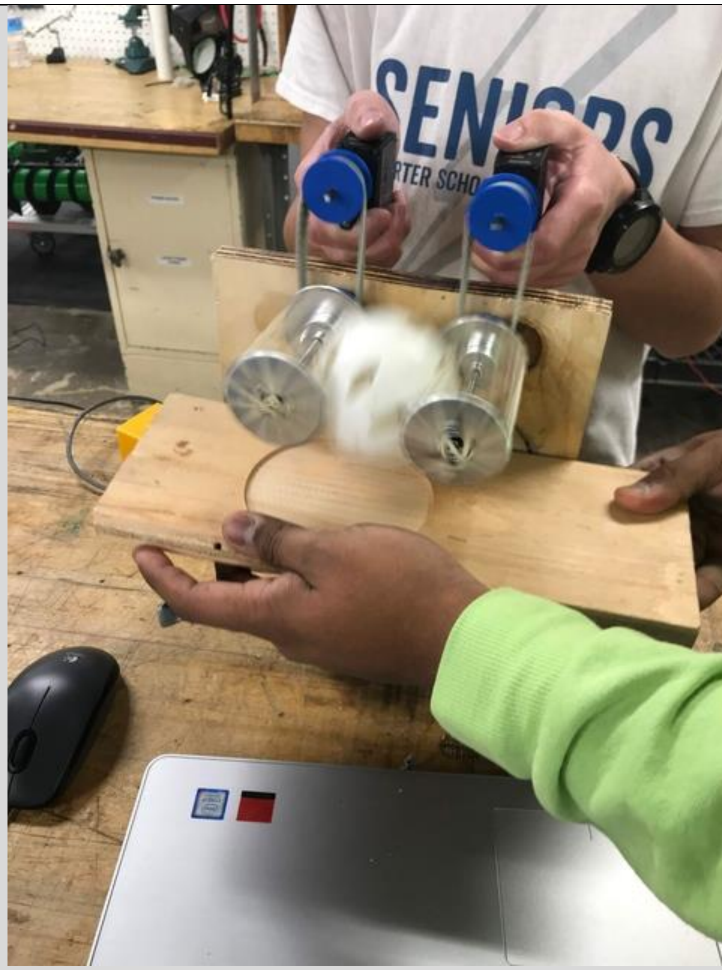
Mechanical Accomplishments:

MMS	
Construct and Test a Prototype: Harvester	With the help of the University of Delaware, our mentor, Arnav, brought 3D printed materials needed for our harvester.

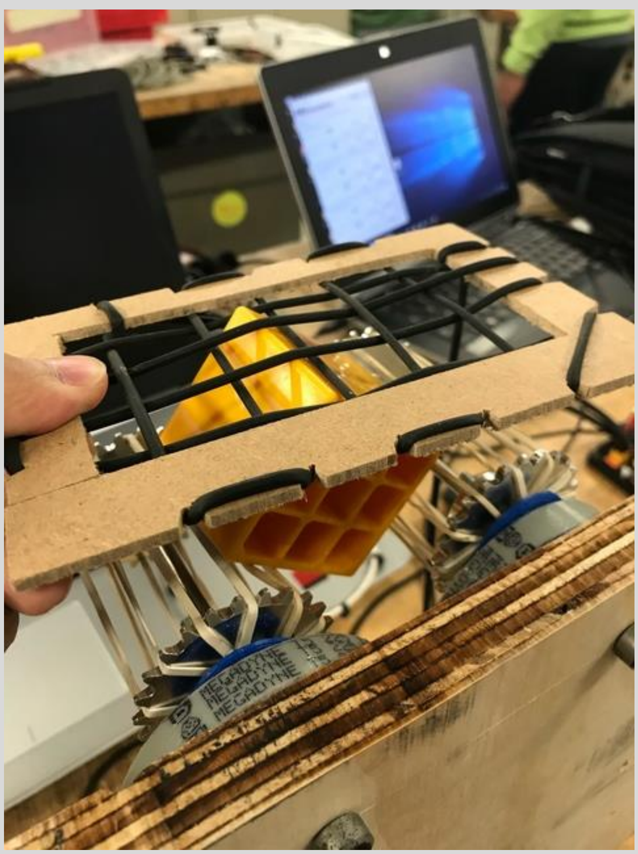
The gears shown above are for the belts that spin the harvester.

We used these sprockets for testing and we don’t think it’s a reliable and final solution. We will end up laser cutting disks with similar radii with holes to hold the rubber bands properly.

	This was the setup we used to test this concept. Two individual servos (VEX 393's) are running the belt drive directly and spinning the sprockets in opposite directions. We continued testing by seeing if it had the ability to collect both gold and silver minerals.  This shows that we ability to harvest gold minerals. It also shows the laptop we used with had the software to run the servos at specific powers.

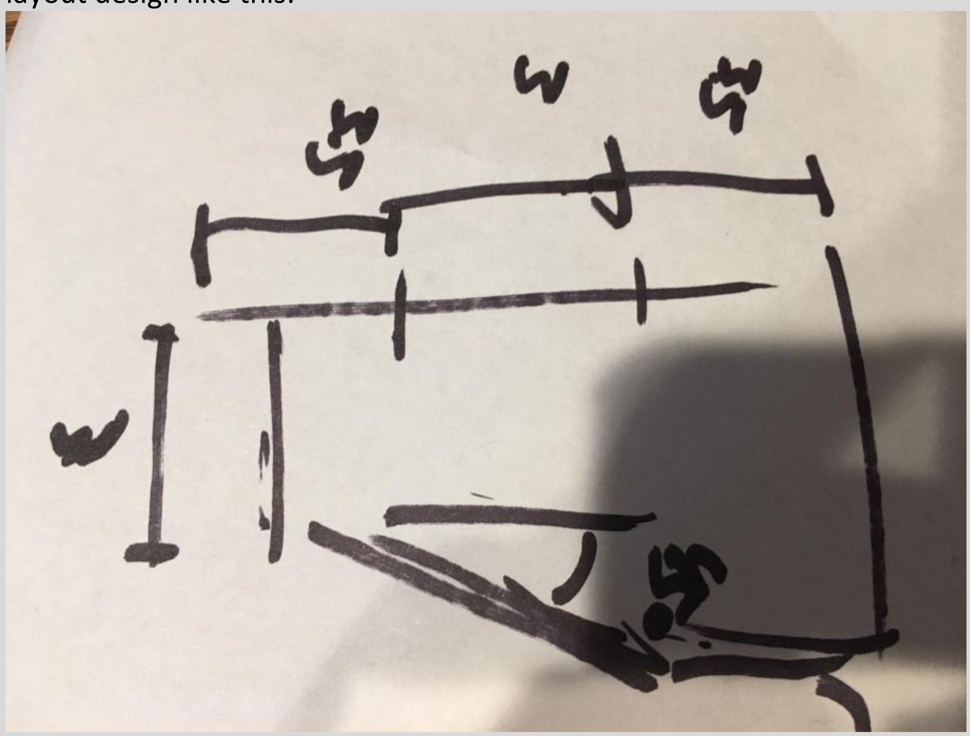


This also shows that the rubber bands give enough tolerance for the silver minerals



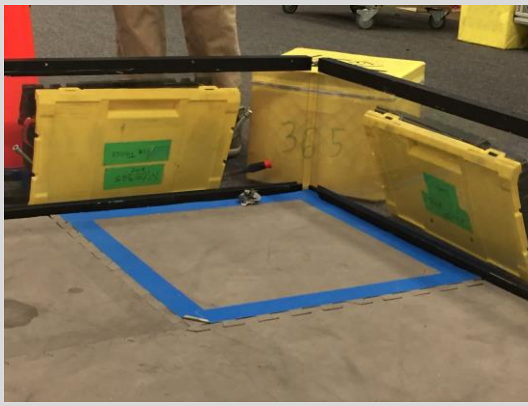
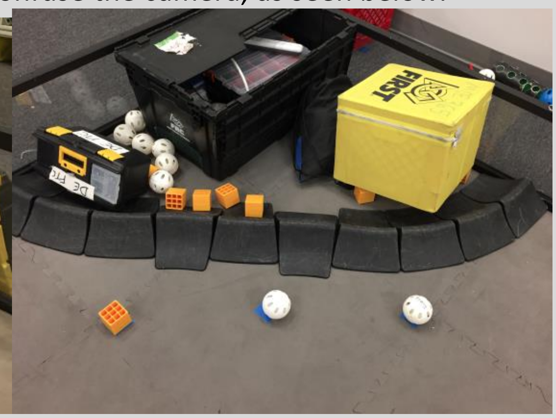
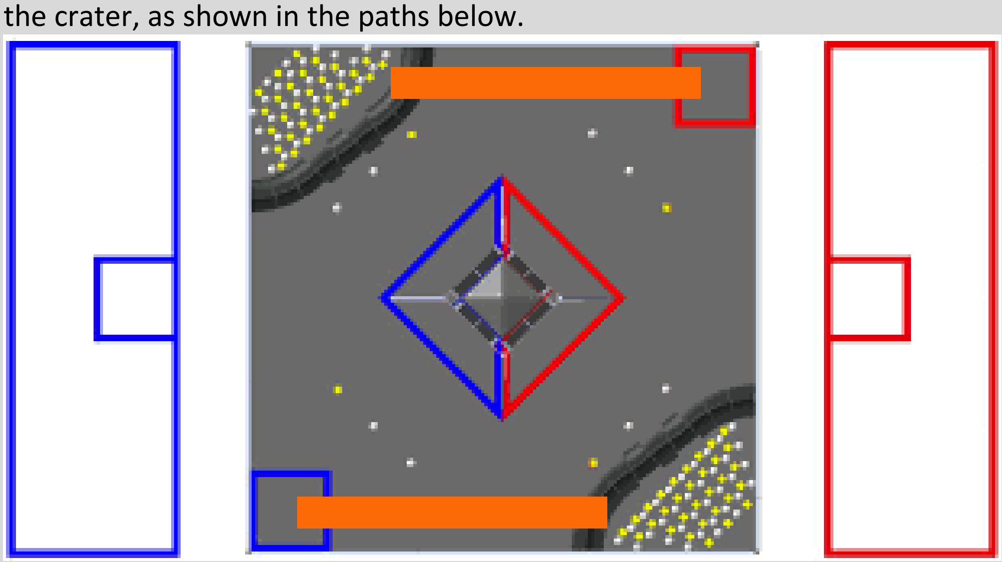
	We're planning to use a net similar to this to prevent the mineral from going all the way through.

Funnel for MMS

Problem: Funnel	In the design Zach and Arnav were thinking of doing, it is going to have two tubes for holding mineral, so there need to be a funnel to score them in one place
Generate Concepts: Funnel for MMS	• Ian was first told to CAD a funnel with one side with two holes and the other with one that is directly under one of the two top holes. • The design to be CADed would have circle tubes from the two holes on the top to the one hole on the bottom • Ian started to CAD it and then showed his progress to Zach • He said that my approach would to work and suggest to do a funnel with a layout design like this:  • Then, Ian create funnel layout like this in CAD by the end of the meeting.

Programming Accomplishments:

Autonomous

Evaluate: New Mineral Identification	For this meeting, the programming team focused mainly on testing and refining our autonomous programs, with a focus on our robot's consistency. We had been experiencing some difficulties with mineral identification during meets and competitions, so we invested a lot of time testing our new and improved mineral recognition system. First, we picked up from where we left off last meeting and ran some initial tests. The new process of mineral identification seemed to work well, but we wanted to be absolutely confident of its consistency. In order to do this, we set up yellow objects and other minerals in order to confuse the camera, as seen below.  Even with the additional yellow and white objects in the background, our new way of mineral identification was successful.
Evaluate: Parking in Crater	While Mineral Sampling worked consistently, we discovered a new issue. When starting on the depot side, we kept hitting the wall when moving from the depot to the crater, as shown in the paths below.  This was due to a gap between the field tiles and the wall, but as this may be an inconsistency we could encounter at a competition, we would like to have a sure solution to this. We plan to add a roller wheel to the side of our robot that will come in contact with the wall when moving from the depot to the crater. This will prevent the wheels from slipping and will stop the robot from repeatedly ramming into the wall.

Non-Technical/Discussion:

- **We first reviewed the MMS design we developed last meeting.**
- **We plan to order new team shirts as soon as possible.**
- **Plans for a pit display have continued to develop, and the formatting and design of it continues to be an ongoing discussion.**
- **Clare designed a handout that we can give to other teams in order to make scouting easier at competitions. It outlines all of our team's scoring capabilities. Everyone agreed that this was a good idea and Clare will continue to refine the sheet as we approach our next major competition.**
- **We have been invited to an outreach with girl scouts on 12/29/18.**

Date: 12/22/18

Duration: 9:00 AM – 2:30 AM

Saturday, December 22, 2018 Meeting

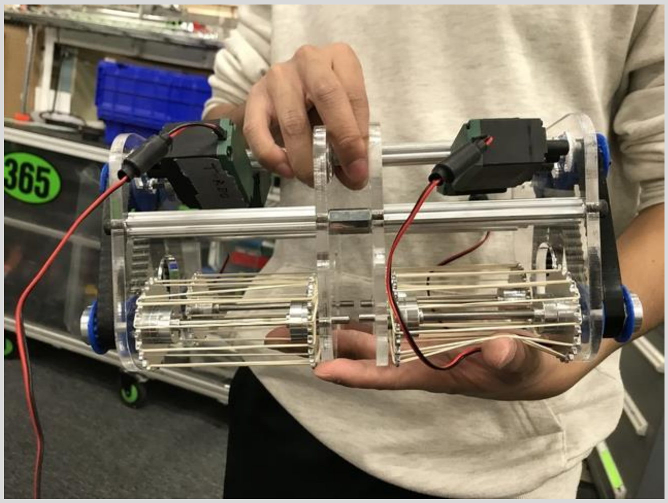
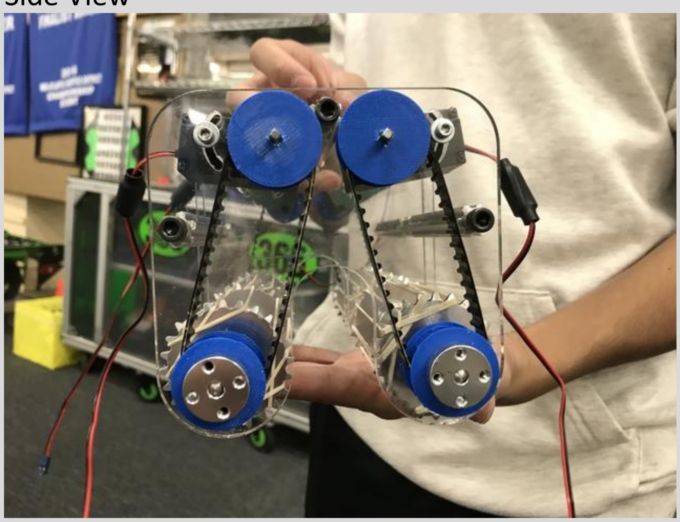
Students:	Patrick	Bryan	Connor	Jonas	Rohan	Karthik	Clare	Ian	Paige	Marcus
Mentors:	**Mr. Prettyman**			**Arnav**			**Zach**			

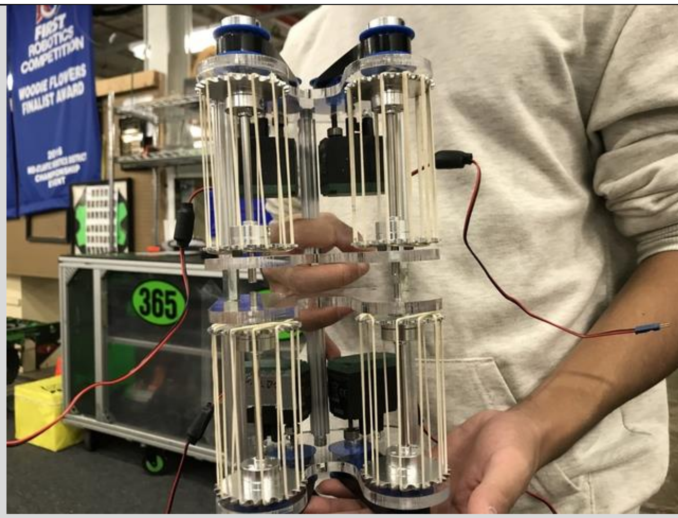
Agenda
Discuss Tuesday and Wednesday Meetings
scuss Status of Notebook

Tasks:		
MMS	**Programming**	**Lift Mechanism**
Build second harvester unit Work on Linear Slide	Work on consistency in our autonomous programs by testing all 12 possible routes multiple times.	To gather materials and start build the linear actuator for the lift mechanism

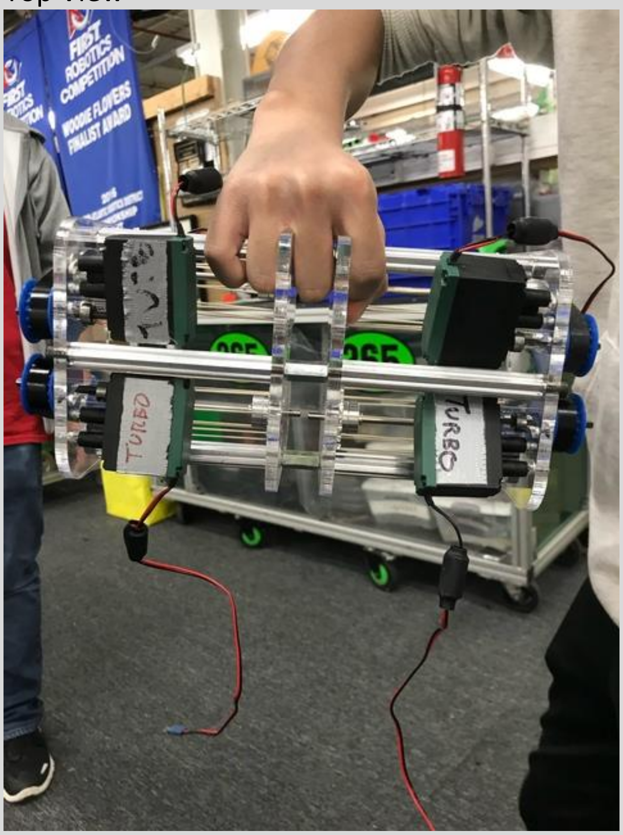
Mechanical Accomplishments:

LLMS	
Fabricate a Solution: **Linear Actuator**	• Ian, Marcus and the team started to collect and gather the piece for the linear actuator and the lift mechanism for the second chassis. • After that, Marcus and Ian took a new channel and actuator piece and marked how long they should be for the lift mechanism that was on the first chassis. • Then, after they marked the two pieces, Marcus and Bryan used the bandsaw to cut the actuator piece and Arnav cut the linear actuator channel with the miter saw. This Linear actuator is identical to the one in our old competition robot, as we saw that it worked perfectly for our purposes. It does, however use motor that is almost 5.5 times faster than the original (3.7:1). We tested its capabilities on a Force Gauge and it was able to generate more than 42 pounds of force so we believe we won't run into any problems.

MMS	
Fabricate a Solution: Harvester	Arnav brought laser cut acrylic from the University of Delaware, using their laser cutter in order to fabricate these pieces. These pieces of acrylic are being used to hold everything together properly. We assembled it and this is the finished product. Front View  Side View  Bottom View (Harvesting Side)



Top View



We need more laser cut hardware, so next meeting Arnav will bring disks that will properly hold the elastics. We found that they often popped off when using the sprockets and we also decided it would look nicer than using sprockets.

Funnel for MMS

Funnel for MMS	
Generate Concepts: Funnel for MMS	• Ian worked on the funnel at home before this meeting and finished the funnel and put it in Slic3r to see how big it is and he saw that the funnel was too big for the printer printing dimension. The width of the model was fine but the length and the high was too large for the printer • He wanted to see what Zach wanted him to do make the funnel smaller

- Zach and the other made a harvester and the length between the two harvesters was smaller than the gap that Ian had in the model.
- So, Ian made the length between the place where the mineral is going from the harvester to the funnel small. This made the length of the model in range of the printer's bed length.
- The Height of the model did get shorter but was not short enough for the printers printing height.
- Ian told his to Zach and he said to decrease the angle of the one side the funnel.
- So, Ian changed the angle from 45 degrees to 40 degree and Ian check if the height was within the 3D printer height dimension and it was.
- Then, he started to remake the model in the meeting and then finished it at home

Programming Accomplishments:

Autonomous

Evaluate: Test Autonomous

Today, the programming team decided to focus on testing all possible autonomous paths. We wanted to check for consistency and identify places to improve. We tracked all of our tests on a Google Sheets and marked when something went wrong, what went wrong, and how to fix it. The categories we tracked were:

- Landed?
- Team marker?
- Gold in Depot? (only on depot side)
- Did not hit additional minerals?
- Park in crater?
- Additional comments?
- Points earned?
- Solution (if an error was encountered)

MOE Auton tests

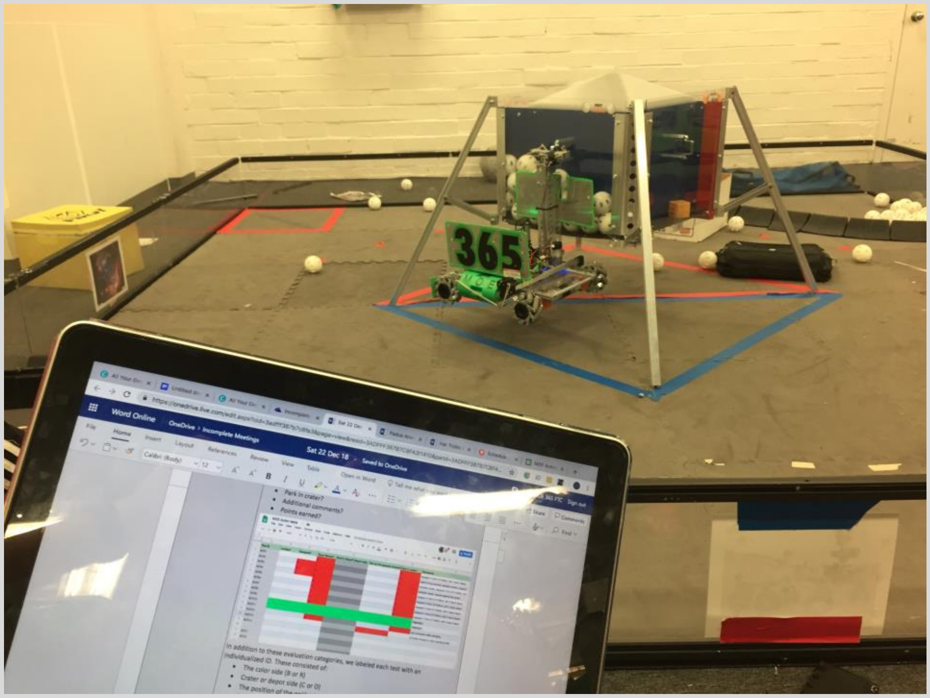
	A	B	C	D	E	F	G	H
1	Test ID	Landed?	Sampled?	Team Marker?	Gold in Depot? (depot side)	Did not hit opposite mineral?	Park in crater?	Comments
2	BCR1			X			X	stopped in front of VuMark, didn't reach depot
3	BCR2		X	X			X	wasn't hung correctly, sampled center, stopped i
4	BCR3		X	X			X	sampled center, stopped in front of VuMark, didr
5	BCR4		X	X			X	sampled center, backed against the lander
6	BCR5			X			X	stopped in front of VuMark, didn't reach depot
7	BCR6			X			X	stopped in front of VuMark, didn't reach depot
8	BCR7			X			X	stopped in front of VuMark, didn't reach depot
9	BCR8			X			X	stopped in front of VuMark, didn't reach depot
10	BCR9			X			X	stopped in front of VuMark, didn't reach depot
11	BCR10							PERFECT
12	BCR11							PERFECT
13	BCR12			X			X	lost connection after sampling
14	BCR13					X		hit white mineral on other sampling field
15	BCR14							
16								
17	BCC1							
18	BCC2							

In addition to these evaluation categories, we labeled each test with an individualized ID. These consisted of:

- The color side (B or R)
- Crater or depot side (C or D)

- The position of the gold mineral (R, C, or L)
- The number of the test in that category (i.e. BDL1, BDL2, BDL3)

By the end of the day, we had run over 60 individual tests and tweaked the program many times. We were happy with the overall result.



We did this because we wanted to take the time to perfect even the small parts that made up our overall autonomous and increase consistency as much as possible. We discovered several things, including:

- Set up the team maker correctly! This messed us up several times.
- We initially ran into an error that stopped the robot from progressing past the VuMark. This meant that it was especially important that we had fallbacks for all programs, so in case something went wrong (i.e. the robot didn't see a VuMark), we would still be able to complete the rest of our autonomous routine.
- We were hitting the mineral in the opposite sampling field while moving back towards the depot. We hadn't discovered this because we weren't always running our tests with the full field set up, but we changed the path of the robot to avoid this issue in the future.
- On average, the robot disconnected far more often than we expected. We may decide to do some troubleshooting in order to reduce the risk of this happening in competition.
- We need to have a backup rubber band brought to the field during competition matches in case the one holding our team marker snaps during set up.

Non-Technical/Discussion:

Buttons	
Fabricate Solution: Buttons	We created Unikesha and Moe Dew buttons. We printed them out on the printer and used the button machine to make over 50 buttons. 

We saw wanted to make sure the notebook was not behind on entries, so Patrick told the team the notebook entries that need to be written. There were many outreaches that were undocumented so we assigned them to different people so we can get it done efficiently.

When Connor turned on the CAD laptop, he saw that all the files in the Downloads folder were deleted. This is bad, because there were many files in there that were referenced by the CAD. This cause all servos, Neverest motors, and Linear actuators to disappear. To make things worse, He did not have backups of the downloads folder – only the CAD folders. He thought all the necessary CAD was in this folder. Most of the CAD was not affected by this. He was able to redownload all the missing CAD files except the Neverest motors with gearboxes, which do not appear to be available online.

Mr. Prettyman told Ian to Print out 4 more of the Camera Mount Block.

- Ian used Slic3r to create a .gcode file for the printer to print out 4 Camera Mount Blocks.
- Ian then made sure the tape was put on right and flat and preheat the printer extruder and print bed
- After that he started the print and watched it but the first one was not printing out right. This might have been that either the tape was not complete stuck on the print bed or the edges of the tap were curving up.

- So, he stoped the print, took the starting print of the tape and put new tape in the middle section the the printing bed.
- He reprinted the model and it started to print good.
- Then, at the end of the meeting, when the print was finished, ian took off the 4 camera Mount Blocks.

Date: 12/29/18

Duration: 9 AM– 2:30 PM

Saturday, December 29, 2018 Meeting

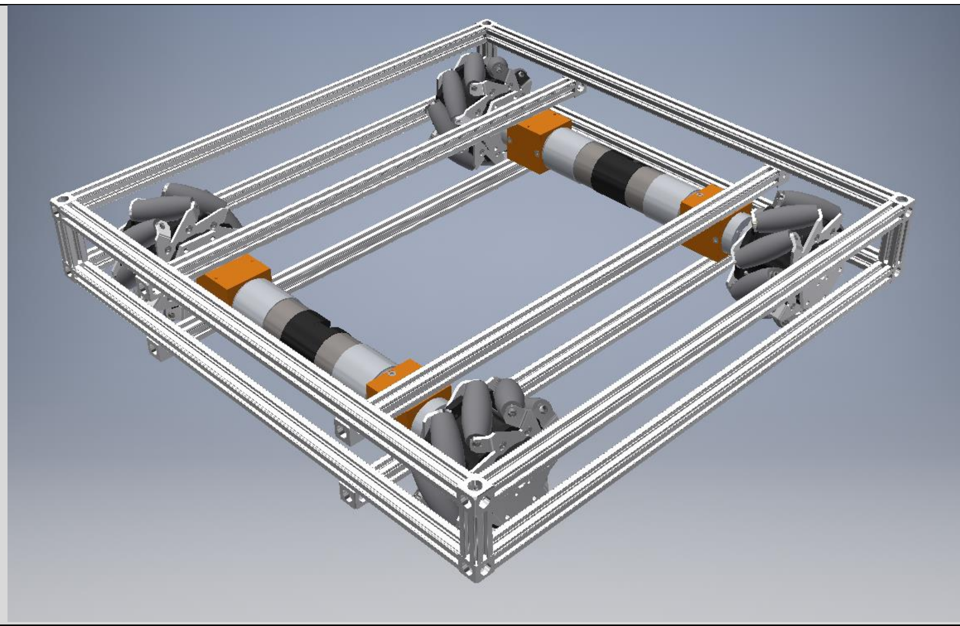
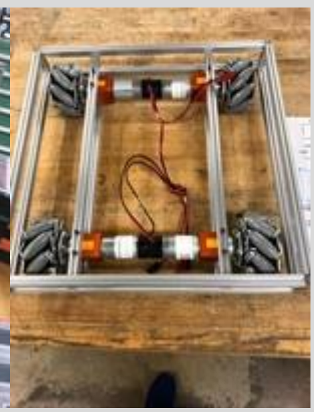
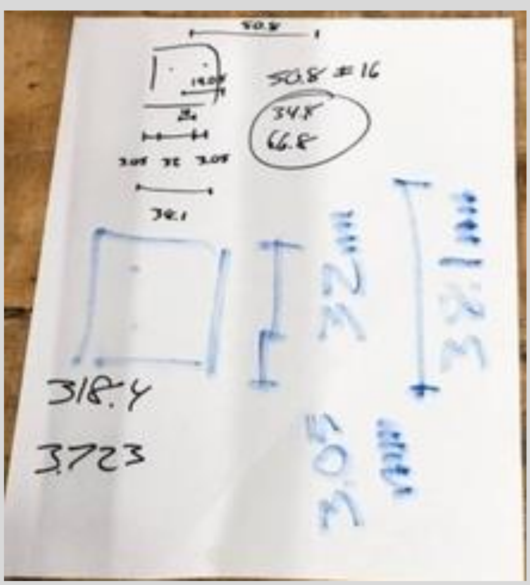
Students:	Patrick	Connor	Bryan	Rohan	Karthik	Paige	Jonas
Mentors:	**Mr. Prettyman**	**Arnav**	**Zach**	**Andrew Szeto**			

Agenda
Discuss Previous Meeting
lk about Status of Notebook entries

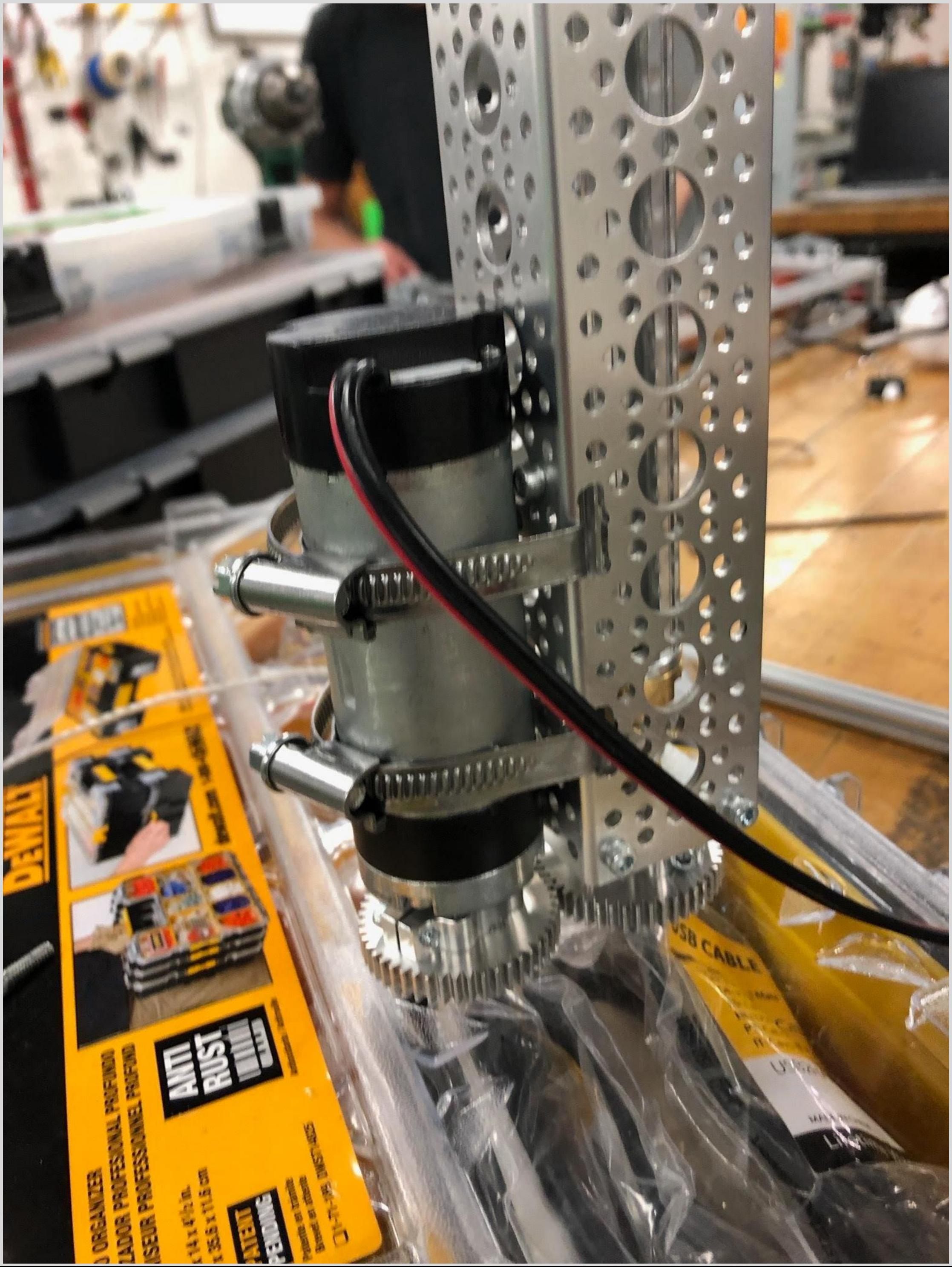
Tasks:	
Chassis	**Judging Presentations**
Work on second chassis • Change gearboxes of motors • Build frame	Refine Judging Presentation

Mechanical Accomplishments:

Chassis	
Fabricate the Solution: Gearboxes	Because we're using Custom 20:1 Gearboxes, we need to disassemble motors and attach the gearbox. This is very difficult because of the inner workings of the motor and the gearbox, so we required assistance from Arnav.
Develop Solution: CAD	CAD for the new chassis has been completed, including motors and wheels. We used the CAD to make sure the robot was no more than 18 inches.

	
Fabricate the Solution: Chassis	Using the CAD that we created, we cut out REV extrusions and Assembled the Chassis  

LLMS

Tweak: Faster LLMS motor	This Linear actuator is identical to the one in our old competition robot, as we saw that it worked perfectly for our purposes. It does, however use motor that is almost 5.5 times faster than the original (3.7:1). We tested its capabilities on a Force Gauge and it was able to generate more than 42 pounds of force so we believe we won't run into any problems. 

Programming Accomplishments:

Autonomous	
Evaluate: Autonomous Reliability	After many, many, many, many tests and successful trials We saw that our autonomous was very unlikely to mess up. This is due to the fallbacks we created and robustness of the code It can even succeed with things that would not even be possible in the game  *Mineral detection with a Yellow Cone in the background*

Generate Concepts: Editing Auton for new Auton	Since we're getting a new chassis, autonomous would be slightly different
	• Different encoder tick when dropping
	    ○ Use teleop with telemetry to find encoder tick value
	• Recalibrate distance sensor
	    ○ Localize the center of the robot using different offsets
	• Change rotation when sampling
	    ○ Camera mount placement may be different

Non-Technical/Discussion:

- **We need to make a more prepared judging presentation so we can know and refine our content**
- **Mission report style: like a skit but with content**
  - **If we do normal style, it won't be as more memorable**
  - **We present as if we're giving a mission report/mission briefing in space**
  - **Futuristic Style presentation and font**
  - **Hit 3 Main Points based off of key learnings:**
    - **Notebook/Team management – we were lacking last year**
    - **Starting Auton Early – used to not have the robot until later so autonomous and programming was not tested as much as it should have been last year**

    - **At least 30 space jokes**
- **Autonomous Changes with new Chassis**

Connor found all of the C.A.D. for the Never Rest motors with 20 gear boxes. He searched all over the Andy Mark website and eventually found them.

Date: 1/5/19

Duration: 9:00AM – 2:30PM

Saturday, January 5, 2019 Meeting

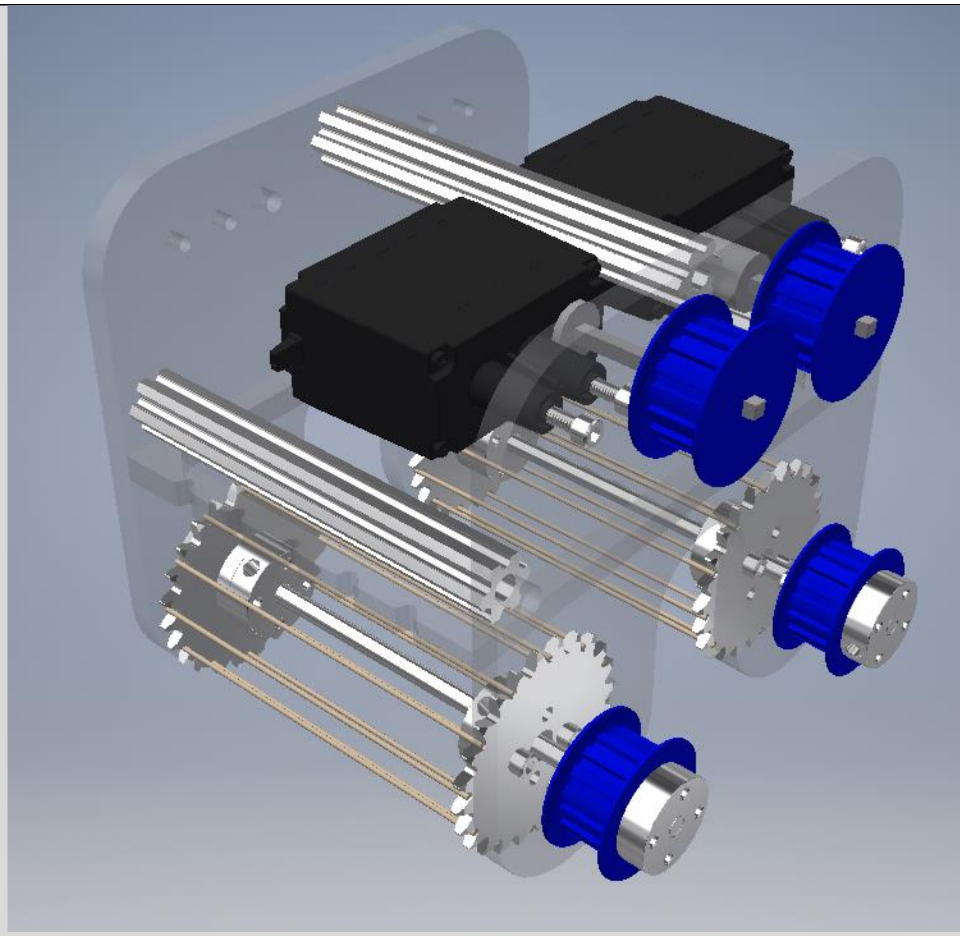
Students:	Connor	Bryan	Patric k	Ian	Marcu s	Kat y	Roha n	Jonas	Paige	Clare	Karthik
Mentors:	**Mr. Prettyman**	**Andrew**	**Zach**								

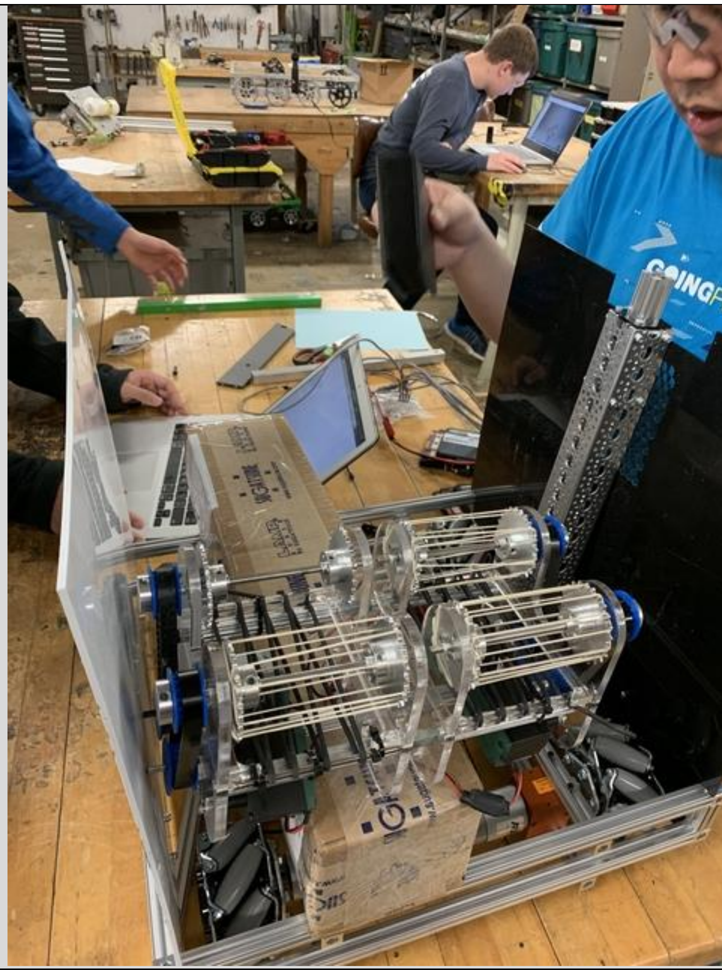
Agenda
Discuss Previous Meeting

Tasks:		
MMS	**Autonomous**	**LLMS**
CAD and check size restraints	Test autonomous Fix any issues that consistently appear	Mount Actuator and test its reach

Mechanical Accomplishments:

MMS

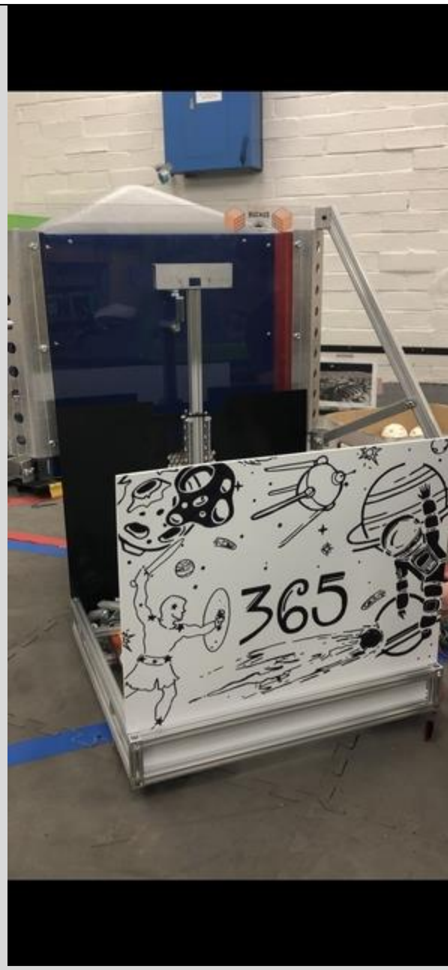
Develop a Solution: CAD Harvester	
Develop a Solution	We used the cardboard box that Sugatsune sent us with our slides in it to estimate the placement of our MMS. We wanted to make sure there was enough space for it



LLMS	
Fabricate Solution: Mounting Actuator	We milled slots into the actuator in order to feed hose claps through and we clamped a 3.7:1 motor onto it.

We then mounted the actuator onto the side of the chassis

We milled a mounting plate for the fingers/hooks to mount onto, making it sturdier than our last one. We then ran the motor all the way up to see if it was tall enough to hang.

Programming Accomplishments:

Autonomous	
Tweak: Autonomous	We tested autonomous for the different gold mineral cases. It was mostly successfully except for one case where our robot would sometimes run into one of the minerals next to the crater, de-scoring it and effectively lowering the amount of points we can get consistently. Fixing this was not very complex. We just changed the ending of our crater autonomous program to move diagonally towards the wall to lower the chance of accidently hitting a mineral. This proved effective and does not show any immediate disadvantages. We tested it a few more times to make sure this change did not have any unintended consequences, and the tests were all successful.

Non-Technical/Discussion:

We used Reveal.js for our judging presentation. It is similar to Sway but has more features and can be used offline. This allows us to work on the presentation without internet, and also decreases the chance of not being able to use it during a real presentation during a competition.

Using Reveal.js, we can have more flexibility with what we want in our presentation because everything is editable through HTML.

This means we can get more creative with the content we put on, including adding simulations.

Date: Tuesday, January 8, 2019

Duration: 3:00-8:30 PM

Tuesday, January 8, 2019 Meeting

Students:	Bryan	Connor	Patrick	Ian	Paige	Rohan	Katy	Marcus	Clare	Karthik
Mentors:	**Mr. Prettyman**	**Andrew**	**Zach**	**Kayla**	**Tobi**	**Mr. Price**				

Agenda
Discuss the competition and key learnings
ırt planning on ways to improve the robot

Tasks:
MMS
• Continue building the mineral system • Finish up building new robot in time for Delaware State competition

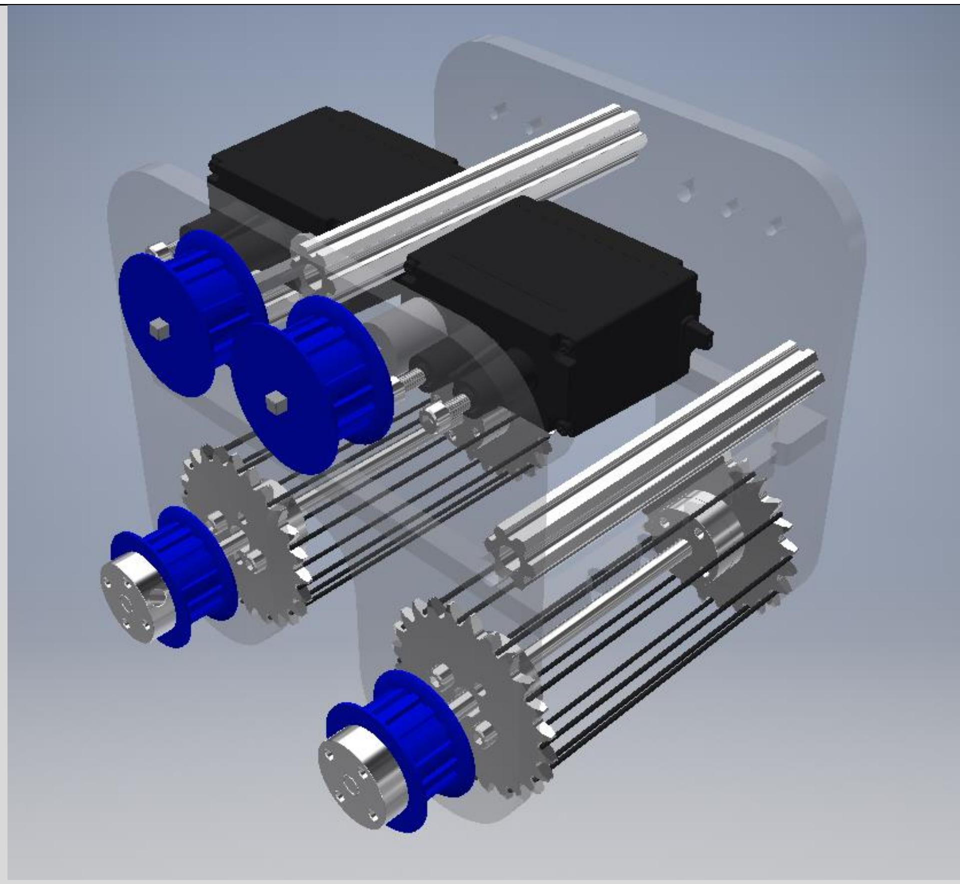
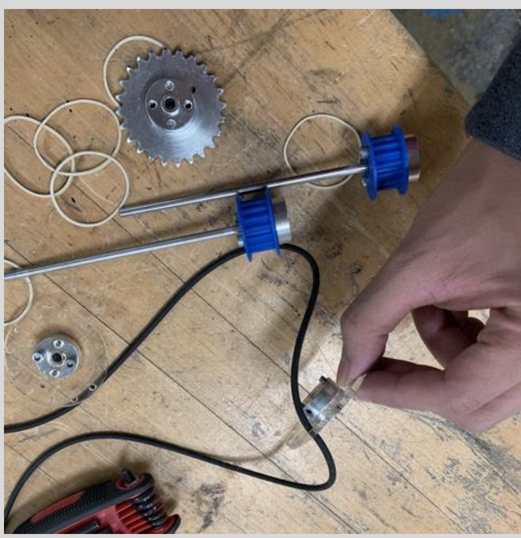
Mechanical Accomplishments:

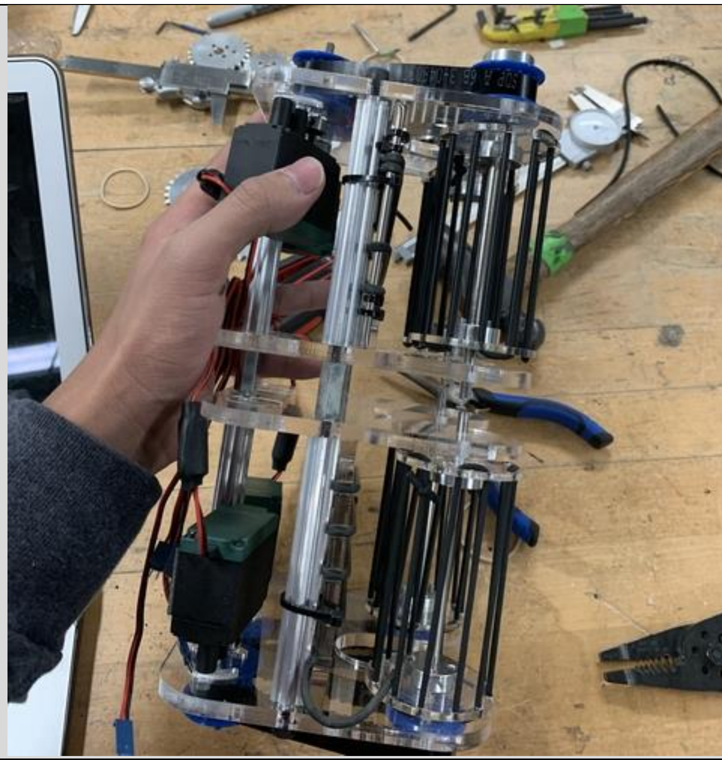
DELIVERABLE: Our robot must be mechanically the same as the first version of our robot

Chassis	
Fabricate Solution: Mount Electronics	To get our new chassis ready for programming, we got the necessary mounts for electronics. This included having a plate to hold the REV Expansion Hubs within the chassis, and the battery holder, phone holder, and battery pack are all mounted onto the side panel. The robot was configured on the phone and ready to test.

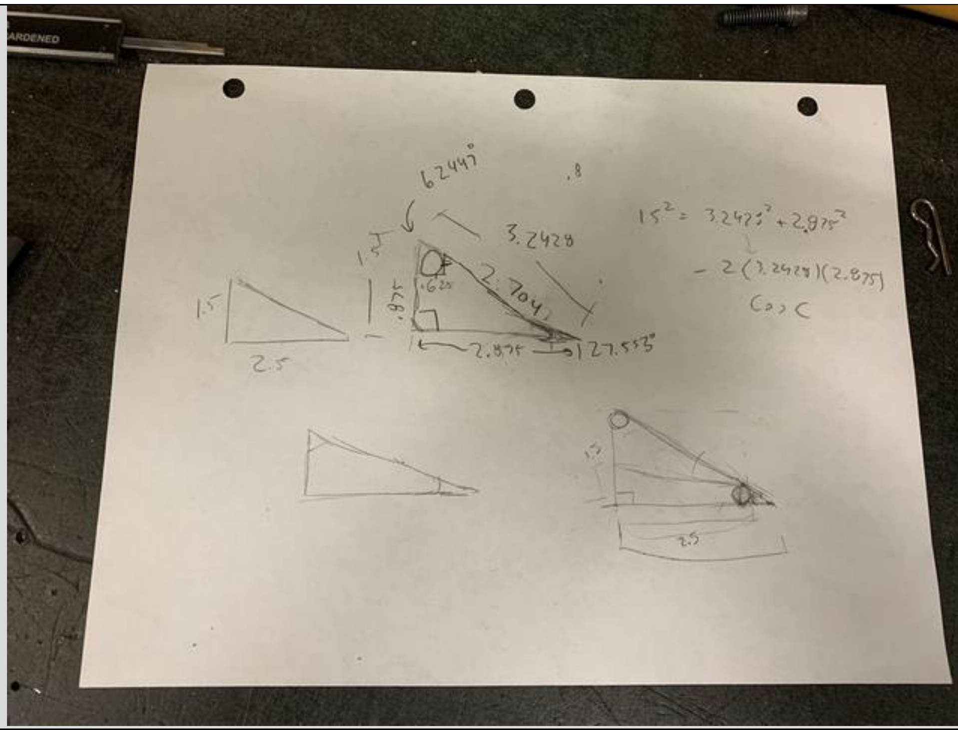
	
Fabricate Solution: Mount Electronics	We decided that we wanted to mount the camera on the lower REV extrusion. We calculated that the 2 inch clearance (approximately 100 pixels) of clearance we had when sampling would mean that we could still use the same method of sampling during autonomous. Also, this is more level with the center of the height of the vuforia tag (4.25 inches) and creates more space for the MMS to be mounted to.

MMS	
Develop a Solution: Latex Intake	Mineral Management System: (1/8/19) For part of the harvester, we originally used rubber bands around two sprockets which were connected to each other. However, after some use, the rubber bands fell off. Connor, Katy, and Patrick thought about another solution that would work better. Because rubber bands were too unreliable, they decided to use latex.

	
Fabricate Solution: Latex Intake	Following our design, we took apart the rubber band intake to replace it with the latex intake  With all of them assembled, the MMS looked like this:

	
	We also came up with the idea of a secondary MMS to increase the pickup range of minerals gives us time to course correct (put this in the right section) “we’ll know by Saturday”
Develop a Solution: Ordering motors	We were placing an AndyMark order with expedited shipping, so we calculated the correct Stall Torque needed and made sure we had double that. We multiplied total estimated weight by the length of the rotation and doubled it. It decided to buy a 104:1 gearbox with extra motors(without gearboxes). 

LLMS	
Develop a Solution: Hanging fingers	We used the design that was on our previous robot because it worked well for us. This time, we calculated the side lengths and angles using the Pythagorean Theorem and the Law of Cosines. We tried having minimum clearance for maximum hold.



Fabricate Solution: Hanging Fingers

We scratched out the triangle onto the material, making sure the hypotenuse stayed on the edge, so had a more finished edge

We proceeded to mill out the shape, to ensure it was the right size.

We sanded it so it had a rounded finish and mounted it to the mounting plate. This picture shows how perfect it fits.

	 Here it is in its open position

Programming Accomplishments:

Autonomous	
Team Discussion: Autonomous Checklist	While our autonomous routines have been extremely reliable on our own practice field, we have not been experiencing as consistent results on competition fields. We have been 36/36 (100%) consistent with full points scored (80 points per match, just in autonomous) according to our tests of every route with each one repeated three times. In order to increase consistency, we created a checklist that should be referenced before and every match. (INSERT PHOTO HERE) Before every match: 1. Bring phones, controllers, team marker, robot to field 2. Load team marker (rubber band on correct side of the servo) 3. Check phone wireless connection 4. Check wiring connections

	5. Check connection between phone and controllers 6. Change/check battery 7. Check/test gyro (if desired) 8. Check that camera is being secured by mount 9. Reset linear actuator 10. Check rubber bands 11. Have backup phones connected and ready After every match: 1. Plug in phones!! 2. Plug in battery 3. Power off robot (if there is a significant break before next match) We hope that by being more attentive and reducing the possible sources of error, this will help our autonomous programs to be more consistent in competition. A change we made is to give our robot time to course correct, lowering the chance of missing our target and providing a more accurate path.

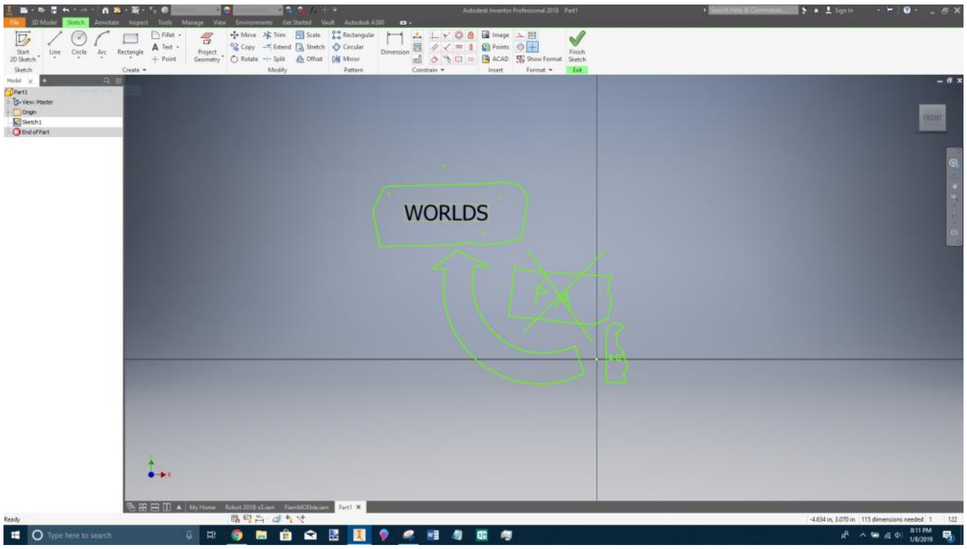
Non-Technical/Discussion:

LESSONS LEARNED FROM Oxford PA QUALIFIER:

- **Overall Team Presentation (during judging and in the pits)**
  - **Presentation needed to be cleaner**
    - **Delivery did not represent our content (We need a better delivery to fully demonstrate our team's merits)**
  - **Wanted a focus and an impact to our outreach**
    - **Many judges asked us about outreach, but we did not have a specific focus to talk about**
  - **We should have a solid poster board provide visuals for teams and judges**
    - **Talking about outreach will be easier with visuals in the pits**
- **Notebook Feedback:**
  - **Needs lessons learned and reasoning behind choices**
  - **More CAD in the Notebook**

- Sketches have no numbers associated with it, and if it is, there's not description with it
- Hard to read formulas

- **EXCELLENT STATEGY FOR GOING TO WORLDS (DIAGRAM):**



- **Role organization:**
  - We thought that our role organization was hindering our progress
    - Do not have not properly defined roles
    - People are part of the sub-teams but are often left without jobs
    - We must redefine people team roles so their role can be described in one sentence
  - Programmers have been on top of things, so they can be split up to speed up mechanical team
- **Business plan feedback**
  - No numbers – no budget, no funding source
- **Judging Presentation:**
  - Judging presentation was cute, but needs to be polished
    - We should memorize a script for a cleaner presentation?
    - Maybe just memorize questions

- **Pit Presence**
    - **We helped many Delaware teams improve, but we do not show it on the pits**
    - **Should have poster/display ready before Delaware States**

Date: 1/12/19

Duration: 9:00AM – 2:30PM

January 12, 2019 Meeting

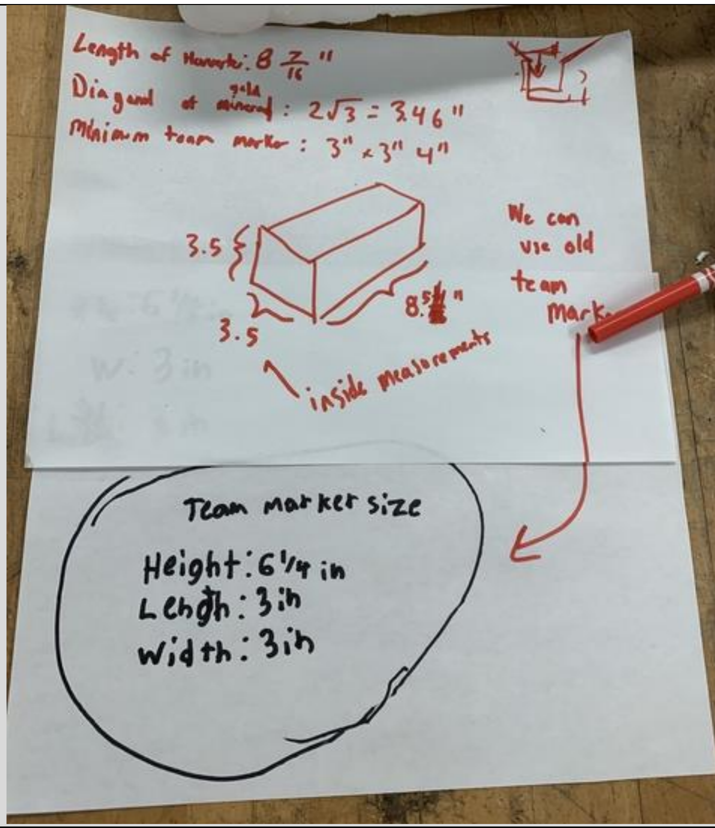
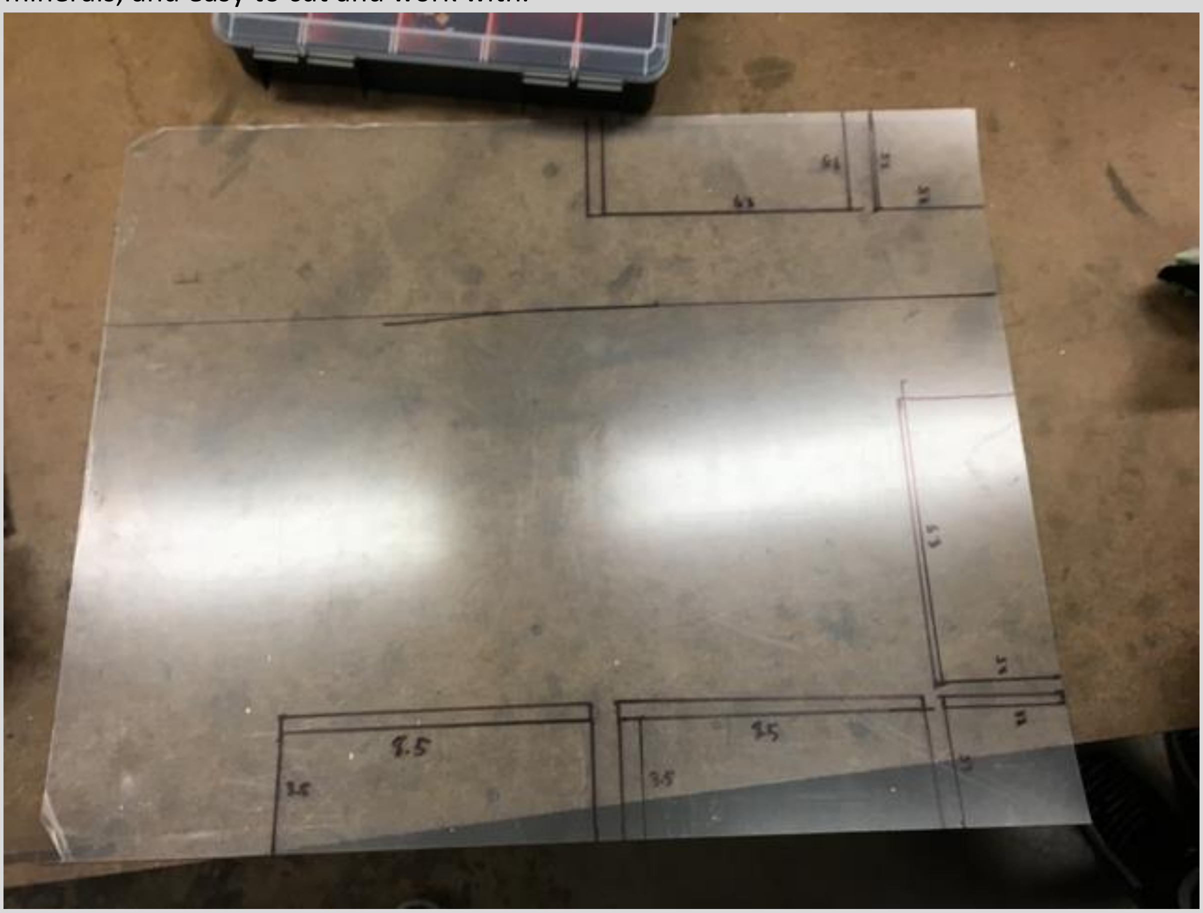
Students:	Patrick	Bryan	Clare	Karthik	Marcus	Paige	Rohan	Connor	Jonas
Mentors:	**Mr. Prettyman**	**Mr. Szeto**	**Kayla**	**Zach**					

Agenda

Tasks:	
MMS	**Programming**
Mount Harvester on a rotation	Edit TeleOp Get Autonomous working on the new robot

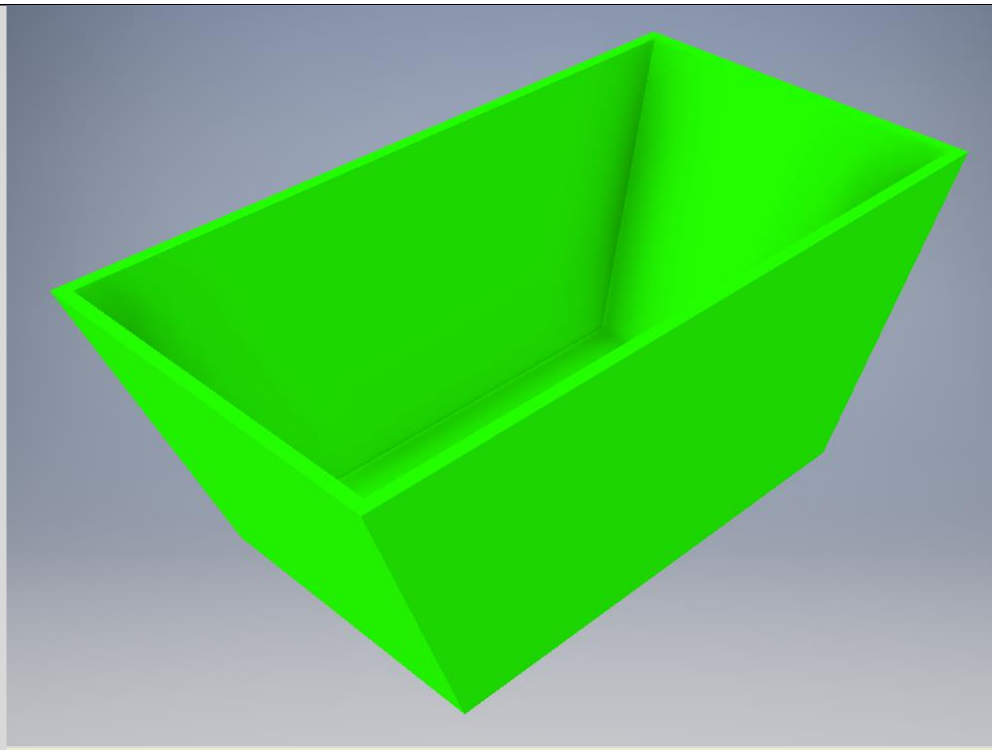
Mechanical Accomplishments:

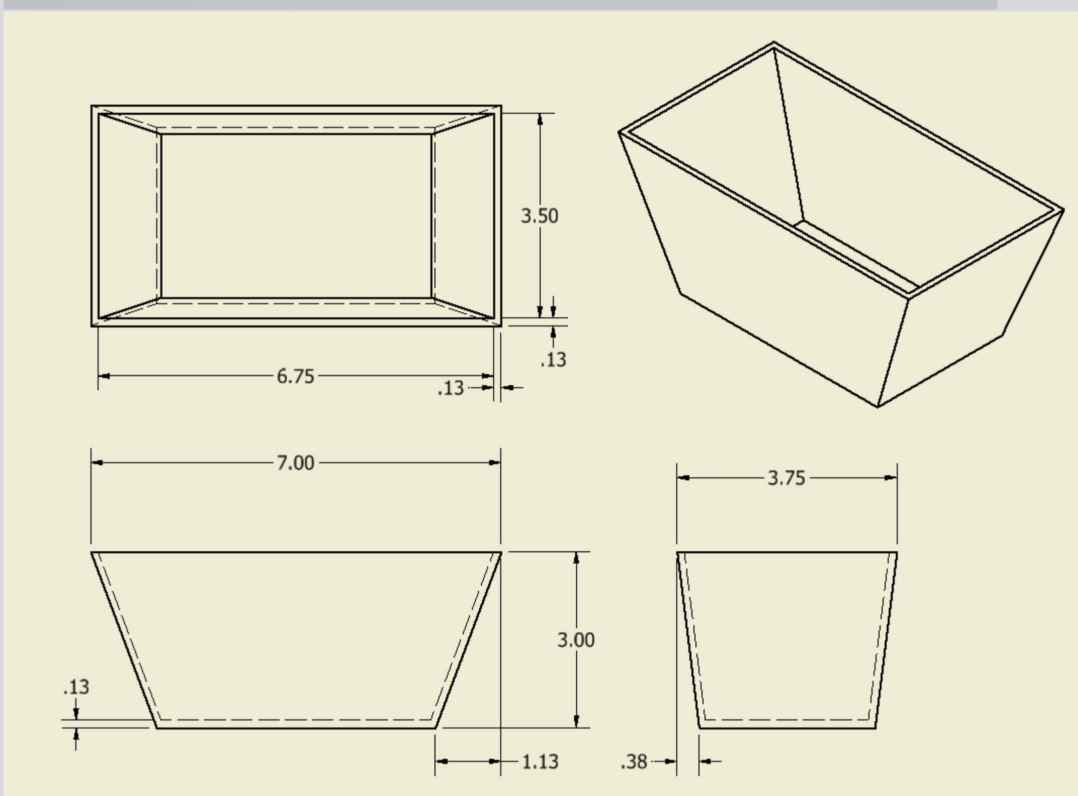
MMS	
Develop a Solution: Basket Dumper	When we score in the lander, we want to use a separate bucket. This bucket must be able to hold AT LEAST two minerals. We accounted for the largest possible size, which is the diagonal of the gold mineral, and also we wanted our team marker to be able to fit inside, so we do not need a separate team marker mechanism

	
Fabricate Solution: Dumping minerals into the lander	To Fabricate this solution, we decided to use Lexan because it is sturdy enough to hold two minerals, and easy to cut and work with.  After making these measurements, we found an old aluminum basket that we decided to use as a prototye before constructing the box

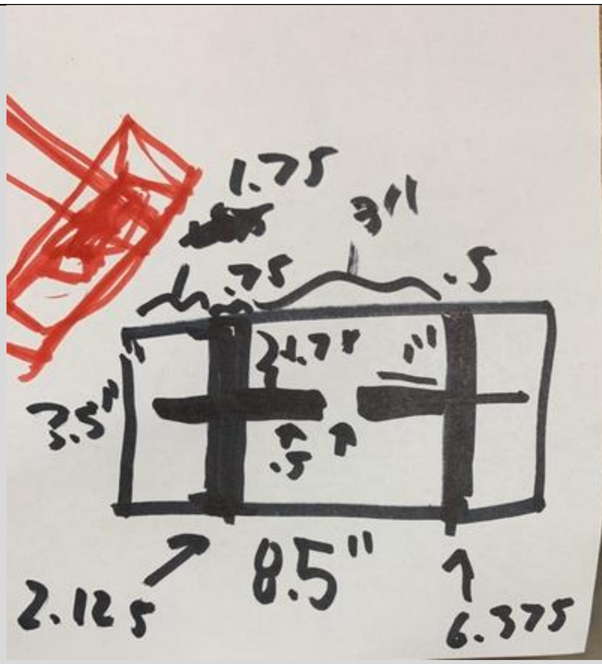
Construct and Test a Prototype: Basket Dumper	Because we had it available, we decided to use an aluminum basket for a prototype.  The basket was too tall, but still fit the minerals so we cut it down and taped it to make it green. 
Tweak: Weight of the box	While being made, the box turned out to be too heavy. To fix this, holes were drilled into the box to make it lighter for the MMS (Mineral Management System) on the robot to score minerals in the lander.

	
Develop a solution: Bucket CAD	Prototype CAD for the bucket was created.





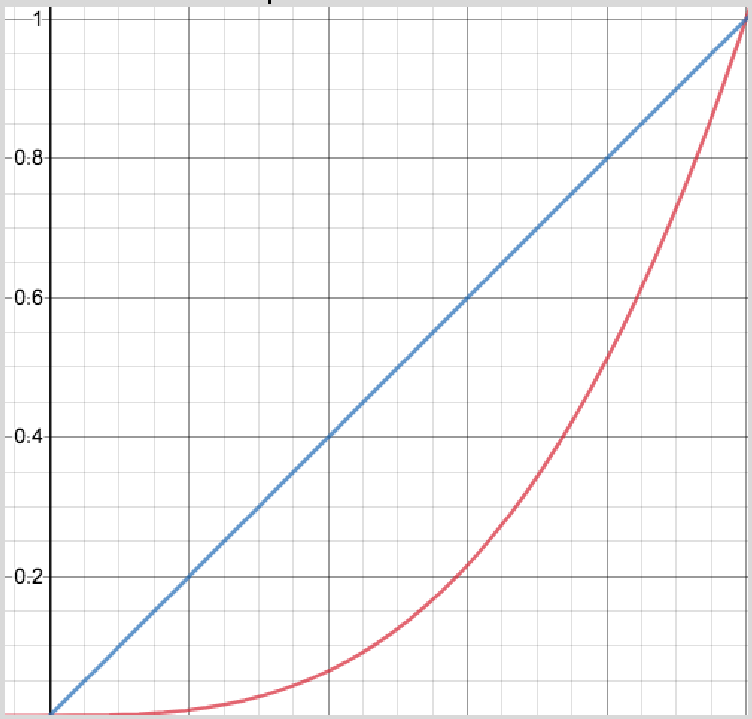
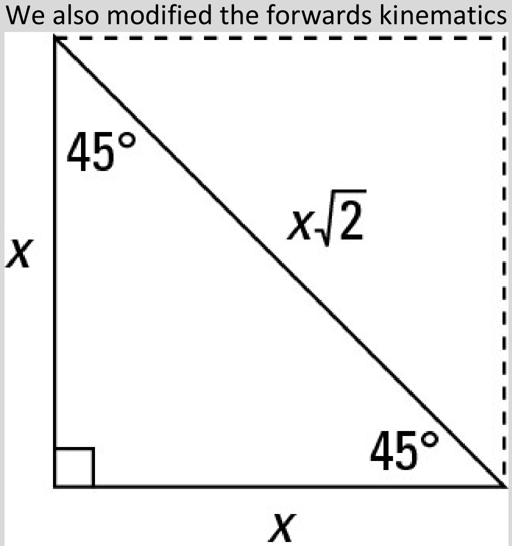
Develop a Solution: Basket Lid	We planned out the necessary dimensions to hold the smallest mineral (the 2" width of the gold mineral) inside the bucket, we decided with a two servo approach to make the lid store inside the robot better



Fabricate Solution: Harvester Rotation	With the harvester finished, we needed to have a way for it to rotate in and out but still stay parallel. We decided that if the harvester is free-spinning, it'll stay parallel due to its sheer weight. We then chose to use a thick hex axle for rotation, as we believed that the lack of the need of using a set screw will reduce the maintenance needed.  Because it's a hex axle, a wrench can be used to turn it as the motor will turn it.

Programming Accomplishments:

TeleOp

Tweak: TeleOp	While at the meet on Friday night, we noticed that the TeleOp controls seemed too sensitive which made it difficult to maneuver the robot. To fix this, we adjusted the program and made it easier to control and more compatible with the new robot. We cubed all of the power so the scale follows a cubic curve  This means that robot moves even slower when we want it to move slower, but still moves quickly at fast speeds. We also modified the forwards kinematics to take into account the smaller strafing vector  The wheels exert a force vector along the diagonal line, so two wheels would create a force vectors that 2*sqrt(2) times the speed when going forwards, compared to when it is strafing. This is why we divided the fwd input during teleop by 2*sqrt(2). This should make driving more controllable and intuitive

Autonomous

Tweak: Autonomous

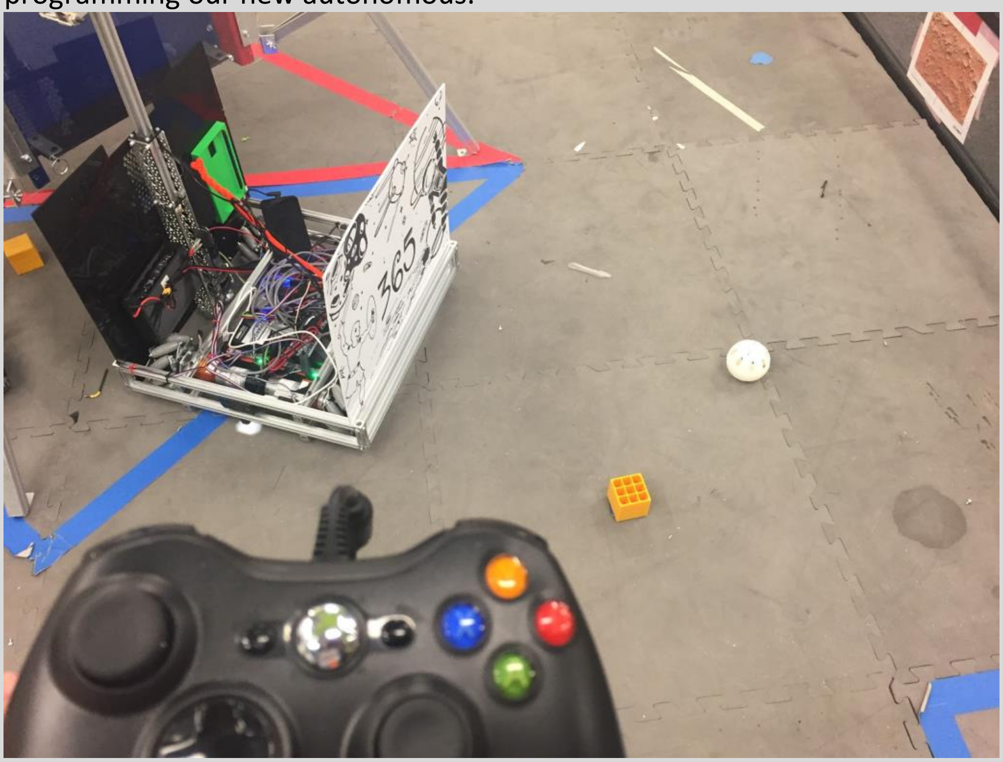
We knew it was very important to have a working autonomous on the new robot, so we spent a lot of time altering our program so it would work with the new robot.

First, we ran encoder tests to see what difference there was between our old robot and our new robot. This is important because it will let us know how much we have to move, per inch.

Encoder Ticks:

Movement:	**Encoder Ticks (per inch):**
Old robot - forward	72
New robot - forward	78
Old robot – strafe	101
New robot – strafe	108

As seen by the numbers above, our new robot needs 6 and 7 more encoder ticks for forward and strafing motions than our old robot. We made this adjustment and began programming our new autonomous.



Non-Technical/Discussion:

Paige, Kayla, and Clare worked on creating a pit display that would show our mechanical progress, programming strategy, outreaches, and team culture. Due to time constraints, we decided to use a tri-fold poster board, but we will look to make a fuller pit display in the future.

Date: 1/13/19

Duration:

Sunday, January 13, 2019 Meeting

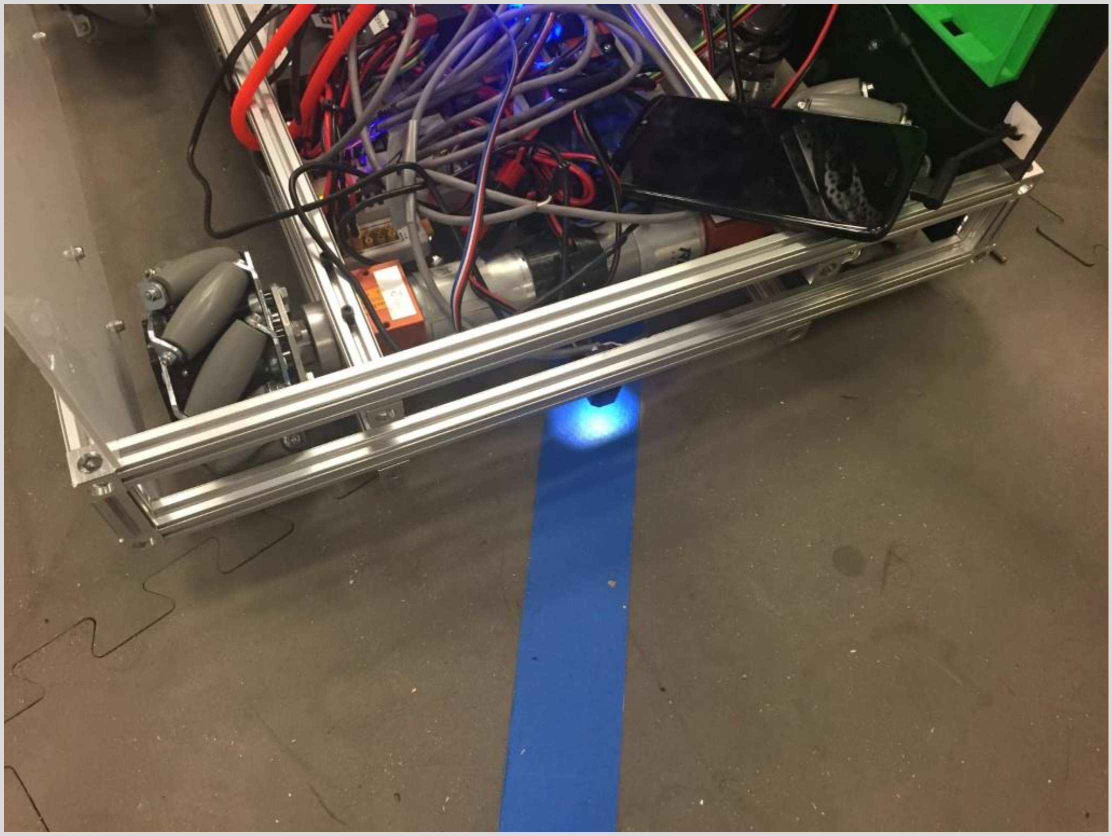
Students:	Patrick	Bryan	Karthik	Rohan
Mentors:	**Mr. Prettyman**	**Zach**		

Agenda
Go to lab and work on Autonomous and MMS

Tasks:	
Autonomous	**MMS**
Make Auton	Create transition module for MMS (“Wrist”)

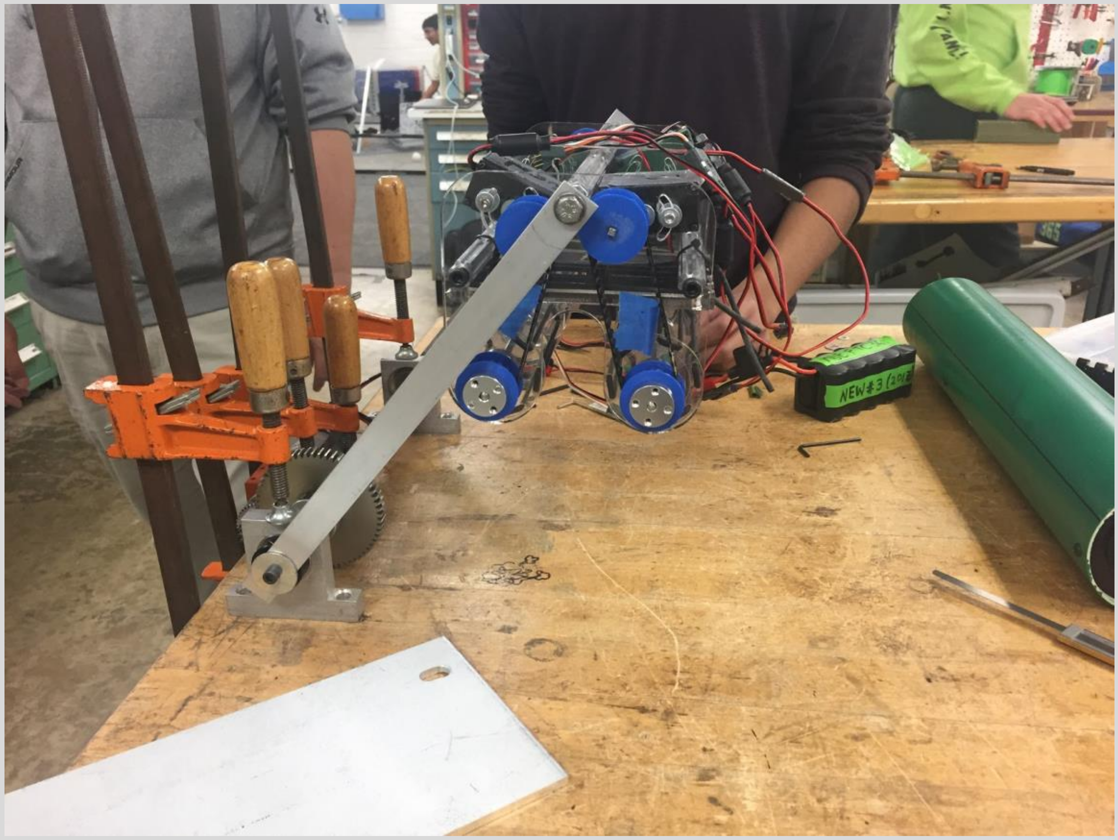
Mechanical Accomplishments:

Chassis

Fabricate Solution: Color sensors	We added color sensors for line following when landing during autonomous. This will help with calibrating the IMU fater landing. 

Mineral Management System

Fabricate a solution: **Wrist**	Because the Minerals need to get into a separate bucket, the harvester needs to be on a rotating wrist to be able to go inside and outside of the robot. This wrist used two bars on

	both ends of the harvester connected by an hexagonal axle. 

Programming Accomplishments:

Autonomous	
Tweak: **Align with line**	Because dropping with a heavier robot can cause more drastic errors, we needed to tweak our dropping method. Rohan and Karthik worked on implementing the new color sensors, allowing our robot to be in a more consistent location after landing. We used the line in front of the lander to adjust our robot's turn by making sure the front and the back of the robot line up with the line. This means we can reset our angle for a more robust autonomous, even if our drop is off

Non-Technical/Discussion:

Date: 1/15/19

Duration: 5:00 PM - 8:30 PM

Tuesday, January 15, 2019 Meeting

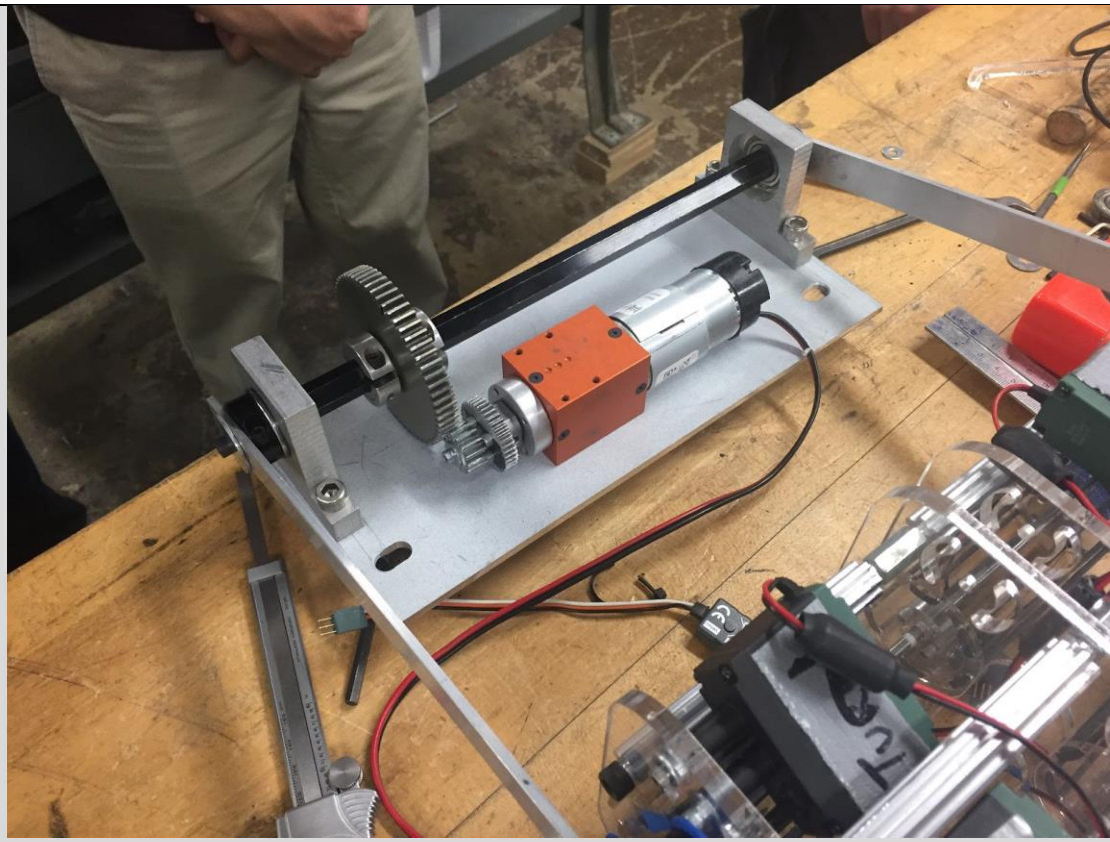
Students:	Bryan	Patrick	Connor	Rohan	Clare	Karthik	Jonas
Mentors:	**Mr. Prettyman**	**Mr. Price**	**Zach**	**Mr. Szeto**			

Agenda
Work in the lab for an hour, then meet in the conference room at 6:00

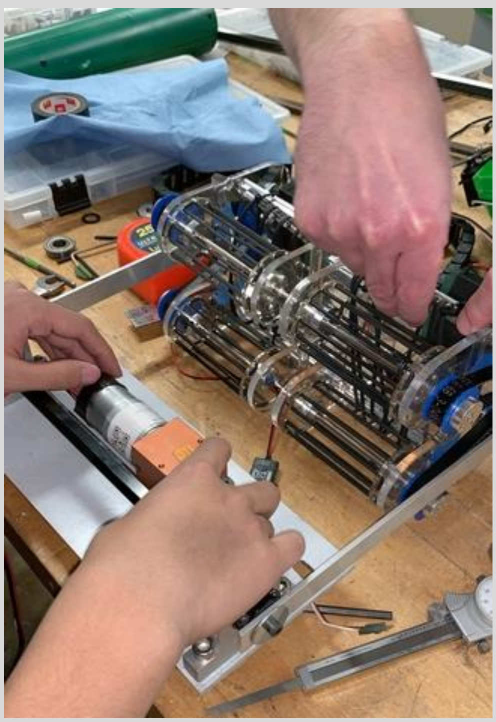
Tasks:	
Mineral Management System	**Autonomous**
Work on the Mineral Management System.	Work on Autonomous.

Mechanical Accomplishments:

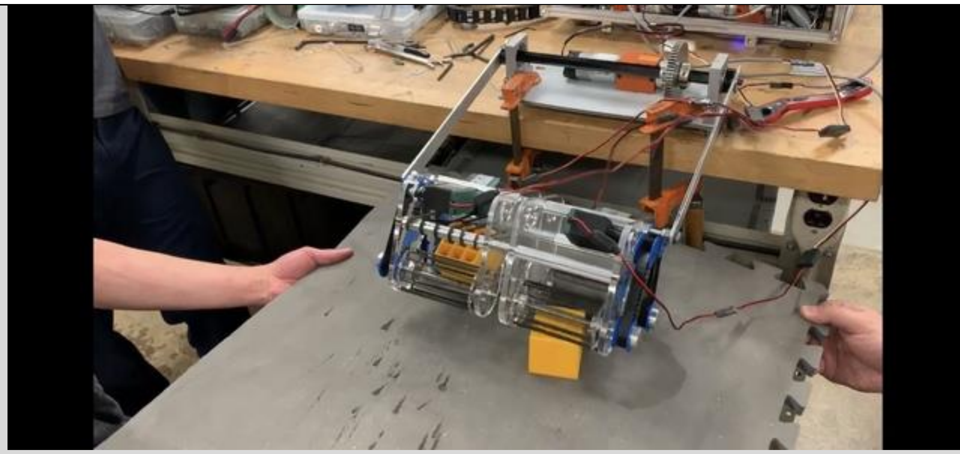
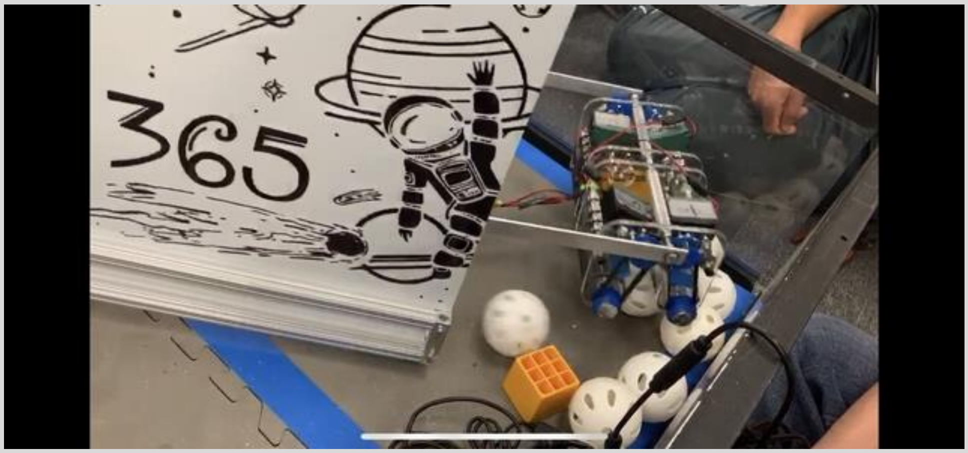
Mineral Management System	
Fabricate Solution: Rotating Harvester	Although we decided to use a Hex axle for its ease during maintenance, it did prove difficult to adapt our hardware for the hex. First, we needed to find an ample amount of collars to keep everything that's on the axle in place. We used two pillow blocks that accepted bearings with hex holes and mounted that onto a thick plate of aluminum. Earlier testing showed that, although the motor was calculated to be able to handle twice its current load, it may need more leverage. Because of this, we made sure used thick steel gears with deep teeth and geared 4:1, giving us eight times the torque needed to handle the load. An axle was machined using the lathe to be able to fit into the motor hole, but keep half of it hex-shaped, so that we could put the proper gear on it.

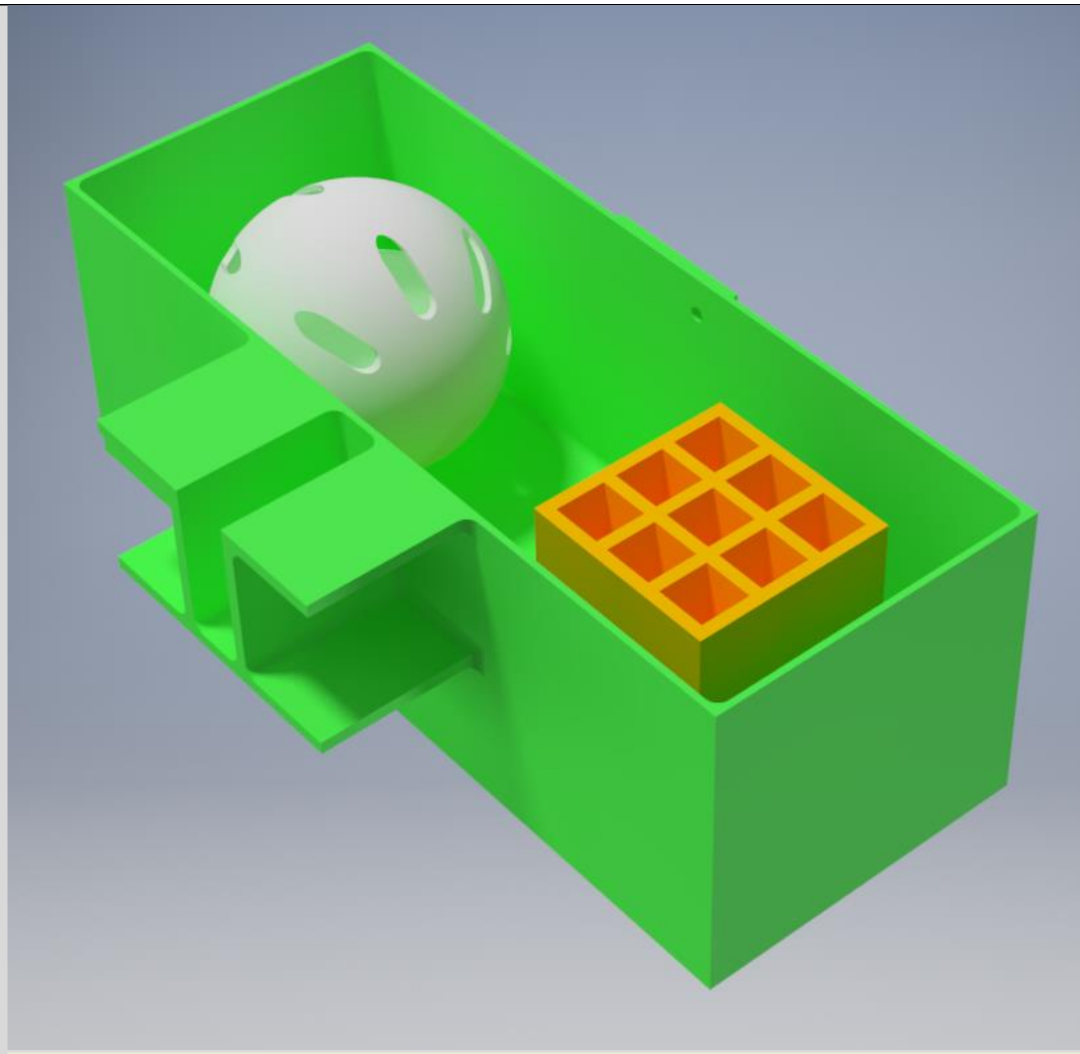


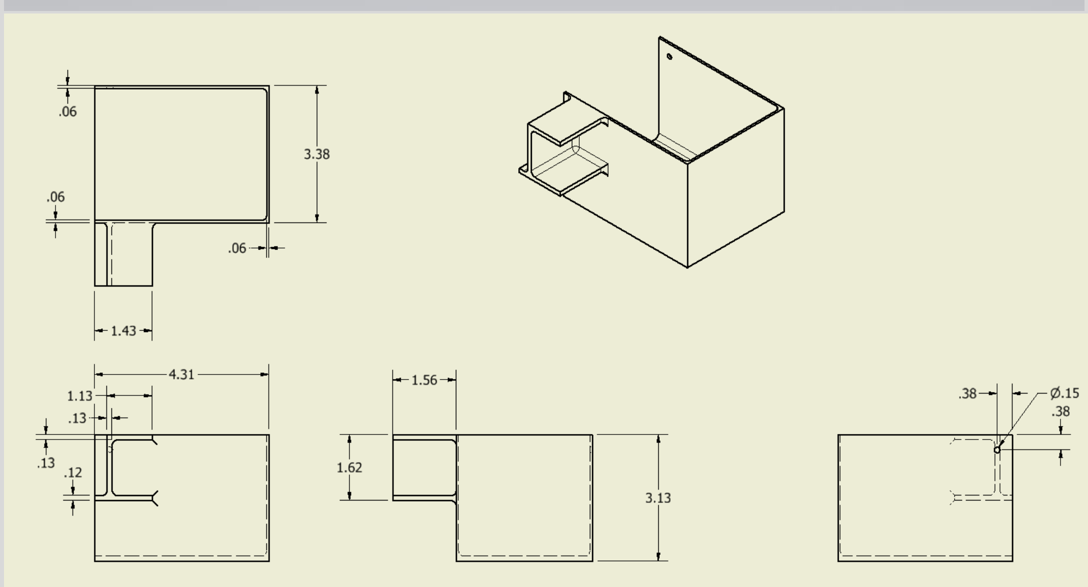
Before testing, we had to make sure the net was redone correctly so the minerals can happily sit inside the harvester.



We wanted to see if we were happy with the results, so we clamped it onto the robot and drove around with it, harvesting minerals and depositing them into our depot.

	  Overall, we're pretty happy with the results, so we decided that we're ready to continue with the next project and leave this one as is.
Develop a Solution: mineral bucket	Connor Made minor adjustments to Ian's design of the bucket. He also had to make it 2 different parts because it didn't fit in the printer.

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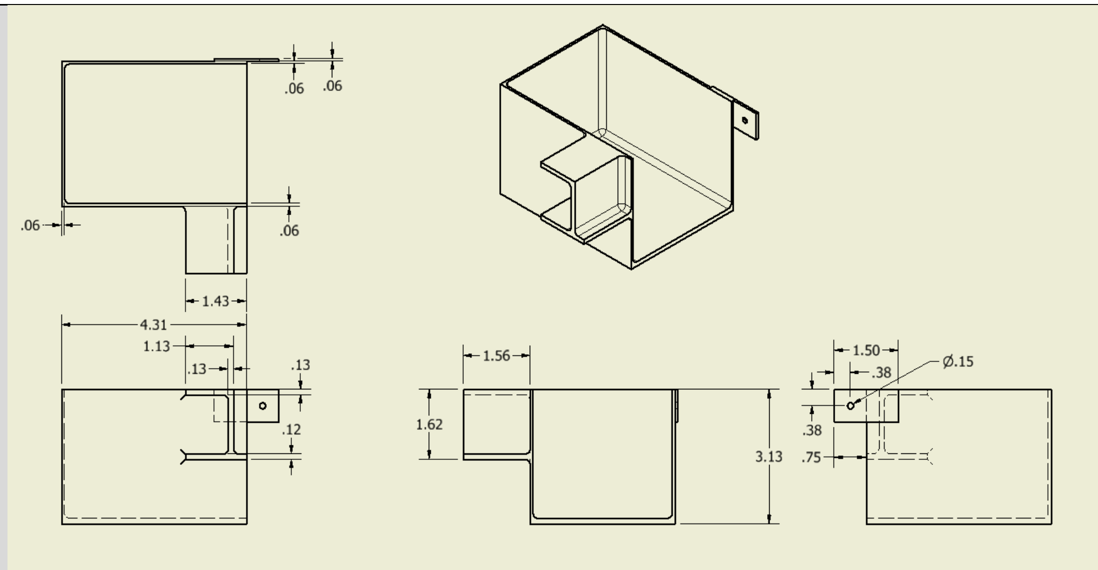
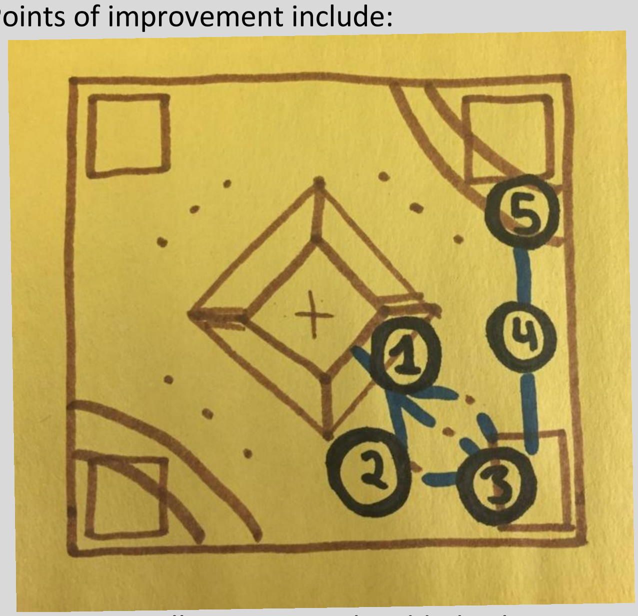


	Andrew began printing the first part of the bucket during this meeting, and it will be finished printing by the next meeting. Then we can print the second part of the bucket.

CAD	
Problem: CAD	There is not enough CAD in the notebook. Also, the CAD is a bit behind and not very good.
Tweak: dimensioned drawings	Connor decided it was time to start using CAD drawings with dimensions instead of just screenshots from the program. An example can be seen with the bucket CAD earlier in this notebook entry.
Tweak: JoyToKey Software	Connor also downloaded the JoyToKey software. This software allows him to use controllers such as an Xbox360 controller or Nintendo Switch Joy-Cons to control the mouse and keyboard. He will be using this software for a few meetings to see

	if it can improve his CAD efficiency. 

Programming Accomplishments:

Autonomous	
Evaluate: New Autonomous	Now that we have the webcam and color sensors mounted onto the chassis, we can start to fully redesign the autonomous. To do this, we will program step by step in order to ensure consistency. Points of improvement include:  1. We will use our newly added color sensors to align with the colored tape after landing. This will make our position more consistent throughout the first part of autonomous.

	2. After sampling on our mineral field, we would like to store this information so we can also sample on our alliance partner's mineral field. 3. We will look to spend less time in the depot area to decrease the chance of colliding with our alliance partner. 4. We will try to run directly along the wall to avoid hitting the opposite sampling field. 5. We will end right along the edge of the crater and then open up our MMS into the crater so we will be immediately set up to start scoring minerals in TeleOp.
Evaluate: Detaching from Lander	To begin our rewriting of autonomous, we started with the first step – lowering and detaching from the lander. First, we had to set up a new pair of phones and configured them to fit the new robot.

Non-Technical/Discussion:

We want to make our notebook entries more data driven so it will be easier for readers to understand why we are changing/making something. To do this, we will aim to incorporate more spreadsheets, graphs, and data-backed explanations.

- **Make a list of what we need to do before Delaware states**
- **Be able to outscore two opposing teams**
  - **Autonomous is priority**
  - **Sample both gold minerals?**
  - **Add odometry wheels to increase consistency?**
  - **Consistently scoring 6 minerals will be very helpful**
- **Should we use old robot or new robot?**
  - **We will use whichever robot can score more consistently**
- **Judging presentation**
  - **1-1.5 minutes about robot, 3-3.5 minutes outreach, business plan, notebook**
  - **We should have a more detailed plan to ensure that we hit all important points**
  - **Should have an emphasis on what makes our team unique**
    - **Active 12 months a year, willing to help all teams, seek opportunities to help underserved communities**

Date: Friday, January 18, 2019

Duration:

Friday, January 18, 2019 Meeting

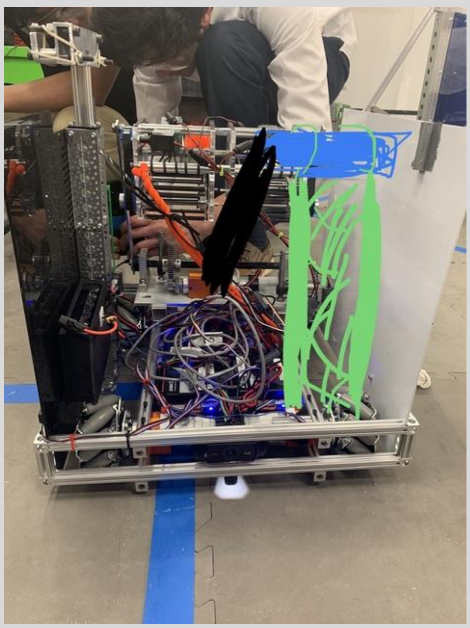
Students:	Connor	Bryan	Patrick	Rohan	Karthik
Mentors:	**Mr. Prettyman**	**Andrew**	**Zach**		

Agenda
Attempt to improve our new robot to the point where it can score more than our old robot, and be able to do it consistently

Autonomous	Chassis	MMS
Fix and debug A* with higher resolution	Brace chassis so the robot stays above 4 inches during autonomous	Finish the rotating arm for scoring minerals into the lander

Mechanical Accomplishments:

MMS	
Develop a Solution: Rotating Arm	The plan is to drill a hole for the motor shaft to go through the carbon fiber. Then drill holes parallel to the motor shaft, and tap threads into the motor shaft to act as a strong set screw.

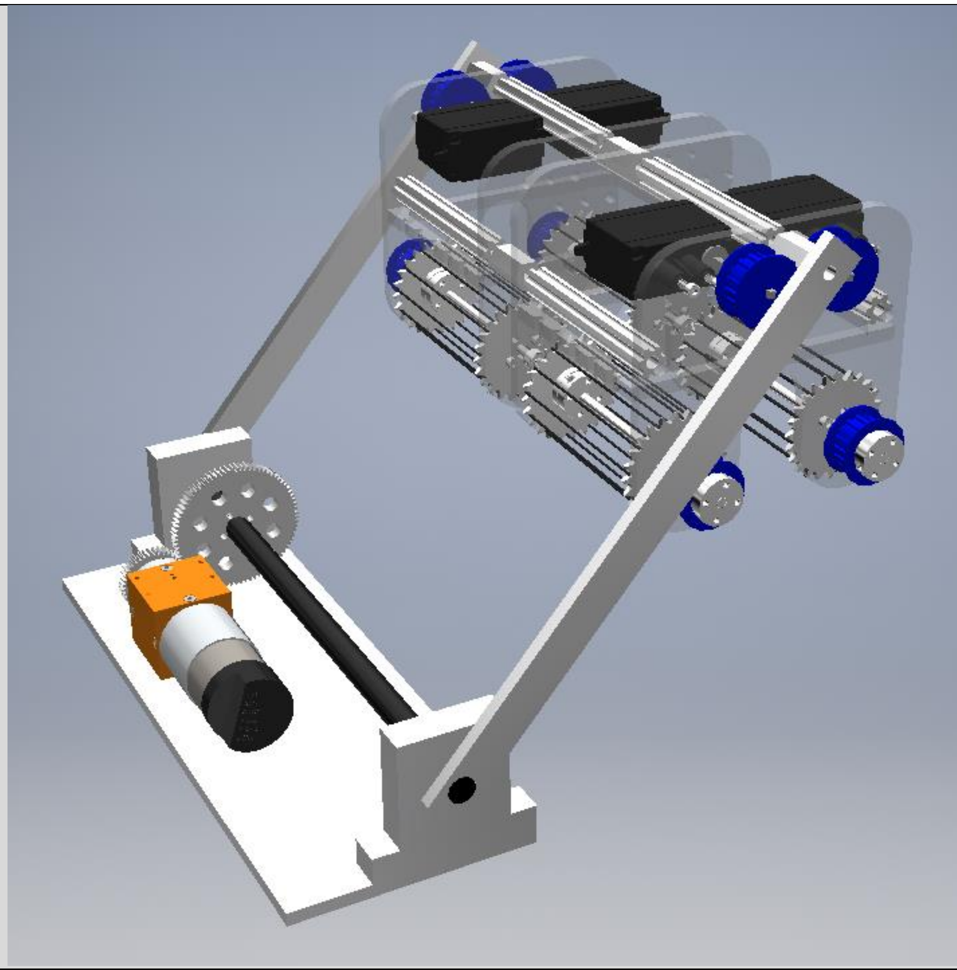
	 It will then be mounted on the back of the robot, and placed like such: 
Fabricate Solution: Rotating Arm	We marked a center hole and drilled a hole .1100 in diameter, which is the recommended size for a 6-32 tap. All went well in terms of drilling the hole and tapping it; however the tap snapped in the process of taking the tap out.

We ended up successfully getting the tap out by putting the reverse end of the tap into the drill press and turning the drill press on until there was no more material left to bite. The rest was able to be screwed out by hand.

By the end of it, we were able to get the screw to thread correctly, however, the tap was too small to accept a 6-32 screw, but a 4-40 screw worked just fine.

We then wanted to figure out how to mount the robot. We knew that we wanted to use REV beams attached to a Tetrix motor mount, but this quick idea wasn't the best and will be revised later.

	
Develop a solution: Harvester	CAD for the harvester has been continued.



Programming Accomplishments:

Autonomous	
Construct and Test a Prototype: Encoder Calibration & Path Following	To ensure a reliable autonomous, we knew that our path following needed to be accurate. This relies on the encoder ticks of our wheels. Because our robot does not have equal weight distribution, we ran into problems with uneven strafing, especially towards the heavier side. We ran tests to calculate Encoder tics per inch when going forward, strafing, and going diagonal, but the the encoder values were not always reliable. We need more testing. We also tested the reliability during A* tests, and it would get to the general area, but it would run into obstacles, and be fairly off of the desired positon.

Date: 1/19/19

Duration: 8:00 AM – 4:00 PM

Saturday, January 19, 2019 Meeting

Students:	Clare	Connor	Katy	Karthik	Jonas	Bryan	Patrick	Paige
Mentors:	**Mr. Prettyman**	**Andrew**	**Zach**					

Agenda
MMS team go directly to the lab, everyone else work in the conference room

Tasks:	
MMS	**Autonomous**
• Work on Linear slide • Work on rotating arm • Finish bucket	Tweak Path following

Mechanical Accomplishments:

MMS	
Design and Test a Prototype: Mineral Holder	Jonas and Paige worked on prototyping the box that would go on the end of the rotating arm. It would hold the two minerals while they were being transported up to the Lander, and they needed to mount a servo onto to the end of it. This would prevent the minerals from falling out until the box was positioned above the Lander.

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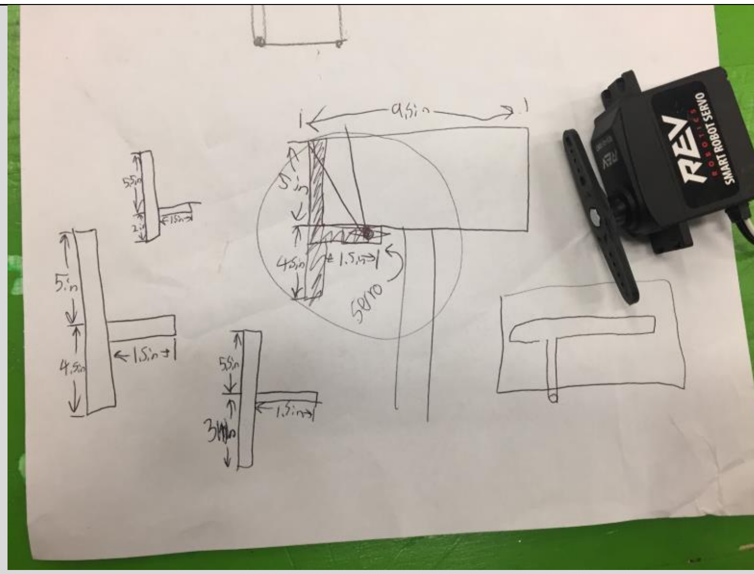
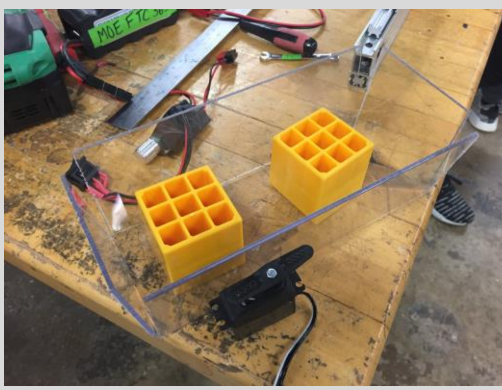
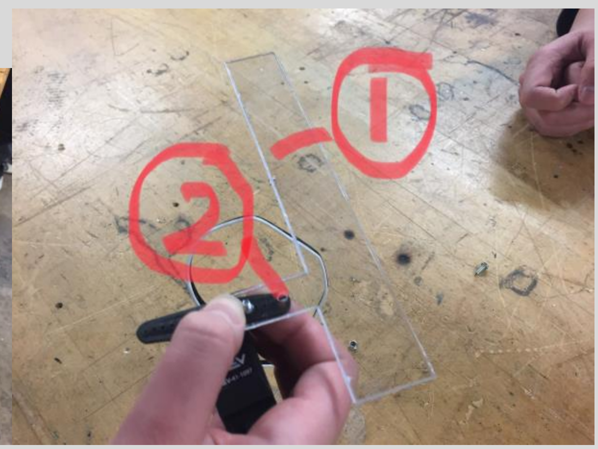


They needed to find the right spot to put the servo, as seen in the drawing above. They also needed to calculate and plan out the correct length of the servo arm so the minerals would be dropped smoothly and quickly.

The dimensions of the final arm were:

- 7.5 inches x .75 inches (piece #1)
- 1.5 inches x .5 inches (piece #2)

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<tr>
<td>Design and Test a Prototype: Rotating Arm</td>
<td>
Bryan worked on constructing the long rotating arm that would lift the minerals up to the lander. He used carbon fiber because it is both strong and very light.

Then, he mounted it onto the robot.
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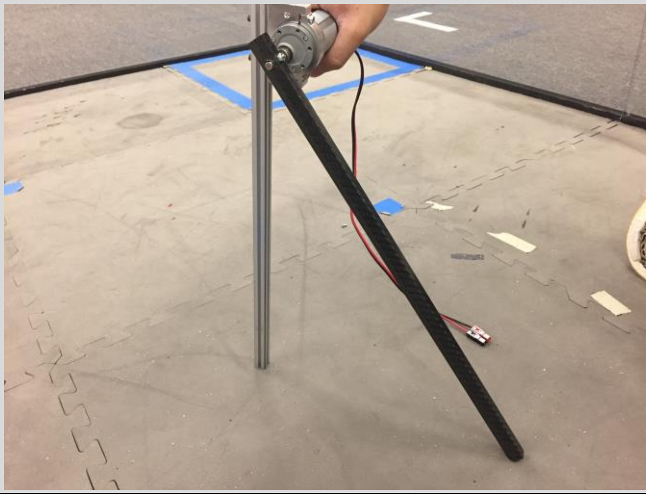
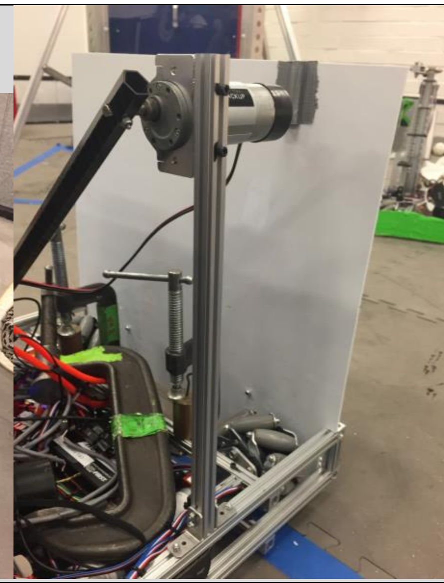
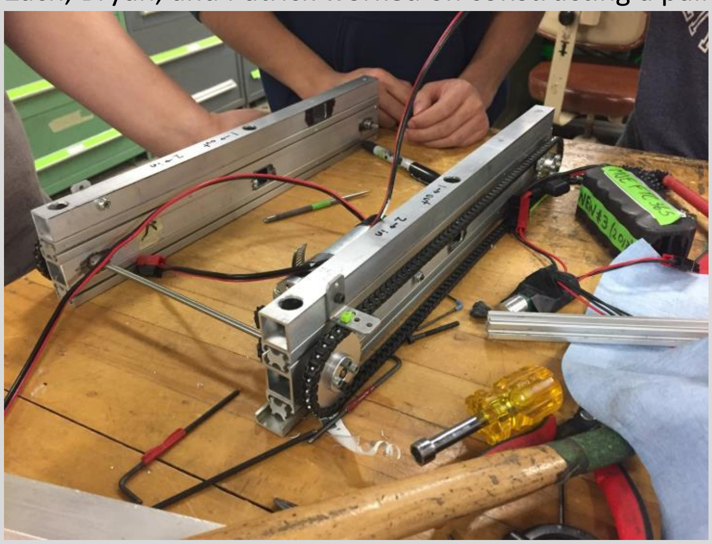
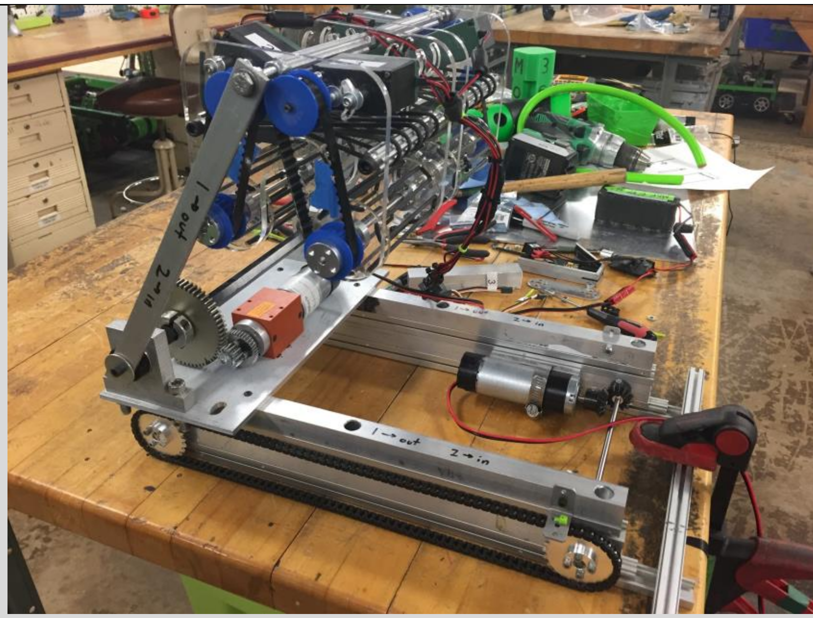
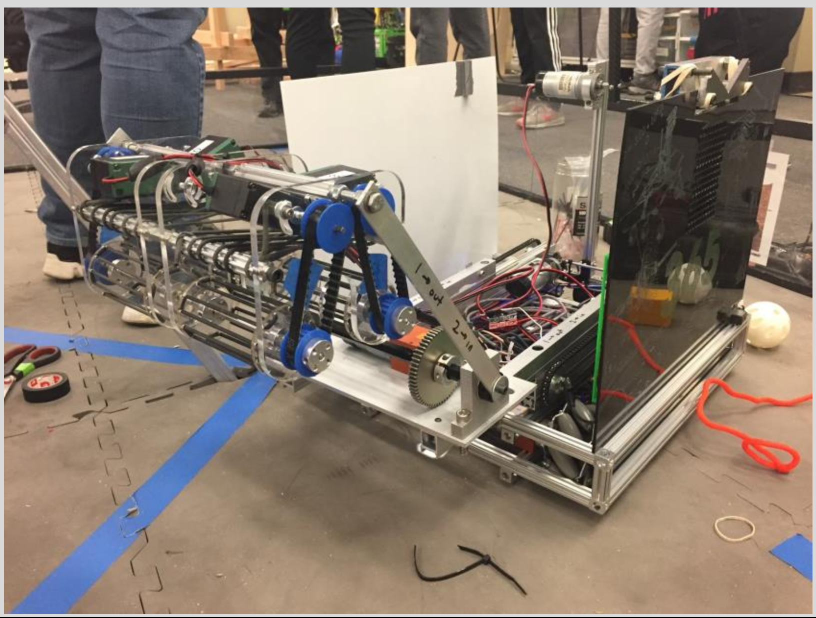
	 
Fabricate Solution: Linear Slides	Zach, Bryan, and Patrick worked on constructing a pair of chain driven linear slides.  We tested it to make sure that it extended properly.  After testing them, they mounted the harvester section onto the linear slides.

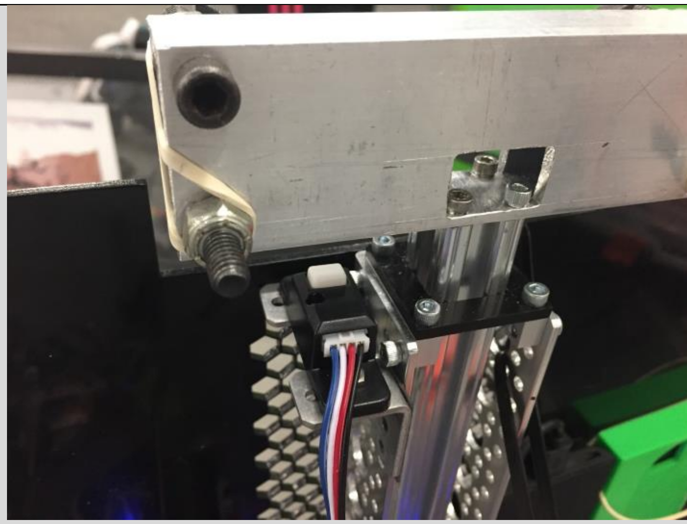
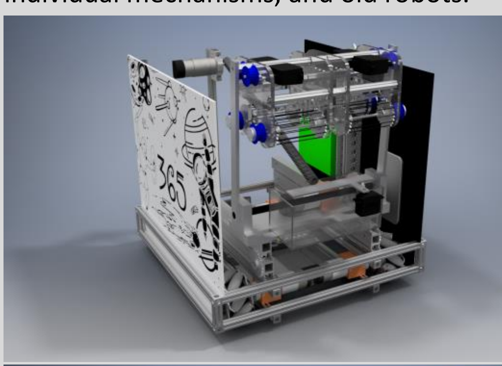
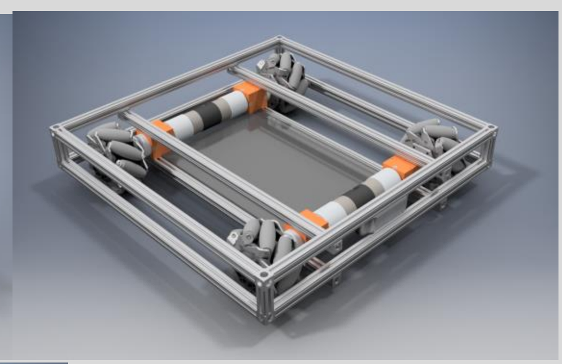
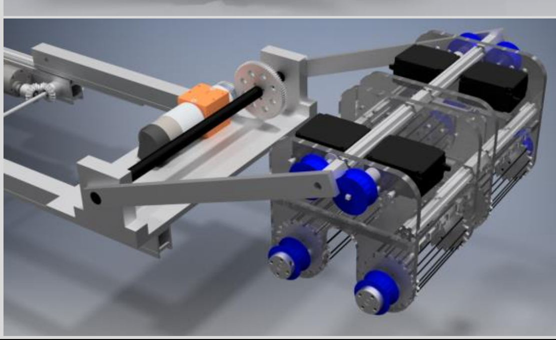
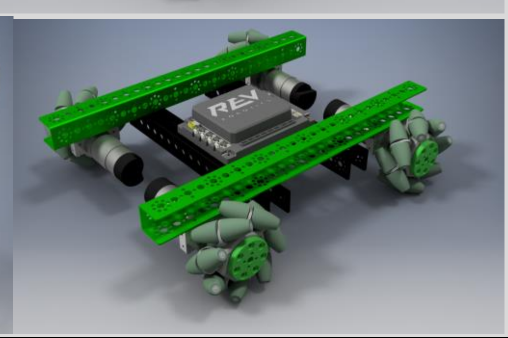


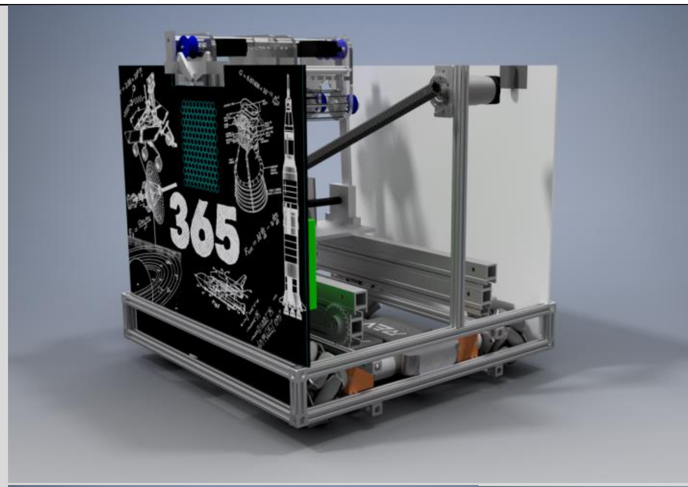
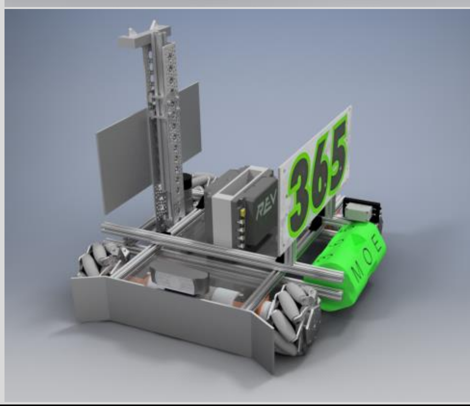
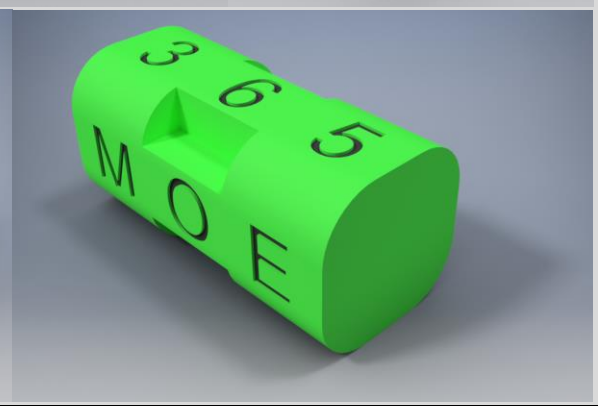
Then, they mounted the entire section onto the robot. Since we have no mounting material to drill into it, we just zip-tied it into place for testing and will work on a proper mount later made out of REV beams to attach to the outer frame of the chassis.



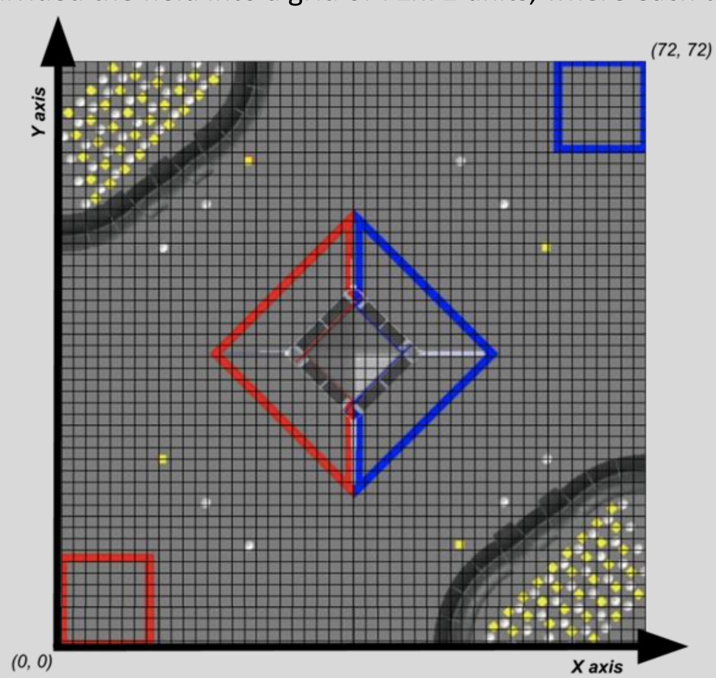
Chassis

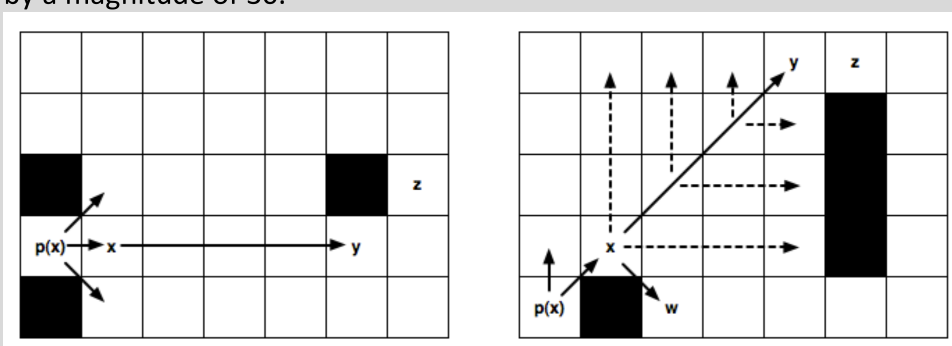
Fabricate Solution: Touch Sensor	Patrick installed a touch sensor underneath the top of the linear actuator. This was important because it would help the programmers maneuver the linear actuator more accurately during autonomous, which would help ensure consistency with our program. It would also protect the mechanism from breaking if the motor was accidentally rotated too far or in the wrong direction.

	
CAD	
Evaluate: JoyToKey Software	By now Connor has tested the JoyToKey software with both Nintendo Switch and Logitech controllers. He thinks that using controllers is more efficient than using mouse and keyboard. Although moving the cursor with a control stick is more difficult than using a mouse, using a controller is useful because he can assign shortcuts to various buttons. He has already assigned shortcuts for copy, paste, undo, redo, constrain, dimension, free move, measure, extrude, new, save, open, create sketch, and place component, and he can theoretically create up to 21 more.
Fabricate Solution: Create renderings	Connor mostly finishes the robot CAD during this meeting. He decides to create high-quality renderings of his CAD for use in the judging presentation and on display in the pit. These can take up to an hour and a half each to render, so he took the CAD computer home and made them on Sunday. He made a total of 8 pictures, showing, the robot, individual mechanisms, and old robots.    

Programming Accomplishments:

Autonomous	
Define Problem: A* Algorithm	Rohan and Karthik wanted to improve upon A* algorithm. Originally, we had divided the field into a grid of 72x72 units, where each unit was 2 inches x 2 inches. 

	While this solution had originally fit our needs, the 2 inch units were too large for precise pathfinding.
Generate Concepts: Improved pathfinding	Initially, we planned to simply divide the field into a grid of 288 x 288 units (.5 inch x .5 inch units) and continue using A* algorithm. However, we soon ran into a problem – the pathfinding became exponentially more complicated. It took almost 90 seconds to finish a calculation! Though we wanted to stick with A* because of the limited time before competition, it was unreasonable to use it when it took almost a minute to find the best path. We had to come up with a new solution.
Develop a Solution: Jump Point Search	The first idea that we attempted to solve this problem was to simply optimize A*. However, we found that most of the major optimizations we could do were already implemented. This meant that we were forced to look for a different algorithm. Searching through various tree search (pathfinding) algorithms, we found one called “Jump Point Search (JPS)” We decided to go with JPS, which is an optimized form of A*. Unlike A*, which goes through every pixel on the field, checking various paths that might not be even remotely close to the destination, JPS prefers straight “jumps” along the field. This means that instead of analyzing every complicated path, our pathfinding algorithm quickly try to draw straight lines to our destination, avoiding obvious paths that wouldn’t be of advantage. This, in theory, should drastically reduce the amount of processing that needs to be done in order to find a path, reducing calculation times by a magnitude of 30.  **A* Algorithm** • Pros: flexible, effective • Cons: slow to run **Jump Point Search** • Pros: runs very quickly, does not check paths that are guaranteed to be sub-optimal • Can only be implemented on uniform-cost grid We converted our existing A* Algorithm to Jump Point Search. However, attempting to run it on the robot was not successful by the end of the meeting, but we plan to continue and fix it next meeting.

Non-Technical/Discussion:

We have one week before the Delaware State Championship!

Katy, Clare, Jonas, and Paige finished the pit display trifold board.

MOE FRC was working in the lab, so everyone who wasn't working on mechanical tasks stayed in the conference room.

We need to edit our judging presentation.

- **We should emphasize our outreach and notebook more, while only highlighting mechanical and programming accomplishments**
- **Involve more people – Clare talks about outreach, Karthik and Jonas talks about programming**
- **We will get a rough script together before Tuesday's meeting**

Date: 1/20/19

Duration:

Sunday, January 20, 2019 Meeting

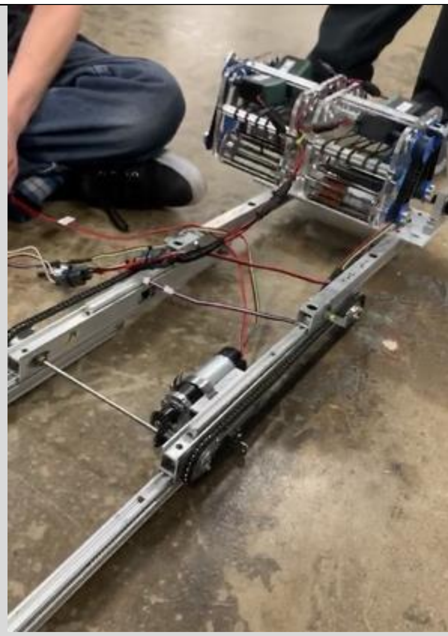
Students:	Patrick	Bryan	Karthik	Rohan
Mentors:	**Mr. Prettyman**		**Zach**	

Agenda
Go straight to lab and work on autonomous and MMS

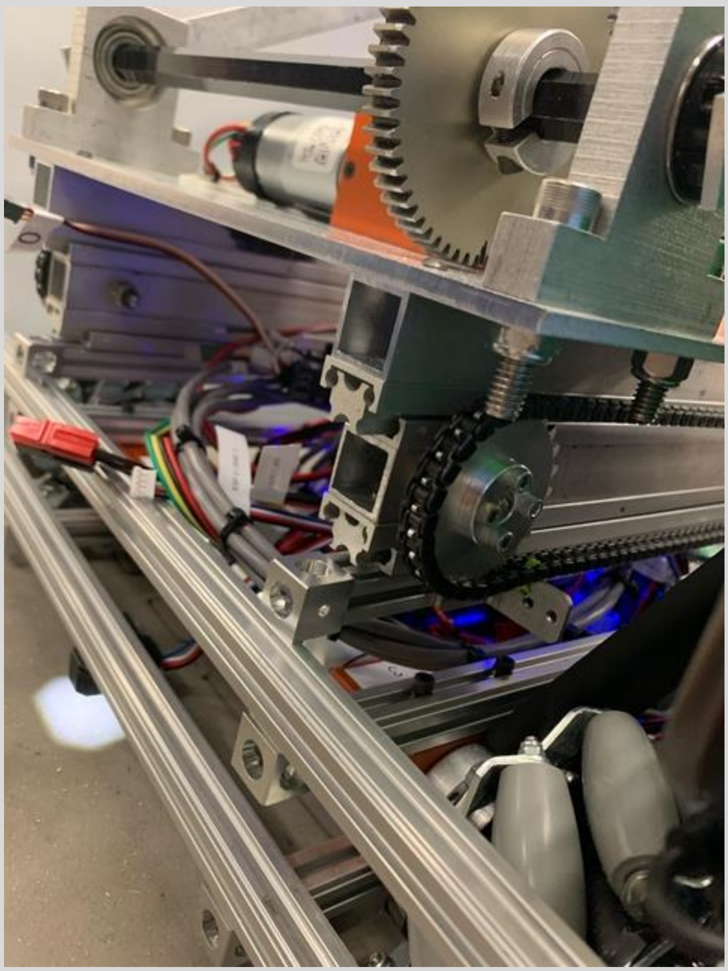
Tasks:	
MMS	**Autonomous**
Finish linear slide of MMS and mount it	Continue tweaking path following

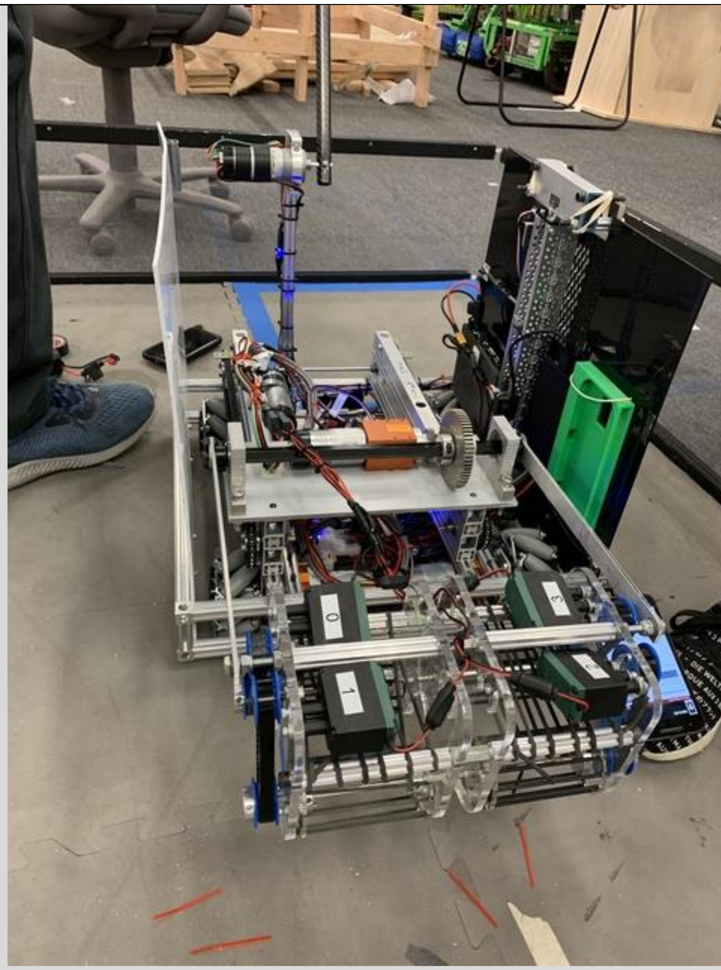
Mechanical Accomplishments:

MMS	
Fabricate Solution: Linear Slides	We mounted REV beams to the bottom state of the linear slides and attached it to the chain. This way, it will be easy to mount because it's compatible with the chassis, and there's room to pin the chain. We tested it by extending it with a motor tester.



We mounted it on the chassis afterwards.



Programming Accomplishments:

Autonomous	
Tweak: Jump Point Search	Our previous attempt at Jump Point Search was not working properly, so we tried finding different ways to implement it. After our 3rd implementation, the algorithm finally worked correctly and we could continue our path following tests
Construct and Test a Prototype: Encoder Values	Before we create an autonomous path, we need to make sure our encoder values are accurate to the robot. We ran tests for the robot to move 2 tiles forward, 2 tiles sideways, and the diagonal of one time and tweaked the encoder values to follow that path Even with multiple tests, the robot still did not always consistently go to the same location, so we might need to set offset encoder values in the future for more accurate movement
Construct and Test a Prototype: JPS Path Following	After tweaking encoder values, we ran the robot using points on the field instead of distances Several tests showed that it was better at strafing towards its heavier side meaning the weight distribution probably caused slippage of the mecanum wheels\

	The algorithm, on the other hand, correctly generated a path from point A to point B meaning we only need to calibrate the encoder ticks We realized that counterweights significantly improved the movement of the robot, but the addition of the linear slide was also sufficient.

Non-Technical/Discussion:

Date: 2/2/19

Duration: 9:00 AM – 2:30 PM

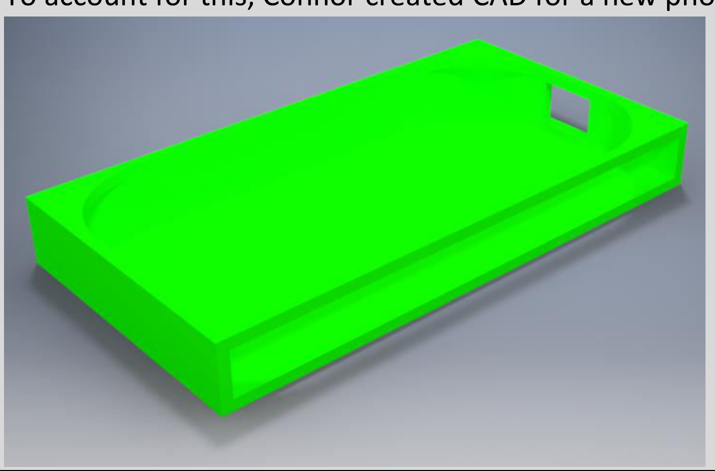
February 2, 2019 Meeting

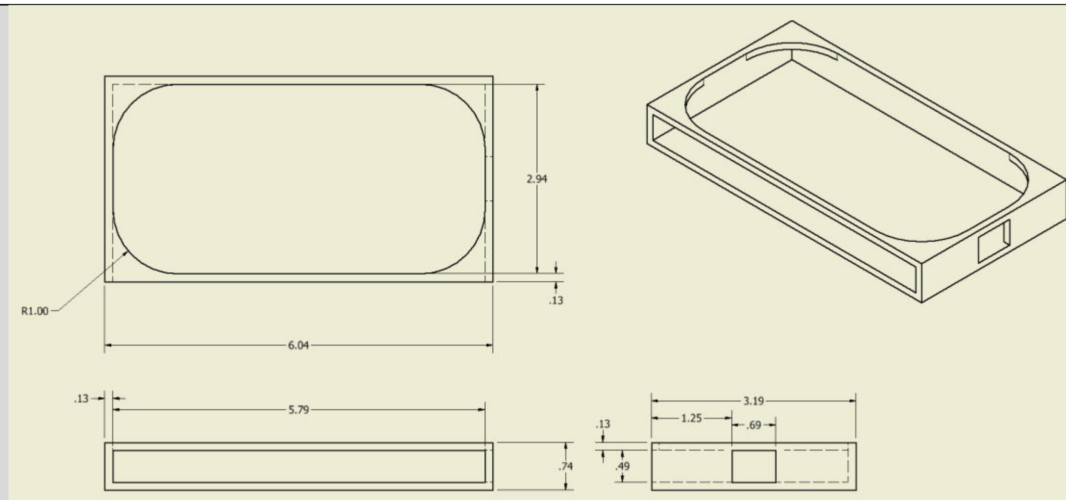
Students:	Paige	Clare	Connor	Ian	Bryan	Jonas	Karthik	Rohan	Patrick
Mentors:	**Mr. Prettyman**	**Mr. Szeto**	**Zach**	**Arnav**					

Agenda
Refocus on new design goals
n projects within each sub tea

Tasks:		
Phone Case	**MMS**	**Programming**
Make a more reliable phone case	Discuss Design Changes with MMS	Discuss Programming and Autonomous Changes

Mechanical Accomplishments:

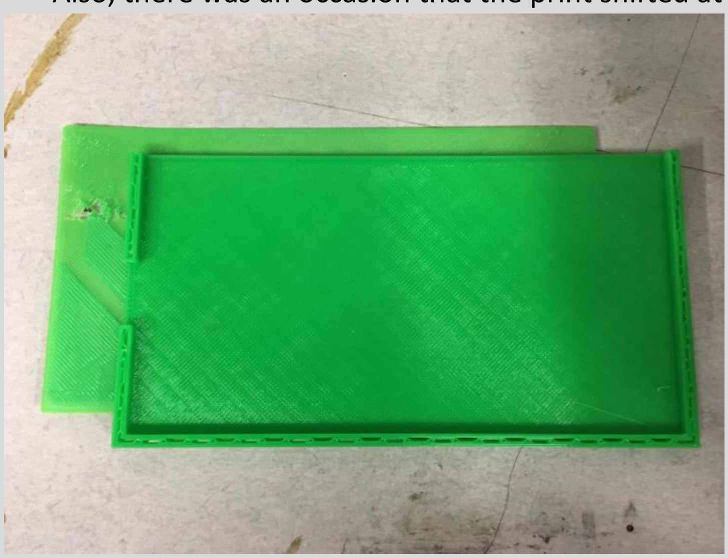
Phone Case	
Problem: Phone Case	There is a problem with the current phone case design. It has a slot on the side, but we would like to be able to insert our phone through a slot in the top so that the phone can be placed in a more secure and safer position.
Develop a Solution: Phone Case	To account for this, Connor created CAD for a new phone case. 



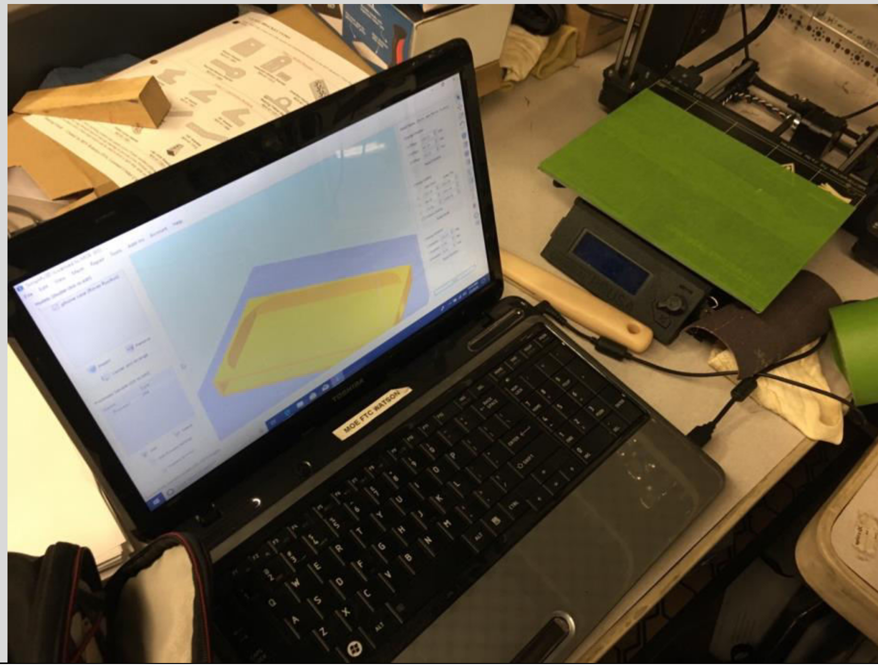
Design and Test prototype: Phone Case

Ian used the 3D printer to make the phone case.

- After Connor finished CAD the phone mount, Ian put the phone mount CAD .stl file into the Slicer program, Simplified 3D
- For the print of the phone case, Ian set it with 0.3 mm layer height, 2 parameters/outer walls, 15% percent infill, and supports on.
- Then, The Slicer made a .gcode file of the phone with the details describe above that the 3D printer can use to print it.
- Next, Ian prepared the 3D printer by preheating the 3D printer extrude and print bed. He also cleaned the extruder nozzle
- Then, he started the printed but stop a few of the print attempts because the first layer was coming out rough from filament that was on the nozzle was smeared onto the print.
- Also, there was an occasion that the print shifted at the second layer



- Then, Ian calibrated the printer and printed it again and the first layer printed perfectly and smoothly

MMS	
Define Problem: Better MMS	While we were happy with our performance at Delaware States, our mineral system was not very effective. This was due to several factors, one of which was time management: 1. We did not have necessary drive practice. 2. We did not have time to implement assisted Tele-Op, so we needed to manually operate each step of the process. Mechanically, there were also problems we ran into. 3. Our harvester was unable to quickly pick up minerals because we needed to be right on top of minerals in order to harvest them. 4. Our rotating arm was not very effective in transporting minerals from the harvester to the top of the Lander.
Generate Concepts: Redesigned MMS	**We made four key design decisions.** **(1) We would like to harvest in the opposite crater.** • This is more of a strategy decision than a design choice. We would like to harvest minerals in the opposing alliance's crater because we will be making it harder for the other alliance to score while making it easier for our partner to score. • 3 robots on their side, versus 1 robot on our side **(2) Smaller form factor for harvester, transition, and scorer** • This will help with control, weight management, and space distribution on

	the robot. • Our old robot was too heavy its center of mass was off to one side, which interfered with movement, scoring, and hanging. **(3) Use a vertical lift rather than a rotating arm** • Rotating mechanisms take up more space because there needs to be extra room set aside to keep their path clear. Vertically moving mechanisms take less space. • Our rotating arm was slow and inconsistent, so a vertically moving slide might be a better option due to a more secure track. **(4) We would like to implement Dump Sort.** • Dump sort is the sorting of minerals as they are being dropped into the lander. • This will make it easier for drivers because they will not have to worry about what minerals they are picking up. • Sorting at the very end of the process seems like the most consistent and simple solution.

Programming Accomplishments:

Autonomous	
Generate Concepts: Future Autonomous	Our primary goal for autonomous is to consistently score the maximum number of points. In order to accomplish this, we would like to implement the following features. 1. Use a more optimized pathfinding, such as PID or Roadrunner. 2. Be able to sample both sets of minerals in autonomous. 3. Score minerals in the Lander during autonomous. Programming list of mechanical upgrades: • Odometry wheels • Team marker starts inside the harvester

TeleOp	
Generate Concepts: Future TeleOp	Our primary goal for TeleOp is to reduce the possibility of driver error as much as possible. In order to accomplish this, we would like to implement the following features.

	1. After viewing the minerals in the crater, the robot should be able to tell its position relative to one mineral, orient itself to face the mineral, and autonomously pick it up. 2. Use Jump Point Search or another pathfinding algorithm to drive back to the correct side of the Lander. 3. Use LED lights to communicate to the driver what kind of minerals the robot has collected, which would be helpful if the robot is harvesting in the opposite crater and the driver can't easily see what the robot is doing. order to accomplish this, we will need to have our webcam able to face into the ter.

Non-Technical/Discussion:

Mr. Prettyman held a meeting in the conference room with parents to discuss hotel and transportation options for World Championships.

Egg Buttons

Date: 2/5/19

Duration: 6:00 PM – 8:30 PM

February 5, 2019 Meeting

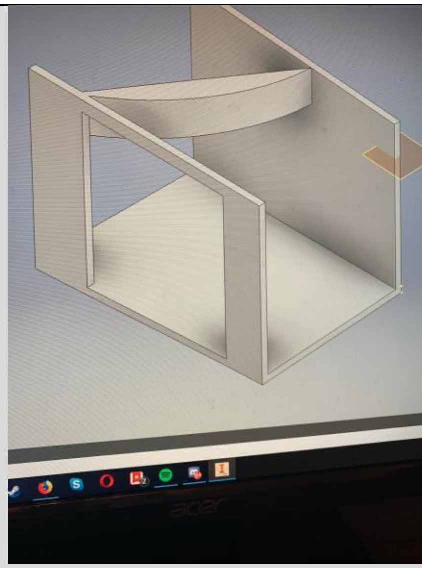
Students:	Connor	Bryan	Karthik	Jonas	Clare	Ian	Katy	Patrick
Mentors:	**Mr. Prettyman**	**Mr. Szeto**	**Arnav**	**Zach**	**Mr. Buckingham**			

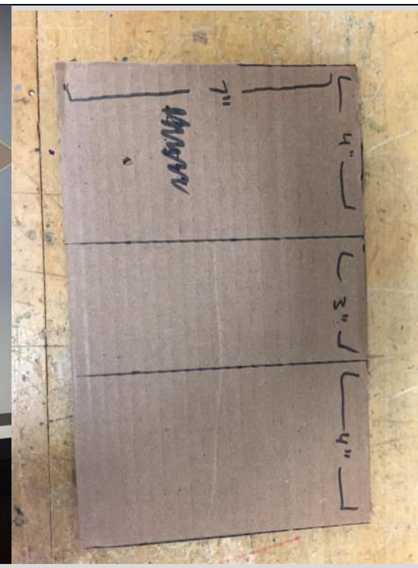
Agenda
Discuss World's Logistics

Tasks:		
MMS	**Autonomous**	**Phone Case**
Prototype Scoring	Tune Odometry Counting	Check the Phone Case Print and discuss changes

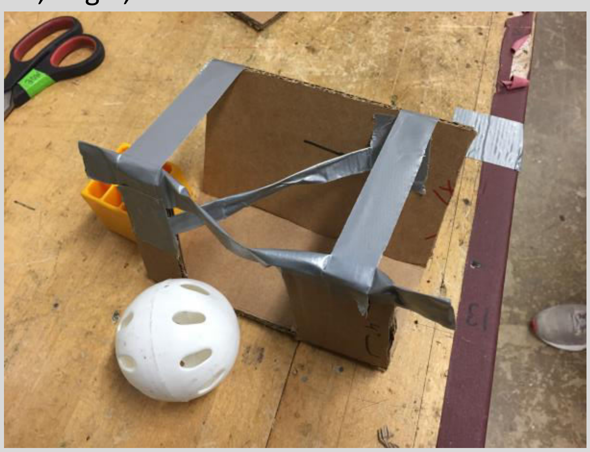
Mechanical Accomplishments:

MMS	
Develop a Solution: Redesigned MMS	Here is a list of criteria we discussed that we wanted on our new mineral management system: **Angled lift for scoring** • Same side as actuator so we can hang when we're done **Single-Feed Harvester** • After analyzing matches, we did not want to finick with harvesting 2 minerals at once **Transfer Mechanism** • Transition would be faster with multiple buckets
Construct and Test a Prototype: Dump Sort	We constructed two different kinds of prototypes for our dump sorting system. We wanted to test multiple different designs so we could see which solution would be the most effective, most space efficient, and most time efficient. First, we made this simple design based off of a CAD picture.

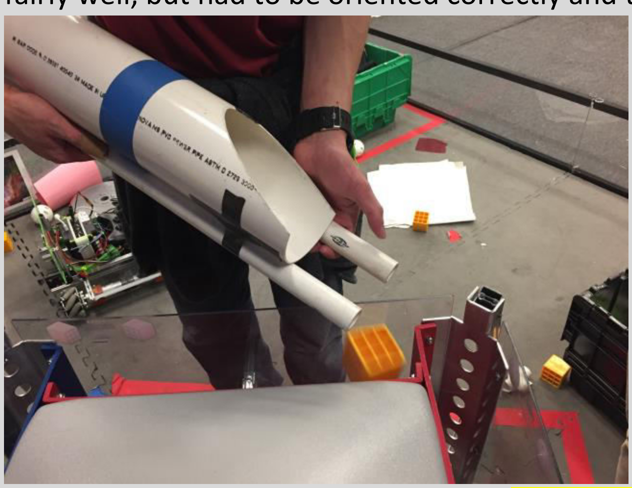




When minerals are slide through the pipe-like container, the cubes slide straight down while the spheres are redirected left. This design proved to be relatively effective and would not take much time to use, as it had a wide margin of error for position, angle, and tilt relative to the Lander.



We also constructed another prototype out of PVC pipe. When the spheres came through, they rolled along the tracks and dropped out when the tracks ended. When the cubes came through, they dropped in between the tracks. This design worked fairly well, but had to be oriented correctly and took more time to use.



Overall, we decided that designing the transition between harvester and dump sort was more important than designing the dump sort mechanism.

Phone Case	
Design and Test Prototype: Phone case	Ian took the finish print of the first version of the phone case off the print bed. Then, he took off the supports. This is what it came out to look like:   This version was a good prototype but did not fit our needs. We were worried that with this design, the buttons on the side of the phone might be pressed on accident by the side of the case.
Develop a Solution: New Phone Case	Ian made a new version of the phone case. The new version has the slot to insert the phone in the top instead of the side. It also had a slot next to where the volume and power buttons were so the phone would not accidentally turn off during a match.

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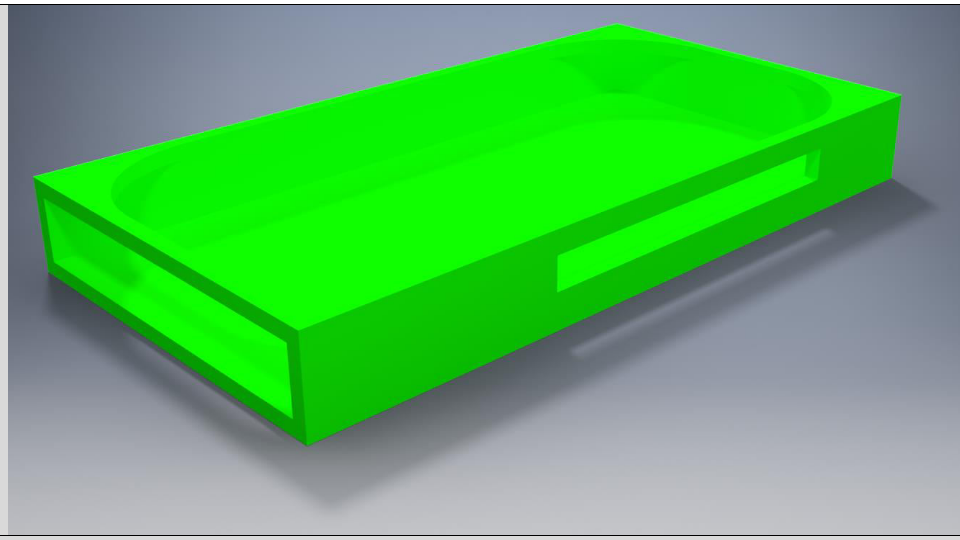
<tr><td></td><td></td></tr>
<tr><td>Design and Test prototype: Phone Case</td><td>Ian Uses the 3D printer to make the phone case.

After Connor finished CAD the phone mount, Ian put the phone mount CAD .stl file into the Slicer program, Simplified 3D
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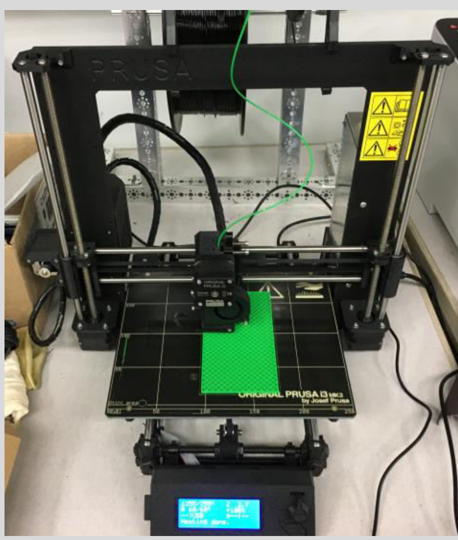

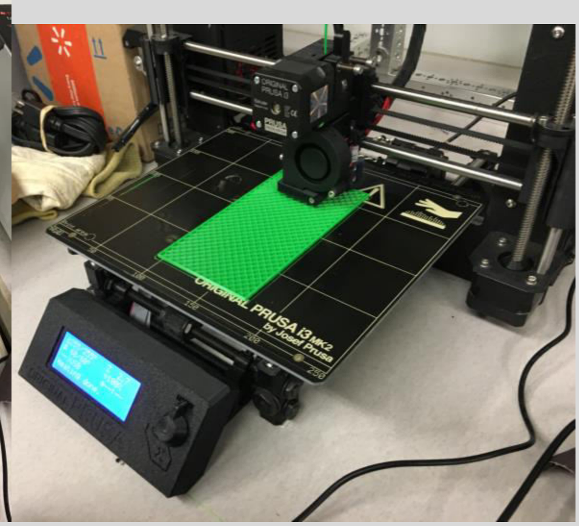
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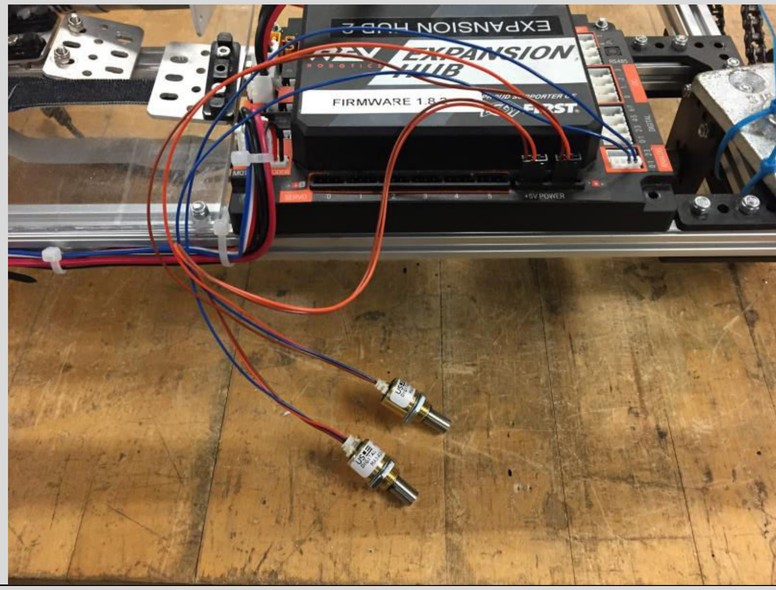
Programming Accomplishments:

Autonomous	
Design and Test a Prototype: Odometry Wheels	One of the upgrades we wanted to make was to add odometry wheels to our robot. Using odometry wheels would make our movement more accurate than if we used the encoders on our motors. This is because the wheels attached to the motors can skid after the motors stop turning, which means that the values we receive may not be accurate. However, the odometry wheels measure the rotation values independently of how much the motors turn, making them more accurate and precise. First, we wired the MA3 encoders onto a chassis. 
Develop a Solution: Encoder ticks counts	The new encoders did not count continuously—it counted from 0 to 5 volts that corresponded to 0 to 360 degrees of the encoder rotation. This means it resets back to 0 after a full rotation. For odometry, we want to track our position so the encoders need to count their rotations, not just know their rotation position. To do this, we tracked if there was a large jump that goes from 5 to 0. Our threshold was a jump that was faster than a 1-volt difference. If the jump is too large, it assumes it made a revolution instead of quickly going back in the other directon. After running a few tests, it worked in the positive direction but did not go negative.

Non-Technical/Discussion:

We have 3 main (non-technical) focuses for World Championships:

- **Photography**
  - we want to record all of our experiences
  - Having a designated photographer will help us document our season

  - **Fundraising**
    - We could ask for sponsorships/donations at a local mall
  - **Social Media Marketing**
    - We used to have active social media accounts but have not added to them recently
    - In order to increase our impact in our community, we should try to keep these accounts updated
- Reminder that there is a March 3rd Deadline for Mechanical team to build MMS
- Team Dragonators asked for help with sampling so we are planning to teach them about using vision code and a webcam
- There will be an FTC Team Rhyme Know Reason programmer on Saturday that is interested in seeing how our team of programmers works together
- Programmers should prepare for Independence school outreach
- Boeing Outreach - looking for more team members
  - Boeing Engineering Week invites JrFLL, FLL, FTC, and FRC teams to showcase their robots
  - Boeing products/production lines will be showcased
  - Delaware team Dragonators will also be there

Date: 2/9/19

Duration: 9:00AM – 2:30PM

February 9, 2019 Meeting

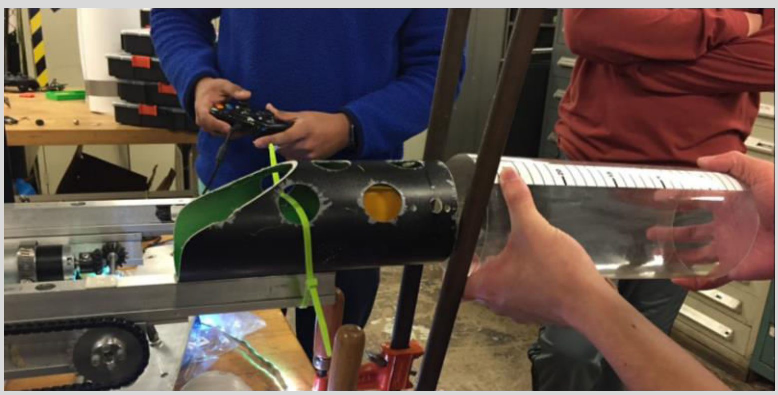
Students:	Jonas	Karthik	Clare	Ian	Connor	Rohan	Marcus
Mentors:	**Mr. Prettyman**	**Mr. Szeto**	**Zach**	**Arnav**			

Agenda
Discuss meeting goals while in the conference room
lit into subteams and work in the lab

Tasks:	
MMS	**Programming**
Test various transfer mechanisms and how to transport minerals up to the Lander.	Figure out how to keep track of rotations for our odometry wheels.

Mechanical Accomplishments:

Phone Case	
Fabricate Solution: New Phone Case	Ian checked on the phone case, which had finished printing.   The print was successful and turned out to be smooth and even. This new design was better than the last one because the phone could be inserted from the top rather, and it had a slot next to the power and volume buttons so that the buttons wouldn't be pressed when the phone moved around in the case.

MMS	
Design and Test a Prototype: Mineral Transfer	Last meeting, we tested several dump sort mechanisms and found many feasible solutions. This made us realize that the transition would be harder to implement than the dump sort mechanism. Because of this, we refocused our attention on the transition between the harvester and scoring lift. We have several ideas, including: 1) Angle the harvester down and let the minerals slide into the lift 2) Have the harvester wheel spin backwards and shoot the minerals into the lift 3) Have the harvester bucket tilt down and roll the minerals into the lift 4) Have the harvester bucket tilt down, and then pull the slide inwards and let the minerals be pushed into the lift 5) After the minerals are harvested, quickly draw the slides back into the robot and let the minerals' inertia cause them to slide into the lift bucket To test idea #5 we set up a tube on a linear slide and held another tube a foot away from it. Then, we loaded minerals into the first tube, moved the linear slide, and tried to move the minerals into the other.  This test was successful. Due to inertia, the minerals easily slid into the second tube when the linear slide moved out and stopped suddenly. We decided that this could be a feasible way to transport minerals from the harvester to the scoring lift. When the harvester slid back into the robot, the minerals could be transferred into a second pipe in the same motion.

Programming Accomplishments:

Assisted TeleOp	
Develop a Solution: Mineral Positioning	One of our programming team's goals was to use assisted TeleOp to eliminate as much driver error as possible. One key part of this included using the webcam to identify a specific mineral that

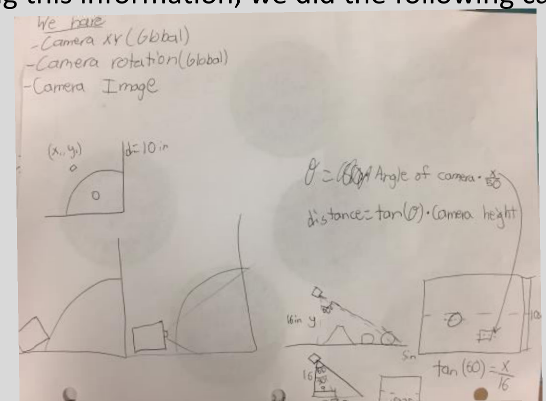
the robot would be able to harvest. This would allow the robot to orient itself in the correct way to harvest the mineral, while getting rid of the possibility of the driver being unable to see into the crater.

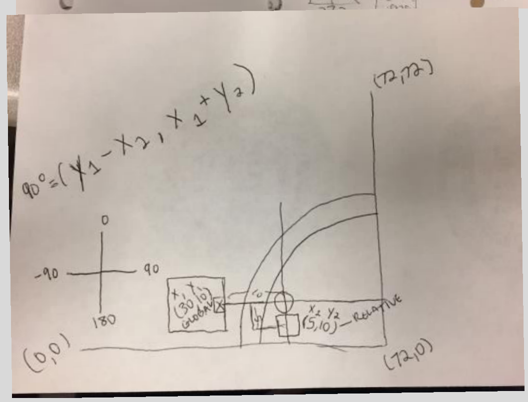
The first step of this was to figure out the global coordinates of a mineral, as viewed by the robot's webcam.

Using our global positioning system, our gyro, and our webcam, we would have the following information:

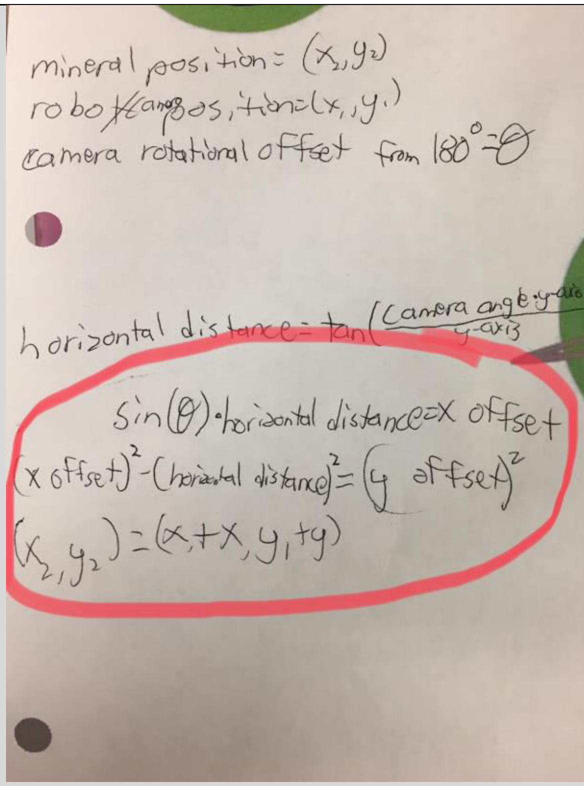
- X and Y position of the camera/robot
- The rotation of the camera/robot
- An image of the mineral, which would allow us to get the (x, y) of the mineral relative to the robot

Using this information, we did the following calculations:





We came up this equation.

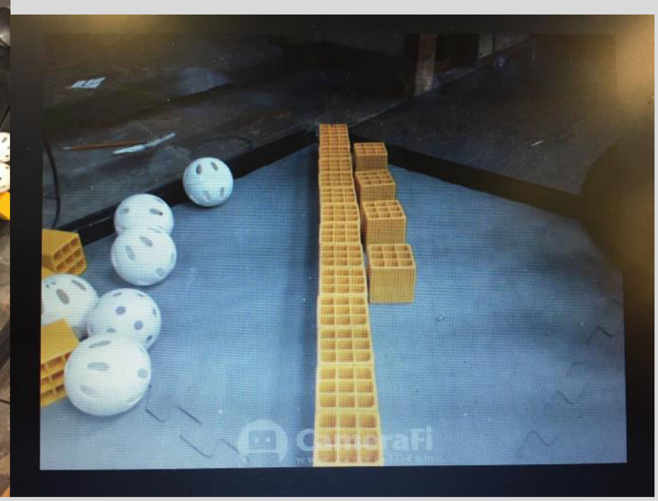


This would allow us to view a mineral, and taking into account the position of the robot, calculate the global coordinates of the mineral.

Then, Clare and Jonas tried to transfer this formula into Java code.

Generate Concepts: Mineral Vision

Next, we took an image using the robot webcam. We wanted to figure out how many inches away an object was based on what its y coordinate was on the image. We placed a straight line of 2 inch blocks coming away from the robot and measured how many inches there were from the robot to the farthest block.

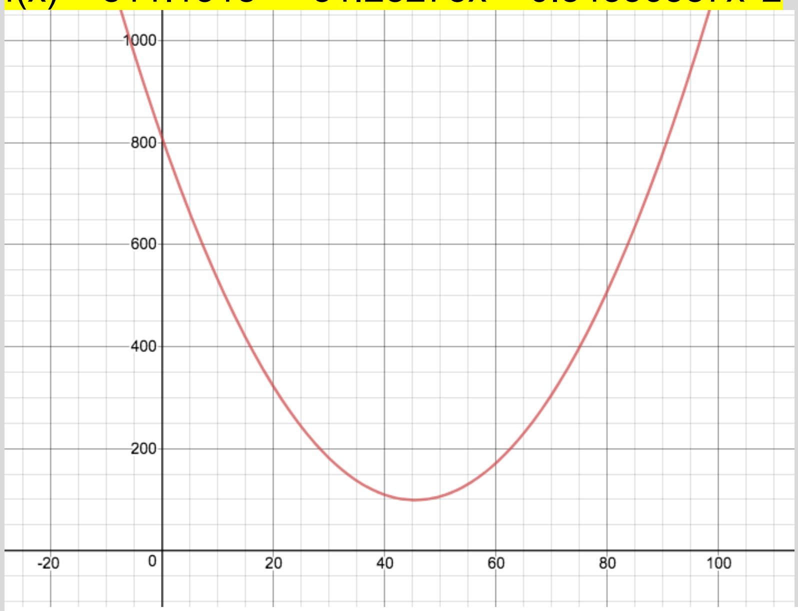
A linear equation would not work for this situation because objects closer to the camera appear bigger than objects farther away. To account for this, we created a table of values based on the image.

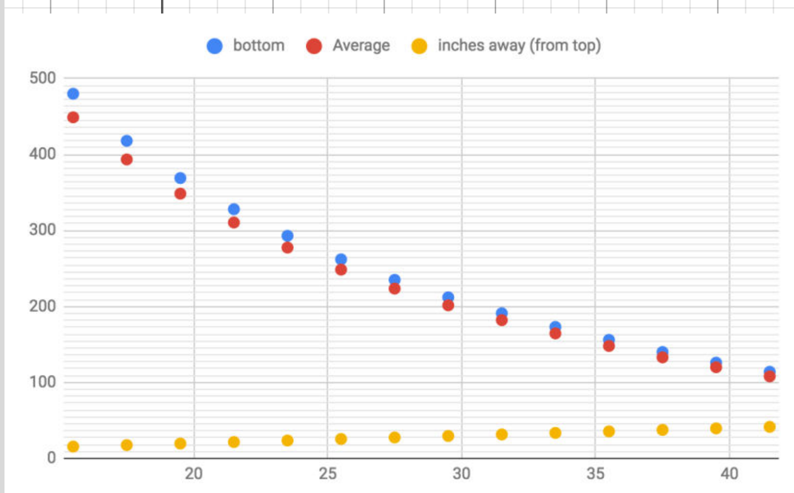
# mineral	Top pixel value	Bottom pixel	Average pixel	inches away

		value		(from top)
1	102	114	108	41.5
2	114	126	120	39.5
3	126	140	133	37.5
4	140	156	148	35.5
5	156	173	164.5	33.5
6	173	191	182	31.5
7	191	212	201.5	29.5
8	212	235	223.5	27.5
9	235	262	248.5	25.5
10	262	293	277.5	23.5
11	293	328	310.5	21.5
12	328	369	348.5	19.5
13	369	418	393.5	17.5
14	418	480	449	15.5

Then, we transferred these values into a quadratic equation.

$f(x) = 811.1318 + -31.28273x + 0.34356387x^2$





Using this equation will allow us to tell how far away a mineral is based on the pixel y coordinate it has.

Non-Technical/Discussion:

A programmer from #8528 Rhyme Know Reason is coming today to see what our programming approach is and how we work together as a team.

Some Assembly Required is stopping in to pick up their engineering notebook, which they left at Delaware States.

Team Dragonators reached out to us to ask about how we identify minerals during mineral sampling. They would like to learn how to implement vision identification and a webcam in order to have a more consistent autonomous. We will invite them to visit us during a future meeting.

One lesson we learned from our Independence FebFest outreach was that we need to make sure that we have all necessary items when we run a demo. We were missing a cable, so the robot was unable to run. Regardless, there was still great interest in our robot.

Marcus and Ian organized Cabinets A and B to make them look cleaner and more organized and easier to find things. Next time, they will organize cabinets C and F (Overflow)

Date: 2/12/19

Duration: 6:00 PM – 8:30 PM

February 12, 2019 Meeting

Students:	Connor	Ian	Bryan	Katy	Clare	Jonas	Karthik
Mentors:	**Mr. Prettyman**	**Zach**	**Arnav**	**Dave**	**Andrew**		

Agenda
Discuss our plans for meeting with Team Dragonators next meeting
ork primarily in the conference room to avoid conflicting with MOE FRC

Tasks:	
Mechanical	**Programming**
Mount odometry wheels	Implement odometry wheel outputs in order to localize more accurately and without seeing a Vumark first.

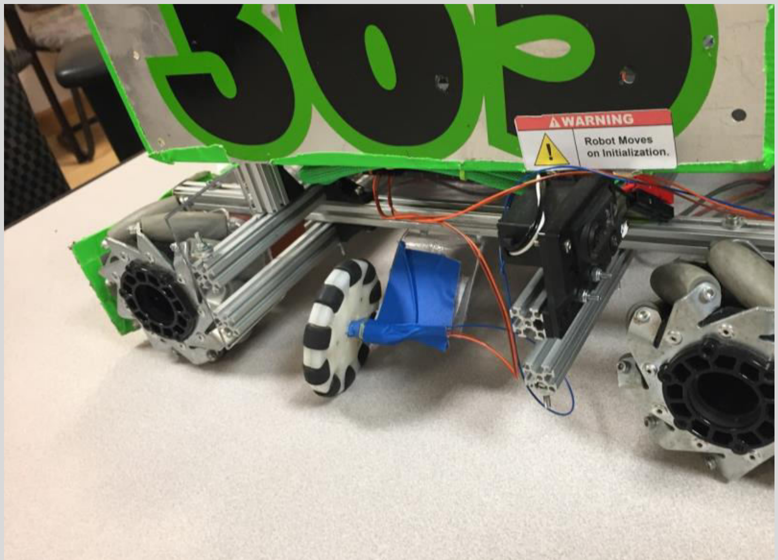
Mechanical Accomplishments:

Odometry Wheel	
Define Problem: Mount two perpendicular odometry wheels	Using CAD, we looked for areas in which we could put odometry wheels. Because the programmers decided to use a 3 inch omni-wheel for odometry, we kept that size in mind. We decided there was the most room in between the frames where the mecanum wheels are mounted to. Unfortunately, the gap is less than 4 inches. This is when we realized that making it a spring-loaded system was less viable. We are leaning towards just making it a plate. The design requirements: • A small plate that can be mounted parallel and perpendicular to the frame but still fit within the 4 inch gap. • A hole that is equal to the outer diameter of the MA3 encoder threads. • A pair of slots for mounting so you can adjust the odometry wheel up and down to get the optimal height for odometry. Connor began to CAD this design and the mechanical team made a quick prototype of the solution to put onto the old chassis so that the programmers could immediately begin designing code.

Chassis

Construct and Test a Prototype: Odometry Wheel

We quickly created a prototype mount of an odometry wheel onto our secondary chassis. This would allow the programming team to start testing code while a more substantial solution was created.



Programming Accomplishments:

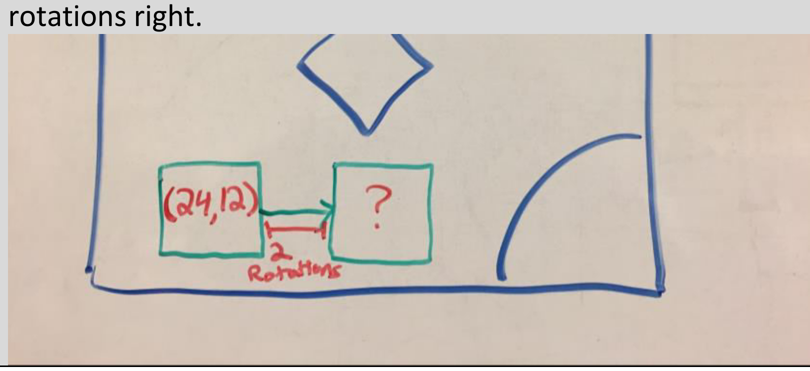
Autonomous

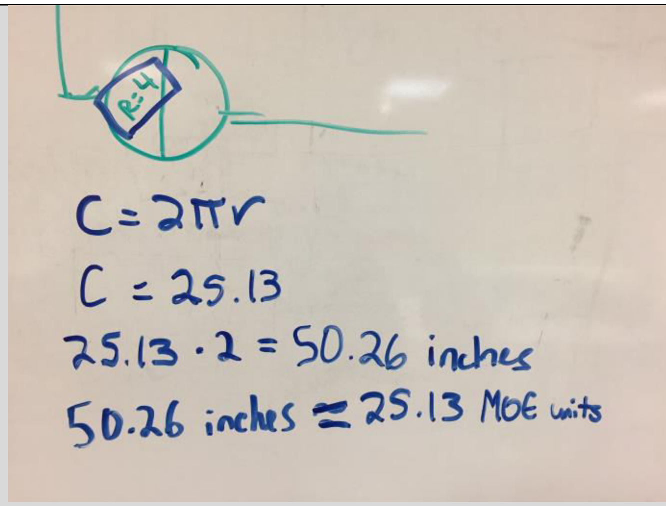
Define Problem: Using Odometry in Localization

An odometry wheel is a wheel not connected to a motor, which allows it to precisely record degree rotation measurements. We would like to utilize odometry wheels to keep track of our position on the field.

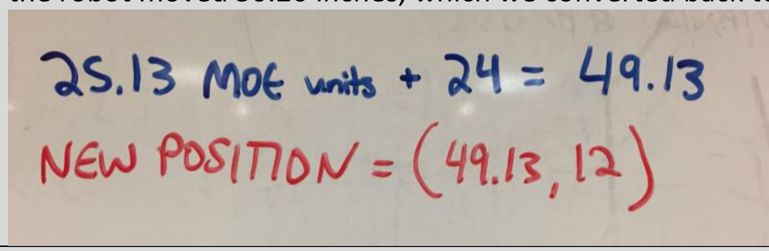
This method will be more accurate than localizing off of Vumarks because using odometry will allow us to precisely track all of our motions, instead of checking whenever we can see a Vumark.

We walked through an example situation. Our robot started at (24,12) and moved 2 rotations right.





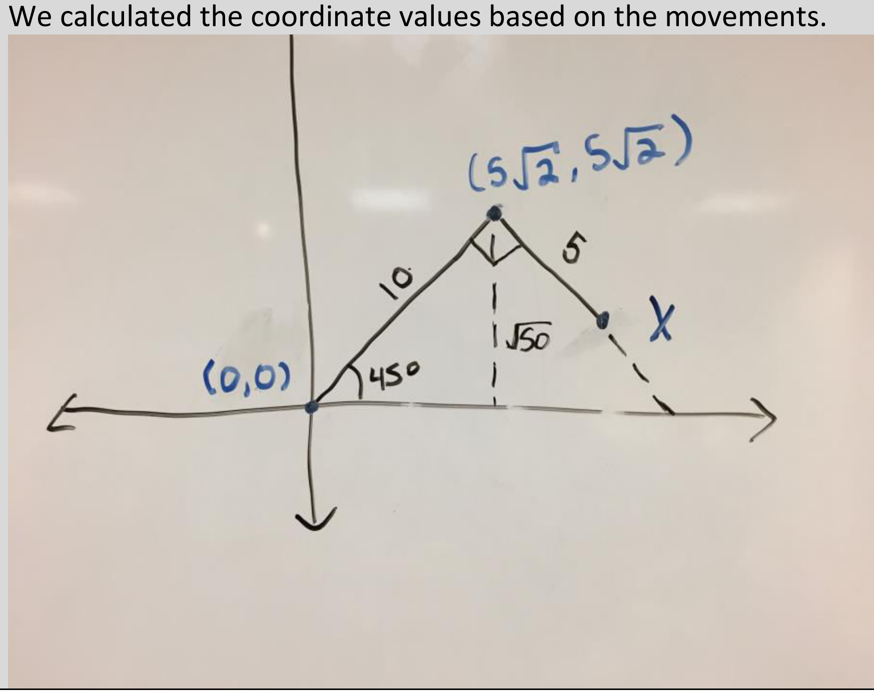
We then calculated the distance per rotation, 25.13, which was the circumference of the wheel. Then, we multiplied it by the number of rotations, 2. This told us that the robot moved 50.26 inches, which we converted back to our MOE units of 2”x 2”.



Generate Concepts: (MOE)dometry Localization

Using TeleOp, we drove the robot around and observed the values we were getting from the odometry wheels through telemetry. We started to write a program which would allow us to update our localized field position based on the odometry values.

We made some starting calculations where we planned a path for our robot to turn 45 degrees right, move 10 inches, turn 90 degrees right, and then move 5 inches. We calculated the coordinate values based on the movements.



Prusa i3 Mk2 3D Printer Upgrade

Mk2 to Mk2.5

- **Ian and Andrew looked at all the parts that need to be printed for the 3D printer upgrade.**
    - **We decided to use the 3D printed parts that were provided by the Prusa website for the Prusa i3 MK2 to MK2.5 and the R3 extruder upgrade for the extruder. This improves the extruder body and printer fan**
- **We also decided that they will replace the print bed with a new print bed on the Prusa i3 MK2 before printing the parts for the 3D printer upgrade.**
    - **This because the print bed has some dents where we scrapped it off when taking off the prints with 3D print spatulas and other tools.**

Non-Technical/Discussion:

On Saturday, team Dragonators is coming for part of our meeting.

- **We will share with them our process for updating our notebook and review their notebook with them**
- **They would like help installing mechanum wheels onto their chassis**
- **They would like to implement a webcam to complete mineral sampling**

We have moved next week's Tuesday meeting to Wednesday because FRC will be in the lab on Tuesday.

We should compile a summary package to give to potential sponsors in order to increase the possibility of gaining additional funding.

The Oxford Pennsylvania State Championship is looking for volunteers on March 3.

On March 2 we have an outreach planned at the Innovation Outreach Tech Fest.

Date: 2/16/2019

Duration: 9:00 AM – 2:30 PM

February 16, 2019 Meeting

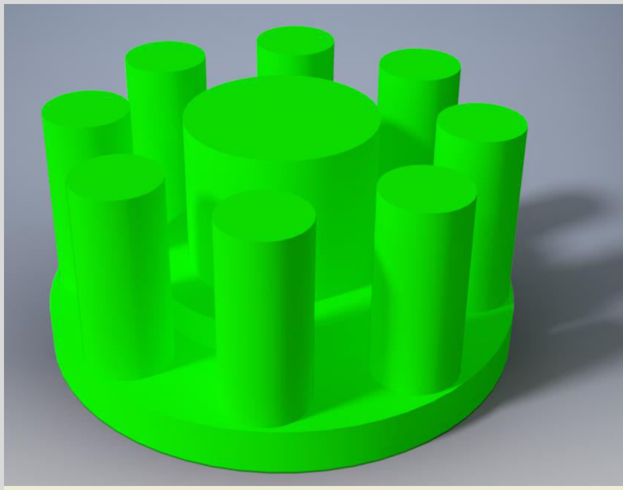
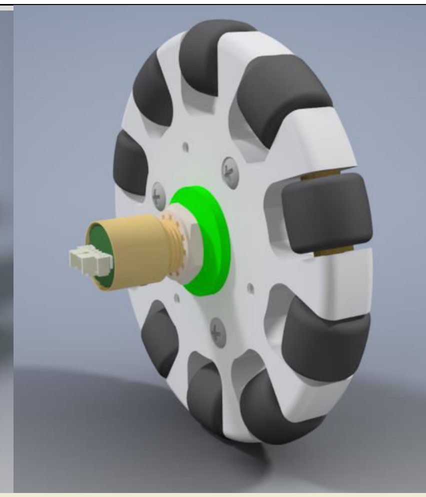
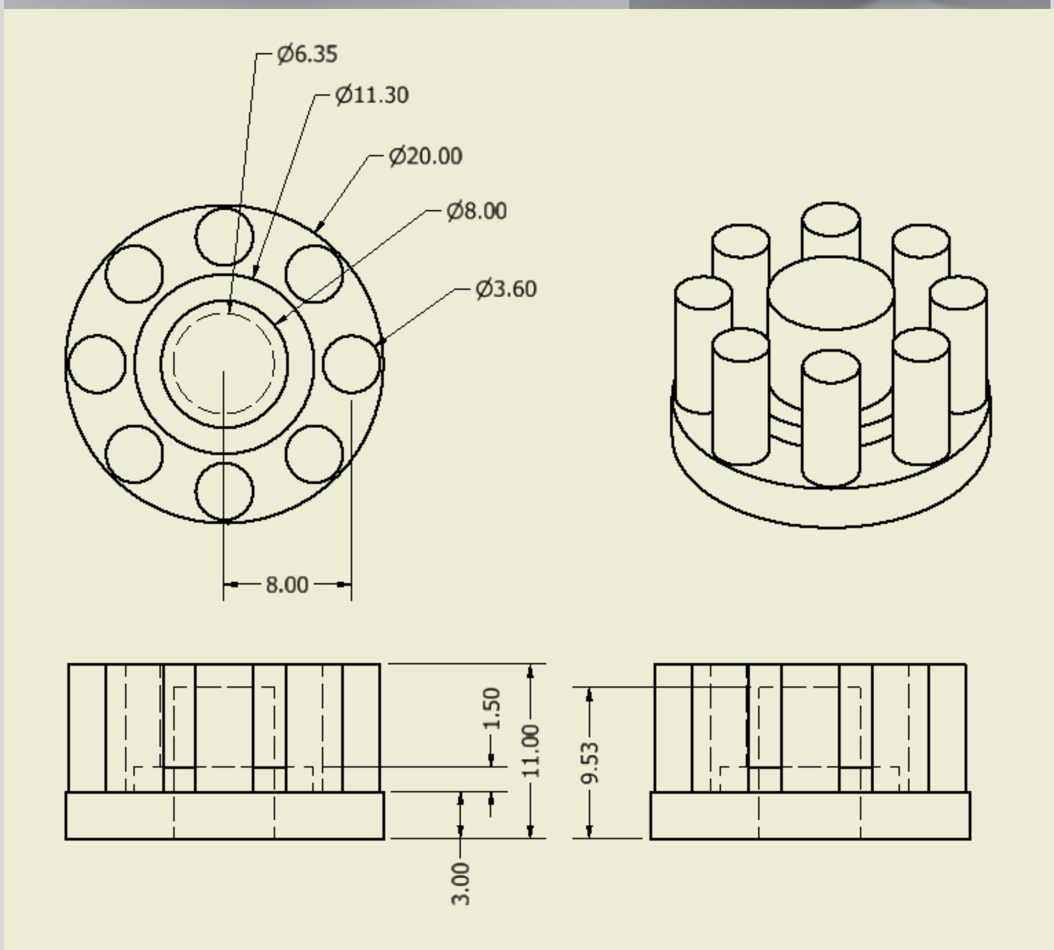
Students:	Rohan	Clare	Bryan	Patrick	Connor	Katy	Karthik	Jonas	Ian	Paige
Mentors:	**Mr. Prettyman**	**Tobi**	**Zach**	**Arnav**	**Mr. Szeto**					

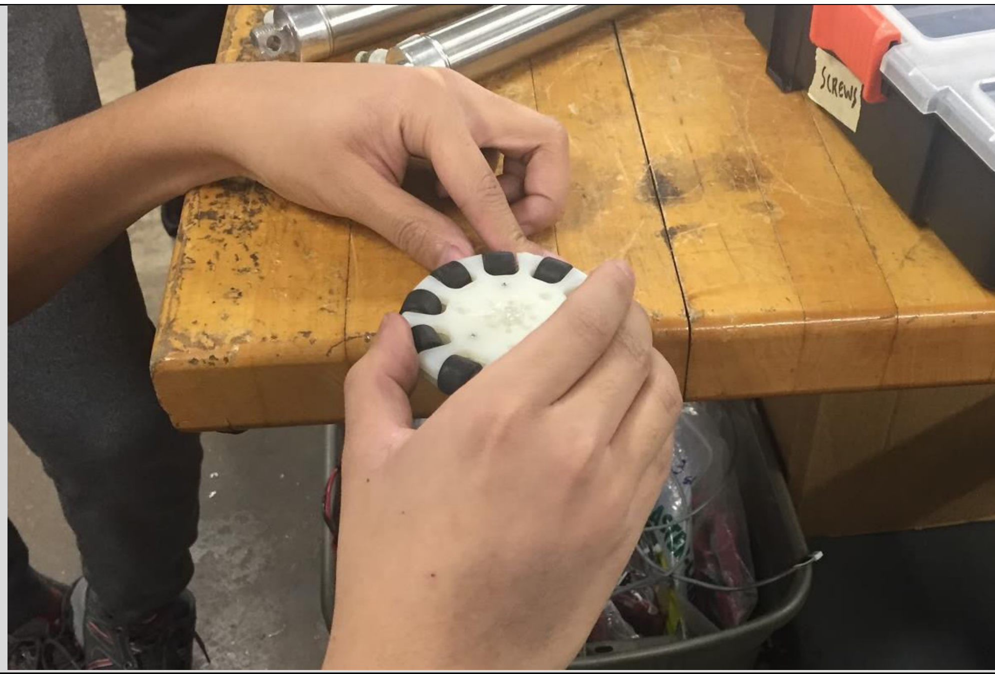
Agenda
y primarily in the conference room to avoid conflicting with MOE FRC.
Team Dragonators is coming from 9:30 – 1:30.

Tasks:		
Odometry Wheels	**Harvester**	**Programming**
Work on odometry wheels mounting and encoder mounting	Work on the new harvester (planning and prototyping)	Help team Dragonators set up mineral sampling with a webcam. Jonas/Clare Continue to work on implementing odometry wheels into localization. Rohan/Karthik

Mechanical Accomplishments:

Odometry Wheels	
Generate Concepts: Omni wheel to MA3 adapter	In the prototype, the encoder was connected to the odometry wheels using tape. However, this is not good enough for a final version. Connor worked to create an adapter in CAD that allowed the encoder to connect to the odometry wheel. It contains holes that fit into the omni wheel, and a hole on the other side that the encoder can enter. It has to fit very tightly or else the wheel or encoder will come out.

	  
Develop a Solution: Omni wheels	Because the programmers wanted to implement odometry inputs into their localization problems, Bryan began setting up odometry wheels. He mounted them to encoders and decided on a place to mount them on the chassis.

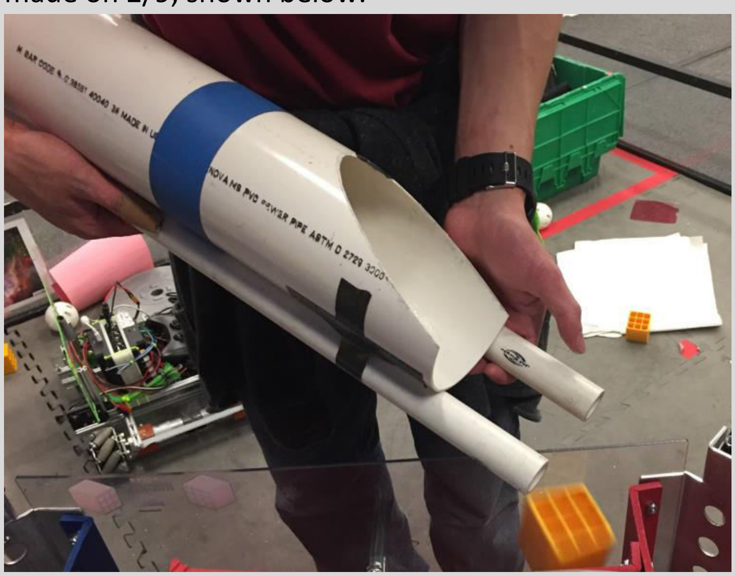


MMS

Generate Concepts: 3D Prints

Bryan worked with Arnav and Zach to design the first prototypes of a dump sort and harvester bucket mechanism. In order to complete these prints, Arnav will use a 3D printer at the University of Delaware because our printer in the lab is not large enough to create something of this size.

For the dump sort mechanism, we would first like to try one of the prototypes we made on 2/9, shown below.



This design works by having the blocks drop straight out of the pipe but letting the silver sphere shaped minerals continue rolling along two track pieces. We will create a simplified version of this as our first prototype.

For the harvester bucket, we will use a simple pipe design with a cutout to let the spinning wheel sit over the top of the tube.

<table>
<tr><th colspan="2">Team Marker</th></tr>
<tr><td>Generate Concepts: New Team Marker</td><td>

Zach and Arnav suggested that Ian make a team marker that can fit into the mineral harvester under the harvesting wheel and the other part is bigger with the 3 by 3 inches length and width minimum dimension for the team marker.
They wanted him to make a team marker with a disc base with a dimeter of 3.5 inches with a high of 0.5 inch. On top of the disc, there would be a cylinder that is Tangent to the side of the disk and the cylinder would have a diameter of 2 and 3/8 inches and a height of 3 and ½ inches.
They also told him to fillet or curve all the sharp edges on the model
The model has the team name and number on the bottom of the disk.

</td></tr>
<tr><td>Design and Test prototype: Team Marker</td><td>
Ian use the 3D printer to make the Team marker and the Omni wheel to MA3 adapter

After Ian finished CAD the Team Marker and Connor finished the CAD for the Omni wheel to MA3 adapter, Ian put the Team Marker and Omni wheel to MA3 adapter CAD .stl files into the Slicer program, Simplified 3D
There is a really handy feature in Simplified 3D, where you can set different profiles of setting for different print parts at the same time.

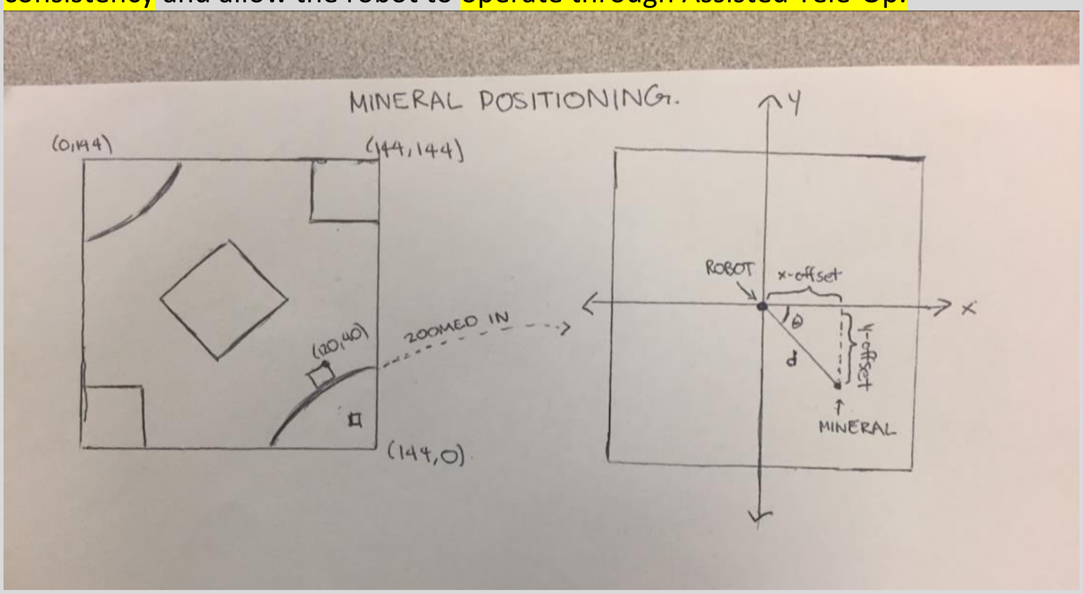
For the print of the Team Marker, Ian set it with 0.3 mm layer height, 3 parameters/outer walls, 15% percent infill, and supports on.
For the print of the odometry wheel adapter, Ian set it with 0.3 mm layer height, 3 parameters/outer walls, 50% percent infill, and supports on.

Then, The Slicer made a .gcode files of the team marker and the omni wheel to MA3 adapter with the details describe above that the 3D printer can use

</td></tr>
</table>

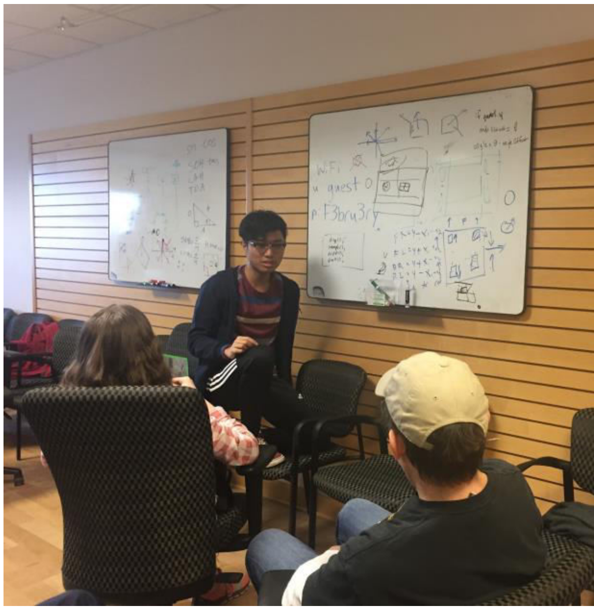
	to print it. • Next, Ian prepared the 3D printer by preheating the 3D printer extrude and print bed. He also cleaned the extruder nozzle • Then, he started the printed and the first layer came out smooth and perfect.

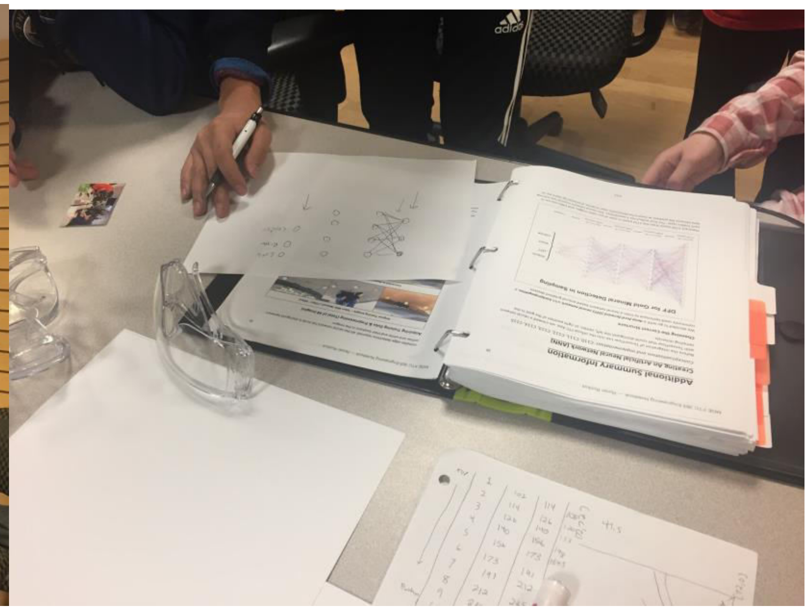
Programming Accomplishments:

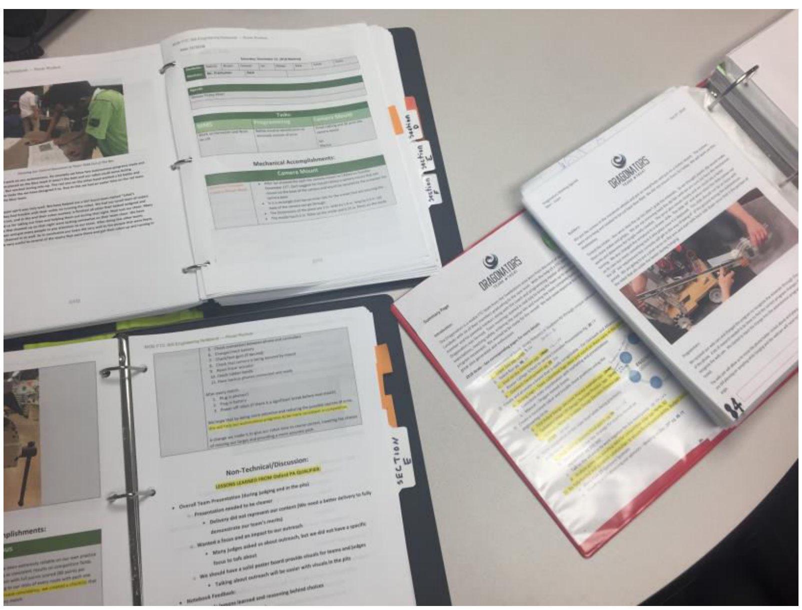
Localization	
Develop a Solution: Complex Localization	We spent most of the meeting talking with team Dragonators about how our autonomous works, helping them set up mineral sampling with a webcam, and explaining how neural networks function. However, we did have some time to continue working towards our goals. • **Using odometry wheels for robot localization** • **Using the camera for mineral localization** Having these two features implemented in our programs will greatly improve our consistency and allow the robot to operate through Assisted Tele-Op.  We refined our calculations for mineral positioning. As demonstrated in the drawing above, we would need to use the angle and coordinates of our robot and figure out the localized coordinates of a mineral based on how far away from the robot's camera it is.

Non-Technical/Discussion:

From 9:30 to 1:30, team 14541 Dragonators visited us. We discussed many aspects of their robot and their plans for World Championships. (More information about this Outreach can be found in the Team Section)







One fundraising option is an event at Panera Bread. Patrick scheduled an event for Sunday, March 10.

Date: 2/23/19

Duration: 9:00 AM – 2:30 PM

February 23, 2019 Meeting

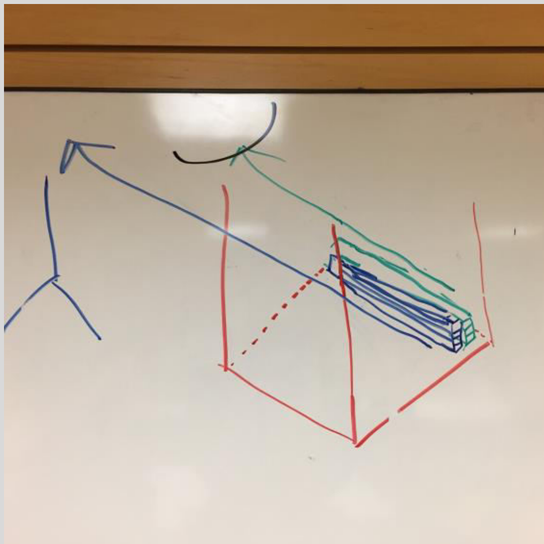
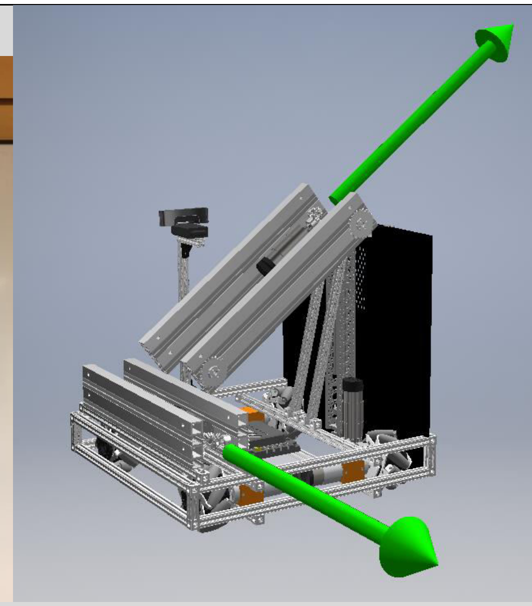
Students:	Patrick	Bryan	Connor	Clare	Jonas	Karthik	Marcus	Ian
Mentors:	**Mr. Prettyman**	**Zach**	**Arnav**	**Mr. Szeto**				

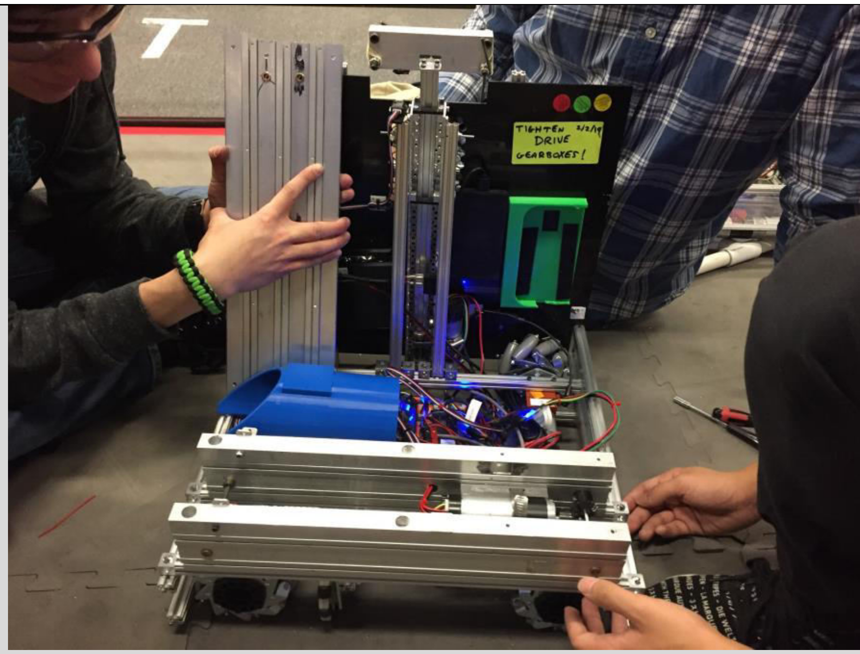
Agenda
Review schedule for the next few weeks
t daily tasks and review timeline objectives

Tasks:	
MMS	**Programming**
Construct and mount the angled slide. Finish mounting both odometry wheels.	Calculate angled paths with mecanum wheels. Test odometry wheels.

Mechanical Accomplishments:

MMS	
Develop a Solution: Angled Slide	The build team continued developing the slide that would transport minerals from the robot up to the Lander and decided on a design. Connor created CAD for the way the planned mechanism would move.

	 
Construct and Test a Prototype: Angled Slide	Bryan worked with Zach and Arnav to create the vertical slides for the scoring lift.  These slides will be used to transport the minerals from the harvester up to the top of the Lander. We decided to use four stages rather than three to ensure that the slide would have enough vertical reach.



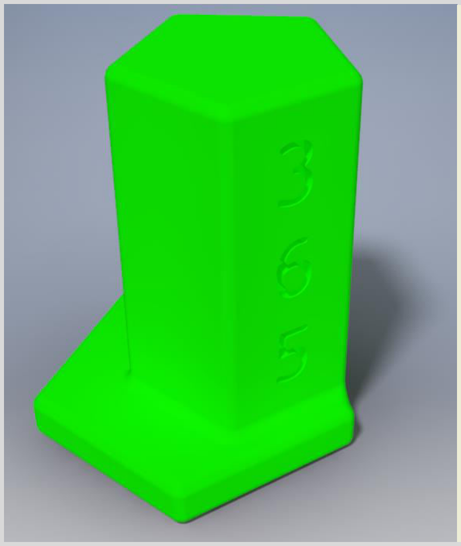
After constructing a basic prototype, we tested the slides and how they would be positioned onto the chassis.

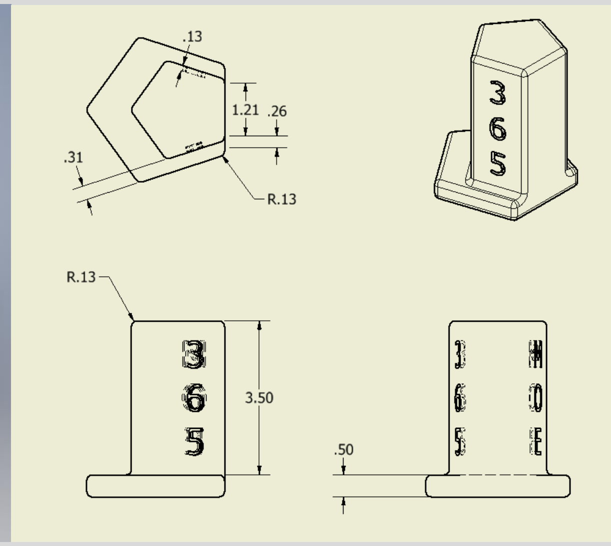
We would like to have the slides mounted on an angle so that the robot does not have to drive all the way to the Lander in order to score minerals. After finding the correct position, we realized that the slide would only be able to have a 15 degree tilt in its current form. This is less than we expected.

Team Marker

Evaluate: New Team Marker

The print of the disk and cylinder Team Marker and the four Omni wheel to MA3 adapts was stopped by Tim, from the FRC team, because he heard a clicking noise coming from our Prusa 3D printer. Also, there was is mysterious white powder on the printing bed and on the stopped parts

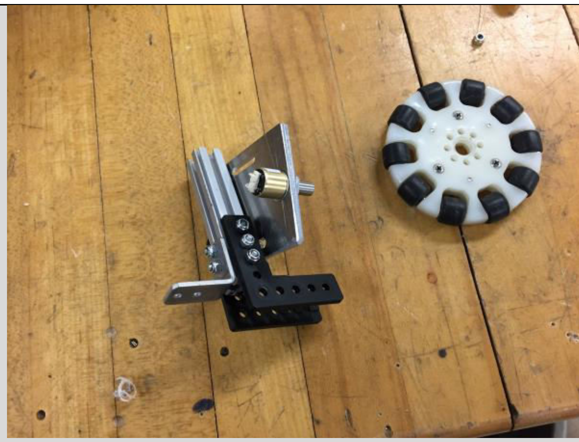
<table>
<tr><td></td><td>We decided that the team marker design from last week was not plausible because it had circular surfaces which could cause it roll out of the depot.</td></tr>
<tr><td>Design and Test prototype: Pentagonal Team Marker</td><td>Connor and Ian redesigned it with a pentagon shape instead of a circular shape. We chose a pentagon over a square or hexagon because it looked the coolest.




Ian use the 3D printer to make the Team marker

After Connor finished CAD the Team Marker, Ian put the Team Marker CAD .stl files into the Slicer program, Simplified 3D
For the print of the Team Marker, Ian set it with 0.3 mm layer height, 3 parameters/outer walls, 20% percent infill, and supports on.
Then, The Slicer made a .gcode files of the team marker with the details describe above that the 3D printer can use to print it.
Next, Ian prepared the 3D printer by preheating the 3D printer extrude and print bed. He also cleaned the extruder nozzle by getting the filament that comes out of the nozzle and filament that has struck to the nozzle.
Then, he started the printed and the first layer came out smooth and perfect.
</td></tr>
</table>

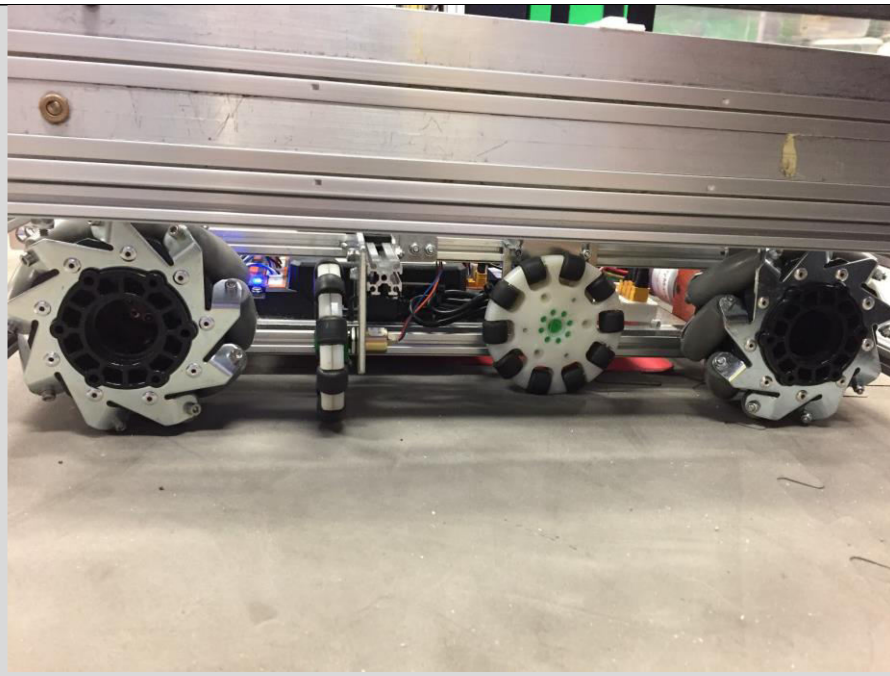
<table>
<tr><th colspan="2">Odometry Wheels</th></tr>
<tr><td>Construct and Test a Prototype: Odometry wheels</td><td>One of the pins on the odometry wheels was crooked, so Bryan bent it back into shape.</td></tr>
</table>



Then, he constructed a stronger mounting piece so that the wheels could be permanently connected to the robot.

We then had to decide where to mount the wheels. We considered mounting them using the outer frame of the chassis, as shown above, but decided not to because this put the wires in a vulnerable position outside the frame.

Instead, we chose the position shown below. This gave the wheels a permanent location and safe wiring access within the frame of the chassis.

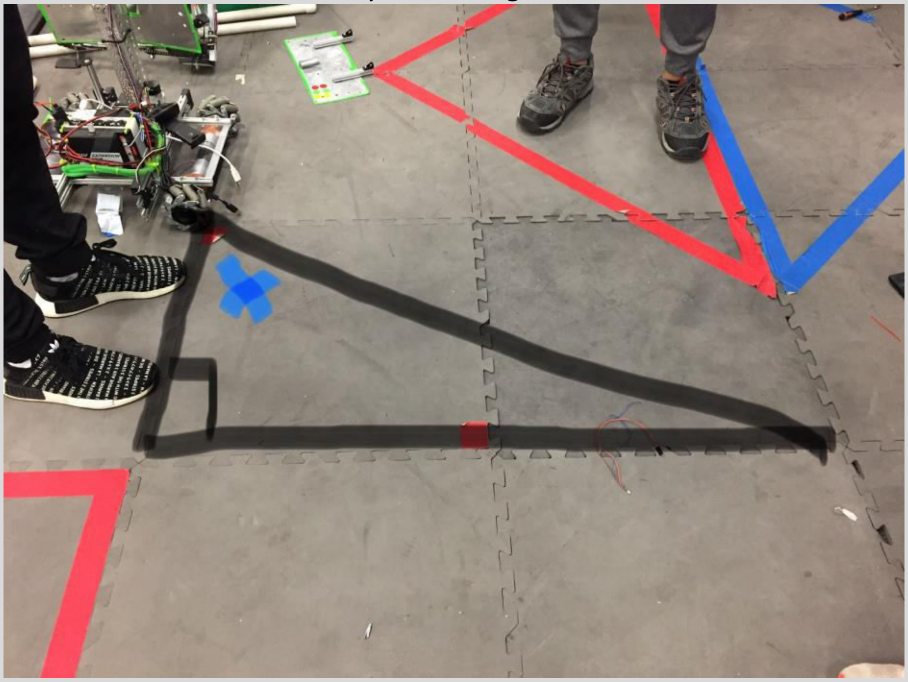
	

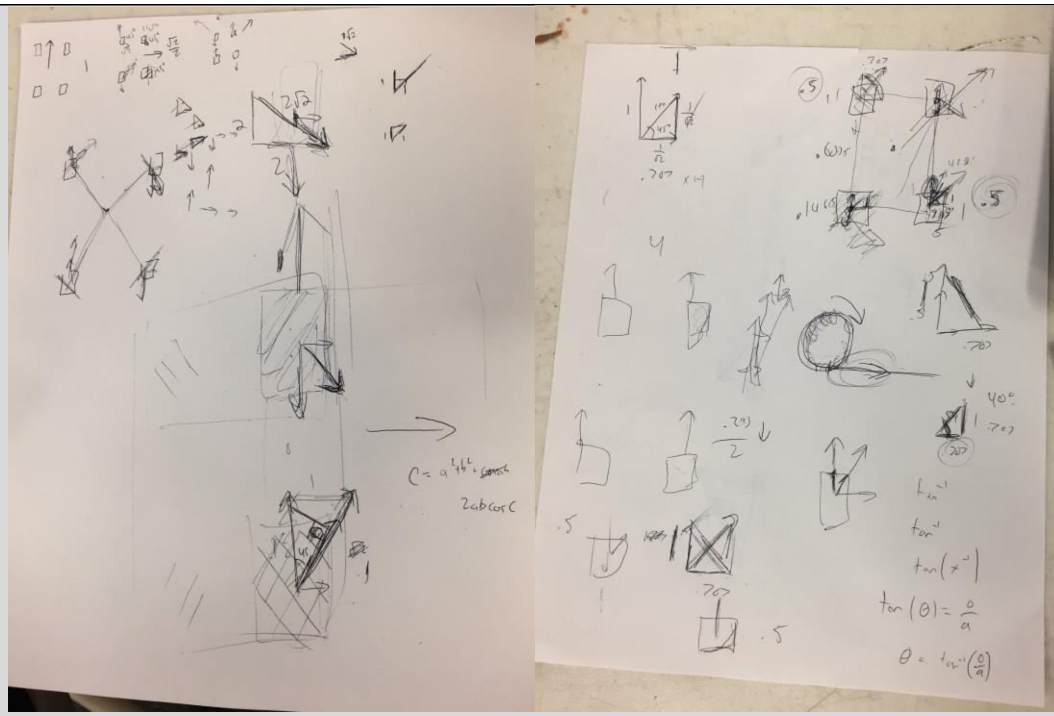
Odometry Wheels

Construct and Test a Prototype: Omni wheel to MA3 adapter	After Ian saw that the print from Saturday the 16th was stopped, he was told to print 2 Omni wheel to MA3 adapters. • Ian put the two Omni wheel to MA3 adapter CAD .stl files into the Slicer program, Simplified 3D • For the print of the Omni wheel to Ma3 adapters, Ian set it with 0.3 mm layer height, 3 parameters/outer walls, 50% percent infill, and supports on. • Then, The Slicer made a .gcode files of the two omni wheel to MA3 adapter with the details describe above that the 3D printer can use to print it. • Next, Ian prepared the 3D printer by preheating the 3D printer extrude and print bed. He also cleaned the extruder nozzle by getting the filament that comes out of the nozzle and filament that has struck to the nozzle. • Then, he started the printed and the first layer came out smooth and perfect. • After the two Omni wheel to MA3 adapters finished printing, the support that printed in the hole, where that MA3 was going to go in, was stuck to the prints and would be hard to come out. • So, Arnav suggested to print the Omni wheel to MA3 adapters without the supports. • Ian used the same slicer settings as before but with no supports • Then, Simplified3d made a .gcode file of the two omni wheel to MA3 adapters with the edited details. • Next, Ian prepared the 3D printer by preheating the 3D printer extrude and print bed. He also cleaned the extruder nozzle by getting the filament that comes out of the nozzle and filament that has struck to the nozzle.

	• Then, he started the printed and the first layer came out smooth and perfect.
	• After the two Omni wheel to MA3 adapters finished printing, the hole where the MA3 shaft goes into the adapter was too small for the shaft to fit in.
	    ○ So, Zach and Arnav drill the hole bigger for the shaft/axial of the MA# to fit in
	• Connor and Ian tried to make the hole bigger by a 1/16 of an inch but when Ian put it in Simplified 3D, the wall between the hole for the MA3 axial and the outer circle was too thin to recognize it.
	    ○ So, we just went back to the original adapter and we will need to drill the holes bigger
	• Then, Ian printed 4 more of the omni wheel to MA3 adapters.

Programming Accomplishments:

Autonomous	
Develop a Solution: Diagonal movement	The programming team worked on developing the necessary equations that would allow the robot to accurately make diagonal movements.  First, as seen in the image above, we need to calculate what angle (x) the robot should travel at in order to get from one point (12,24) to another (36, 12).

	 Then, using this angle, we need to assign power values to each of the four mecanum wheels in order to travel at this given angle, for a certain distance. After the odometry wheels were mounted, we discovered that our initial calculations were incorrect. The robot either strafed straight in one direction or at a 45 degree angle. We were unable to complete these calculations during this meeting, but we will continue to work on it next Tuesday.
Develop a Solution: Turning Compensation	Also, turning would contribute to the movement of the odometry which would affect where the robot think it is unless we take the gyro angle into account. Turning would create a similar movement as a diagonal translation, so there must be an offset. We first knew that the distance that the wheel would move if the wheel was along the tangent of a given circle, the wheel would move along the circumference, so the distance that the wheel moves is theta/360 * 2r(pi), where theta is the angle of the robot. This would not work if the wheel is not along the tangent, like both wheels are. Using the angle that is away from the center rotation, and how far it is away, we can track the horizontal translation component by getting the height of the tangent line. Knowing that the tangent is 90 degrees from the center, we can create a triangle and use the sine relations to find the side length of the height

Non-Technical/Discussion:

Outreach Schedule:

March 2/3 - Pennsylvania State Championships

March 7 – IO Festival

March 10 – Panera fundraiser/ Christiana Mall visit?

March ?? - Delaware Cup, not scheduled

April 15 - Outreach with VEX IQ team, not yet scheduled

Our Wednesday meeting was cancelled due to snow. There is no team meeting next Saturday due to the PA State Championships.

We will start organizing a potential fundraising/sponsorship opportunity at the mall by contacting them to see what our options are.

We set up a GoFundMe page in order to make it easier for friends/relatives to donate. We will promote it using social media.
https://www.gofundme.com/moe-365-ftc-to-world-championships

We will continue brainstorming what we would like our pit to look like. We started organizing and putting tools into our cart.

We would like to potentially host a final meet with all Delaware teams at some point in March. We will have to discuss more about the specific date and location.

Connor mentored a VEX IQ team over the summer, and they would like us to host a demo for them. We will aim to complete this event a week before leaving for World Championships.

Connor began making a CAD presentation on PowerPoint. This is *not* part of the judging presentation. Instead, it will be on display in the pit at Worlds. The presentation will explain the main mechanical mechanisms and sensors of the robot and their CAD images. A rough draft of this presentation will be done before Tuesday and presented to the team during the Tuesday meeting.

Marcus and Ian worked on organizing cabinet C and organized most of it, but were not able to finish organizing everything in the cabinet. So, next time that they clean the cabinets, they will finish organizing Cabinet C.

Date: 2/26/19

Duration: 6:00 PM – 8:30 PM

February 26, 2019 Meeting

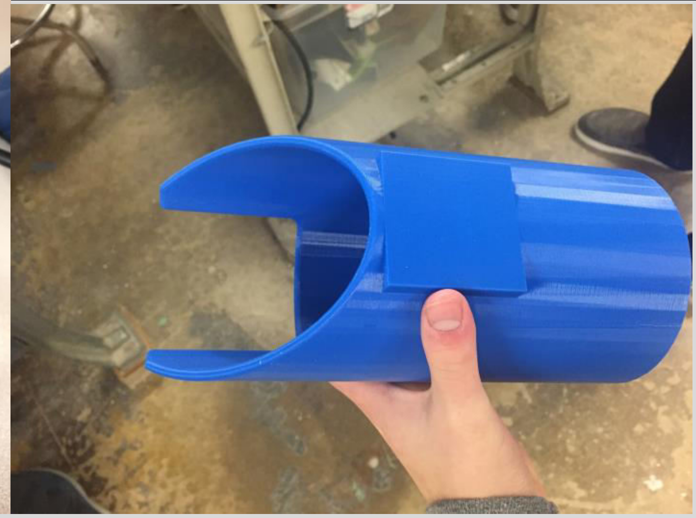
Students:	Patrick	Bryan	Ian	Connor	Paige	Jonas	Clare
Mentors:	**Mr. Prettyman**	**Arnav**	**Mr. Buckingham**	**Zach**	**Andrew**		

Agenda
• Meet in conference room
• Overview of goals and issues: mechanical must work on sorter, programmers work on correction feedback loop

Tasks:	
Mechanical	**Programming**
Attach sorting mechanism to lift Print new team marker design	Implement PIDs

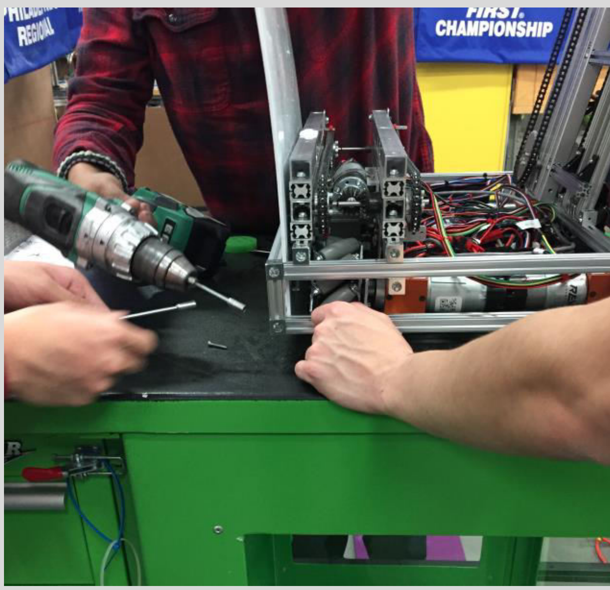
Mechanical Accomplishments:

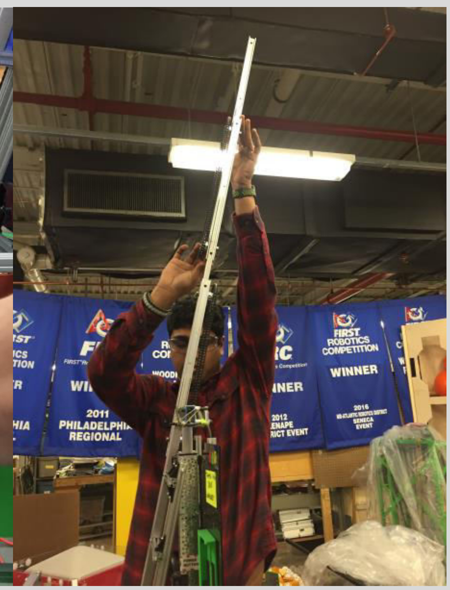
MMS	
Fabricate Solution: 3D Prints	Arnav brought in the 3D printed harvester bucket that had been printing over the weekend. It has space to easily mount a wheel or other harvesting mechanism's motor and to have a servo connecting the bucket to the linear slides. We will attach the harvesting mechanism to it during the next meeting.



Design and Test a Prototype: Angled Lift

During this meeting, we worked on our angled lift. Last meeting, we were able to assemble it but did not mount it yet. Today, we focused on mounting and testing how much height it was able to achieve.



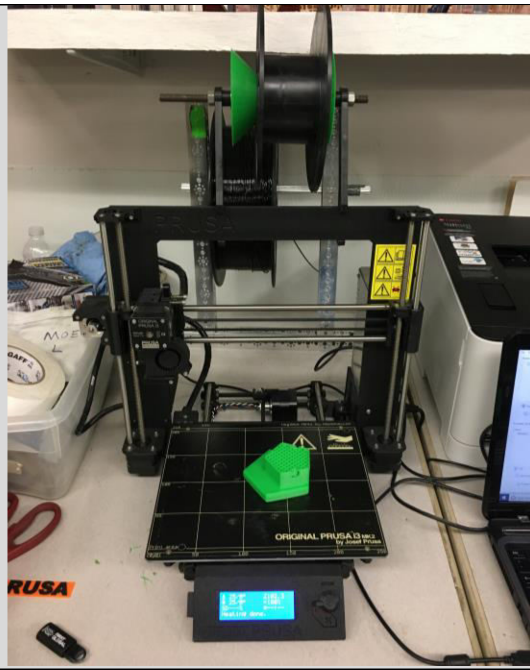


Because we had decided to use four stages rather than three, we found that we had a very large amount of vertical reach. It was high enough to comfortably reach the Lander, which would come into use as it would give us more flexibility when mounting our dump sort mechanism.

Team Marker

Design and Test prototype: Pentagonal Team Marker

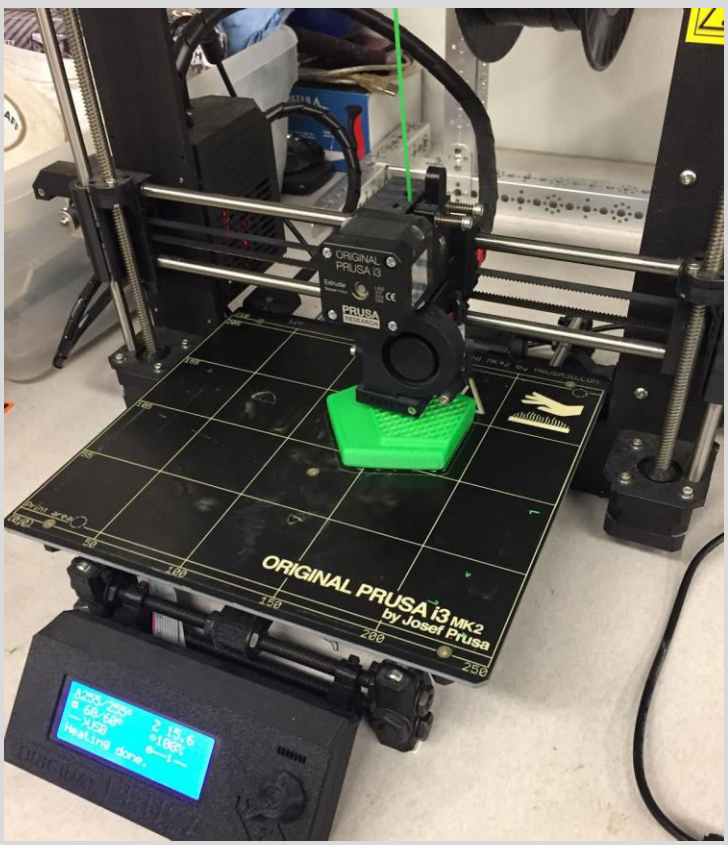
Ian went to check if the team marker finished but found that it did not print it fully. This is because there was not enough filament in the spool when Ian started the print on Saturday and the spool was empty.



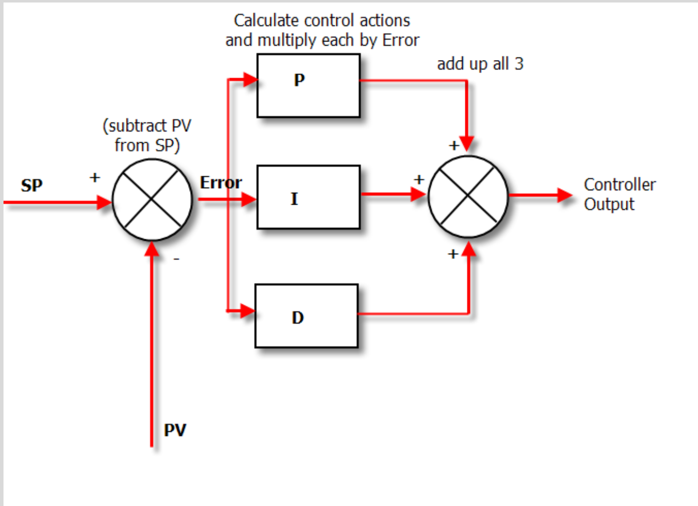
Tweak: New Team Marker

After seeing that the previous team marker did not print, he restarted the print

- He used the same setting for the print as the previous, which is 3 perimeters, 0.3-layer height, 50% infill and supports on
- Then, he good the 3D printer ready by preheating the nozzle and bed for petg filament, cleaned off the nozzle and calibrated it.
- Then, Ian started printing it and the first layer came out smooth.



Programming Accomplishments:

Autonomous	
Define Problem: Encoder Inconsistency	While we have been developing the equations needed for localization through the encoders connected to odometry wheels, we also remembered that encoders are very accurate but difficult to use precisely when trying to move a certain number of encoder ticks and then stop. For example, if we want the robot to move forward 100 ticks and then stop, we will face the issue of overshooting. This is because the robot will have to hit the value 100, register this, and then stop powering the motors. This leaves plenty of room for error due to the wheels skidding further than anticipated. We will have to implement an additional function so that the encoders can be used with full accuracy.
Generate Concepts: PIDs	Patrick was already familiar with a solution to compensate for encoder inaccuracies, and he explained it to Jonas and Clare. We can implement PID software to account for overshooting, undershooting, and other inconsistent movements. • PID stands for Proportional, Integral, Derivative feedback loop. • Essentially, an ideal value (Set Point) is set as the input of the feedback loop, and there are controllers and action paths to check and adjust the Process Variable (actual value) until it matches the Set Point. • Despite sounding simple, many variables can affect the value of the Process Variable, and thus many action paths must be made, accounting for the many possible adjustments that are needed. • A very simple PID loop looks like this:  • SP (Ideal Value)-PV (Actual Value) = Error • Error is multiplied by however many control actions are needed to adjust the value • These values will be sent to the Controller Output so it knows what needs to change • P (Proportional): kP, also known as the proportional gain constant, is a constant set before anything is done. The kP should be just right, because if it is too large of a value then the loop will be unstable, and if it is too small the adjustment will be

ineffective. When the PID process runs and the error is calculated, the kP will be multiplied by this error to calculate the Proportional output.

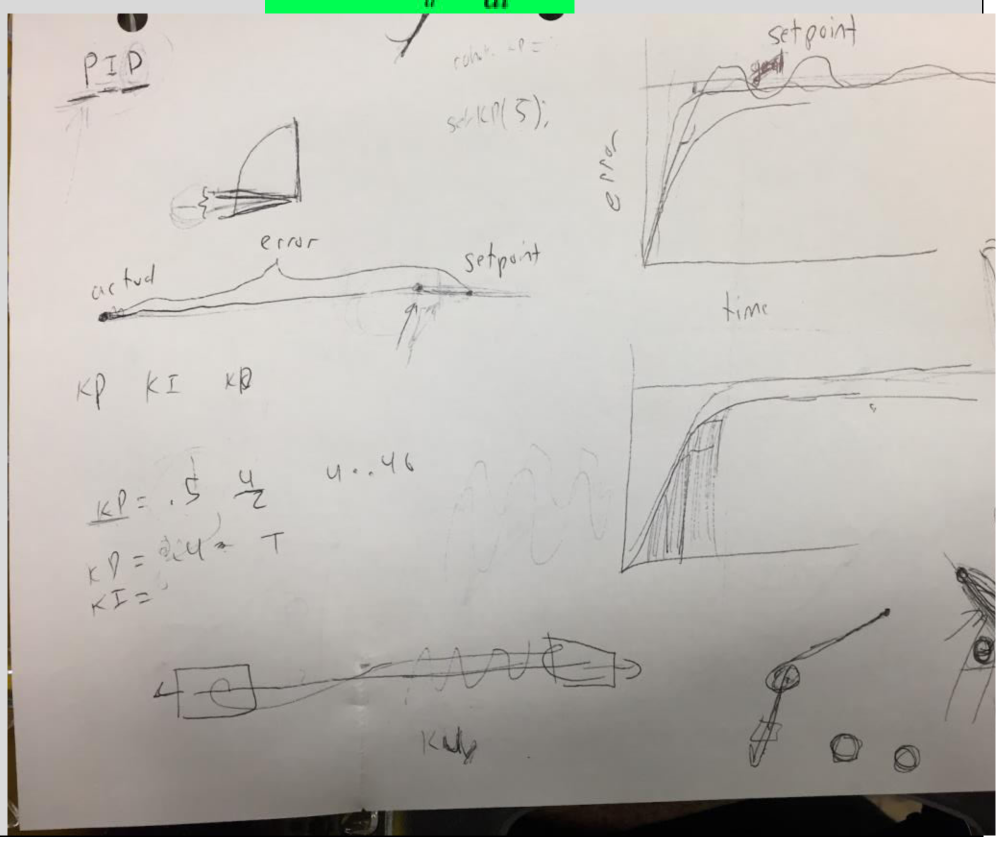
$$P_{out} = K_p e(t)$$

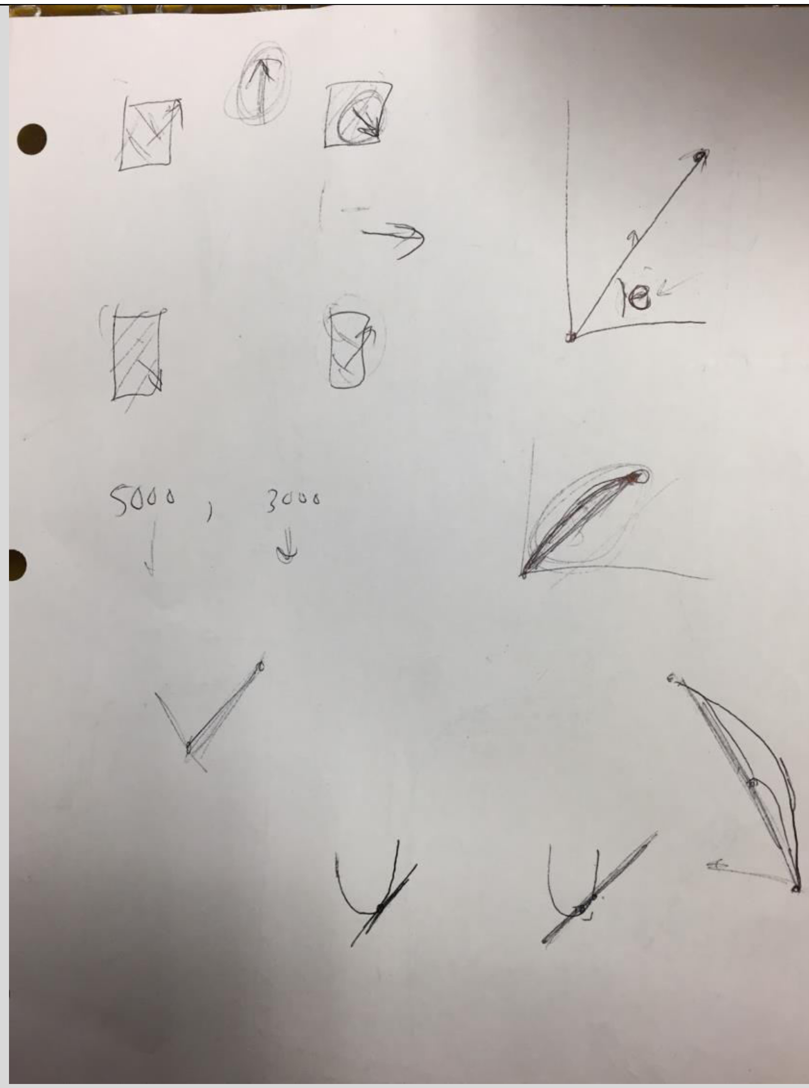
- I (Integral): This provides a total of all the instantaneous errors over time. This calculates accumulated error, which is multiplied by kI, the integral gain constant. This factor aids in preventing error created from the proportional value, but because of the accumulated error calculations that integral calculation can overshoot the ideal value.

$$I_{out} - K_i \int_0^t e(T)dT$$

- D (Derivative): Because derivatives calculate instantaneous slopes, this part of the loop determines the slope of the error, and then multiplied by kD, the derivative gain constant. This, however, is not commonly used as the difference it makes on the corrections vary in different situations.

$$D_{out} = K_d \frac{de(t)}{dt}$$



Non-Technical/Discussion:

- **Our IO Tech Festival outreach event is on Saturday, so our regular meeting is cancelled.**
- **Pennsylvania State Championships are on Saturday and Sunday.**
- **Our goal is to have a functioning prototype of our new mineral system by March 2-4.**
- **On March 10, we have our Panera fundraiser. We will spread awareness of this through social media.**

Date: 3/5/19

Duration: 6:00 PM – 8:30 PM

March 5, 2019 Meeting

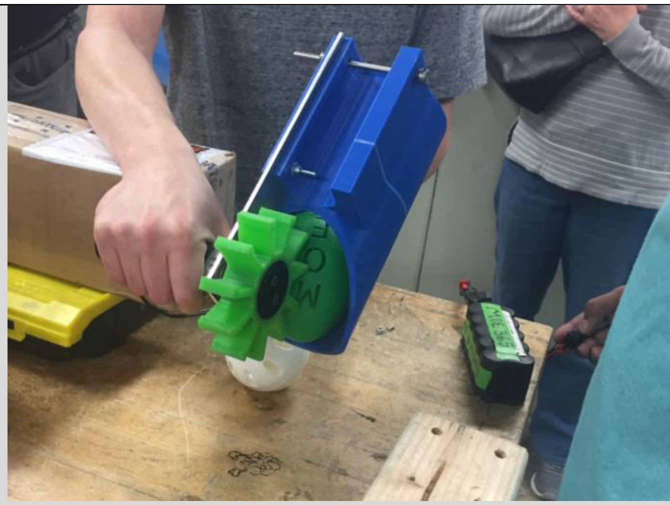
Students:	Katy	Karthik	Clare	Paige	Patrick	Connor	Ian	Jonas	Rohan	Bryan
Mentors:	**Mr. Prettyman**	**Mr. Buckingham**	**Zach**	**Mr. Price**	**Andrew**	**Arnav**				

Agenda
Go directly to lab and meet with subteams
sign tasks within each team

Tasks:		
Mechanical	**Programming**	**Team Marker**
Attach wheel to harvester Mount and test harvester Bryan, Katy, Patrick	Continue working on camera analysis of minerals Clare, Jonas Continue working on odometry movement Rohan, Karthik	Check if the print of the team marker finished and how it printed

Mechanical Accomplishments:

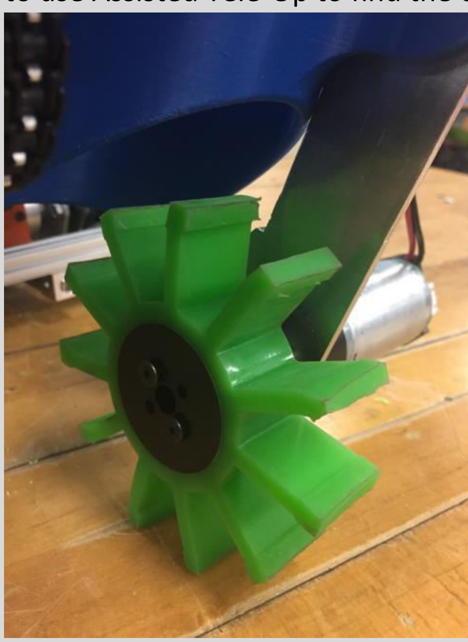
MMS	
Generate Concepts: Harvester Design	From analyzing current and past matches, our team found that the most effective harvesters frequently had flexible surgical tubing spinning at very fast speeds. One idea we had was to use a rubber wheel commonly found on FRC robots and to cut out parts of the exterior wheel in order to create small fins. We think that this idea may be an effective solution because the fins will be space efficient but still be flexible and fast enough to harvest quickly. We decided to make a prototype today.
Develop a Solution: Harvester	After carefully cutting slits into the wheel, we mounted it to a motor. Then, we mounted it onto the harvester bucket that had been printed for last meeting. Before mounting it to the chassis, we first tested the prototype by itself to see if the idea was feasible.

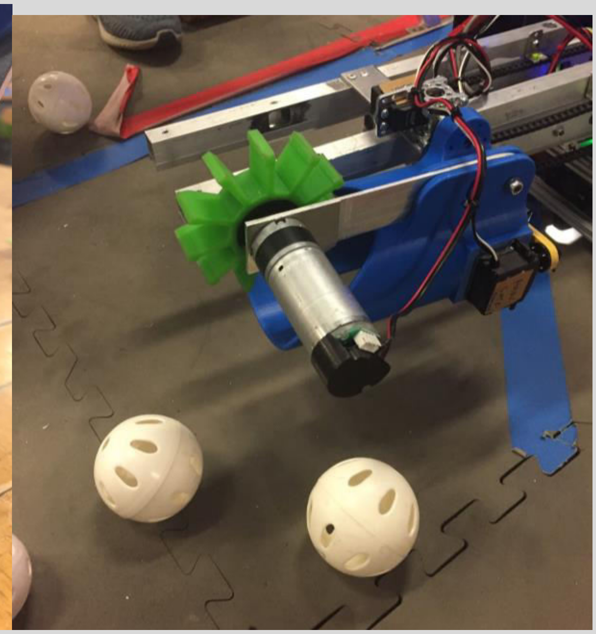


After testing it on and off the field, we found that it harvested very efficiently. As shown above, the team marker also fit very well inside the design. We found that the design was very feasible, so we continued with the prototype.

Design and Test a Prototype: Harvester

We now want to see if it functions the same way when attached to the robot. First, we permanently mounted the wheel to bucket using a servo so that the driver can control how far above the floor the wheel is positioned. This flexibility will allow us to use Assisted Tele-Op to find the optimal height and position for the harvester.





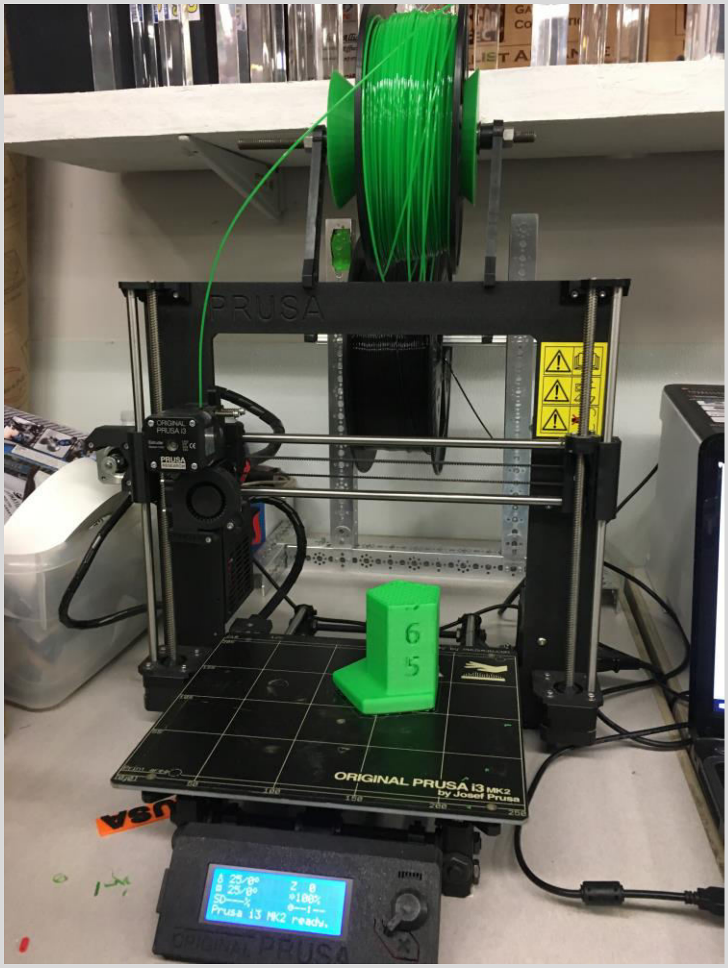
After finishing the mounting, we tested our design on the field. We were extremely happy with how well it was able to perform. It was easy to position and the only problems we faced were harvesting minerals when they were against a wall, as the motor, which stuck out to the side, sometimes prevented the wheel from coming into contact with the minerals.

However, we think that these tests were very successful. We will continue with this idea and continue to develop it.

Team Marker

Evaluate: Team Marker

Ian check if the print of the team marker had completed correctly but it had stopped for some reason. It might have stopped because of a power outage, some accidently stopping it, or maybe there was a nozzle clog.



Design and Test a Prototype: Team Marker

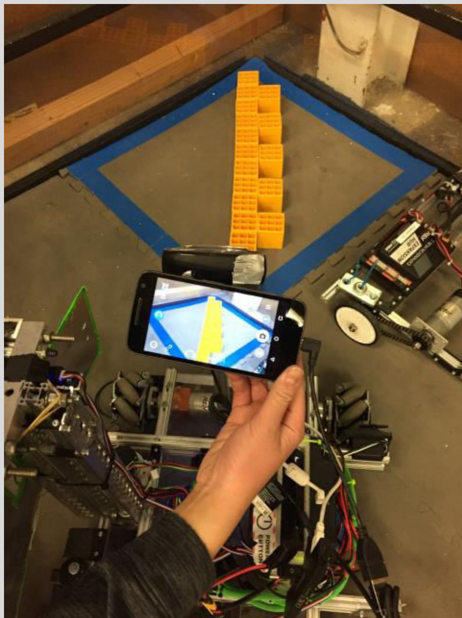
- With the Simplified 3D, Ian kept the setting for the Team Marker
  - 3 Perimeters
  - 20% infill (Grid)
  - 0.3 mm layer height
  - Supports On
- Then, Ian looked how the print was going to print with those setting in the slicer
- The slicer made the team marker into a .gcode, with the settings above, which is a file that the printer can use to print the parts.
- Ian prepared the 3D printer by turning it on, putting glue on the bed, heating up extruder and print bed up for PETG filament, and calibrated it by homing the x y and z axis's.
- Then, Ian started printing it and the first layer of the print printed ouf smoothly.

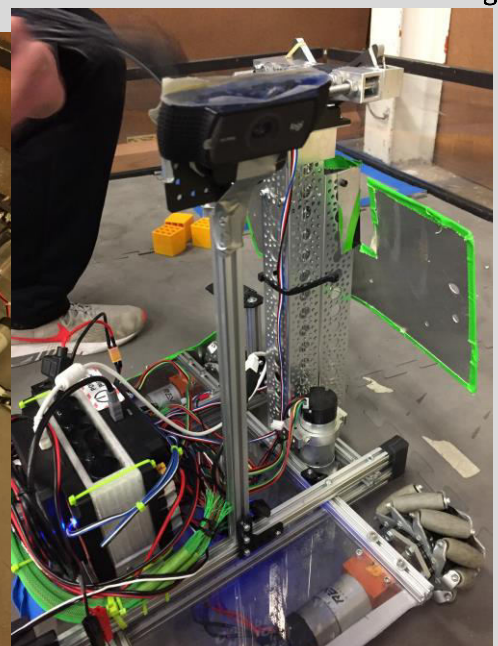
Programming Accomplishments:

Autonomous

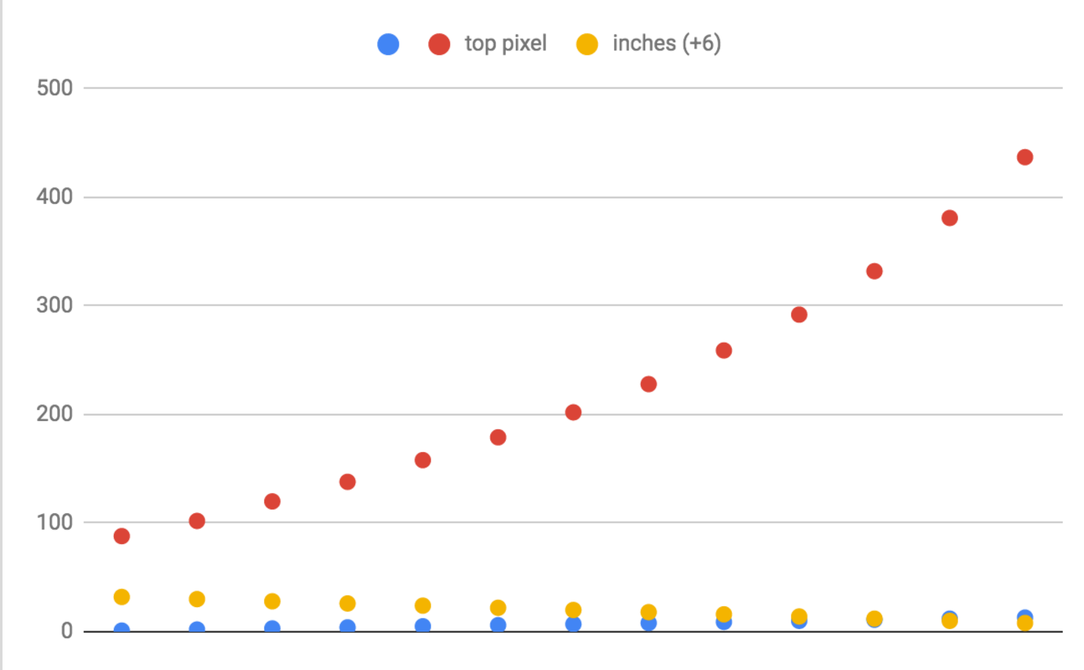
Design and Test a Prototype: Mineral identification

Jonas and Clare continued working on the objective of being able to figure out the coordinates of minerals through use of the webcam. We redid our graphs, data points, and equation, as we wanted to test at a more realistic camera angle.





Mineral #	top pixel	inches (+6)
1	88	32
2	102	30
3	120	28
4	138	26
5	158	24
6	179	22
7	202	20
8	228	18
9	259	16
10	292	14
11	332	12
12	381	10
13	437	8



f(x) = .000141433x^2-.14089x+42.8988

Non-Technical/Discussion:

We have received several donations since the last meeting and will continue promoting our GoFundMe page.

Our outreach on Saturday was very successful and we had an enjoyable experience at the IO Tech Festival. More information about this outreach in the Team section

We will settle on a location and date to host the Delaware Cup, preferably during the last week of March.

We will start stocking up on spirit gear for World Championships, which includes making more buttons.

We made many more egg buttons and printed over 200 Panera flyers.

Date: 3/12/19

Duration: 6:00 PM- 8:30

March 12, 2019 Meeting

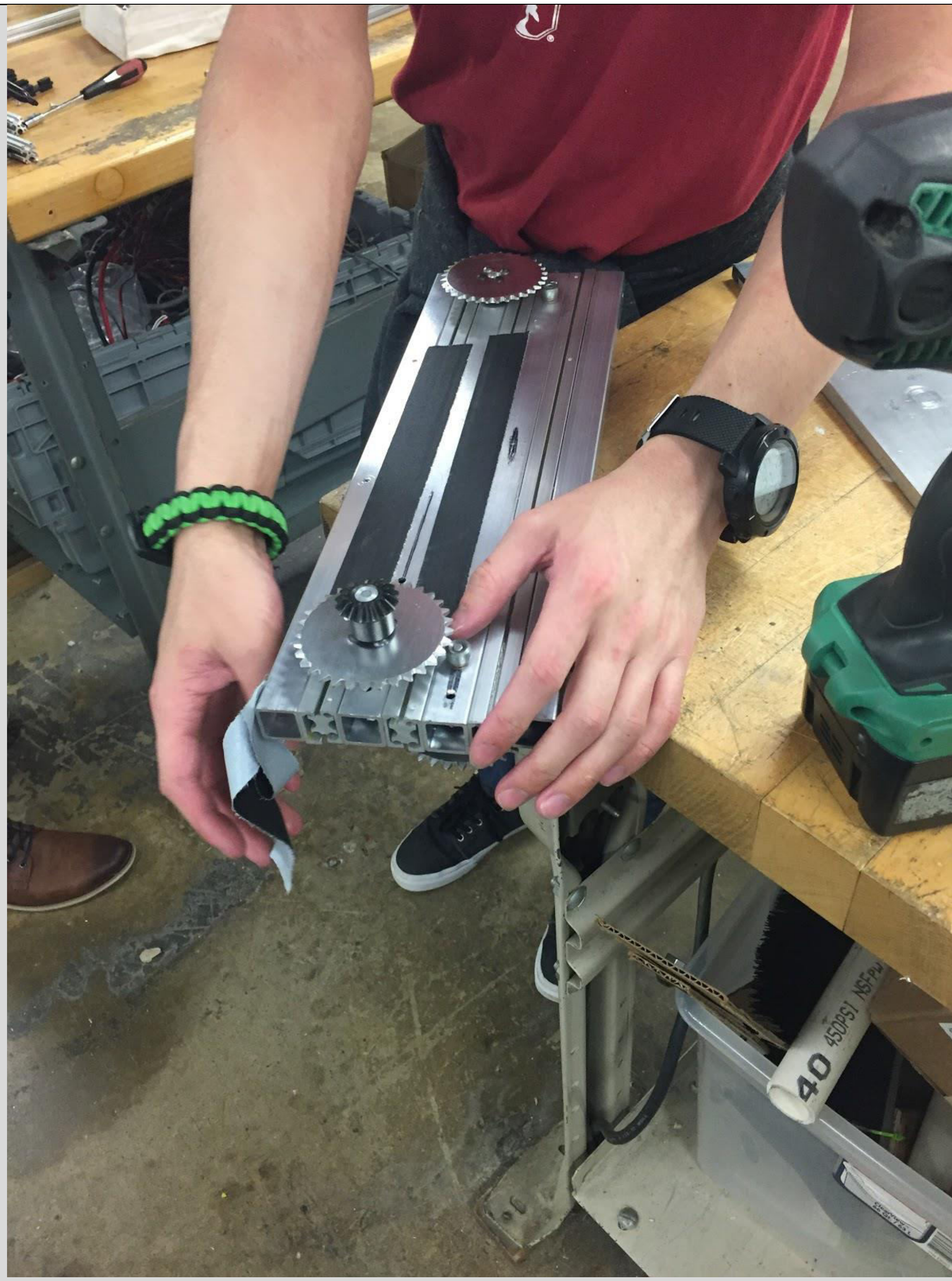
Students:	Connor	Ian	Bryan	Patrick	Katy	Rohan	Paige	Clare	Katy	Jonas	Karthik
Mentors:	**Mr. Prettyman**	**Mr. Price**	**Andrew**	**Zach**	**Arnav**						

Agenda
Meet in the conference room to update progress

Tasks:		
Mechanical	**Programming**	**Prusa i3 Mk2 to M2.5**
Finish building the sliding lift for MMS Zach Arnav Bryan	Improve encoder accuracy in odometry movement Karthik Rohan Clare Jonas	Finish calibration the z axis height to print the right filament height. Finish calibrating the printer.

Mechanical Accomplishments:

MMS	
Design and Test a Prototype: Lift	Bryan worked with Zach and Arnav to continue working on the angled lift that will transport minerals from the harvester to the Lander. Their goal was the complete the lift by the end of the meeting.

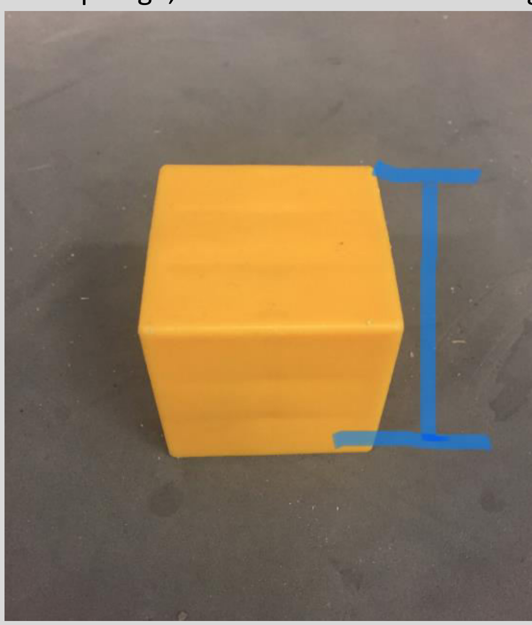
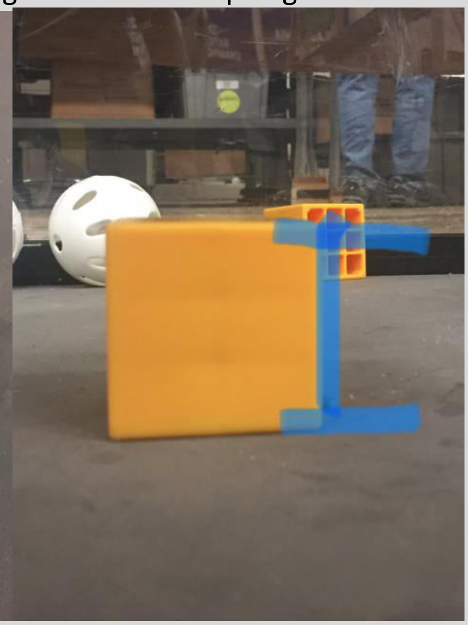


By the end of the meeting, we were able to clamp the slides down and use a motor test how it extended horizontally.

Then, using the iPhone Measure App, we clamped it to a 15-degree angle and ran the motor. The test proved to be successful, as the motor had no problem lifting itself.

Programming Accomplishments:

Autonomous	
Generate Concepts:	• Jonas investigated the idea of using the camera's focal length in order to

Mineral Localization	determine the mineral's distance from the robot. $\text{distance to object (mm)} = \frac{\text{focal length (mm)} * \text{real height of the object (mm)} * \text{image height (pixels)}}{\text{object height (pixels)} * \text{sensor height (mm)}}$ • This idea is interesting but we are unsure if it will be able to work well with a 3D object. The formula we are using requires the height of the object and the height of the object in the camera frame, which is not currently viable. • The reason this does not work is because at the camera's current height and angle, the camera will see the height as the front bottom edge to the back top edge, rather than the bottom edge to the front top edge.   ^ Incorrect height measurement ^ ^ correct height measurement ^
Design and Test a Prototype: Odometry Encoders	Rohan and Karthik worked on improving the encoder accuracy in the odometry wheels. There were issues when trying to figure out the exact number of tics for the odometry wheels, partly due to the wrap around of the MA3 encoders. The encoder, rather than taking a continual count of how many rotations the wheel has experienced, measures each rotation individually and resets to zero after 360 degrees have been recorded. This greatly complicated the programming for using odometry to record rotation and angle measurements, as the encoder does not automatically provide how many degrees or rotations have occurred. However, Rohan and Karthik found a way around this issue and began tracking each rotation with the intention of eventually converting this distance into MOE units and updating the robot's localized position in real time. This will allow us to always know the robot's position without seeing a Vumark or other landmark.

Prusa i3 Mk2 Printer Upgrade

Prusa i3 mk2 Upgrade

Andrew and Ian replaced the print bed of the Prusa i3 mk2 because the print bed on the printer on the printer had holes/dents in the bed from scrapping them off when getting the prints out with a spatula.

The process of replacing the printing bed:

- **They got the new bed out that they were replacing the old bed with to have a printing bed with a smooth surface**
- **They turned the 3D printer on its side to unscrew it from the base it is mounted on.**
  - **When they look at the base that the printing bed was on, they saw that two screws were missing which can explain why bed was vibrating when in those corners when the printer was printing**
- **Then, they took the wires out of the control board of the 3D printer**
- **They plugged in the wires for the thermistor and heated bed of the new printing bed into the control board**
- **They mounted the new printing bed onto the base to secure it to the printer**
- **After, Ian and Andrew did tests and calibration on the printer to get it to print well. They did a did a X, Y, and Z axis calibration and a First layer calibration to test adjust the z height between the print bed and the nozzle to get the right layer thickness when printing.He started by doing a first layer calibration, which is a test that prints lines and then a square, to calibrate the high of the Z axis or how far the nozzle of the extruder is from the bed.**
  - **For the first test, the original Z height was 1.250 but the nozzle was too low of to the bed and mash smashing into the bed**
  - **For the second test, Ian changed the Z height to 1.100 mm and the first layer calibration and the lines and the square print well and at the right height.**
- **Then, Ian printed out a 20 mm test cube from Thingverse,** https://www.thingiverse.com/thing:1008046, to check if the printer is printing the layers correctly and the 3D printer is printing right
  - The 3D printer printed the test cube really well, so now the 3D print is back to printing.

Non-Technical/Discussion:

Paige, Jonas, Ian, and Mr. Prettyman worked on building the pit and finding what pieces of pvc pipe we needed to buy. We are a 4 ft and 5 ft pvc pipes for each side and with the pvc pipe connects, the pipe was 9 ft and 10 in long and 9 ft and 10 ins width. The max legal pit length and width is 10 ft by 10 ft. We built to levels of the pit wall but we did not get to make the roof of the pit.

After planning out the pit's structure on CAD, Marcus and Paige organized the PVC pipes and built the pit in the lab, memorizing the building process so Marcus could easily build the pit himself in Detroit.

Date: 3/19/19

Duration: 6:00 PM – 8:30 PM

March 19, 2019 Meeting

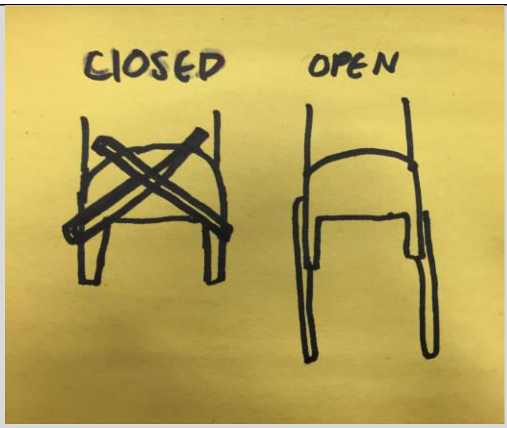
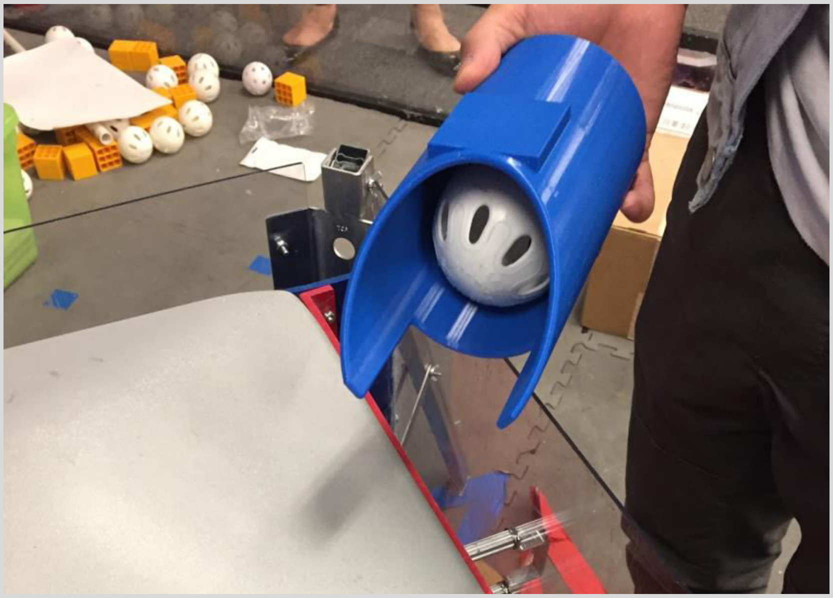
Students:	Karthik	Clare	Paige	Rohan	Ian	Jonas	Patrick	Bryan	Katy
Mentors:	**Mr. Prettyman**	**Tobi**	**Mr. Buckingham**						

Agenda
Discuss fundraising/scheduling goals while meeting in conference room
lit into sub-teams and work in lab

Tasks:		
Mechanical	**Programming**	**Prusa i3 Mk2.5 Upgrade**
Test Dump Sort Fix height problem Plan the Transfer mechanism	Continue working on mineral localization	Check to see if the extruder parts for the 3D print upgrade came out well and take them off the print bed Then, start printing the rambo parts for the 3D printer upgrade.

Mechanical Accomplishments:

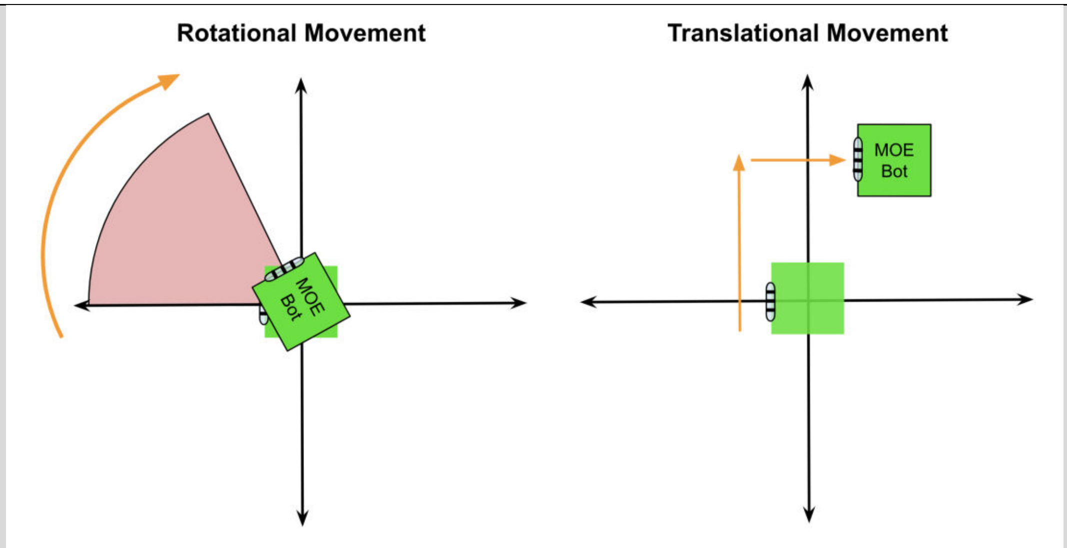
MMS	
Evaluate: Dump Sort	Patrick worked with Jonas and Clare to test the 3D printed dump sort mechanism and trying to determine the optimal angle for releasing the minerals. Originally, we were going to design a servo releasing mechanism that would extend the path the Silver, sphere shaped minerals would have to take, as shown below.

	 However, after our tests, we determined that the Silver and Gold minerals were already being separated very distinctly and that there was a decent margin of error. Because of the accuracy and design of our original dump sort container, it is not necessary for us to make a complex release mechanism.  Using this principle, we brainstormed ideas on how to contain and then release the minerals. We agreed that a simple servo with a thin flap would be the best option because it is simple, accurate, and easy to implement.
Tweak: Mechanism Positioning	Bryan and Patrick made a key design decision. We had originally put our vertical slide next to our linear actuator, but we realized that this design was too tall and extended beyond the 18 inch limit. This meant that we had to rearrange some of the parts on our robot. We knew we would have to move the vertical slide somewhere where it could be below the wheel base. There was no room on the front of the robot, so we had to move it to the back of the robot. To summarize, the vertical lift moved from being on the same side as the hanging to the opposite side. We lost the benefit of being able to hang right after scoring a

	cycle. The other benefit is that we wouldn't have to turn to score because the vertical lift is still on the side of our robot. The problem that we faced is that it was on the wrong side. To address this problem, we flipped the orientation of the robot, so that it harvested from the back of the robot, which was to be set as the new front of the robot. In addition, the linear slide with the mineral harvester was taking up the back half of the robot, so we had to move it over to make room for the vertical slide. The odometry wheels also had to be repositioned to accommodate these changes. We finished remounting and securing all objects. We ran some tests with the motor tester, and no problems showed up.
Problem: Transfer Mechanism	So far, the mechanism that transfers the mineral from the harvester to the dump-sorting dispenser has proved to be the most difficult engineering challenge. This is because, first, we have passed our motor limit, so we wanted it to be a passive transfer (or use existing motors). With such a close proximity of the two systems (harvester and dispenser), it seemed impossible to make a mechanism that would fit in between.
Develop a Solution: Conveyor Belt	Because of the lack of viable ideas, the only idea we had was to make a conveyor belt, which has many cons. It was slow, and we had to actively use a servo. However, it seemed to be the only solution that would fit in our system. The plan was to mount the servo at the very back of the robot, behind the dispenser. We then could put a pulley on the servo and then put a pulley at the front of the robot. Slots would be cut into the middle of both mechanisms in order to fit a conveyor belt through. We tested this idea by rigging the pulleys using clamps. The conveyor belt didn't seem to want to grip the balls, so we may have to address the problem later.

Programming Accomplishments:

Autonomous	
Design and Test a Prototype: Odometry Localization	Rohan and Jonas reviewed the code they had written for using odometry wheel inputs for advanced localization. They worked on tuning their turning constants, so that the odometry wheels would be able to reliably localize and figure out its position.

	 To use the odometry wheels reliably, we have to be able to distinguish between rotational movement and translational movement. The typical way to solve this issue is through a mechanical paradigm, which involves the use of additional odometry wheels opposite to each on of importance. By averaging the values of botwh wheels (positive & negative changes would cancel out), one could get an accurate measurement of only translational movement. Applying this methodology to our robot, we would have 4 odometry wheels on the robot. Due to the fact that we did not have space for 4 odometry wheels, our team has to resort to other options to discount rotational movement. This has been done through the gyro and a measure we created known as “rotational offset”. This “rotational offset” would be used as a subtractor to discount any non-important odometry values. By dividing the angle difference (found between each refresh of the odometry wheels’ position) over 360, and multiplying by the “rotational offset”, an appropriate offset measure can be found for each wheel. By calibrating & turning a “rotational offset” for each of the two odometry wheels, we can accurately discount any rotational motion, allowing only translational movement to be used in the calculation of the robot’s position.
Design and Test a Prototype: Mineral Vision	Jonas and Clare continued working on their project to use the webcam to identify, locate, and localize minerals. We reviewed our spreadsheet data and tested the quadratic equation we had come up with at a previous meeting.

f(x) = 811.1318 + -31.28273x + 0.34356387x^2			f(x) = pixels the top of the mineral is from the top of the image			
Quadratic ^			x = distance the furthest point of the mineral is from the camera (horizontal)			
f(x) = 57.339 - 0.17229207x + 0.00017880925x^2			f(x) = distance			
			x = pixels			
	top pixel	inches (+6)	y=y= 0.500000x2−38x+792.000		y=y= 0.875000x2−43.75x+731.000	
1	88	32				
2	102	30			y = .4201x^2 - 31.347x + 660.889	
3	120	28				
4	138	26	**f(x) = .000141433x^2-.14089x+42.8988**			
5	158	24	**x is the pixel count from the top**			
6	179	22	**f(x) is the inches the blocks are away**			
7	202	20				
8	228	18				
9	259	16				
10	292	14				
11	332	12				
12	381	10				
13	437	8				

Then, we used it to make a simple OpMode in Android Studio. The goal of designing this program was to test the feasibility of using the webcam to identify minerals and to see if it was a viable solution that could be implemented in our final code. All of this is working towards our end goal of being able to autonomously harvest minerals.

Prusa i3 Mk2 to Mk2.5 Upgrade

- **Ian checked the print of the new extruder 3D printed prints to see if the prints printed really well**
  - **All the parts came out prettily and are ready for the upgrade**
- **Then, Ian cleaned off the glue of the bed because he might have put too much for the extruder 3D parts.**
- **He then looked at the .gcode file for the motherboard/rambo parts that was on the Prusa website**
- **He prepared the 3D printer for the print**
  - **Ian put glue on the printing bed for adhesion for the parts to stick to the bed better**
  - **He heated up the extrude and the print bed to the temperatures for the pteg filament the team is using**
  - **He cleaned the nozzle of the extruder so filament is not stuck on the nozzle**
  - **He calibrated the printer by homing the x, y, and z axis.**
- **He started the prints for the rambo board parts**
- **the first layer came out well and smooth, but when the printer started the second layer it shifted the layer back for some reason, so Ian stopped the print.**
- **He took the started print off the bed and reprinted it but he stopped it because it was the end of the meeting and he did not want to print it if the problem of the layer shift was going to happen again.**

Non-Technical/Discussion:

We have succeeded in raising over $1,300 on our GoFundMe page and will continue to share and promote it. We expect to have gained $300-400 through our Panera fundraiser, but we have not received proceeds yet.

We will continue working on designing and building the pit display. Connor has been improving his slideshow presentation and the programmers will make something to be put on a monitor screen. In Detroit, we hope to check in and assemble our pit display on Tuesday afternoon, which will leave time to prepare for presentations/matches on Wednesday morning.

We will come up with more ideas for spirit, including button designs. Paige has been making more buttons, and we would like to come up with more designs and ideas for other types of spirit gear.

Date: 3/26/19

Duration: 6:00 PM – 8:00 PM

March 26, 2019 **Meeting**

Students:	Connor	Rohan	Jonas	Page
Mentors:	**Mr. Prettyman**	**Mr. Price**	**Andrew**	

Agenda
Small number of people at the meeting. Will end at 8:00 instead of 8:30
cause we are missing many team members, we will focus on the Pit Display and Judging Presentation rather an anything technical

Tasks:	
Pit Display	**CAD**
Work on the pit for FIRST® TECH Challenge world championships.	Work on CAD PowerPoint for pit display

Non-Technical/Discussion:

Connor made a spreadsheet of everything he thought should be in the CAD presentation. This includes everything in the rough draft plus some extra slides with videos or details about the old robot.

With the help of Mr. Price, we built the pit assembly and color-coded the pipes with duct tape according to their length. This will make it easier for us to quickly assemble the structure at the World Championships.


MOE

Date: 3/30/19

Duration: 9:00 AM – 2:30 PM

March 30, 2019 Meeting

Students:	Connor	Bryan	Patrick	Rohan	Katy	Karthik	Marcus	Clare
Mentors:	**Mr. Prettyman**		**Zach**		**Arnav**			

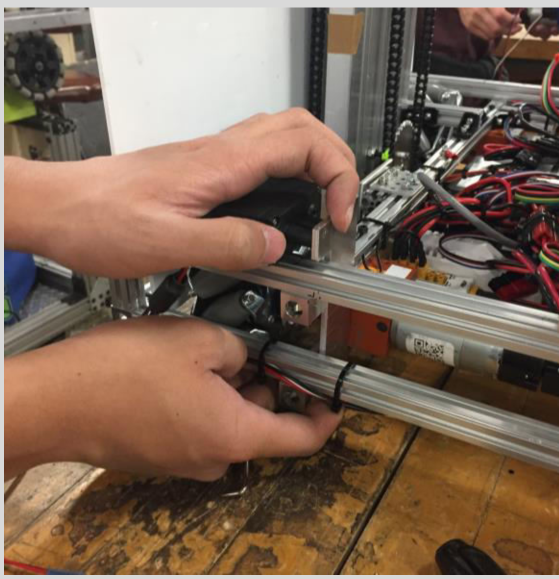
Agenda
Discuss progress while in the conference room
rk in lab

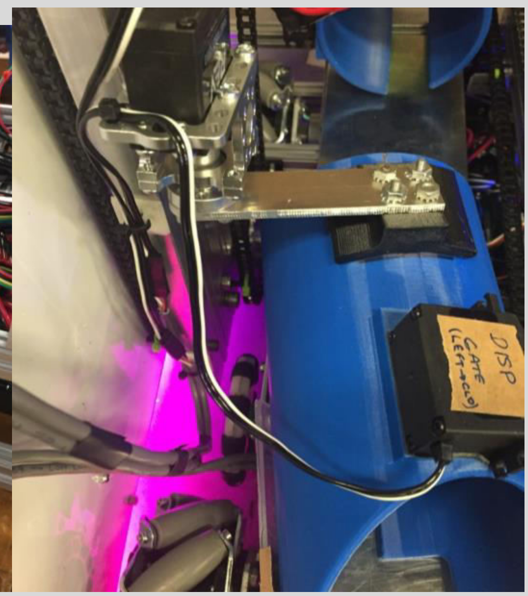
Tasks:	
Mechanical	**Programming**
Mount Dump Sort and Harvester Complete wiring so that the MMS can be tested	Use a simulation to test code while waiting for use of the robot

Mechanical Accomplishments:

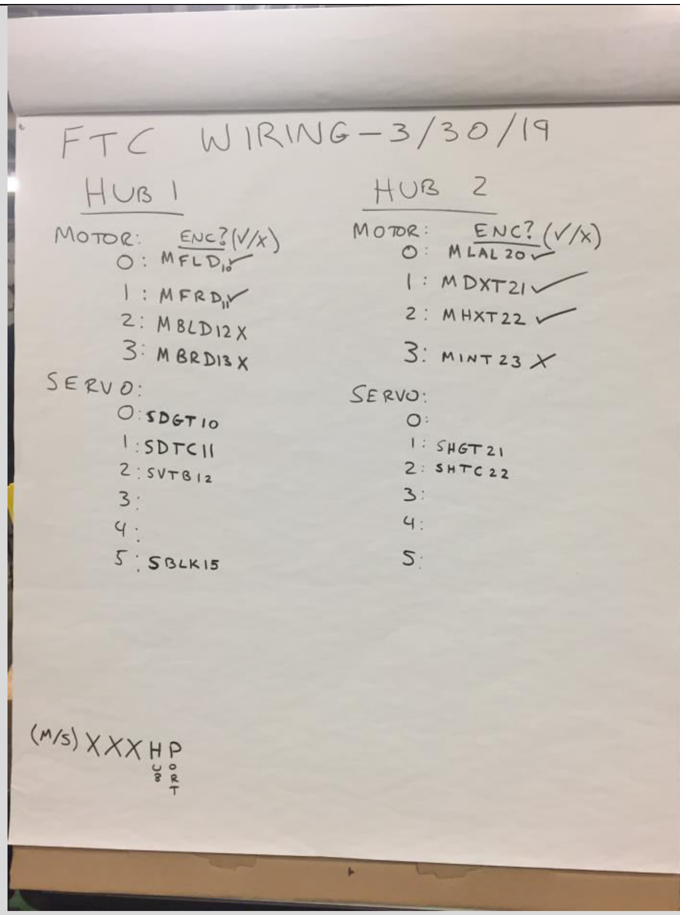
MMS	
Design and Test a Prototype: Mounting MMS	The mechanical team aimed to complete a testable prototype of the MMS. The harvester was mounted through use of a servo so that it will be able to rotate freely. This will allow the harvester to be more flexible and effective when collecting minerals.

Bryan worked on mounting a servo to the vertical lift. This would allow the Dump Sort to rotate 180 degrees, from facing the inside of the robot to facing the outside. Then, he mounted the Dump Sort tube to the other end of the servo.





Finally, Bryan worked with Andrew to complete the wiring of the chassis.



Next meeting, we hope to start setting up TeleOp code.

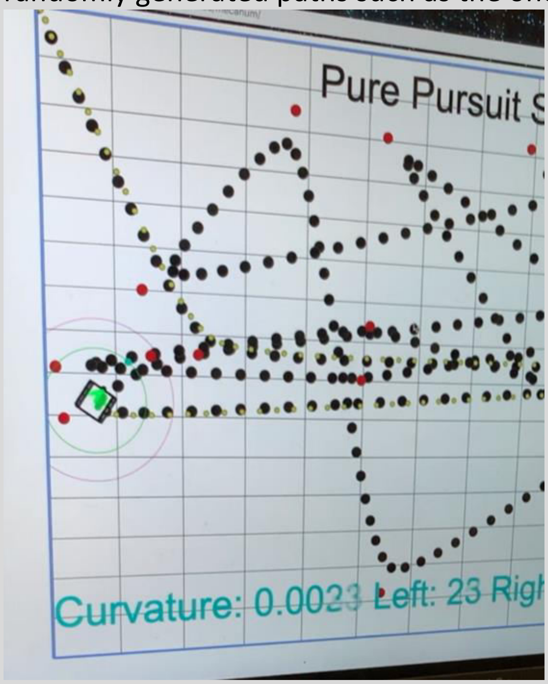
Lighting

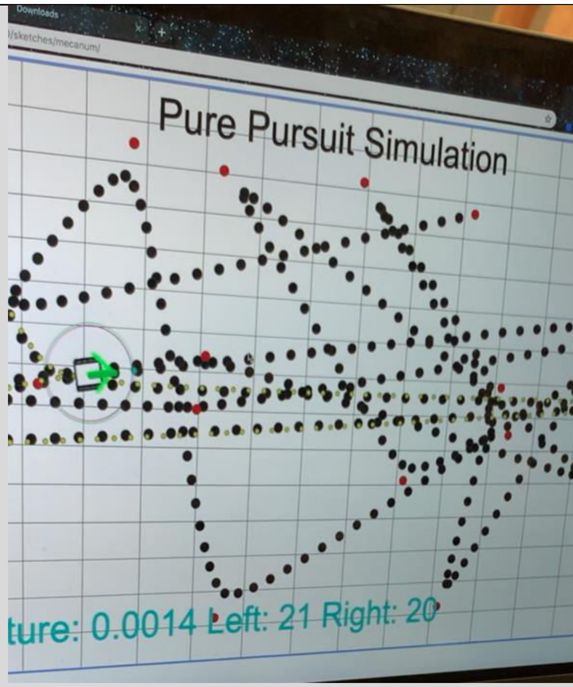
Fabricate Solution: Underglow

With Andrew's help, we installed LED lighting underneath the frame of our chassis.

	We hope to implement a color system where our robot's lights will be the same color as our alliance, or simply keep them green for team spirit!

Programming Accomplishments:

Autonomous	
	We used an FTC 2D simulation to see if we could find any mathematical errors in the program before implementing it onto the actual robot. Another reason we worked on the simulation was because the robot was being worked on, but we needed to be able to test the code. Previously, our integration of Pure Pursuit into the simulation included following randomly generated paths such as the one below  We needed to fix a few things about the simulation. First, the curvature-velocity adjustment was still not sufficient for sharp turns. Although it slowed down to complete the turn, the robot still overshot the turn and needed to find its way back to the path We found that this would not be effective in true applications because it veers off too far from the path and may cause crashes into obstacles. We needed a solution that slowed the robot down to a stop so it could complete the turn

	 After it turned on the spot, it still was able to do gradual turns while moving, so it worked greatly.

Non-Technical/Discussion:

Katy and Clare reviewed the progress that had been made on our team GoFundMe page. We have currently raised $1,425 and will continue to promote it. Jonas, Ian, Patrick, and Mr. Prettyman all helped write thank you notes for those who donated.

For spirit gear, we tested sizes of jackets and organized an order. Andrew will make the jacket design.

Katy and Clare worked on updating and coming up with ideas for our social media Facebook page and on ideas for our pit display.

Date: 4/2/19

Duration: 6:00 PM – 8:30 PM

April 2, 2019 Meeting

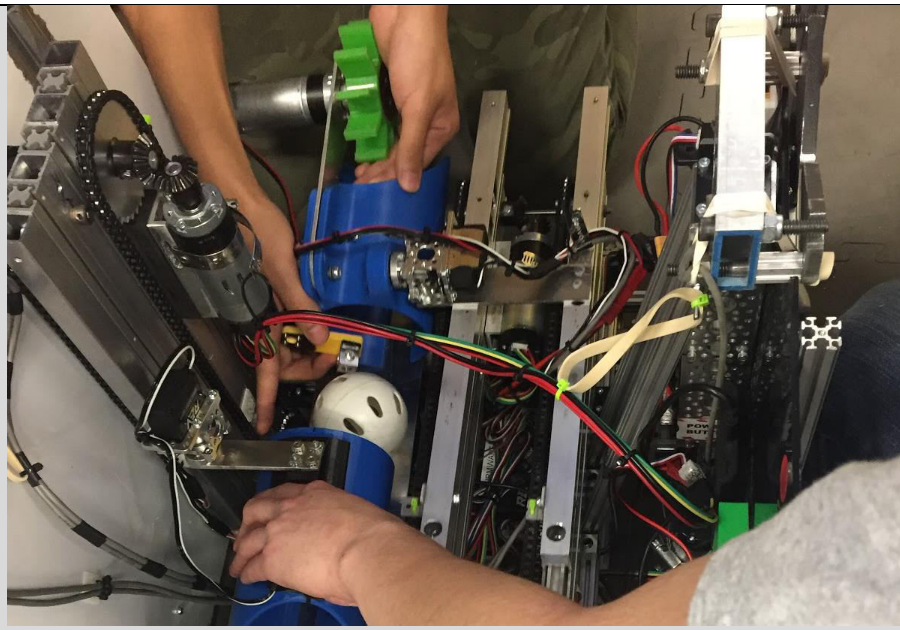
Students:	Rohan	Clare	Karthik	Paige	Katy	Ian	Patrick	Bryan	Marcus	Connor
Mentors:	**Mr. Prettyman**	**Mr. Price**	**Arnav**	**Zach**						

Agenda
Start packing for Worlds
ntinue building MMS

Tasks:	
Mechanical	**Programming**
Create transition between harvester and lift – Bryan, Zach, Arnav Test harvesting - Patrick Make Driver Station - Marcus	Work on Judging Presentation, Control Document, and Notebook entries while waiting to test on the robot Karthik, Rohan, Clare

Mechanical Accomplishments:

MMS	
Evaluate: Transition	For the transition between harvester and vertical lift, we initially had two ideas: • Spin the green wheel backwards to shoot the minerals out the back and let them slide into the second tube • Angle the harvester backwards and let the minerals fall out into the second tube However, after testing these ideas by hand, we were unable to get either to work consistently. Spinning the wheel backwards was unreliable because the minerals were not always in contact with the wheel by the time the harvester had been retracted. Angling the harvester backwards was inaccurate because the minerals frequently got caught in between the pipes.



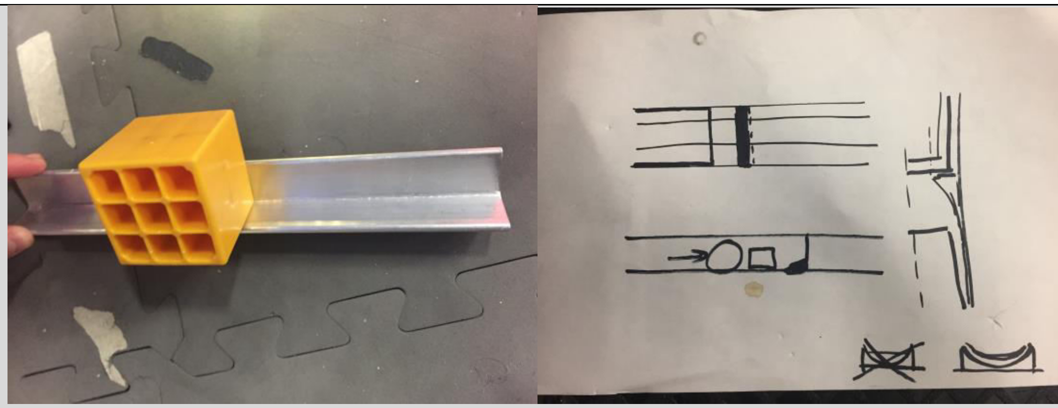
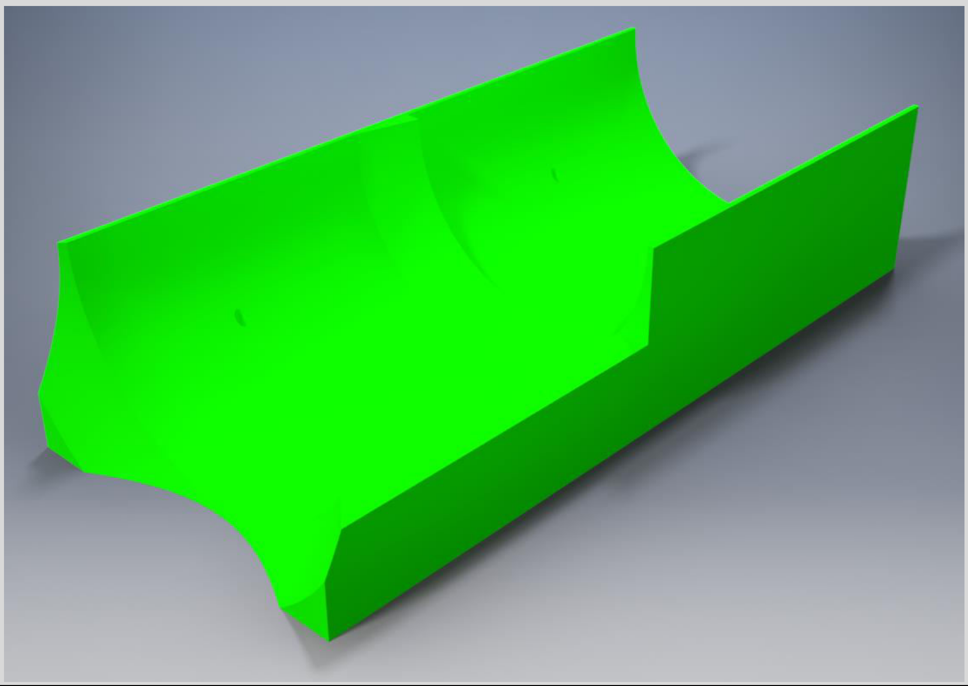
Instead, we tested a third idea.

- We angled the harvester backward and dumped the minerals into the space between the pipe. Then, we dropped the servo gate and pushed the harvester backwards which resulted in the minerals being forced into the vertical lift.
- This idea worked with 1 ball, 2 balls, 1 cube, and 1 cube/1 ball. However, it did not work with 2 cubes.
- This was because the cubes needed to be rolled slightly in order to tip inside the vertical lift. With 2 cubes being lined up together, they provided enough resistance against the servo to stay in between the pipes.

We decided to implement a track to make this idea compatible with any combination of minerals. We believed a print could be made that would fit in between the dispenser and the harvester would also be a pipe that the two mechanisms index into. It would feature a ramp to help minerals get into the dispenser and hopefully also provide more protection from minerals falling into our robot during transfer.

Mineral Transfer Ramp

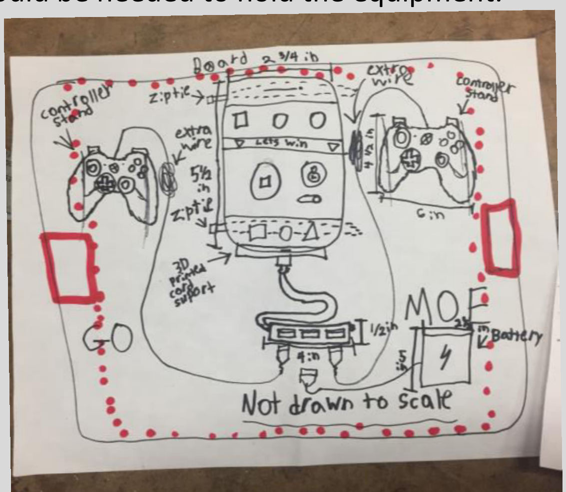
Define Problem: Mineral Transfer Ramp	We needed to be able to transfer minerals from the harvester to the scorer easy, accurately, and consistently.

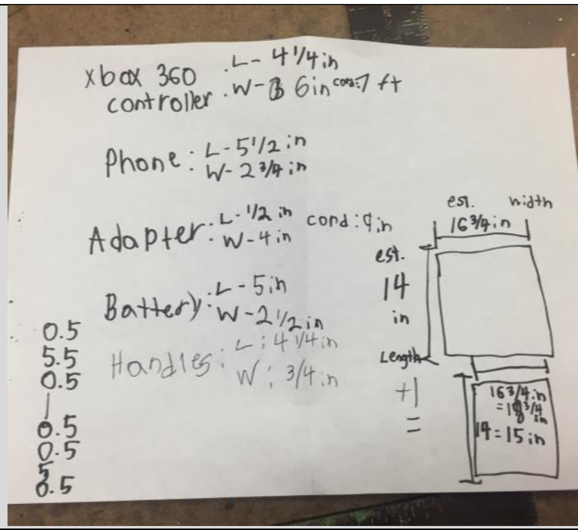
<table>
<tr>
<td>Generate Concepts: Design</td>
<td>
Ian and Connor worked with the mechanical team to design the ramp.
</td>
</tr>
<tr>
<td>Design and Test prototype: Mineral Transfer Ramp</td>
<td>Ian use the 3D printer to make the Mineral Transfer Ramp

After Zach and Arnav finished CADing the Mineral Transfer Ramp, Ian put the Mineral Transfer Ramp CAD .stl files into the Slicer program, Simplified 3D
For the print of the Mineral Transfer Ramp, Ian set it with 0.3 mm layer height, 2 parameters/outer walls, 10% percent infill, and supports off.
Then, The Slicer made a .gcode files of the mineral transfer ramp with the details describe above that the 3D printer can use to print it.
He prepared the 3D printer for the print

Ian put glue on the printing bed for adhesion for the parts to stick to the bed better
He heated up the extrude and the print bed to the temperatures for the pteg filament the team is using
He cleaned the nozzle of the extruder so filament is not stuck on the nozzle
He calibrated the printer by homing the x, y, and z axis.

Then, he started the printed and the first layer came out smooth and perfect.
</td>
</tr>
</table>

Driver Station	
Define Problem: Driver Station	We noticed that at competitions, we frequently will have to make multiple trips in order to get both controllers, phones, and other necessary equipment for matches. To make this process easier, we have considered implementing a driver station board for a while, and Marcus decided to begin building one. Having a driver station will make it easier, more convenient, and more efficient for us to pack for competitions and queue for matches.
Generate Concepts: Design	Marcus took measurements of our controllers and phones. Then, he began conceptualizing a design of what the board would look like and what mechanisms would be needed to hold the equipment.  



Programming Accomplishments:

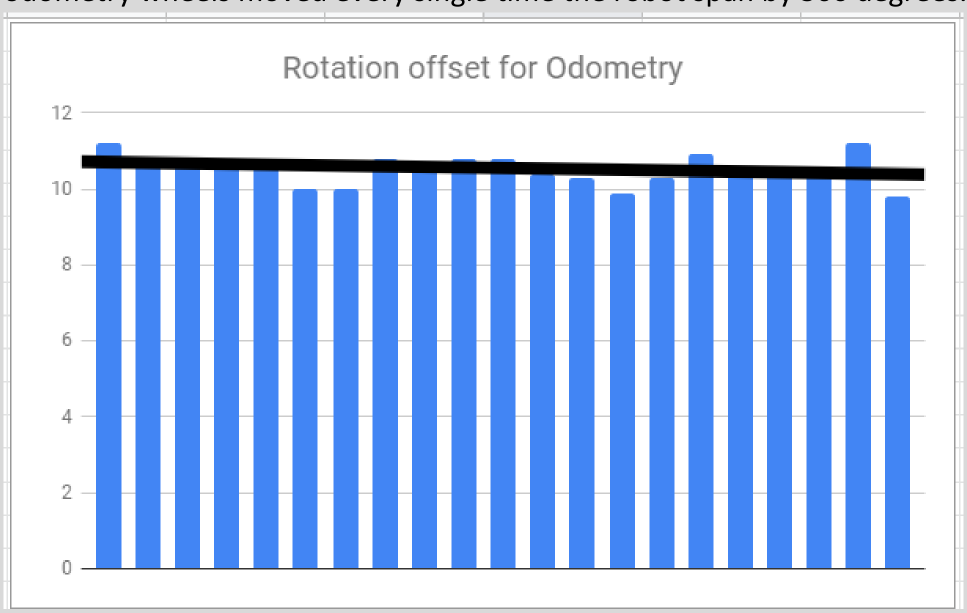
Autonomous

Tweak: Odometry code

The programmers spent time reviewing and debugging the odometry code so that it will be as easy as possible to implement it onto the finished chassis. Pure Pursuit was dependent on accurate line-following, which meant that being even a few inches off from off from our target could mean hitting an obstacle. The major part of the odometry code that had to be fixed was the turn corrections.

We found that trying to theoretically calculate how much the odometry wheels turn when the robot turns was not a viable option

Instead, we decided to just perform repeated tests, checking to see how much the odometry wheels moved every single time the robot span by 360 degrees.



The results were pretty consistent. The rotational offset was 23.2 inches for the front wheel and 11.2 inches for the right wheel. This is the number of inches the

	odometry wheel turned every time the robot turned 360 degrees. We used this value as an offset. For example, if the robot turned 90 degrees, we would subtract (90/360) *11.2 inches from the front wheel. This would balance out the movement caused by rotation in the robot, and give us the exact location of the robot.

Non-Technical/Discussion:

The mechanical team plans on finishing a working prototype of the MMS by Saturday to allow for testing and improvement.

Patrick will compile a list of all remaining objectives and will be in charge of task management.

Our Panera fundraiser resulted in $125.

We will finalize our team jacket order once everyone submits sizes and names.

ccv

Date: 4/6/19

Duration: 9:00 AM – 2:30 PM

Saturday, April 6, 2019 Meeting

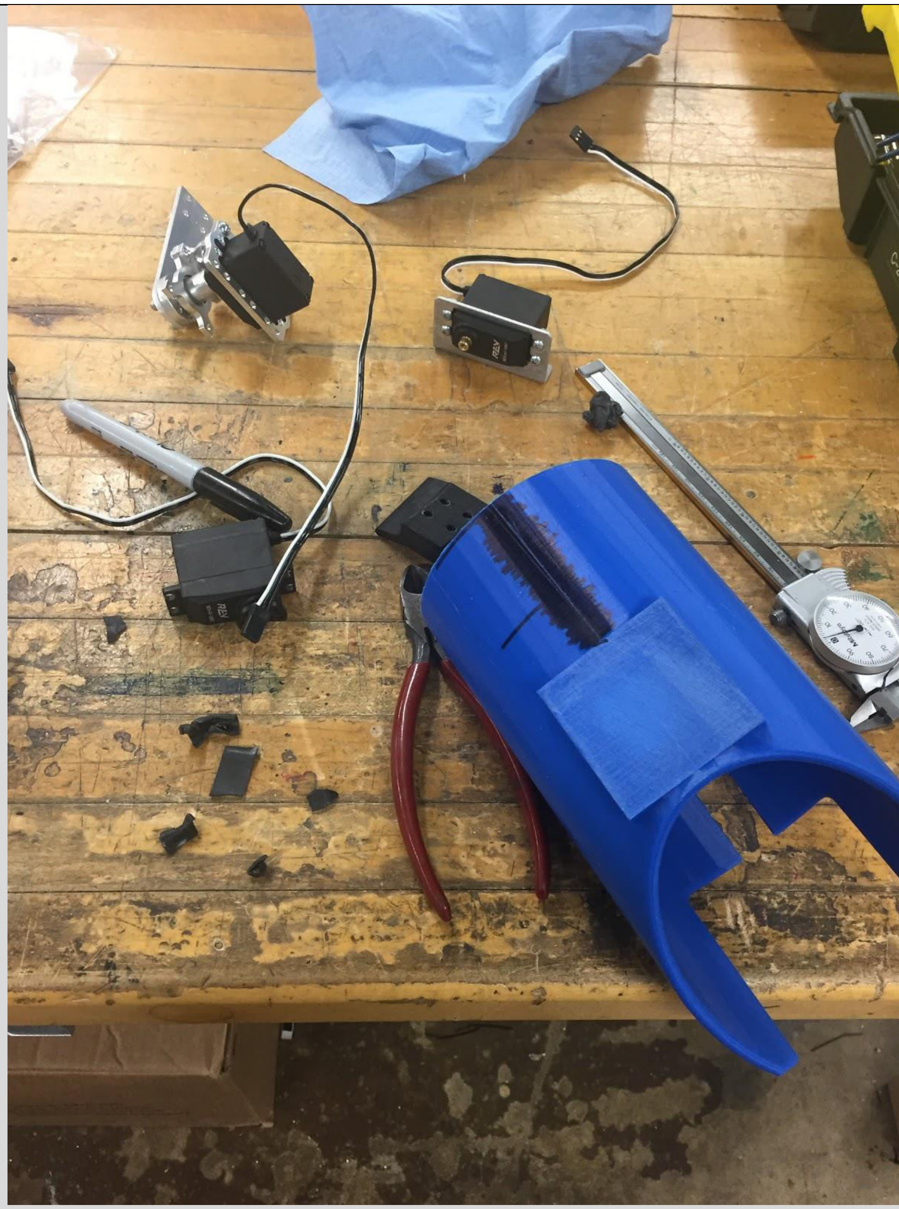
Students:	Connor	Paige	Clare	Ian	Karthik	Rohan	Jonas
Mentors:	**Zach**	**Arnav**					

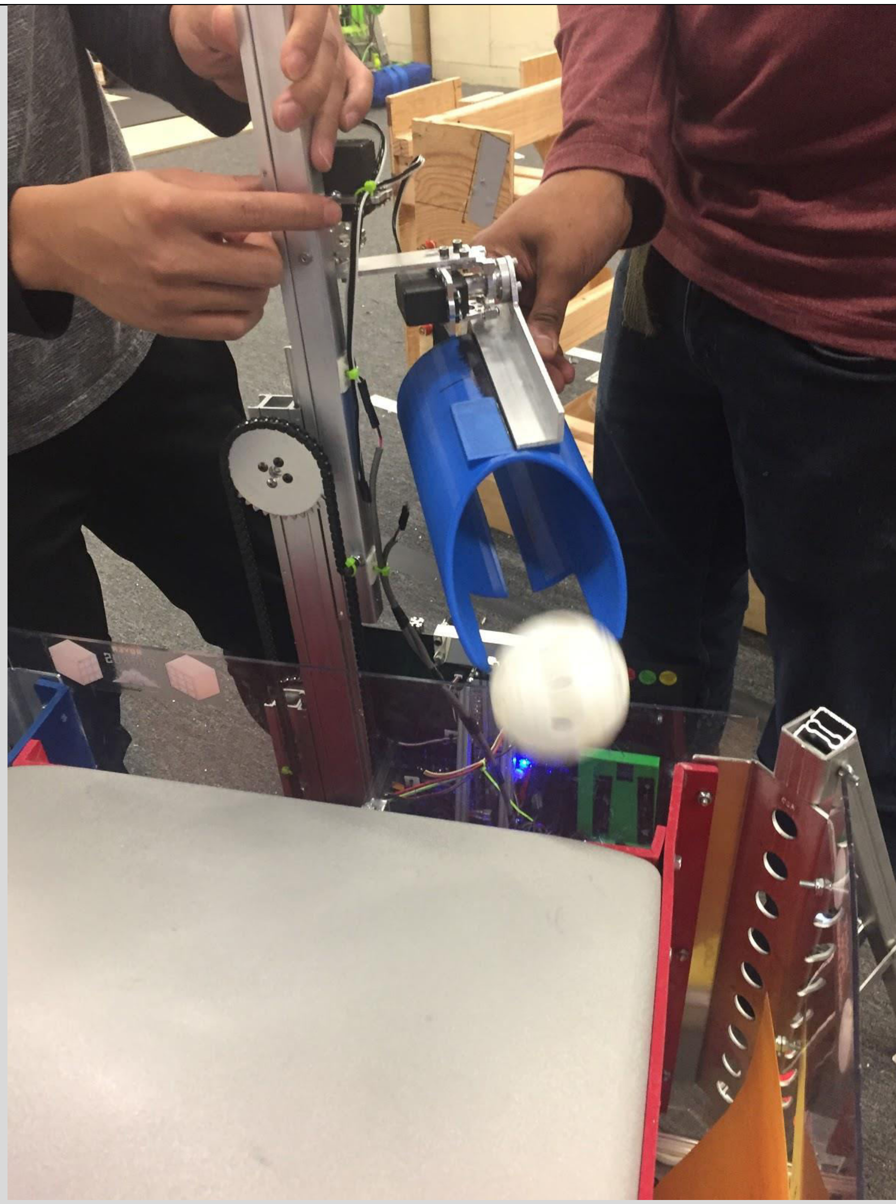
Agenda
Meet outside the lab and assign jobs independently
cide goals within each sub team

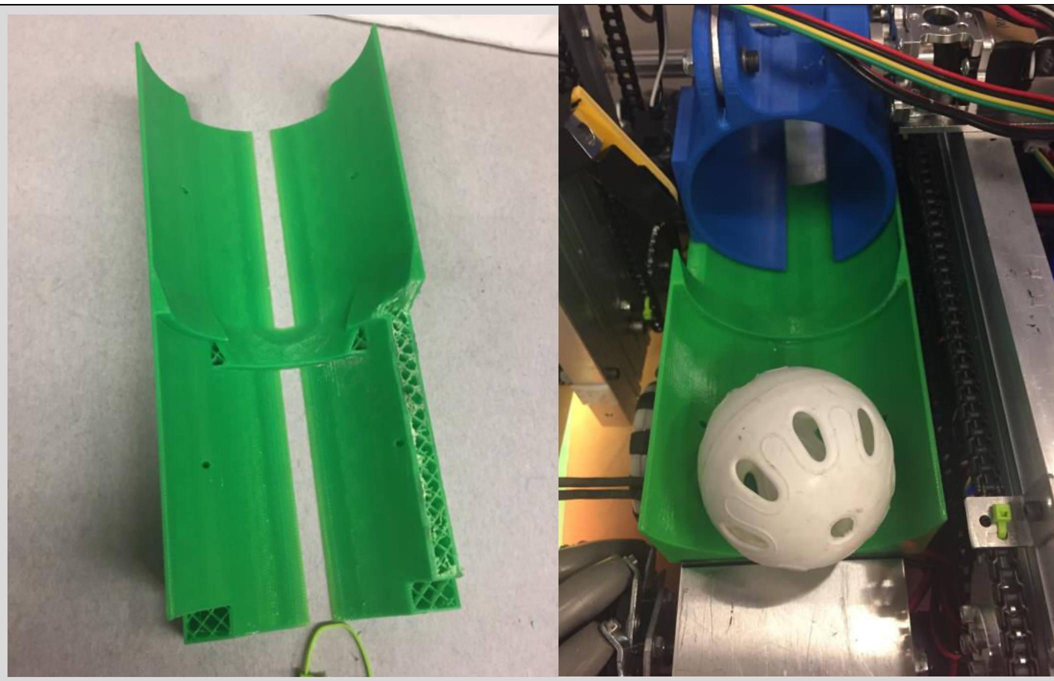
Tasks:		
Buttons	**MMS**	**Programming**
Continue making more spirit gear	Implement ramp into design Do initial tests of MMS	• Adapt program to accommodate the mechanical features of our new competition robot • Be able to correctly identify mineral position from webcam

Mechanical Accomplishments:

MMS	



	
Tweak: Transfer Ramp	The first attempt at printing the ramp had a layer shift near the middle of the print(leftmost image), so Zach and Arnav made a new model of the ramp and then printed it. Thankfully, the second print (rightmost image) turned out perfect, with a tiny layer shift toward the bottom, and was ready to be mounted onto the chassis.

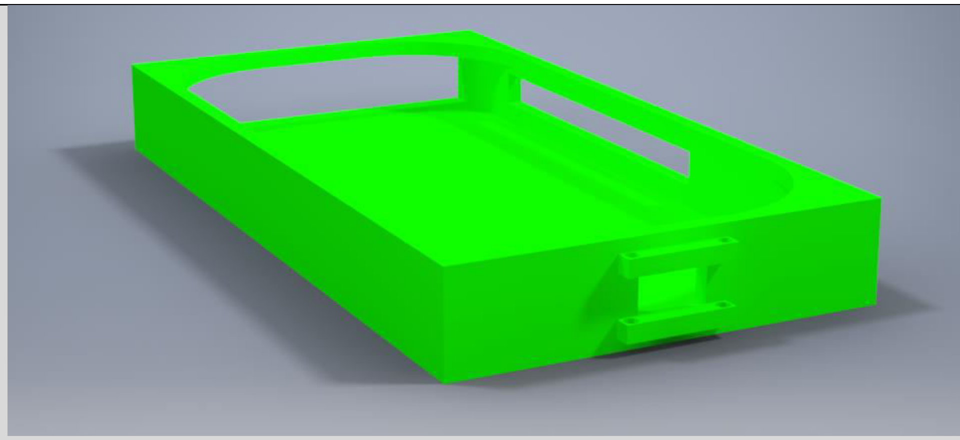
	 The ramp is designed with two tier levels so that the minerals can smoothly travel from the harvester bucket to the other without ever having to travel up a ridge.

LLMS	
Tweak: Hanging Fingers	I realized that the fingers were loose and affected hanged. I tried milling out a new spacer that would account for the looseness; however, it still wasn´t good enough to let us hang about 4 inches. I realized that a problem is that we could not tighten it hard enough or else it couldn´t spin, so I put bearings in between the fingers and the plate so that we could tighten it down but it still be able to turn. The bearings changed the spacing of the fingers so I needed to countersink a screw instead. This way, the fingers could lie flush with the lander.

Driver Station	
Design and Test a Prototype: Driver Station	After last meeting, Marcus spray painted the driver station board. He continued to assemble it today, and added LED lights along the bottom.

Phone Case	
Evaluate: Phone case	The previous phone case had an issue where the cable could be unplugged. The new phone case fixes this.

	 The holes in the front allow zip ties to hold the cable in place.

Tweak: Phone Case	Ian use the 3D printer to make the Mineral Transfer Ramp
	• After Connor finished CADing the Phone case, Ian put the Phone case CAD .stl files into the Slicer program, Simplified 3D
	• For the print of the Phone Case, Ian set it with 0.3 mm layer height, 2 parameters/outer walls, 15% percent infill, and supports on.
	• Then, The Slicer made a .gcode files of the phone case with the details describe above that the 3D printer can use to print it.
	• **He prepared the 3D printer for the print**
	  ○ **Ian turned on the 3D printer**
	  ○ **He heated up the extrude and the print bed to the temperatures for the pteg filament the team is using**
	  ○ **He cleaned the nozzle of the extruder so filament is not stuck on the nozzle**
	  ○ **He calibrated the printer by homing the x, y, and z axis.**
	• Then, he started the printed and the first layer came out kind of smooth
	• for some reason when the printer tries to print Stright diagonal lines it does it prints then with some filament jutting out so Ian need to research how to prevent that from happening.

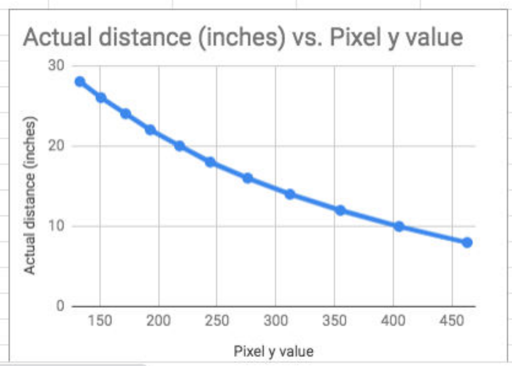
Programming Accomplishments:

Autonomous	
Design and Test a Prototype: Mineral Localization	Rohan, Jonas, and Karthik worked on fixing their program for identifying the coordinates of minerals. They debugged the program and got it working, but need to test the validity of the data.

Jonas is redoing the measurements for the equation that returns the distance of each mineral based on its position in a picture. The task is simplified by the fact that each gold mineral is 2”x2”x2”.

He assembled the spreadsheet shown below to find the graph showing the pixel value in relation to the actual inch value.

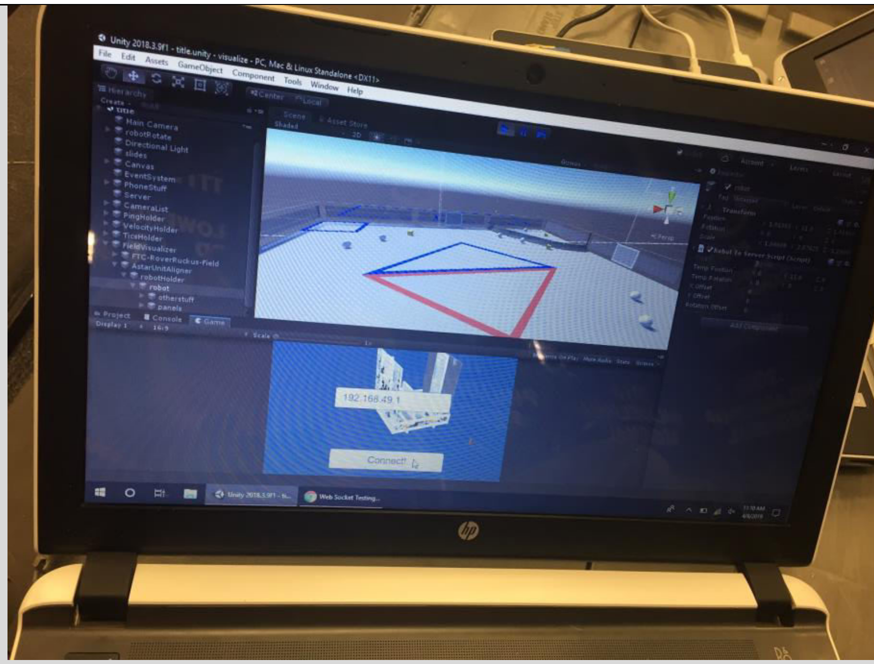
	A	B	C	D	E	F	G	H
39	distance to object (mm) = focal length (mm) * real height of the object (mm) * image height (pixels)							
40	--							
41	object height (pixels) * sensor height (mm)							
42								
43								
44	focal length	3.67 mm						
45	sensor height	3.60 mm		3.67 * 50.8 * 480		top of equation =	89489.28	
46	object height	14 pixels		14 * 3.6	24*3.6			
47	real height	50.8 mm		3.67 * 50.8 * 480				
48	image height	480 pixels		[object height] * 3.6		90 * 3.6	81*3.6	14 (+6)
49								
50		Pixel y value	Actual distance (inches)					
51		463	8					
52		405	10					
53		355	12					
54		312	14					
55		276	16					
56		244	18					
57		218	20					
58		193	22					
59		172	24					
60		151	26					
61		133	28					
62								
63								



Tweak: Adapting Code

Rohan and Karthik started to adapt all of their previous code to the new robot. This includes tasks such as adapting TeleOp, odometry, and autonomous to fit the new chassis.

In order to test our code, we ran a virtual simulation through the engine Unity. This allowed us to not only run our programs virtually, but also to digitally track where our robot is on the field through a representation on the screen.



One of the main benefits of running a virtual simulation was that it allowed us to see if an issue was due to an error in code or mechanical deficiency.

Prusa i3 mk2

On the prints of the two ramp models, there was a layer shift on the x axis. It was a big shift when printing the first model of the map and a little layer shift on the second ramp model.

To try to fix the layer shifting problem, Ian researched how to fix the issue and did a self-test of the printer to see the cause, possibly due to the x-axis motor or something else. When the test ended, it said that everything was functioning, including the x-axis and y-axis movement.

Then Ian tested if the printer layer shift on the x axis with a print we need to print.

Non-Technical/Discussion:

Mr. Prettyman could not come to the meeting today, so every team member was responsible for independently deciding what their most important objective was and to work on it this meeting.

Date: 4/9/19

Duration: 6:00 PM – 8:30 PM

April 9, 2019 Meeting

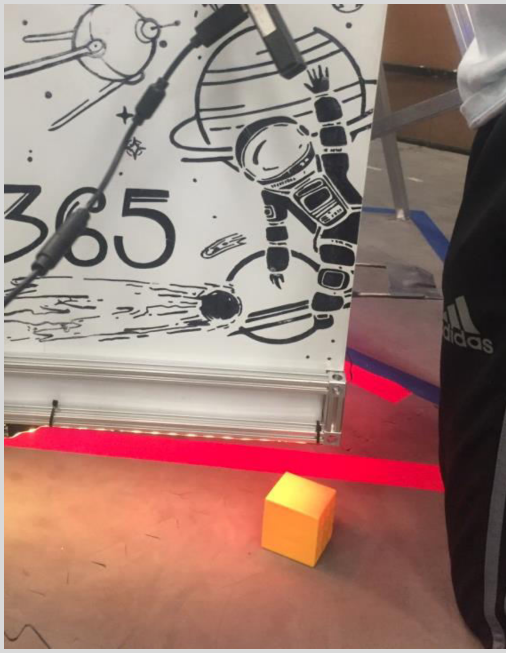
Students:	Patrick	Bryan	Clare	Rohan	Paige	Ian	Jonas	Connor
Mentors:	**Mr. Prettyman**	**Mr. Price**	**Arnav**	**Zach**				

Agenda
Discuss priorities and timeline
sign tasks within sub teams

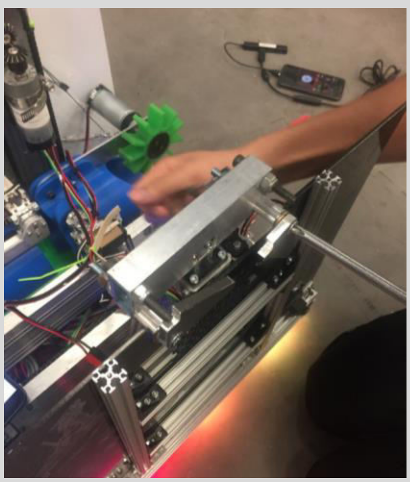
Tasks:	
Mechanical	**Programming**
Fix hanging mechanism Test MMS	Transfer Autonomous programs onto new chassis Create Assisted TeleOp to speed up MMS

Mechanical Accomplishments:

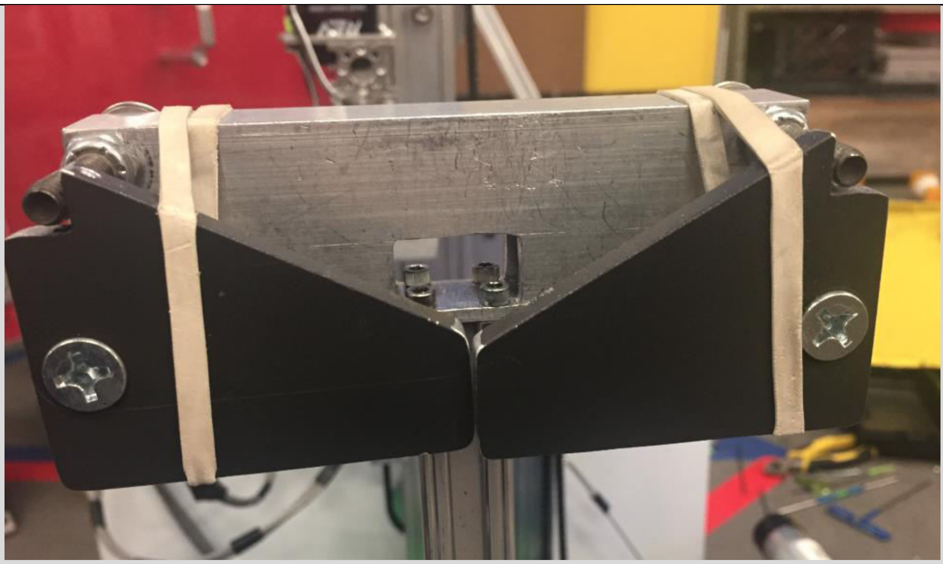
LLMS	
Tweak: Latch Design	We ran into an issue with our hanging system. Because the robot had gotten so much heavier from the MMS, it was no longer 4 inches off the ground when hanging, as it was leaning backward off of the bracket more drastically than before. This means that we had to alter the design of LLMS in order to stay the required 4 inches off the ground. One solution we attempted, as shown in rightmost image below, was to insert a bracing piece inside the bracket to force the robot to maintain an upward position. This was a promising idea but was still short of the 4-inch mark.



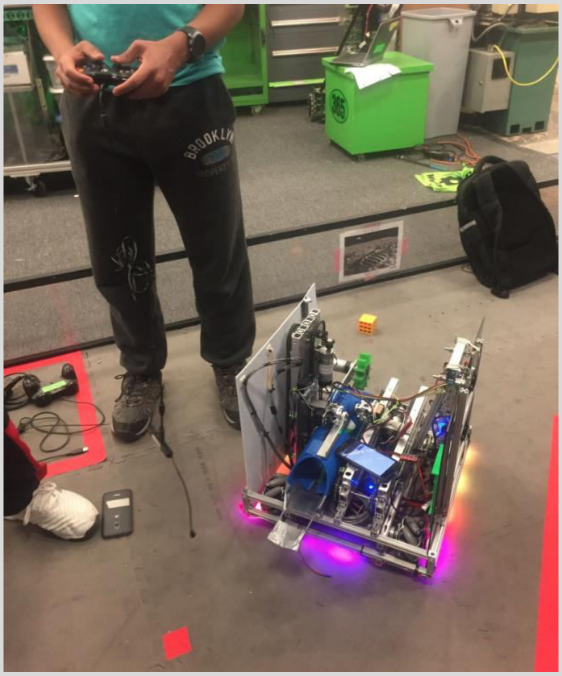
Instead, we decided on a different idea. We are going to modify the thickness of the "finger" latching pieces so that the robot will sit slightly higher up. This will allow us to meet the 4-inch requirement when hanging.



The end result looked like this:

	 A test confirmed that it was successful in meeting the 18" requirement.

Programming Accomplishments:

TeleOp	
Design and Test a Prototype: New TeleOp	The programmers worked on modifying our original code to accurately fit onto the new bot. We added code to TeleOp to fix the strafing when the robot moves left or right. Previously, we would run standard mecanum strafing code, where the two left wheels would turn inwards, and the two right wheels would turn outwards. This would cause the robot to overall move left.  When we tested this code with the new robot however, we found that the robot

	would slowly turn left as we strafed. Because of the new harvester and scoring mechanism, there was more weight placed on the back than on the front. Therefore, the back of the robot was moving faster than the front. We fixed this problem by changing our strafe code to move using very specific motor values. We tested different powers for each of the four wheels until the robot was moving accurately to the side

Autonomous	
Tweak: Autonomous	We also worked on modifying our original autonomous programs to fit the new bot. We were able to reuse most of the same code and only had to make minor adjustments at different points. Jonas also worked on the mineral identifying code. The program works and a test confirms that the returned data is accurate. By locating the top pixel of the mineral on the Vuforia image, the robot can tell how far away it is due to the fixed position and rotation of the camera relative to the robot. Basic trigonometry can identify the mineral's global position on the field given the robot coordinates and gyro. We can use this solution in many ways, including Mineral Sampling in Autonomous and potentially for mineral harvesting in Assisted TeleOp so that the robot can view a mineral and automatically move to the optimal position to harvest it.

3D printing

- **Connor gave Ian to the file for the dispenser tube for the MMS to print an extra tube for the World Competition in Detroit**
- Ian put the Dispenser tube CAD .stl files into the Slicer program, Simplified 3D
- For the print of the Dispenser Tube, Ian set it with 0.3 mm layer height, 3 parameters/outer walls, 30% percent infill, and supports on.
- Then, The Slicer made a .gcode files of the dispenser tube with the details describe above that the 3D printer can use to print it.
- **He prepared the 3D printer for the print**
    - **Ian turned on the 3D printer**
    - **He heated up the extrude and the print bed to the temperatures for the pteg filament the team is using**
    - **He cleaned the nozzle of the extruder so filament is not stuck on the nozzle**
    - **He calibrated the printer by homing the x, y, and z axis.**
- Then, he started the print and the first layer came out kind of smooth

Non-Technical/Discussion:

Connor needed the harvester and dispenser tube from Zach and Arnav to continue CAD. However, Zach and Arnav have Inventor 2019 while Connor only has 2018. Because of this, Connor spends most of the meeting downloading the newest version of Inventor.

Date: 4/13/19

Duration: 9:00 AM – 2:30 PM

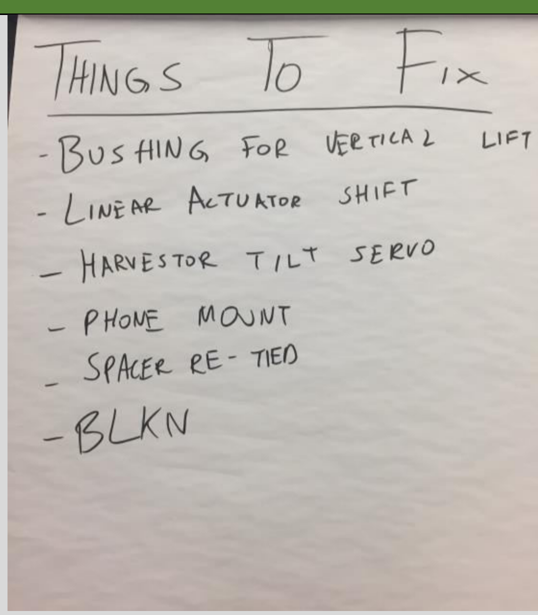
April 13, 2019 Meeting

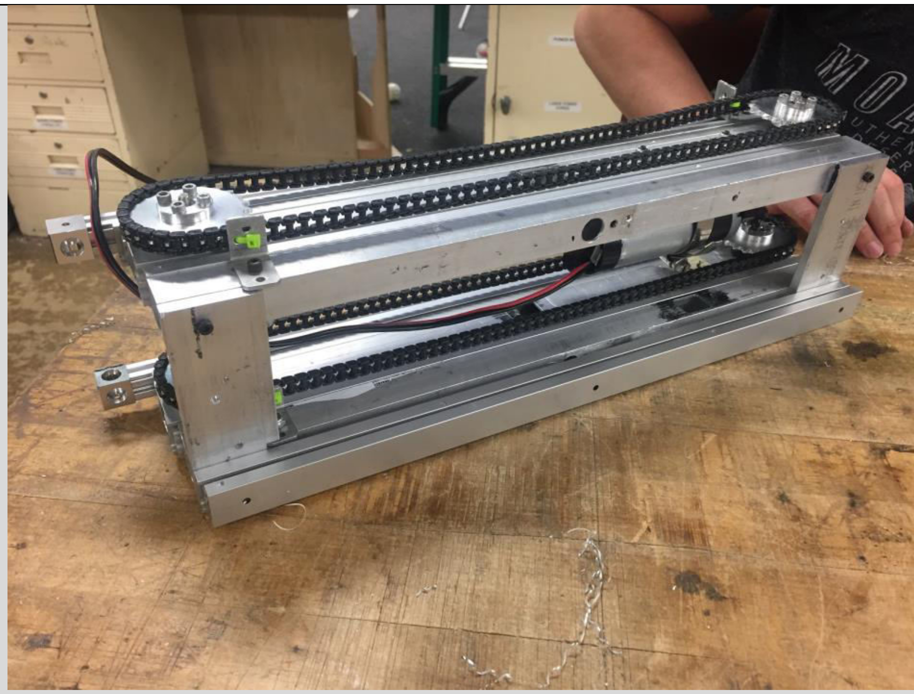
Students:	Katy	Clare	Connor	Ian	Jonas	Marcus	Rohan	Patrick	Bryan	Paige	Karthik
Mentors:	**Mr. Prettyman**	**Mr. Price**	**Zach**	**Andrew Szeto**	**Arnav**						

Agenda
• Fix minor and major issues on the robot before going to worlds
•

Tasks:	
Mechanical	**Programming**
Add another layer to slide	Test autonomous basic movement with pure pursuit

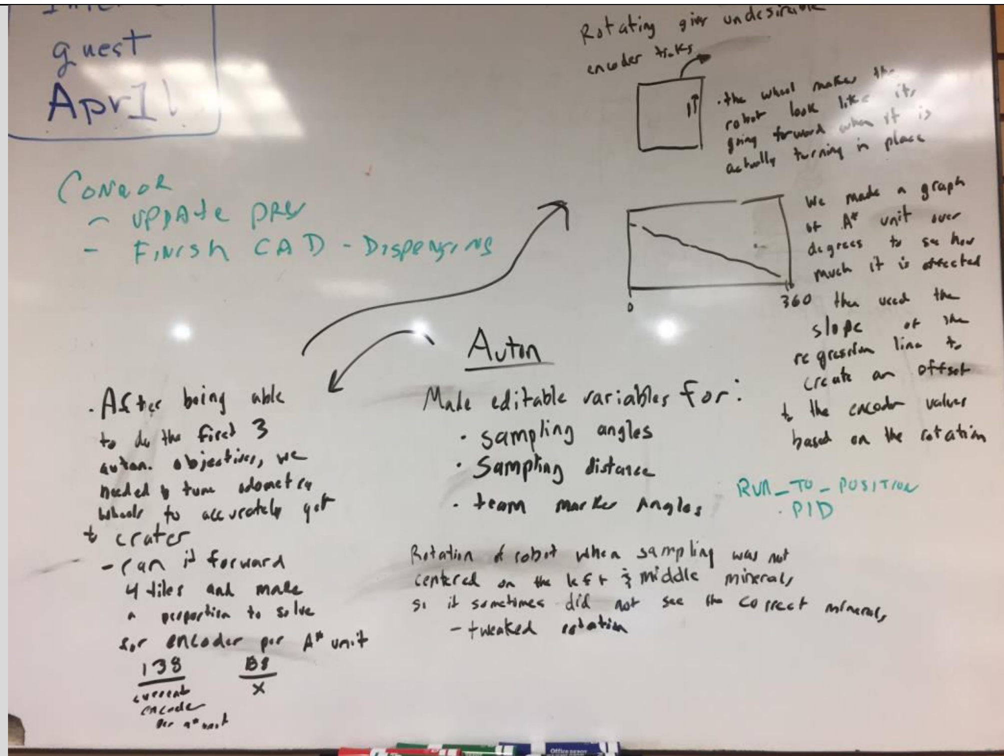
Mechanical Accomplishments:

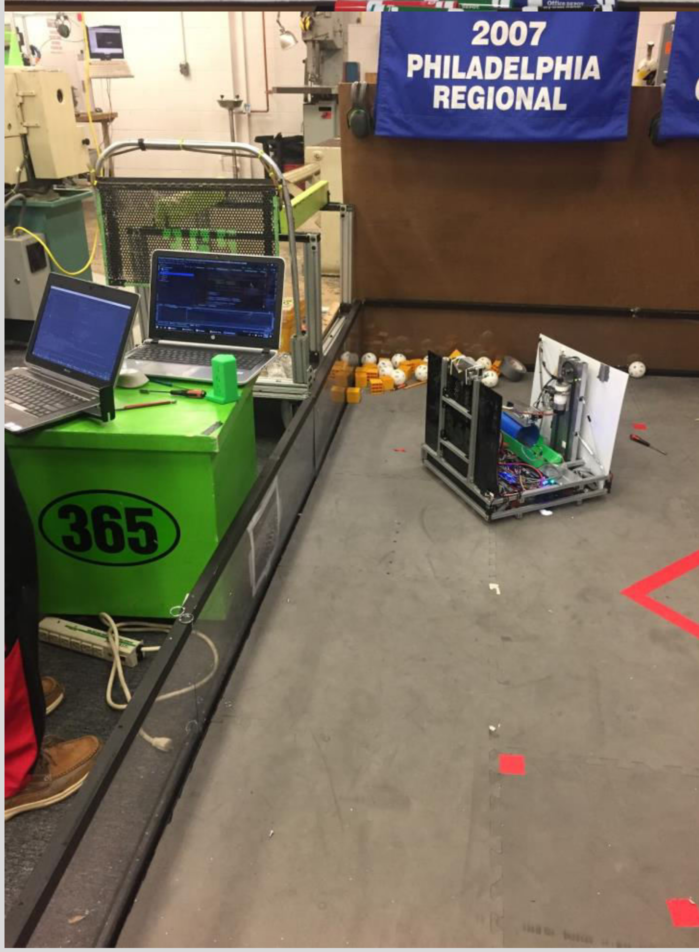
MMS	
Fabricate: Add another slide	

	 The slide was too short for an effective tele-op or autonomous period, so we added another 14 inches of extension, so it can reach further into the crater, and we can also use it to score the team marker and part in the crater during autonomous.
Tweak: Harvester Gate	The gate extension was only attached using duct tape, and since we want reliability, we took out the duct tape and bolted the extension down to the gate.
Fabricate: New Dispenser	We had the dispenser extension also only attached using duct tape, so we wanted to replace that. We had recently made a backup 3D print of the dispenser using green filament. Although it didn’t use ABS, it was more visually aesthetic and would do the job just as well. So, while the programmers had the robot, we added a new extension on the green dispenser, this time using black tape to make it look better. We also learned of some shortcomings of the blue tape, most notably, the fact that the blocks would fall too early, so we patched up the hole, so that blocks would travel a little further when being dispensed

Programming Accomplishments:

Autonomous





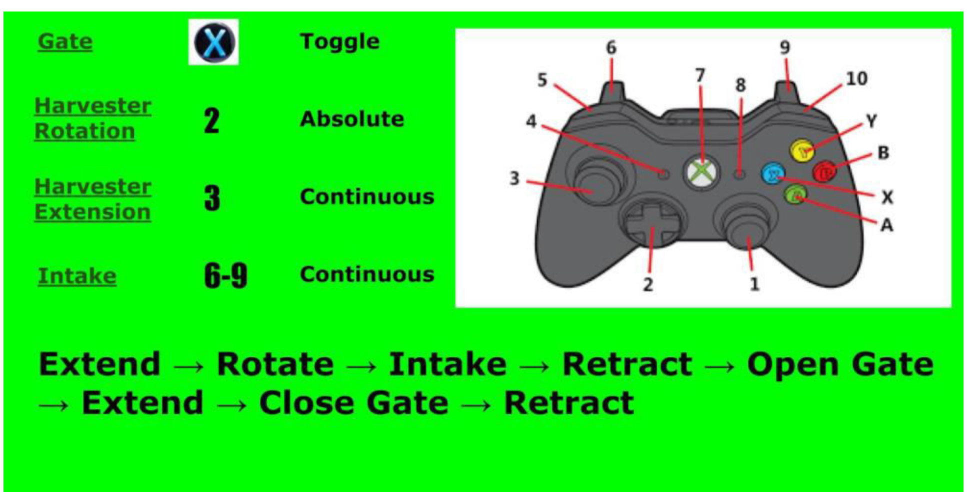
*test pathing with Pure pursuit

3D Printing

- Ian checked how the dispenser tube printed out and it printed out good and then he took off the support off the print
- Connor changed the CAD for the harvester tube and the phone case and he gave Ian to the file for the harvester tube for the MMS to print an extra tube and the phone case for the robot for the World Competition in Detroit
- Ian put the Harvester tube, phone case and two Omni wheel to MA3 adapter CAD .stl files into the Slicer program, Simplified 3D
- Simplified 3D has the feature that you can set different profiles for different objects that are printing at the same time. Ian set the profiles for the dispenser tube, phone case, and Omni wheel to MA3 adapter as:
    - For the print of the dispenser tube, Ian set it with 0.3 mm layer height, 3 parameters/outer walls, 30% percent infill, and supports off.
    - For the print of the Phone case, Ian set it with 0.3 mm layer height, 2 parameters/outer walls, 15% percent infill, and supports on.
    - For the print of the two Omni wheel to MA3 adapters, Ian set it with 0.3 mm layer height, 3 parameters/outer walls, 50% infill, and support off.
- Then, The Slicer made a .gcode file of the dispenser tube, phone case, the two Omni wheel to MA3 adapters with the details describe above that the 3D printer can use to print it.
- He prepared the 3D printer for the print
    - Ian turned on the 3D printer
    - He heated up the extrude and the print bed to the temperatures for the pteg filament that he he is currently using, which is green pteg filament
    - He cleaned the nozzle of the extruder so filament is not stuck on the nozzle
    - He calibrated the printer by homing the x, y, and z axis.
- Then, he started the print, he watched the first layer print and the first layer came out kind of smooth.

Non-Technical/Discussion:

- Below is the finished pit structure:



control map for secondary driver

Date: 4/16/19

Duration: 4:00 PM – 8:30 PM

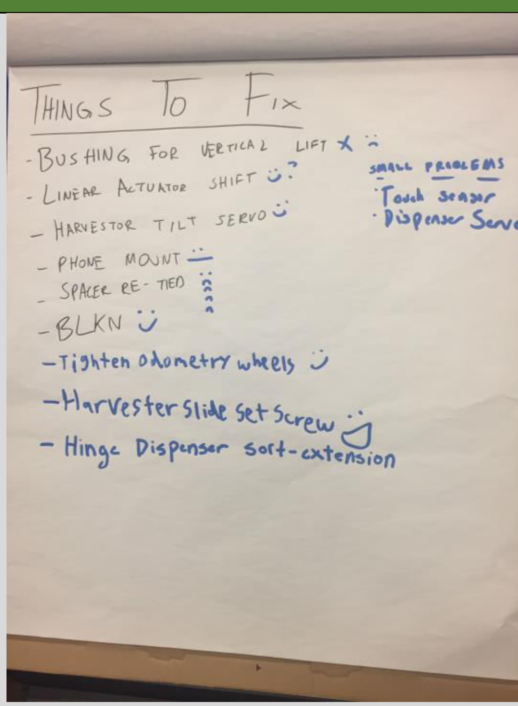
April 16, 2019 Meeting

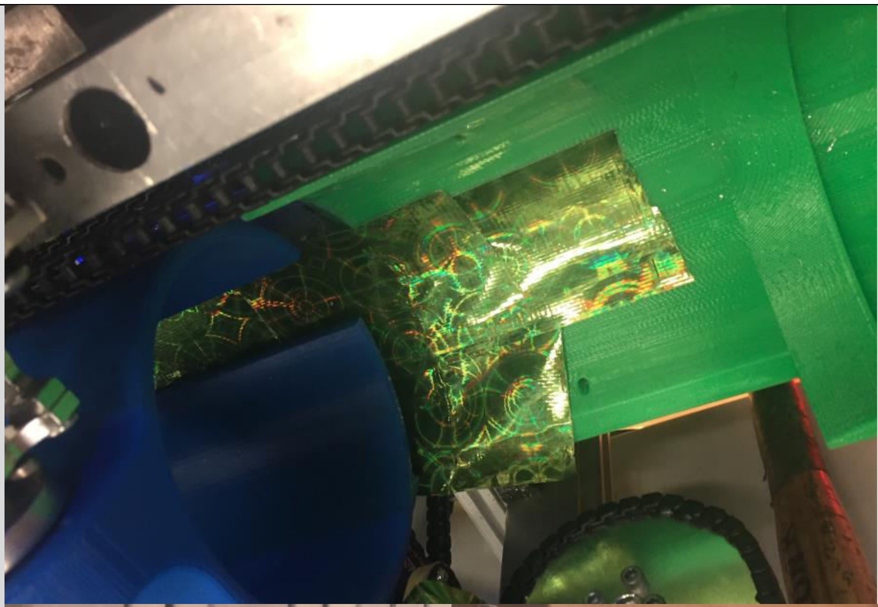
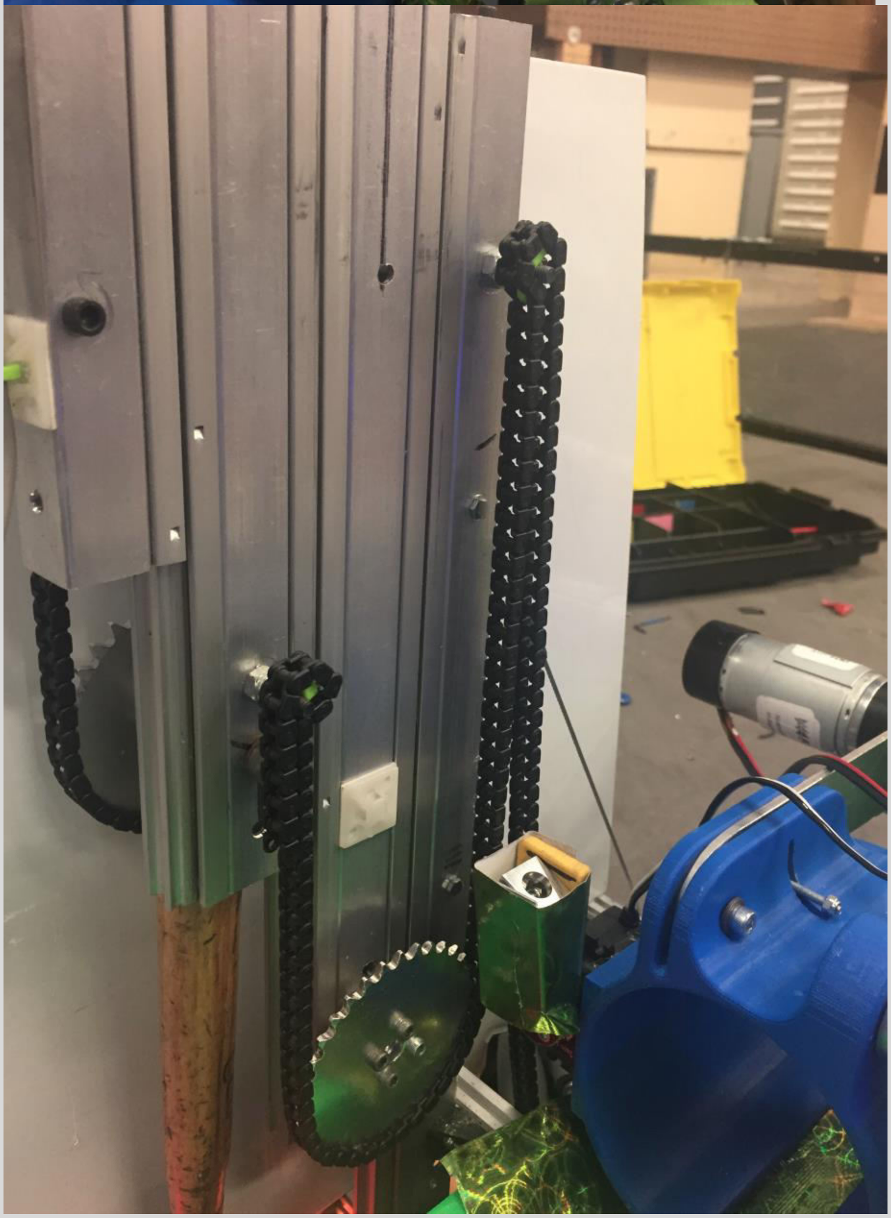
Students:	Patrick	Bryan	Clare	Ian	Jonas	Rohan	Karthik	Connor	Paige
Mentors:	**Mr. Prettyman**		**Zach**			**Arnav**			

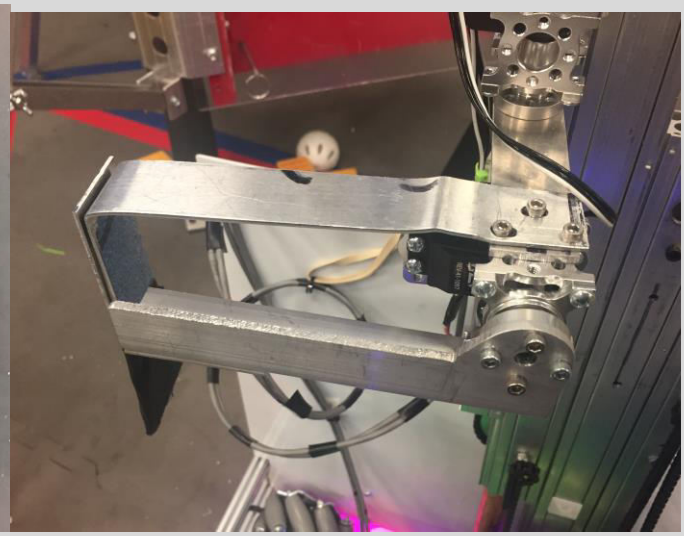
Agenda
Go directly to lab
sess priorities and begin packing
Update list of issues and discuss best path of completion

Tasks:	

Mechanical Accomplishments:

MMS	
	

	 
Tweak: Dump Sort	Patrick took off the old dump sort print and constructed a stronger mount in order

Mount	to ensure that the mechanism would not move or fall off. We transitioned over to Ian's new green print over the old one but will also bring the old one as a backup in case the green one breaks.  

Dump Sort	
Define a Problem: Dump Sort	• The newly attached servo next to the dump sort is now blocking the minerals from entering the dump sort gate.
Develop a solution: Pillow Block	 • Instead of using a pillow block as is, Bryan thought about removing the bearing inside and threading an axel through, attaching the gate to this. • The two main problems were: 1. The gate was unable to lock and stay in place 2. The hole was too big
Develop a solution 2.0: Vertical Hinge	• This solution would work well, the only issue was if we could find a hinge small enough given the space constraints. Bryan is not able to find two to test this theory.
Develop a solution 3.0: Programming a rotating path	• Bryan was considering the original storage of the motor with a newly programmed path for the dump sort to move into position. • However, this idea was quickly shut down by the mentors as they believed programming would be much more difficult than building an alternative solution.
Develop a solution 4.0: Horizontal hinge	• Attaching a horizontal hinge to the bottom of the dispenser, with an attached extension, properly shaped and lengthened in order to extend the dispenser to the needed margin of error. • Placed vertically in front of the dump sorter, where it will flip out when needed.
Construct and Create a Prototype	• Bryan has cut out a piece of polycarbonate the shape of the dispensing gate, and drilled holes to attach the horizontal hinge

Programming Accomplishments:

	The programming team is working to develop the final versions of autonomous and tele-op. They are currently creating an Assisted Tele-op program, where the robot is pre-programmed to mov e during the Tele-op time of the competition. Essentially, this is autonomous in tele-op. They also created a side-program allowing drivers to control the robot whenever they choose to. The programmers are also writing code for the newly attached parts (done by the Mechanical team). Rohan is revising and editing the control document, adding finishing touches. Karthik is helping him edit and create visuals to go along with the information. Jonas is using CodingBat to further develop his knowledge of programming in general, simultaneously applying these skills as he programs for the robot.  After the majority of this is completed, the coding will be condensed and simplified so it is easy to revise and read if necessary.

3D Printing

- Ian checked how the harvester tube, phone case and the two Omni wheel to MA3 adapters printed out and the phone case and the Omni wheel to MA3 adapters printed wheel but the havester tube did not finish printing because the spool of filament did not have enough filament for it to finish. then he took off the support off the phone case
- Ian put the Harvester tube and phone case CAD .stl files into the Slicer program, Simplified 3D

- Simplified 3D has the feature that you can set different profiles for different objects that are printing at the same time. Ian set the profiles for the dispenser tube, phone case, and Omni wheel to MA3 adapter as:
    - For the print of the Dispenser Tube, Ian set it with 0.3 mm layer height, 3 parameters/outer walls, 30% percent infill, and supports off.
    - For the print of the Dispenser Tube, Ian set it with 0.3 mm layer height, 2 parameters/outer walls, 15% percent infill, and supports on.
- Then, The Slicer made a .gcode file of the dispenser tube and phone case with the details describe above that the 3D printer can use to print it.
- He prepared the 3D printer for the print
    - Ian turned on the 3D printer
    - He put in black pteg filament into the extruder because the green petg filament spool ran out of filament
    - He heated up the extrude and the print bed to the temperatures for the black petg filament
    - He cleaned the nozzle of the extruder so filament is not stuck on the nozzle
    - He calibrated the printer by homing the x, y, and z axis.
- Then, he started the print, he watched the first layer print and the first layer came out kind of smooth.

Non-Technical/Discussion:

- Buttons: Quite a few buttons were made by Clare, Paige, and Jonas. Clare organized and prepared all of them for shipment to Detroit.
- Roles and housekeeping were discussed for Detroit, and where to go on different days, etc.
- Team members were told to visit the First Inspires website to review the official Worlds information:

Awards and Ceremonies

Competition Kickoff Welcome Ceremony
FIRST Tech Challenge will host our competition kickoff on the *FIRST* Tech Challenge competition fields on Wednesday, at 3:00pm.

***FIRST* Tech Challenge Awards Ceremony**
The *FIRST* Tech Challenge Judged Awards Ceremony will be at our competition fields on Saturday at 12:30pm. We will award the winners of our event judged awards and our division finalist awards. Our Inspire winner and winning alliance will be awarded at our *FIRST* Closing Ceremony at Ford Field, on Saturday.

***FIRST* Closing Ceremonies**
FIRST Championship Closing Celebration including *FIRST* Robotics Competition and *FIRST* Tech Challenge Final Matches.
Saturday, April 27, 2019 - 6:00 pm to 8:30 pm, Ford Field

Ford Field Access
All officially badged participants will enter Ford Field through metal detectors. All participants should limit the bags that are brought to Ford Field as bags slow the entry process. All bags will be checked manually. Please only bring your essentials and, if possible, return bags and backpacks back to your hotels before attending the closing ceremony.
Please store your tools and electronics before coming to the closing ceremony.

Driver's Meeting

A mandatory Drivers Meeting will be held on Wednesday at 2:00pm on the competition fields. Qualification Matches will begin at 4:00pm on Wednesday.

Field

- Judging presentation must be revised; the visuals need to be updated
- Presentation also needs to be practiced, since some of the original members will not be there in time to participate in the presentation
- Patrick, Bryan, and Jonas are practicing driving the robot. A few issues are: the transfer of minerals from the harvester to the dump sorter, and the harvesting of too many balls which would result in penalties in the actual competition