TECH NINJA TEAM

FTC#9929

ENGINEERING NOTEBOOK

2018-2019 ROVER RUCKUS

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An Introduction to FTC Team #9929 "The Tech Ninja Team"

It all started in a basement with the Nelson family and the Matthews family. They were in the process of completing an overly complicated machine to, drum roll please, unzip a zipper. These two families had decided to complete the 2014 rube Goldberg machine challenge over a couple of weekends, for fun. After a few hours, one industrial shelf, and a ton of tape later, it finally worked. Then we went on hiatus for a few months before starting FLL. The team choose to "dominate" with education as LED (Lego Education Domination). The final robot didn't do so well but at least our name was cool.

Year two of our team's engineering adventure to becoming the Tech Ninja Team we are now brought some changes. A lot of changes. A few of the older team mates (Calvin, Kate, and Lauren) pushed the coaches to offer FTC after seeing the robots built for this competition online. They managed to convince the FLL coaches to start a FTC team. We unpackaged our first kit to build a robot in the basement of Coach Matthews. All of the team members were excited to begin building. Our team name came from a joke when we were unpacking the boxes of robot parts. We were all pretty excited about the cool parts that we unpacked and thought they were really cool, when someone said "Just wait until we unpack the ninjas". Thus the Tech Ninja Team was born, along with a cool acronym (T.N.T). after beginning work on the robot we moved to coach Nelson's garage for more space. The name for our robot, Skittlebot, came from an exercise we did to better understand programing. Shortly before the team's first qualifier we got a new space to practice in at the to be Homewood Science Center. Little did the team know at the time how lucky we were to have the space. We would end up 11th place with a Control Award when the season was over.

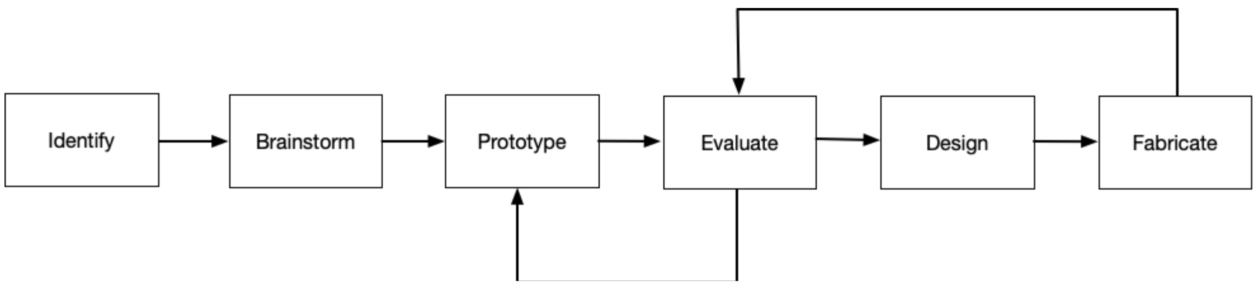
During our first off season we moved into our own room in the science center that is often referred to as the robot room. This space would allow us to expand more and start to learn more advanced techniques for building our robot. We are also started using Slack (a communication platform) and GitHub (a program storage platform) to better our team's communication. We researched prior seasons and worked on building mechanisms we noticed were used throughout the challenges. Later, we moved into the garage at the Science Center which gave us more space and the ability to add more power tools to use when building our robots. The team and our workshop have evolved over time to become more capable.

This season's robot "Zaphod BeebleBot" has parts we designed in CAD using Fusion360 and manufactured using a CNC router that we purchased over the summer. We've also added motion profiles to our programming to make the robot move more smoothly and accurately. The team has started to fill roles outside of build and programming to help the team as a whole get better by creating processes, standards and checklists. We hope that changes we made to the team will help us move farther.

How We Work

Like many FTC teams, we have a build team, a software and controls team and drive teams. Team members choose which team they work on based on their interests and skills, but sometimes because of need or particular interest they may do work on parts of the robot that are not their "usual" team.

We follow this engineering design process:



- Identify – identify the problem to be solved
- Brainstorm – brainstorm solutions
- Prototype – quickly build physical or mathematical models to evaluate the brainstormed solutions
- Evaluate – run experiments to see if the solution works
- Design – design a solution to use on the robot based on the prototype(s) and the evaluation
- Fabricate – machine, assemble or program the solution that was designed. Evaluate whether it meets the requirement.

Our engineering notebook entries indicate which step(s) we are doing at the time.

This season, Kaylin has added the concept of "roles" to our team handbook. These roles are designed to make the team better by making the things we do more consistent and also provide leadership opportunities to our team members. We felt it was important for team members to apply and be interviewed for these roles to get experience in interviewing for a job. The roles we have filled this year are:

- **CAD Director** (Liam) - Responsible for making sure that the CAD models describing the robot are complete and up to date. CAD models are important for the build sub team as well as providing documentation of the process to be used in the team's engineering notebook.
- **Electrical and Controls Director** (Ernest) - Responsible for working with the build and software sub- teams to ensure we have the needed motors, servos, wires and sensors and supporting code to field a competitive robot. They are also responsible for these components being robustly and neatly installed on the robot.

- **Marketing Director** (Lauren) - Responsible for maintaining the team’s public image. This includes planning the social media calendar, marketing our robot for tournaments, overseeing the design of fan gear, making buttons, and maintaining the team’s style and identity standards.
- **Operations Director** (Hannah) - Responsible for making sure the competitions (league meets, qualifiers, tournaments, etc.) run smoothly for the team. Tasks include: creating and executing checklists for tools, materials, and other necessities required for competitions, pre-competition scouting, and planning judging presentations.
- **Workshop and Pit Director** (Kaylin) - Responsible for making sure that our home workshop, and the pit workshop stay clean, organized, and are used efficiently - keeping team members focused on the task at hand by finding tools and parts to build or repair the robot, and helping the documentation director keep track of what happens at each meeting or match.

Team-Bios

 Hannah Beezie 4 years with FIRST Sophomore	I enjoy reading, drawing, and riding my bike in my spare time. I am a member of my school's Scholastic Bowl team and an IB Prep Academy student. I am also pursuing the PLTW Engineering courses available to me. Also, I enjoy attending team meetings and practices. I am primarily a part of the build team, but I also am the robot operator on the drive team. I joined FIRST because I was interested in engineering and robotics, and wanted to learn more about STEM than I did in school.

 Matthew Blake 1st[rd] year with FIRST Junior	My name is Matthew Blake. This is my first year participating in First Tech Challenge. The main reason I decided to participate in FTC is the perspective of technology being in my daily life. Also being able to create technology such as robots is very interesting to me. In my time outside of FTC I participate in organized basketball leagues.

Caleb Clark
2ndrd year with FIRST
Junior

Hello! My name is Kelvin Caleb Clark Jr. but my family and friends call me “Caleb”. I am a 17 year old, junior class student attending Homewood-Flossmoor High School in Flossmoor, IL. A few of my favorite subjects are Science and Graphic Design.

After graduating from high school, my goal is to attend a college/university that offers my interest in the field of software development focusing on Gaming Design where I can pursue a career in technical architecture or mechanical engineering.

In my free time, I enjoy computer graphic designing, video gaming designing, video gaming, and building Lego advanced sets. I am a collector of Hot Wheels, and Transformers!

Habtamu Epley
3rrd year with FIRST
7th Grade

Hi I am Habtamu Epley, I am 13 years old. After doing FLL for 2 years and being the oldest student there, moving up to FTC and being one of the youngest was a big change for me. The change was good for me though because that meant I was not the one teaching others, I was the one learning from others and making mistakes. But mistakes are only actions in which something can be learned and improved. So, in other words, I am going to be able to learn, make mistakes, and soon be able to teach others.

Katelyn Ingles
1strd year with FIRST
9th Grade

Hi, my name is Katelyn Ingles, I'm 14, and in 9th grade. I currently go to Southland College Prep, but I'm transferring to a new school in the fall. This is my first year in FIRST. I joined this team because I wanted to learn more about Engineering and Technology. Also, I wanted to make friends who were interested in STEM because, there are very few at my school who do. Outside of school I play violin, participate in math bowl, and student council. I am on the programming team, but sometimes work with the build team. I like STEM, music, anime, friends and family.

Lauren Matthews
5th year with FIRST
Sophomore

My name is Lauren Matthews. I am 15 and attend HF High School. I have participated in FIRST as a whole for four years. For my first year I competed in FLL. After that season was over I, along with a few other team members, crossed over to the new FTC Team. I have always enjoyed engineering and have done other science related activities outside of FIRST.

I also enjoy Olympic recurve archery, reading, drawing, and writing. I am on the programing team, have helped the build team occasionally, and am a coach for a drive team. I am excited to see where this team will go in the future years.

Kaylin Matthews
5th year with FIRST
8th grade

I am an 8th grader at Parker Jr. High. This is my second year with FTC. I participated in 3 years of First Lego League (FLL) before joining FTC.

I am on the build team and enjoy constructing things and then being able to see them work to do a task. I'm also the pit and workshop director. FTC has taught me valuable skills, such as teamwork, engineering, and perseverance, that I will remember my whole life.

Outside of FTC, I enjoy playing soccer, playing my flute, and reading.

I was introduced to FIRST when my dad and some of the other coaches started a FLL team 5 years ago. I've stuck with it ever since.

Liam Nelson
5th year with FIRST
8th Grade

I am 13 years old, and I enjoy playing the trumpet, violin, and lacrosse. This is my fifth year with FIRST, but my first three years were in FLL. I learned how to do CAD, and I am the CAD director on the team. I am planning to get into IMSA for high school and then maybe pursue a career in physics or engineering.

I was introduced to FIRST several years ago when I joined First Lego League. I was interested, and I have been a big part of every team I've been on ever since.

Logan Nelson
3rd year with FIRST
7th grade

I am 12 years old, I play the drums, have a mini root beer stand and I play soccer. This is my 4th year in FIRST and I like robots.

I'm a 10th grader at HF High School. This is my 4th year with HF Robotics, third year in FTC. I really like the programming and driving/operating challenges that FTC gives me. In addition to robotics I play tenor saxophone in the school bands and a basement band. I would like to go into physics or computer sciences in the future. Science is cool and good.

Calvin Uecker
5th year with FIRST
Sophomore

I am in Science Olympiad, I play soccer, I like art, and I have two bunnies.

I am on the build team and a robot driver.

I joined FIRST two years ago,, after I went to a LEGO robot programming event and learned about FTC.

Taylor Washington
3rd[d] year with FIRST
Sophomore

Jeremy Wesley
4[rd] year with FIRST
Junior

I plan to attend the United States Air Force academy in CO, I play alto saxophone in band for Homewood-Flossmoor High school, I am the 2nd vice president for my chapter in Top Teens of America, I am a mentee in 100 Black Men of Chicago and I am in Kappa League.

I am on the build team.

My mom introduced me to FIRST one day and it was something I found special so I stuck with it because I love building and understanding how things work. I always had a thirst for knowledge so when I heard about FTC I was interested real quick.

	I am 13 years old.I do soccer,lacrosse,and track.This is my 4th year in first.I am the electronics director.I learned CAD this year I joined FTC because when I was in FLL it looked cool how they were building bigger robots.
Ernest Woods 4rd year with FIRST 8th Grade	

2000+
People reached overall

1 Mile
Marched with robot - July 4

1 new robot
Designed for Outreach

3 League Meets
Hosted – including qualifier

11 Events
Held overall

600
Followers on social media

Hosting league meets, qualifiers

We believe that in order to be successful as a team, outreach to both the community and competing teams is necessary. This season we have hosted two league meets and one qualifier to stir excitement about robotics in the community. We worked hard to bring robotics competition to our local middle school. We wanted community members to see the energy at these tournaments.

Robot Block Party at MSI

“Celebrate National Robotics Week by checking out the cool ‘bots designed by Chicago-area student and amateur teams, and interacting with some state-of-the-art robots.”
Our first outreach opportunity after the Illinois State FTC tournament was in early spring, at the Museum of Science and Industry’s annual “Robot Block Party”. The MSI Robot Block Party was many team members first exposure to FIRST Robotics. It was really fun for that to come full circle and be on the other end of the event. We estimate we had over 300 visitors that drove our robot and saw demos of our Relic Recovery robot at this event.

Flossmoor Service League House Walk at Homewood Science Center

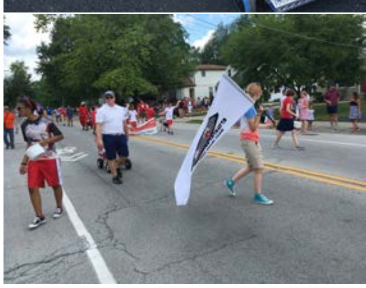
Many local service organizations host housewalks in our community. Flossmoor Service League's housewalk had a twist, one of the "houses" attendees could visit was the Homewood Science Center - where we have our work shop. We explained FTC to the attendees, and gave them a chance to drive our robots.

“ParadeBot” is Built - Homewood July 4th Parade

This season we took marching in in the 4th of July parade to the next level, we built a whole robot dedicated to it. That’s right we built “ParadeBot” equipped with 6000 mAhs of power and 1500 cubic inches of candy storage. On the 4th of July we set out with “ParadeBot” decked in patriotic attire and marched over a mile in the Homewood 4th of July parade. We tossed candy to our adoring fans and tried to avoid getting soaked by the SWAT team and their water guns.





Workshop Open Houses During Wednesday Night Farmers' Markets

(500 attendees across 3 dates)

This season we had open house hours during the evening Farmers' Market and were able to reach a different audience than the morning Farmers' Market. We saw a lot more kids interested in our team. We saw about 120-200 attendees per event. We used our Mindcuber Lego Mindstorms robot to explain color sensors, servos, distance sensors and an algorithm for solving a rubix cube. We had DIY button making - with explanations of the press die in industry. We let attendees program a “robot” (another attendee) to travel from one end of our workshop to another to retrieve a bag of Skittles with our “Skittlebot” language, which is a series of cards with simple commands for the “robot” to follow. The most popular activity by far was getting to drive our first season's robot, also known as Skittlebot. We had kids and adults lined up waiting to try!

PopUp Science - Bubble Bash

Later in the offseason, we volunteered at PopUp Science - Bubble Bash. We reused "ParadeBot" and turned him into "BubbleBot" by adding a bubble machine to him. We drove 'BubbleBot" around to advertise the event. We hosted an open house during the event that was similar to our farmers market activities. (200 attendees)

Pop-Up Science - Take Flight

In the beginning of the season, there was yet another PopUp Science event that we volunteered for - Take Flight. We did not use any robot for this, however we did use our normal practice space for it. What we did here was use a leaf blower to demonstrate Bernoulli's principle by blowing it on a toilet paper roll on a stick. (75 attendees)

Social Media

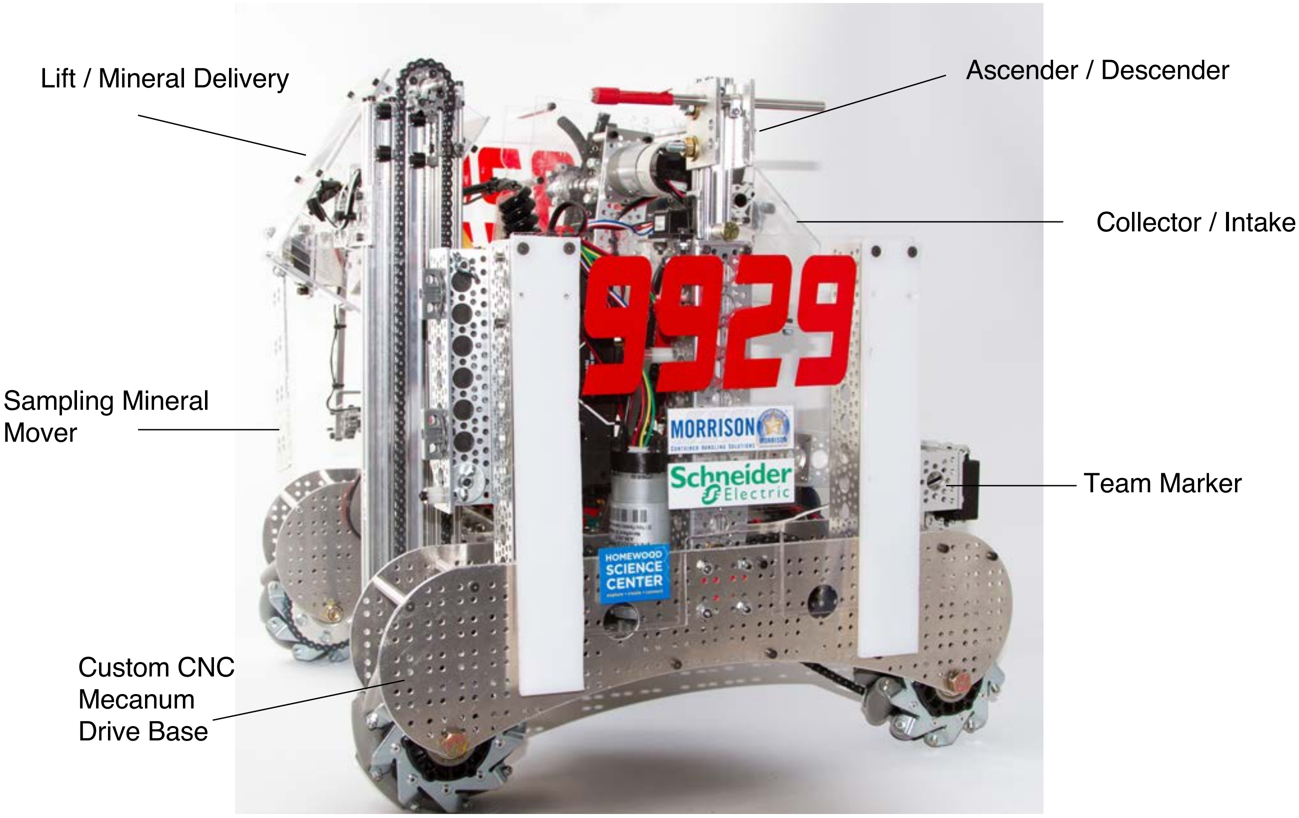
Facebook – We have our own Facebook Page, used more to reach local audiences (upcoming events, news). We have 150+ followers that are primarily within the state of Illinois or are family and friends of the team members.

Twitter – We are @FTC9929 on Twitter. Here is where we tend to keep up with other FTC teams, sharing our successes (and experiments that don't quite work out). We have over 450 followers, and we enjoy seeing how teams around the world are having fun with robots and STEM.

YouTube – We have many videos including footage of previous matches and tech tips such as "Friends Don't Let Friends Use KEP Nuts"

GitHub – We share all our robot code with the world as we write it at *https://github.com/HF-Robotics/ftc_app/*. We've structured our program such that much of it is reusable season-to-season and we're hoping that it may be a jumping off point for teams that need help in this area.

Robot Overview



Game Analysis and Strategy

This year's game involves a strategy that succeeds in performing all tasks presented in the Challenge. The major tasks associated with this year's Challenge are descending from the lander, scoring marker, sampling, scoring minerals and ascending on the lander. In some ways this year's game seems pretty simple but succeeding inside that simplicity has taken much hard work.

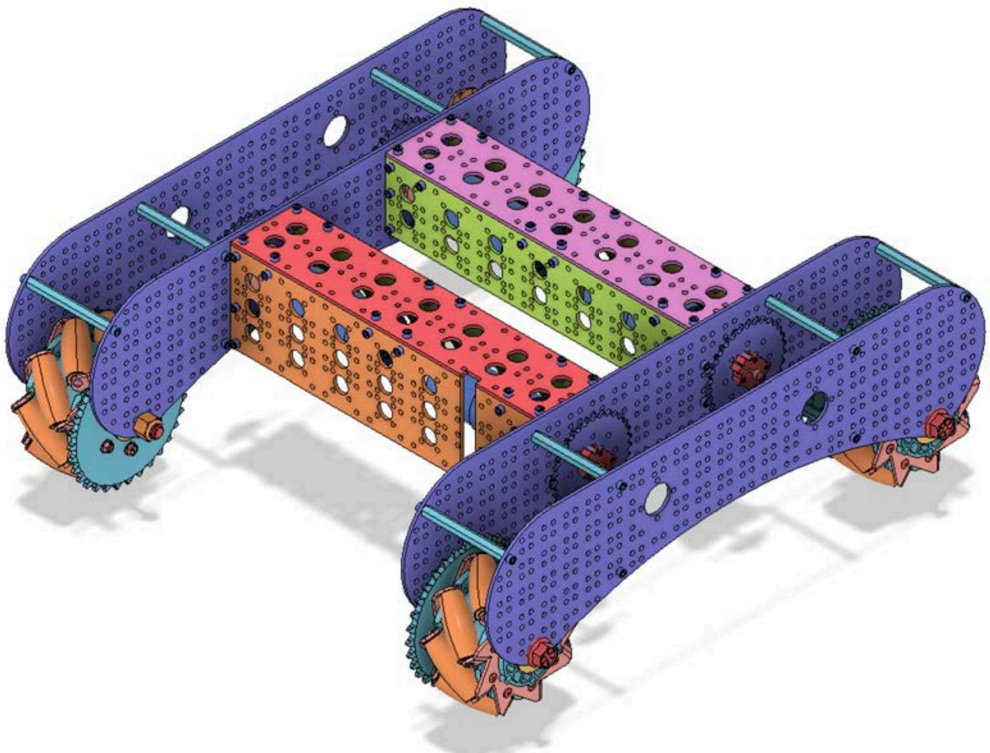
With the objective of being able to perform competitively, at a very high level, our first goal was improving from last year's robot, place higher, and to be able to choose our alliance partners. We set out to have the highest scoring robot possible, to help create strong alliances. We tried to create a robot that was equally strong in autonomous as it is in tele-op. To accomplish this, we had a build weekend, where we:

- Analyzed the game and identified the ways to score points, and the constraints of the game
- Had team members simulate being robots, and had them play the game to understand how it might be played by actual robots
- Used the information we discovered to create a priority list of robot mechanisms and qualities:

- Fast collection of minerals
- Light-weight
- Being able to drive into crater
- Raise and lower robot
- Place marker
- Sample minerals
- Scoring minerals into the lander

Robot Mechanisms

Drive Base

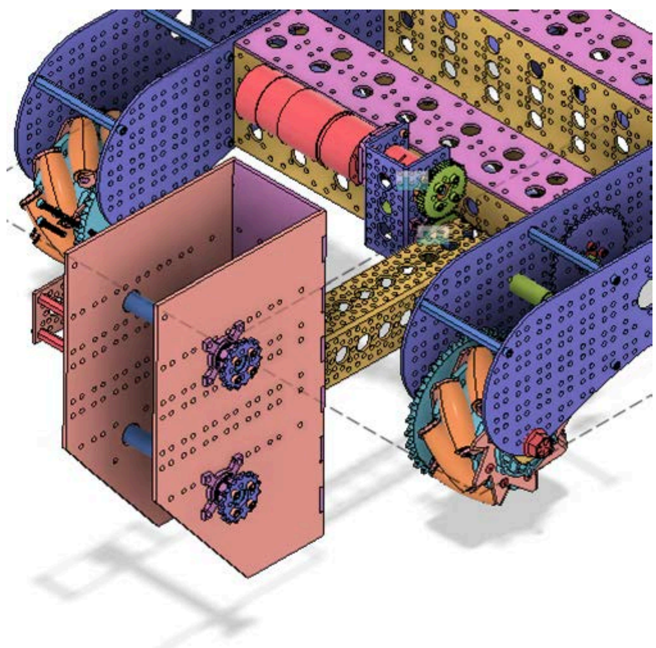


- We started with a selection matrix for drive bases that met the criteria from the priority list, we ended up choosing a Mecanum drive base for maneuverability.
- Ernest prototyped side plates with cardboard until they fit over the crater wall, then moved to Actobotics and Coroplast to get real dimensions to be used in designing it in CAD
- We designed our first side plates for the drive base, they didn't quite meet the required attributes (Aesthetics over function)
- We made another attempt in CAD that had more space to mount mechanisms.
- Our final design added many more pattern holes – allowing more flexibility in mounting new mechanisms without drilling. This resulted in the overall shape of today.(didn't have enough flexibility to mount new mechanisms without drilling)

Ascender/Descender

- Mounted it directly to the drive base
- Lead screw driven by an NR40 (too slow), then an NR20 (no longer available – thus no spare), then an NR20 orbital (different geometry – required different gears and a shim)
- Why a separate mechanism?
    - Weight vs. speed for scoring minerals
    - Blast Radius - if we break the ascender/descender, we don't lose ability to score minerals, and vice-versa

Collector

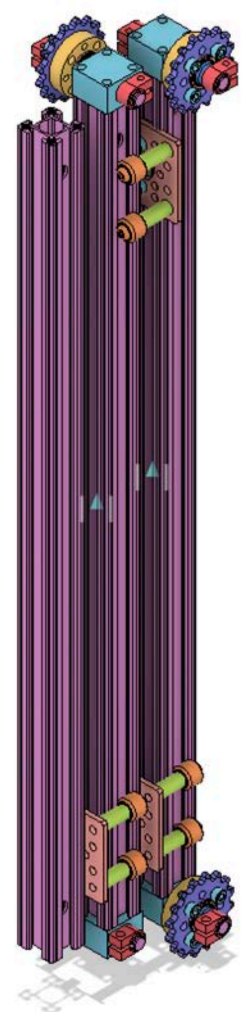


The team went through a lot of iterations before we had a working collector

- 3-4 "horizontal" collectors -
    - Minerals didn't fit once rubber band wheels were installed
    - Not completely modeled in CAD - minerals were not in CAD and fit was not checked then
    - Rubber band wheels kept breaking
    - Collector came down on top of minerals, and then could not collect them
- Leading to a vertical collector
    - Sweeps fell out – solution was known from Velocity Vortex collector
    - Grip tape to keep minerals from spinning rather than rolling
    - Swapped REV Core-Hex motor for NR-40, more speed, more power

Mineral Delivery Mechanism

- Chain-driven elevator – The team has struggled with strings for 2 seasons for elevators - chains seemed to be more reliable:
  - Relic Recovery - short travel, repeated many times – issues could be fixed between matches
  - Velocity Vortex - long travel, once – issues could be fixed between matches
- Closed loop control for safe operation which automatically:
  - Raises completely to top
  - Lowers completely to bottom
  - Tips mineral holding box to holding or loading position automatically

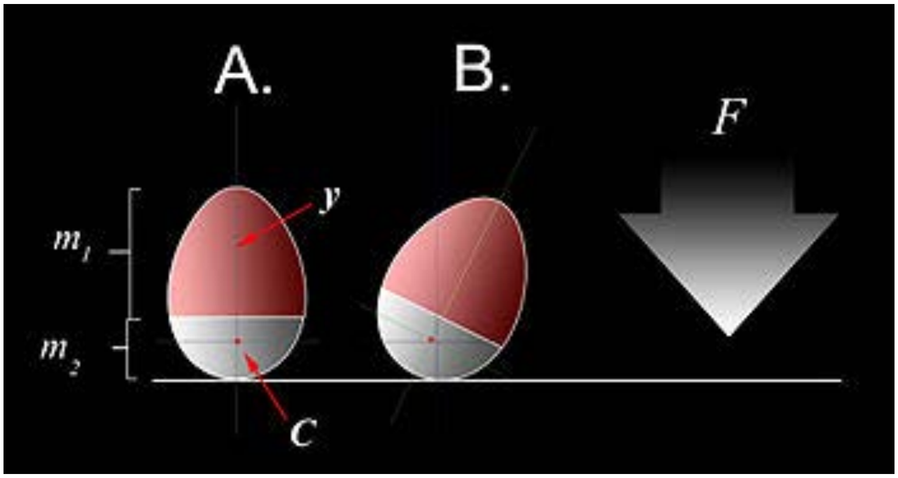


Team Marker and Delivery Mechanism

We made a choice as team to make a team marker that would right itself for the reasons of it:

- Being memorable
- Being more consistent
- Less likely to cause damage by landing on the wrong side

We drew inspiration off of the a child's toy, known as a weeble, that also rights itself. It is from said toy that we choose the egg shape of the team marker.



The ability to right itself comes from the low center of gravity, created by the ballast and the shape of the team marker, and the curved surface of the team marker.

The egg shape of the marker means the center of gravity is lower than it would be on a sphere of the same size. By adding additional weight in the lower portion of the egg (our ballast of choice is kep-nuts) we lower the center of gravity farther. The slightly flat section at the very bottom helps to ensure that it does not continue to wobble after it is upright. There is also a bridge that separates the upper and lower section to add support and make adding a ballast easier.

The mechanism for delivering the team marker went through two iterations:

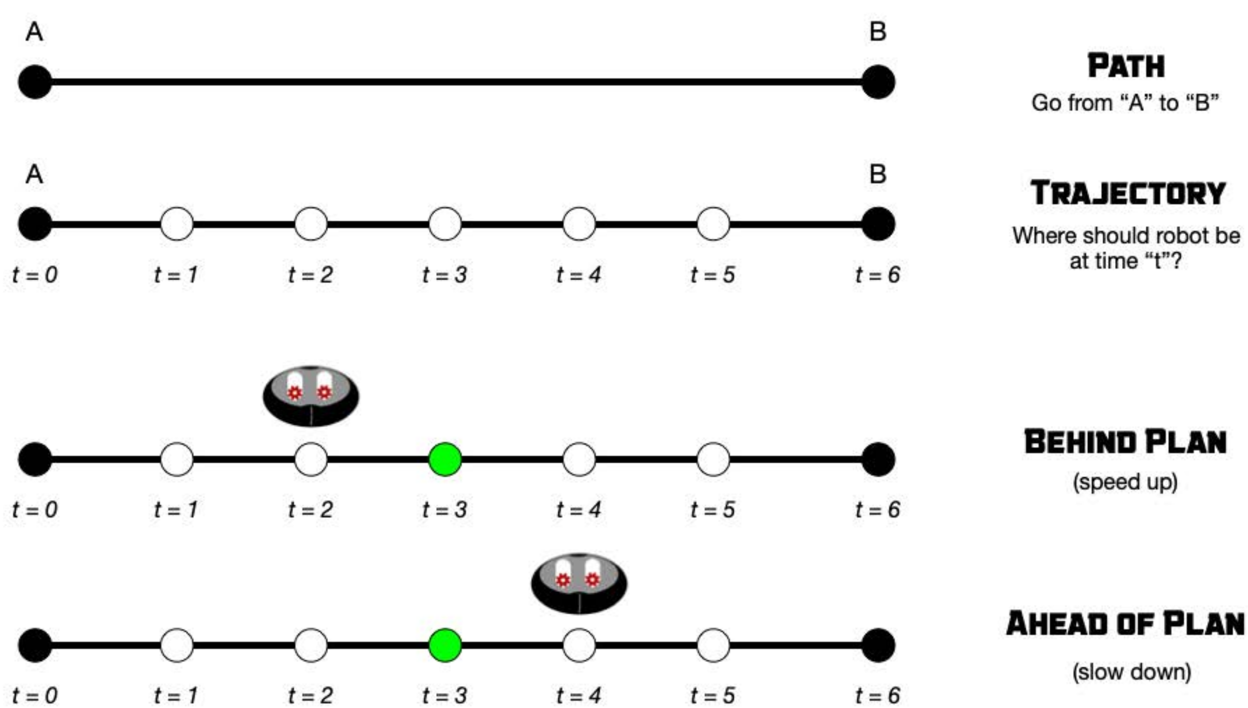
- First tipped the team marker, rolled out of robot.
    - Often worked in our favor
    - Sometimes rolled in unexpected directions – including out of the depot (no score)
- Second “drops” team marker a short distance – more consistent placement

“We aim for controllability and accuracy”

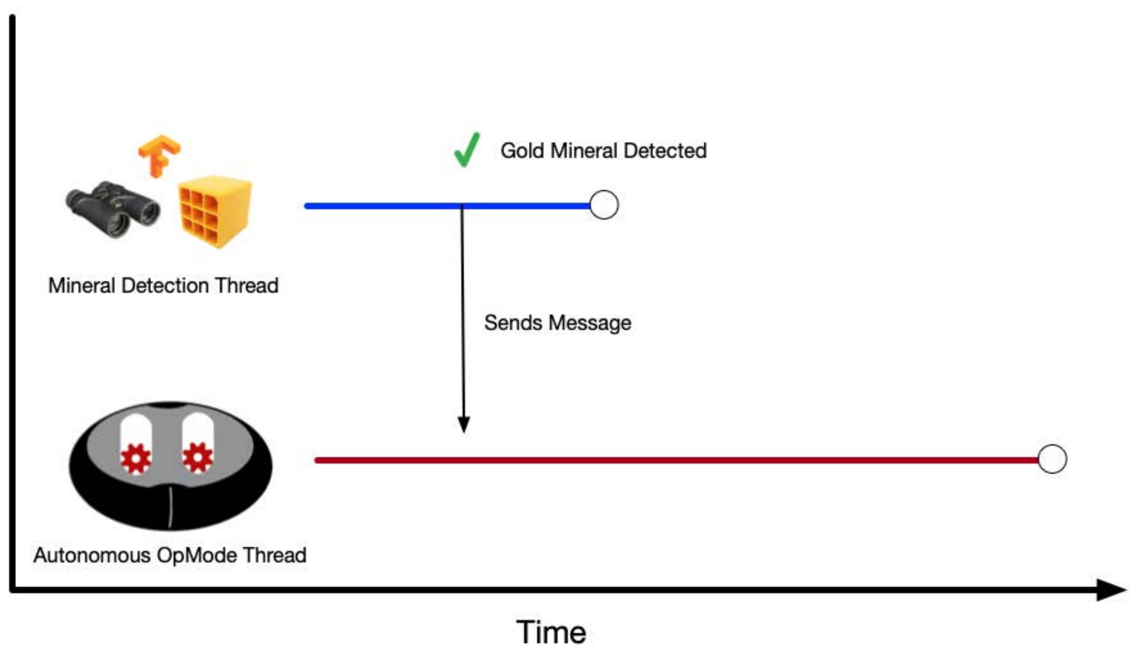
We run a full autonomous; including starting latched onto lander, sampling, claiming the depot, and parking on the crater. As in prior seasons, our autonomous “routes” are selectable from the drivers’ station during “init”, and we support configurable delays – which is a great help for scheduling with our alliance partners that can place a team marker in the depot.

A new feature present in this year’s autonomous is motion profiles. Motion profiling uses trajectories, which are a path plus where we expect to be on said path at any given time, to decide how fast and where to go. The trajectory system we use uses both feedback - where our sensors (encoders in this case) think they are - and feed forward - where we expect to be on the trajectory at that moment. The feed forward is determined by an equation using velocity measurements taken at the beginning of the season.

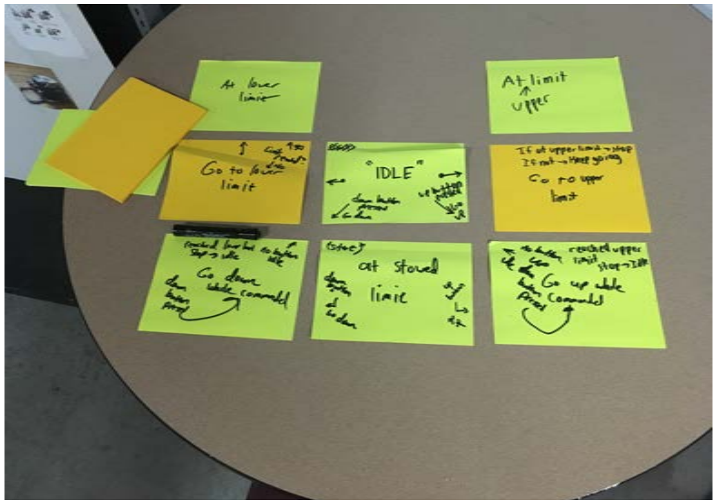
This method allows the robot to run with smooth, accurate motion during autonomous as the speed changes based on how far off the feedback is from the feed forward rather than tracking a single end goal like a traditional PID would do. The following figure shows the difference between paths, trajectories, and when our code would speed up or slow down based feedback from encoders on being ahead, or behind the planned trajectory:

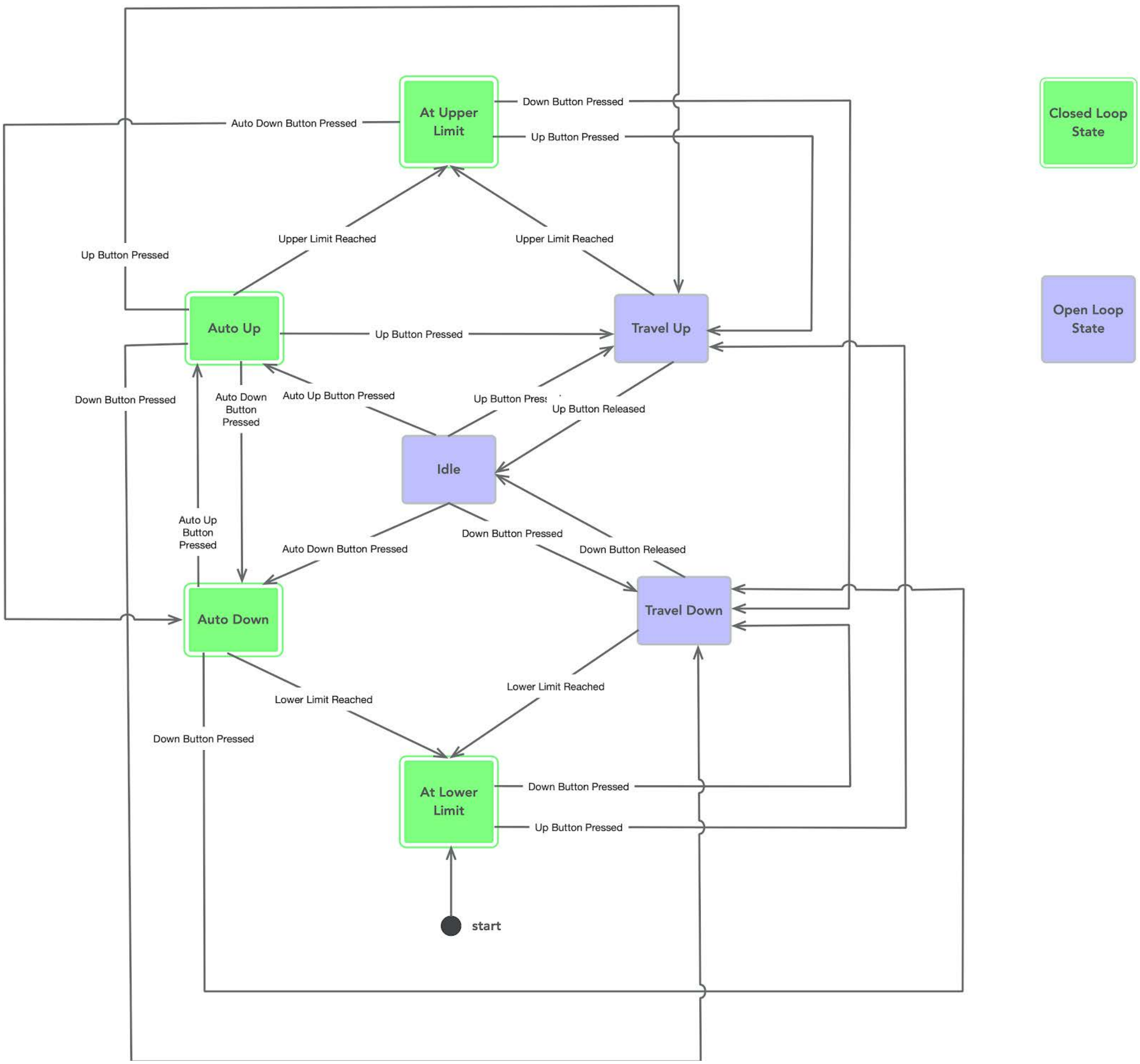


This is our first season using TensorFlow computer vision. Similar to our robot last season, we run mineral detection for sampling on a separate thread, so that our autonomous does not need to wait for mineral detection to happen – and will still proceed and score points if the mineral is not detected, or if TensorFlow crashes or hangs. If our autonomous code does not receive a message from the thread where tensor flow is running by the time it gets to the minerals, it will choose the center mineral as the gold mineral – which will be correct 33% of the time, and we will have no penalty if we move it if it is not the gold mineral.



In tele-op we started to implement code that allowed us to condense multiple repeated actions into the press of one or two buttons. This practice can be seen in our elevator (the lift that is used to move minerals up to the lander on our robot). For this code we use an open loop - decisions are made based on driver controller input, and closed loop - decisions are made based on sensors and on robot functions much like autonomous. We also keep track of where the mineral scoring box should be positioned at each stage of the loop, allowing us to put its use on one button to deposit the minerals. The following picture is our original post-it design of the state machine, with a detailed diagram on the next page:

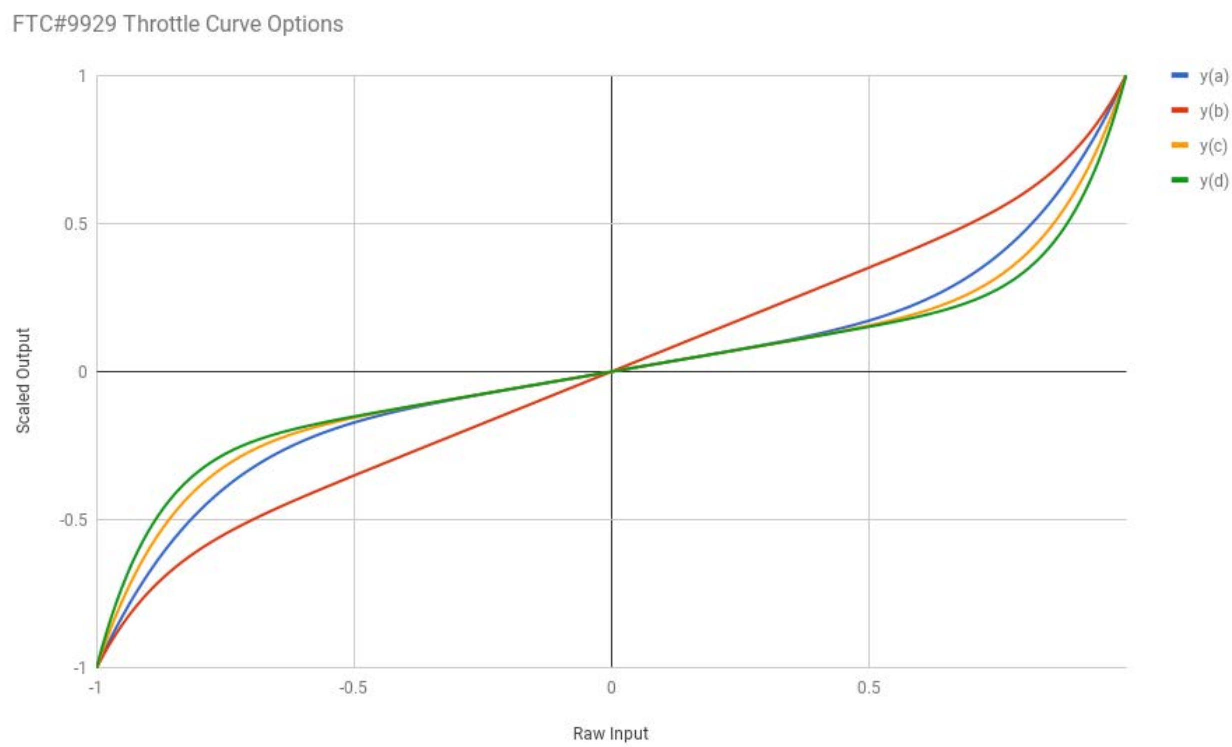

At lower limit
At limit upper
Go to lower limit
"IDLE"
If at upper limit → stop
If not → keep going
Go to upper limit
Go down while commanded
at stored limit
reached upper limit
stop → Idle
Go up while commanded



Another step we took to reach better controllability and accuracy was the installation of multiple safeties. We use both hard and soft stops that allow our drivers to operate mechanisms with much less worry of breaking them in the process. This is one of the features that allows us to run certain functions of our robot, such as the elevator, at high speeds. We also have two buttons on the controller related to the safeties; the “unsafe” button - which disables the code-based safety and is used if a failure happens with the safety, causing the robot to be less usable, and the e-stop button - which stops all automatic functions on the robot if the safeties fail to do so.

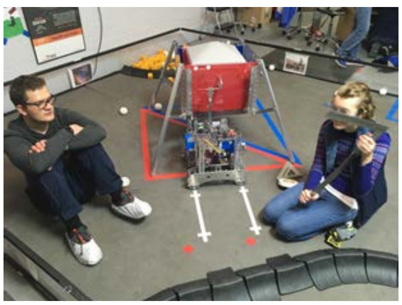
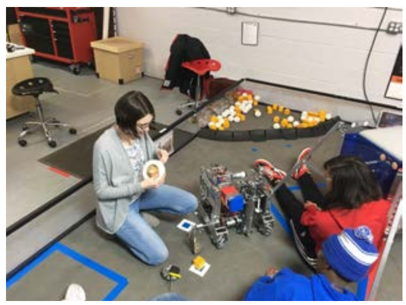
Our tele-op code also contains functionality that makes things easier for our drivers, and places less mechanical strain on the robot, such as:

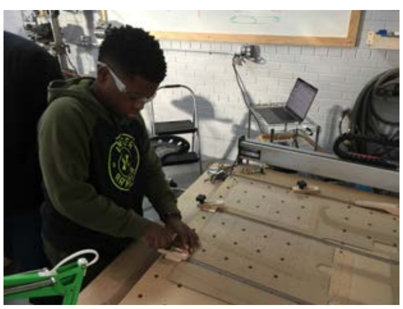
- Low-pass filters
    - Smooths out driving and prevents jerky movements
- Independent throttle curves
    - Allows us to give different speeds and limits to different parts of the robot

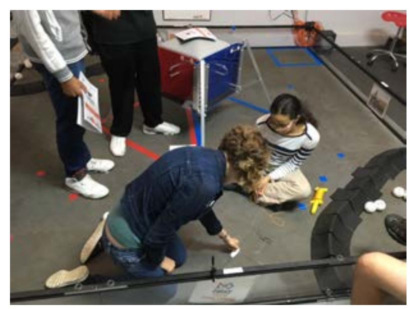


Engineering








	September 9, 2018	10:00 AM-4:00 PM

Contributors: Hannah, Liam, Logan

Entries

1. CNC

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

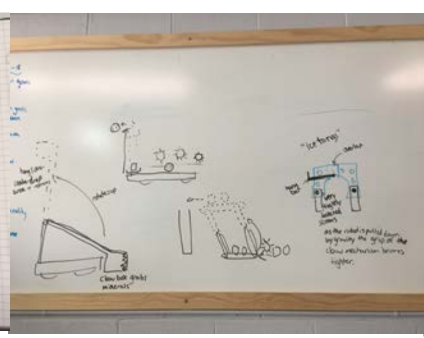
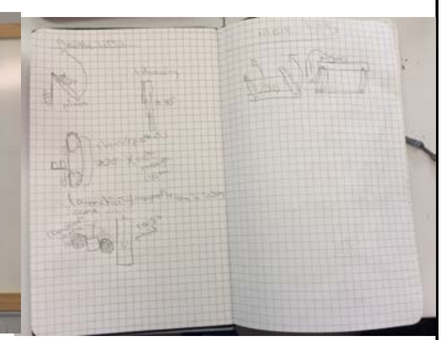
- *What we did*
  - Flattened out CNC table using the CNC machine, cutting .005” off bed

- *Why we did it*
  - We need a completely flat CNC bed if we’re going to use it effectively this season.

[Liam]

2. Brainstorming

Identify	**Brainstorm**	Select	Prototype	Evaluate	Design	Fabricate

	- *What we did* -Brainstormed a few mechanisms for collecting minerals - *Why we did it* - To be ready to prototype designs **[Liam]**

	SEPTEMBER 14, 2018	5:00 PM -8:00 PM

Contributors: Caleb, Drew, Hannah, Kaylin, Lauren, Liam, Logan, Taylor.

Entries

1. People Robots

Identify	Brainstorm	Select	**Prototype**	Evaluate	Design	Fabricate

Using "People Robots" to prototype

- *What we did*

  - Had 4 people act as robots and try to score as many points as they can on a 2:00 min teleop period.
  - For the first round, Hannah, Liam, Logan, and Drew were the robots. The team noticed that they were all moving faster than a normal robot would move, and that they were picking up the minerals at a much faster, more efficient rate than any robot we could see at the competition.
  - On the second round, Hannah, Logan, Kelvin, and Louis were the robots, and they had to walk on their knees, which made the speed part of the game more realistic, if a bit silly-looking.

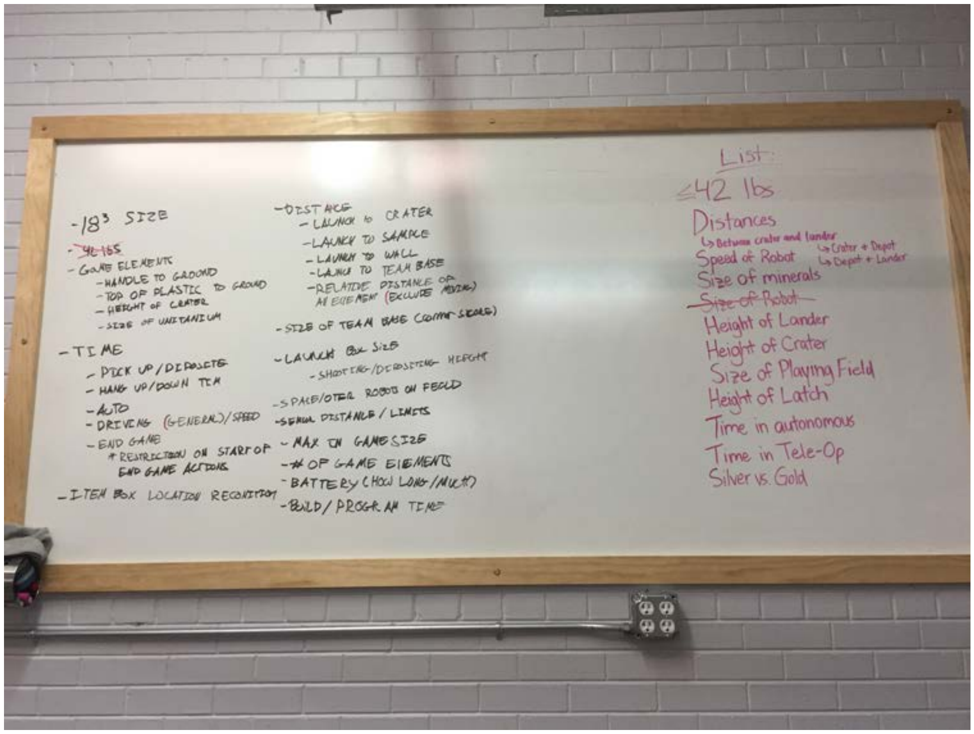
- *Why we did it*

  - to see how the robot might move on the field
  - to figure out how humans would complete the game and see if we could replicate in robotically

[Kaylin]

2. Brainstorming

Identify	**Brainstorm**	Select	Prototype	Evaluate	Design	Fabricate



Basic Brainstorming

- *What we did*
    - We divided into two teams and came up with a list of constraints for this season's robot

- *Why we did it*
    - to learn what requirements our robot has to meet to do well this season

[Kaylin]

	September 15, 2018	7AM-7PM

- **Contributors: Calvin, Ernest, Katelyn, Kaylin, Kelvin, Lauren, Liam, Logan, Matthew, Taylor**

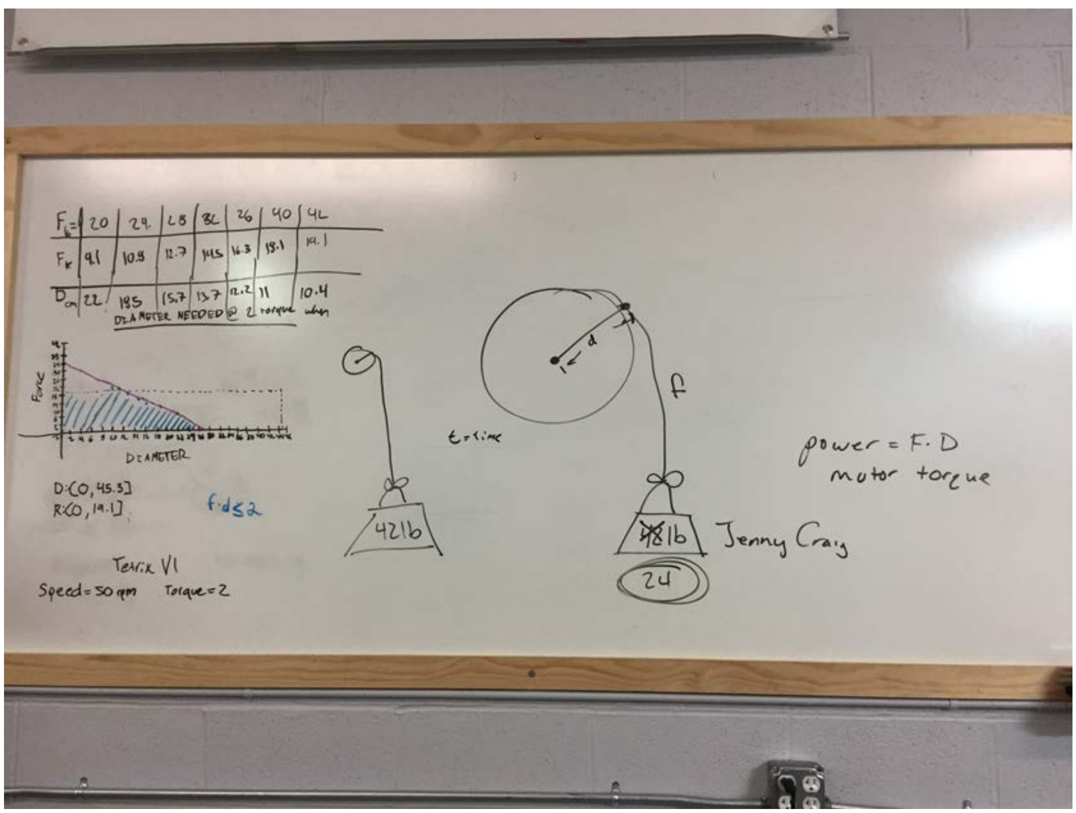
Entries

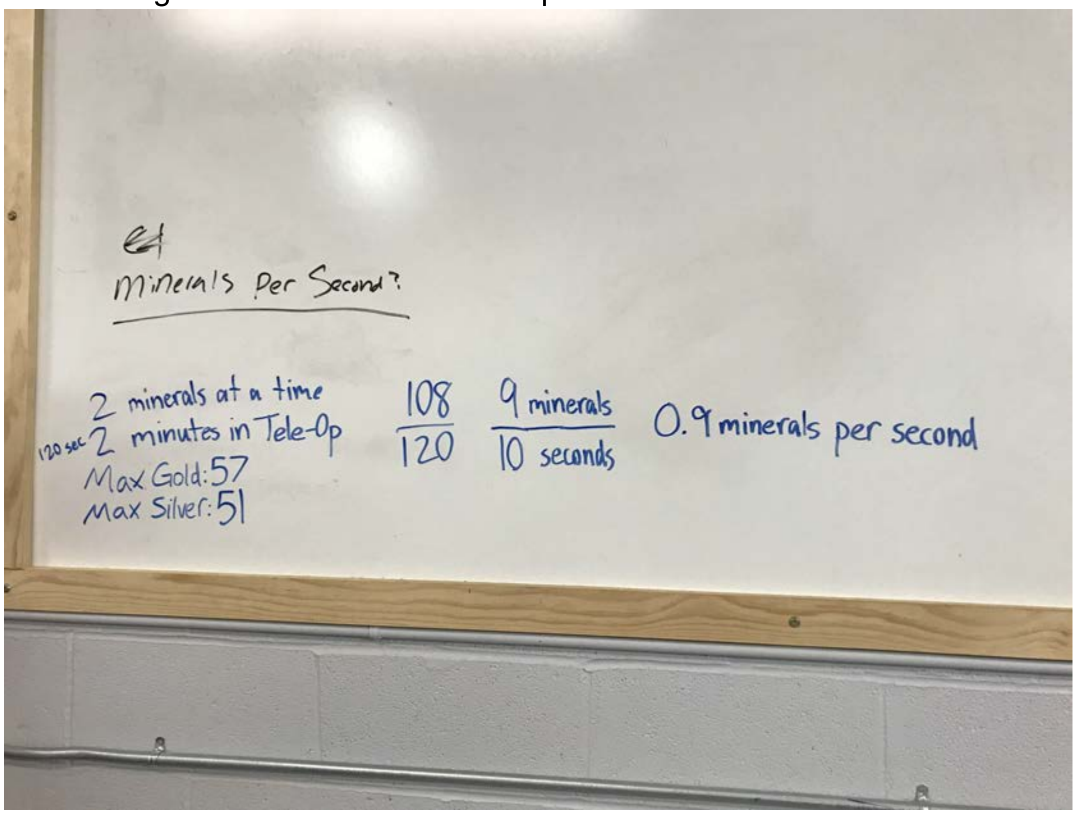
1. Brainstorming Constraints

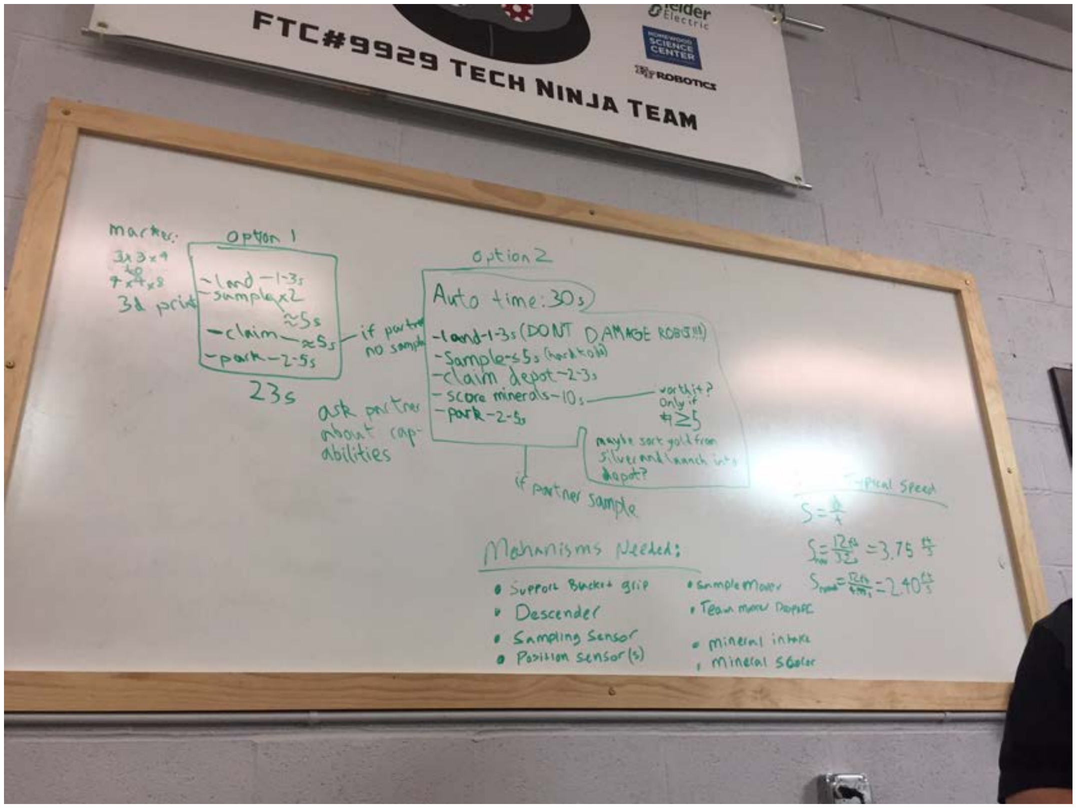
Identify	Brainstorm	Select	Prototype	Evaluate	Design	Fabricate

Constraints

- 18” cube
- 42 lbs
- Game elements
  - Height of handle on lander to ground
  - Top of lander screen to ground
  - Height of lander
  - Size of unobtanium
  - Silver vs. gold unobtanium
  - Size of playing field
- Time
  - Pick up/deposit
  - Hang up/down time
  - Auto
  - Driving (general)/speed
  - Endgame
    - Restriction on start of endgame actions
- Item box location recognition
- Distance
  - Lander to crater
  - Lander to sample
  - Lander to wall
  - Lander to team depot
  - Relative distance of all elements
- Size of depot (corner score zone)

	• Lander box size ◦ Shooting/depositing height • Space/other robots on field • Sensor distance/limits • Max in game size • # of game elements • Battery (How long/much) • Build/program time • Speed of robot **Liam**
2. Lift constraints	**Identify** | Brainstorm | Select | Prototype | Evaluate | Design | Fabricate  **Liam**
3. Mineral Collection	**Identify** | Brainstorm | Select | Prototype | Evaluate | Design | Fabricate

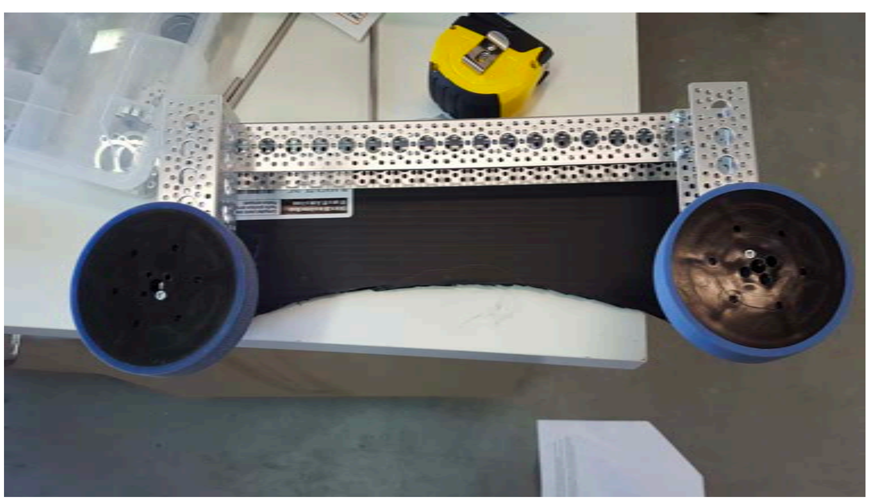
Mechanism	We were identifying the constraints on whatever the mineral collection mechanism is going to be. We stuffed as many minerals as we could into the lander and found that the maximum amount of gold and silver minerals were 57 and 51, respectively. Using this information, we added the two numbers together, divided that number by 120 for the time we have in tele-op and got a maximum mineral loading speed of 0.9 minerals per second, assuming we can start right as the driver-controlled period starts**.**  **Liam**
4. Game Strategy	**Identify** | Brainstorm | Select | Prototype | Evaluate | Design | Fabricate

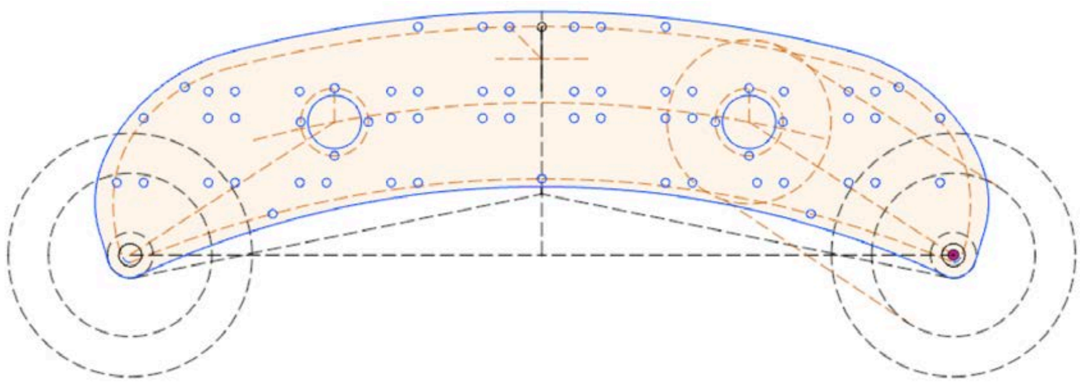


We were trying to figure out what our strategy would be for the autonomous part of the game this season, because the programming team needed something to work on, even during the build weekend. We approximated the amount of time the tasks we could take based on our past experience in FTC. Here are the strategies we came up with:

1. Strategy 1
    a. Descend from lander (1-3s)
    b. Sample mineral (twice if alliance partner can't do it, ~5s each)
    c. Claim the depot (~5s)
    d. Park (2-5s)
    e. All of these give us a total time of 23s.
2. Strategy 2
    a. Descend from lander (1-3s, more if needed to not damage the robot)
    b. Sample (5s)
    c. Claim depot (2-3s)
    d. Score minerals (10s)
    e. Park (2-5s)
    f. Total time of 26s

We discussed if scoring minerals into the cargo hold during

	autonomous were worth it, and we decided that they would only be worth it if there were 5 or more minerals that we could score, because one mineral in the correct cargo hold is worth 5 points, and sampling the other gold mineral is worth 25 points, so we opted to use the second strategy only if our alliance partner can sample minerals. We then discussed the mechanisms we would need in order to do all these tasks, and here is the list we came up with: ● Support bracket grip (lander) ● Descender (for coming off the lander) ● Sampling sensor ● Position sensor(s) ● Sample mover ● Team marker drop-off ● Mineral intake ● Mineral scorer Finally, we did a test to figure out what our typical speed would be using last year's robot. We found that it could go all along the side of the field, which is 12 feet long, in 3.2 seconds at max speed, giving us a maximum speed of 3.75 ft/s. We did the same test but at a slightly slower, more average speed, and that got us across the field in 4.99 seconds, giving us a normal speed of 2.4 ft/s. **Liam**
5. Drive Base Geometry	Identify | Brainstorm | Select | Prototype | Evaluate | **Design** | Fabricate 

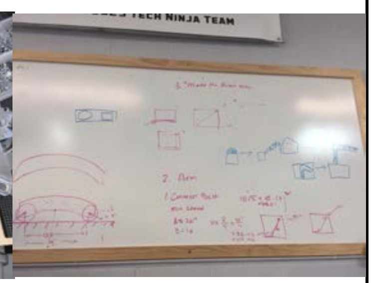
	Ernest and Mr. Beezie made a mockup of a wheelbase, with coroplast for sides. They rolled it over the crater and noted where the sides made contact and continued to trim it away until the wheelbase cleared the crater rim without touching. The dimensions of this mockup were then used by Liam to design a drivebase side plate in CAD with a similar geometry to be cut out of aluminum on the CNC:  We made the bottom of the drive base curved so that we can get over the crater easily. The lowered wheel holes also contribute to that. The rest of the holes are for motors and Actobotics plate/channel mounting. **Liam**

	September 16, 2018	7:00 AM-7:00 PM

Contributors: Caleb, Ernest, Katelyn, Kaylin, Liam, Logan, Lauren, Matthew, Taylor

Entries	
1. Started Building Side Plates	Identify / Brainstorm / Select / Prototype / Evaluate / Design / **Fabricate**



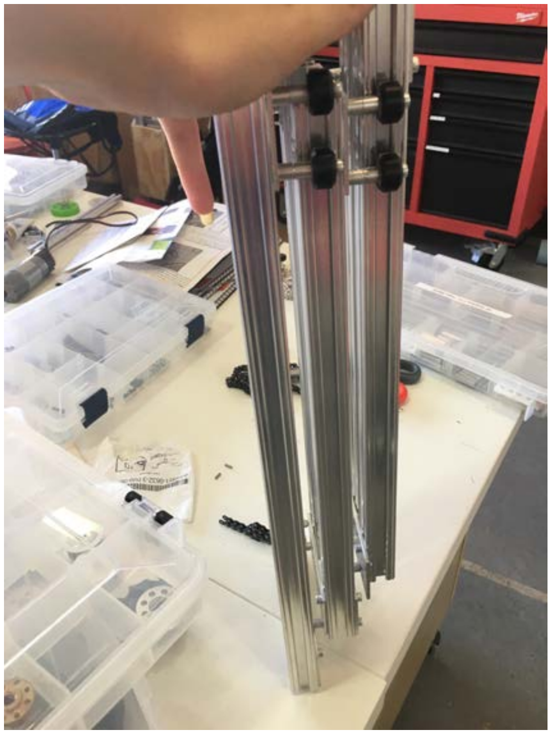


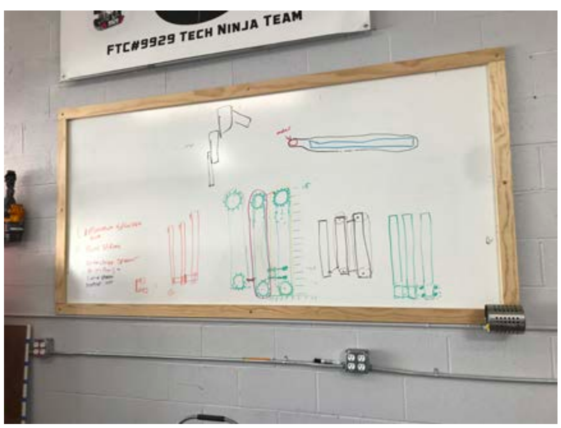
- *What we did*
    - We cut out basic side plates on the C.N.C and started constructing a working drive base
- *Why we did it*
    - We need a working drive base to prototype other parts
    - We want to see if the drive base design will be able to get over the crater

[Kaylin]

2. Started Building Lift

Identify	Brainstorm	Select	**Prototype**	Evaluate	Design	Fabricate





- *What we did*
    - We put together the chain driven lift together
- *Why we did it*
    - We wanted to see if the lift would work on our robot.
    - We wanted to use the lift to prototype other parts.

[Kaylin]

	September 23, 2018	4-6 PM
Contributors: Habtamu, Hannah, Katelyn, Kaylin, Liam, Logan		

Entries

1. Changing Sprockets

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

What We Did:

- We inserted data about our sprockets into a chain length calculator
- The result was a 64-link chain, which we proceeded to make four of; one for each wheel.
- We put the chains on the sprockets in between the side plates on each side of the robot.

Why we did this:

- We used the chain length calculator to be more efficient and to prevent miscounting.
- We needed sprockets to drive the wheels.

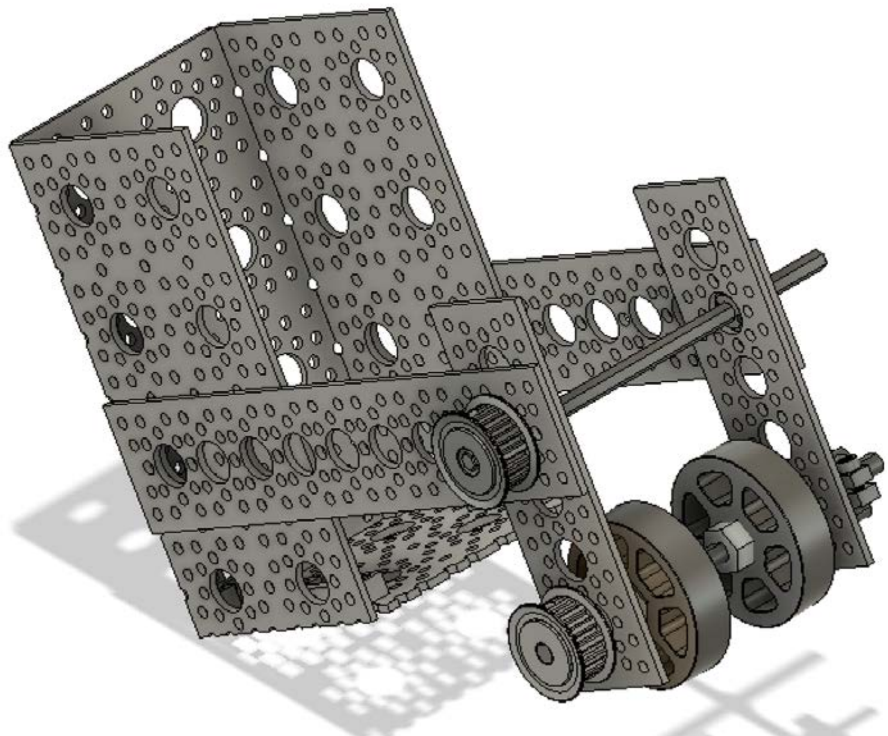
Changing Sprockets **- Katelyn, Liam**

2. Intake Mechanism

Identify	Brainstorm	Select	**Prototype**	Evaluate	Design	Fabricate

What we did:

- First, we made a vertical box out of Actobotics plates in CAD, with mounting points for the motor.
    - Attached some “arms” using Actobotics plates
    - Ran a D-shaft and a hex shaft through the arms.
    - Attached a timing pulley to each shaft.
    - Attached compliant wheels to the D-shaft.

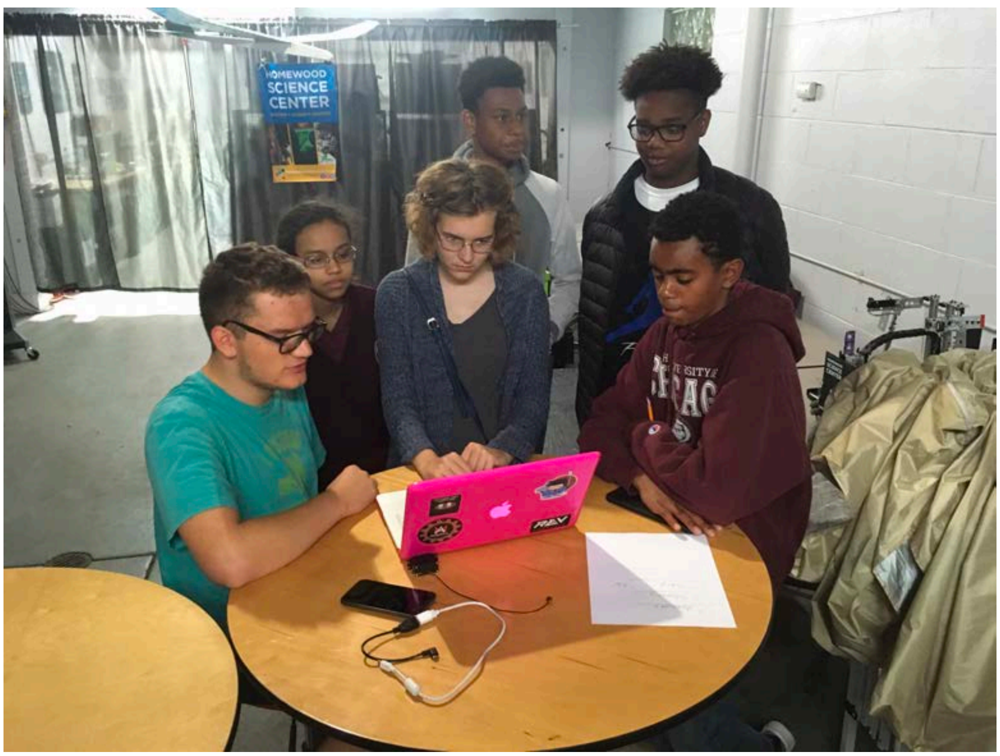
	 **Katelyn, Liam**

	September 28, 2018	6:00PM-9:00 PM
Contributors: Caleb, Calvin, Habtamu, Katelyn, Lauren, Matthew, Kaylin, Ernest, Liam		

Entries

1. Develop basic tele-op

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**



How the hardware map works for tele-op

- *What we did*
  - Mapped out the robot's hub address and configured it for our phone
- *Why we did it*

	- In order for any part of the robot to work, it must have all motors and servos connected to a working hub, which must be connected to a working phone that has been configured to that specific hub. Otherwise it would just be a hunk of metal and wire. **Created tele-op for for rover ruckus** - *What we did* - Removed the excess code form last year's tele-op until there was only mecanum drive - *Why we did it* - The team had previously decided to use mecanum drive. We knew that we had a working drive program for mecanum drive from last season. Wanting to have an operational drive base as soon as possible we decided to reuse last year's code as a starting point for this season. **-** **[Calvin]**
2. Experimented with USB hubs, webcam and Vuforia	Identify | Brainstorm | Select | Prototype | **Evaluate** | Design | Fabricate

- ***USB***
    - *What we did*
        - Tested two different USB hubs to see what would work
    - *Why we did it*
        - We did it because we knew that some USB hubs were not compatible with the webcam we were using at the time. We found both hubs were compatible but one had an issue. That issue being a button on the port had to be activated and if it was deactivated after init it would cause an error to be thrown.
- ***Webcam and vuforia***
    - *What we did*
        - Tested how well the webcam and vuforia could detect the image from the game.
    - *Why we did it*
        - We plan to use vuforia to orient ourselves after we descend in autonomous. We need to be able to properly orient yourself, hopefully with the images before continuing. We most likely land on an angle to them so reading them at an angle is important. We also

	will be a good distance away and moving could cause us to lose points if we run into a silver mineral. **[Lauren]**

3. Discussed timing and routes for autonomous	Identify | **Brainstorm** | Select | Prototype | Evaluate | Design | Fabricate
	
	- *What we did*
	    - Calculated time and route for possible autonomous
	- *Why we did it*
	    - We need to know how long each action takes to plan timeout limits (a limit that stops an action after a specific amount of time to help maximize points and minimize penalties during autonomous). We need to know this also to plan how long we have for descent from the lander to help inform the build team of what the descent mechanism is required to do (we calculated around ten seconds for descent with the current drive base). We also planned routes as distance traveled plays into the timing of the match.
	
	[Lauren]

4. Building Prototype Drive Base	Identify | Brainstorm | Select | Prototype | Evaluate | Design | **Fabricate**

- *What we did*
  - We finished constructing the prototype drive base
  - We noticed when we tested the base that we needed to flip the mecanum wheels.
- *Why we did it*
  - We need the prototype drive base to see how our real drive base will move and how the mechanisms will work with it
  - We needed to switch the wheels around so the base could move correctly.

[Kaylin]

5. Continued Building Lift

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

- *What we did*
    - We continued working on the Lift mech.
- *Why we did it*
    - We want the lift working as soon as possible so we can prototype new mechs. with it.

[Kaylin]

	September 30, 2018	4pm-6pm
Contributors: Hannah, Taylor, Logan, Liam, Ernest, Lauren, Kaylin, Katelyn		

Entries

1. Discussed Intake Options

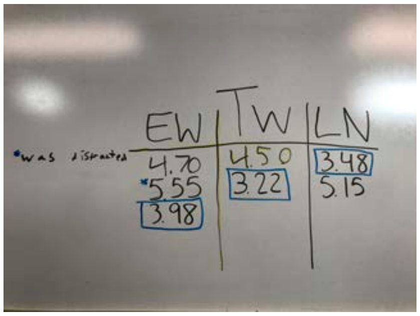
Identify	**Brainstorm**	Select	Prototype	Evaluate	Design	Fabricate


- *What we did*
  - We discussed different options for the intake of minerals on our robot
- *Why we did it*
  - We did this to make sure we explored all our options before we decided on which on to put on the robot.
  - We wanted the whole team's input on this mechanism because it is such a crucial part of our robot.

[Kaylin]

2. Testing Drive Base

Identify	Brainstorm	Select	Prototype	Evaluate	Design	Fabricate



- *What we did*
    - We drove the robot from the lander to the corner of the field and recorded the times.
- *Why we did it*
    - We did this to see how well our drive base design could get over the crater. We found out it did pretty well and was able to get over the crater efficiently.

[Kaylin]

3. Mineral Placement

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

- *What we did*
    - We marked out the position of minerals on the field
- *Why we did it*
    - We did this so we could finish the field
    - We did this so we could practice on a finished field
    - We did this to make sure we could finish autonomous

[Kaylin]

<table>
<tr>
<td>4. Wired Encoders</td>
<td>

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

- *What we did*
    - We wired up the encoders on the motors
- *Why we did it*
    - We did this so we could experiment with autonomous

[Kaylin]
</td>
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</table>

	October 5, 2018	6:00-9:00 PM

Contributors: Caleb, Calvin, Habtamu, Kaylin, Katelyn, Lauren, Liam, Logan, Matthew

Entries

1. Learned about Motion Profiles from Team 254

Identify	**Brainstorm**	Select	Prototype	Evaluate	Design	Fabricate

We watched a video from the Cheesy Poofs to learn about motion profiling. We watched the video to determine our strategy when approaching motion profiling.

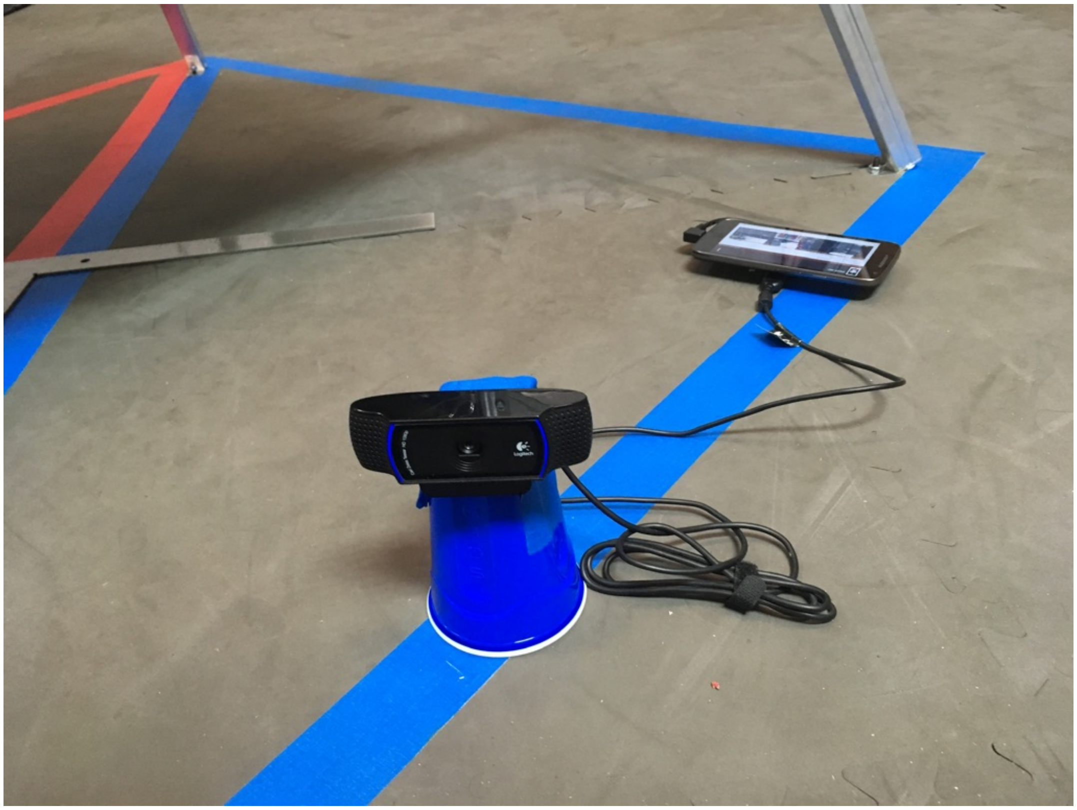
We want to use motion profiling to achieve a more accurate autonomous. After watching the video we had a discussion of the matter of how and why we wanted to use motion profiling this season. This was to get a better grasp of understanding of motion profiling.

[Lauren]

2. VuForia on-field position detection experiment

Identify	Brainstorm	Select	**Prototype**	Evaluate	Design	Fabricate

To test VuForia we used a macgyvered robot (a plastic cup and some tape attached to the webcam) to test the VuForia system. We used this system because a measurement closer to the ones we would be seeing on the robot.

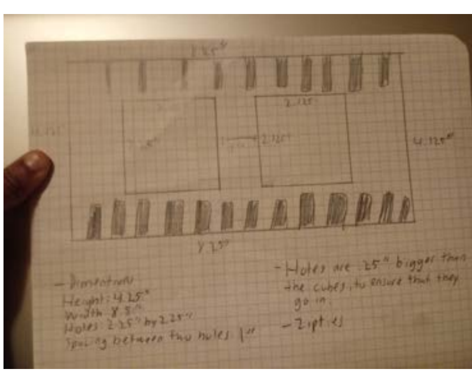


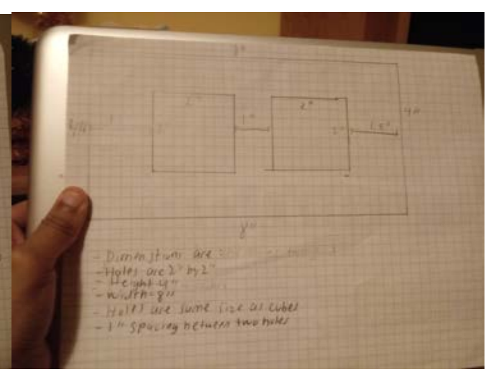
We measured using a grid system recently set up on the field as we plan to use Motion Profiling. We also took these measurements to see how the incorrect aspect ratios of the first VuForia pictures would affect the measurement during the game.

[Lauren]

3. Mineral Intake

Identify	**Brainstorm**	Select	Prototype	Evaluate	Design	Fabricate





We discussed intake mechanism design so we can move forward in building it.

	The drawings above show an idea we have for holes in the bottom of the intake mechanism that the gold minerals will fall through, so that we automatically sort them out from the silver minerals, making it easier for us to score into the lander. **[Katelyn]**

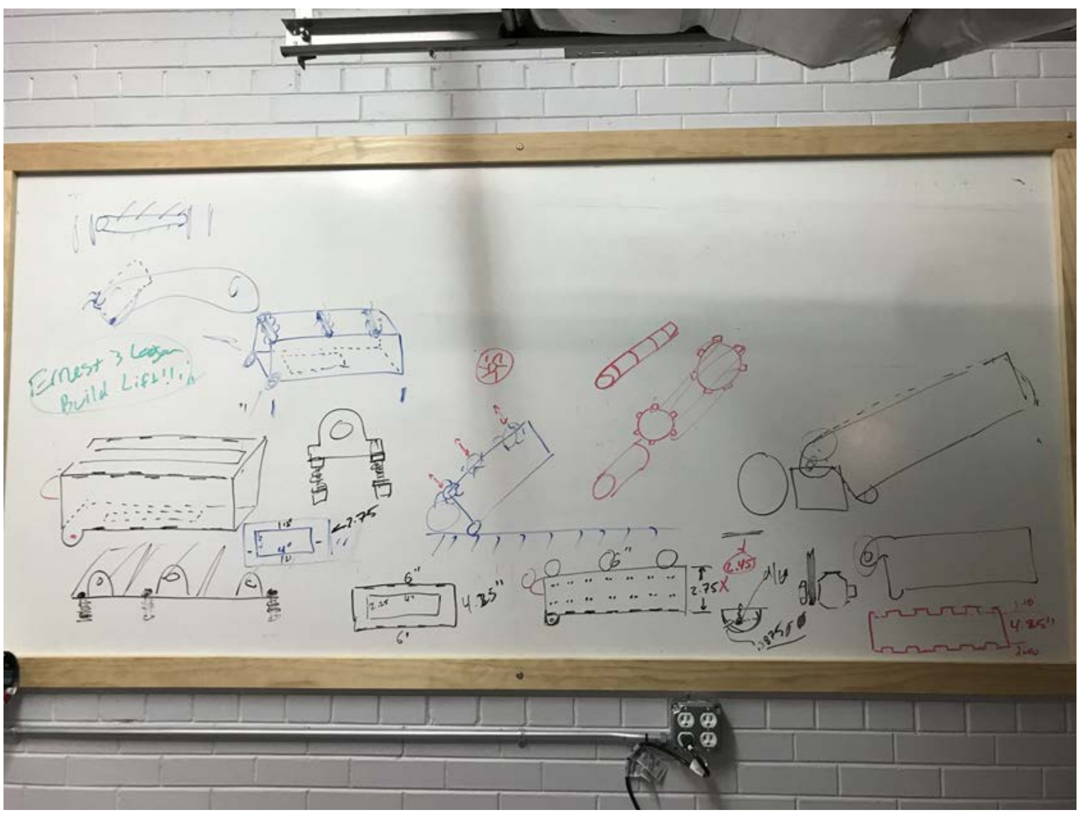
	October 7, 2018	4PM-6PM
Contributors: Caleb, Ernest, Habtamu, Kaleb, Katelyn, Kaylin, Lauren, Liam, Logan, Matthew, Taylor		

Entries

1. Mineral Sorter/Intake

Identify	**Brainstorm**	Select	Prototype	Evaluate	Design	Fabricate

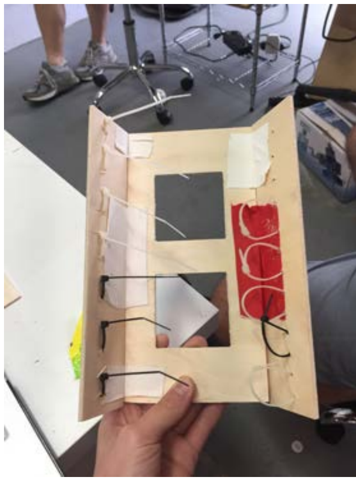
We discussed ways to make a mineral sorter and intake. We knew we were going to sort the gold minerals from the silver by making them fall through a hole in the bottom of a “sorting box”, whose sole purpose is to, as the name suggests, sort the minerals from each other. We had to figure out a way to keep the minerals moving through and not get stuck in the hole in the bottom.

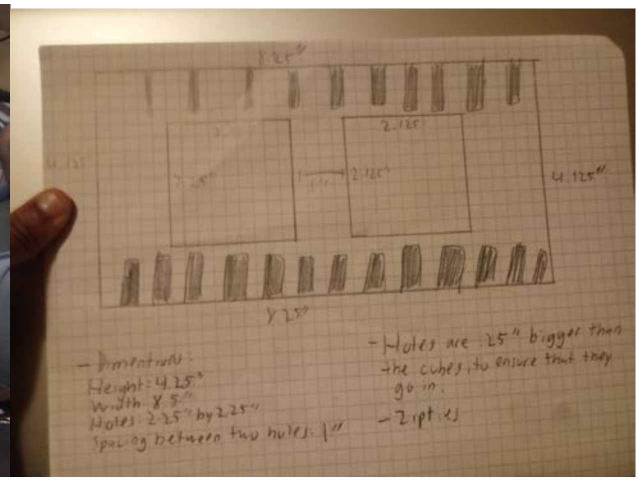


Here is what we did:

- We had an initial design of intake and motion wheels as tubing or

	PVC with fingers made out of poly cord or surgical tubing. ● Our sorting box design has multiple intake wheels throughout it, to keep the minerals moving, and a hole in the bottom to get rid of the gold minerals ● We had an idea of spring-loading the pillow blocks with the shafts going through them, so that we could push both gold and silver minerals through the box. This would be done either individually by pillow block or together with all the pillow blocks connected to a plate ● We have two drawings of the bottom plate of our sorting box with measurements up there. ● We had a new idea, where we had gear-like hubs across the box from each other, with rubber bands running between them. These would serve as our intake wheels. We might not even have to spring-load them to get them to work. ● On the bottom of the sorting box, we're going to have V-wheels on the bottom, just to help it get over the crater without getting caught. ● We were putting holes in the side plates of the sorting box for zip ties. They will guide the minerals into the hole. ● We decided to put the hole on the side of the bottom plate, instead of in the middle. We did this because we could save space, and lining up the gold minerals will be easier with a flat surface than with two sets of zip ties. ● Finally, we're going to design the sorting box pieces in such a way that they have tabs on the ends of them, which help us put them together at nice, 90-degree angles so that it's really easy to epoxy them together. Below are a prototype sorting box and the measurements for said prototype. You can see our zip-tie idea in action here. We changed the holes into one larger hole after we made these.




4.125"
- Dimentions:
Height: 4.25"
Width: 8.5"
Holes: 2.25" by 2.25"
Spacing between two holes: 1"
- Holes are .25" bigger than the cubes, to ensure that they go in.
- Zipties

[Liam]

	October 12, 2018	6:00-9:00 AM/PM

Contributors: Katelyn, Kelvin, Liam, Matthew

Entries

1. Planning first autonomous route

Identify	Brainstorm	Select	Prototype	Evaluate	**Design**	Fabricate

Point	Sample Set 1		Sample Set 2		Sample Set 3		Remeasures		Stats	
	x	y	x	y	x	y	x	y	stddev(x)	stddev(y)
1	25.500	-30.000	26.000	-28.000	26.000	-27.500		-27.875	0.289	1.323
2	54.500	1.500	54.500	1.500	54.500	1.500			0.000	0.000
3	61.500	1.500	61.500	1.500	61.500	1.500			0.000	0.000
4	59.500	-1.000	60.000	-0.250	60.000	-0.500			0.289	0.382
5	60.000	-44.500	60.000	-44.500	60.000	-44.500			0.000	0.000
6	61.000	15.500	61.200	15.500	61.000	15.500			0.115	0.000

- *What we did*
  - We measured the x and y coordinates(in in.) for each step 3 times.
  - Recorded our results
  - We put our results on a spreadsheet to get standard deviation
  - One of the measurements was off, so we remeasured this to get a more accurate measurement for y-

coordinate for step 1, and this made the step 1 deviation decrease.
- *Why we did it*
  - *To make sure we have an accurate layout for the autonomous route red #1*

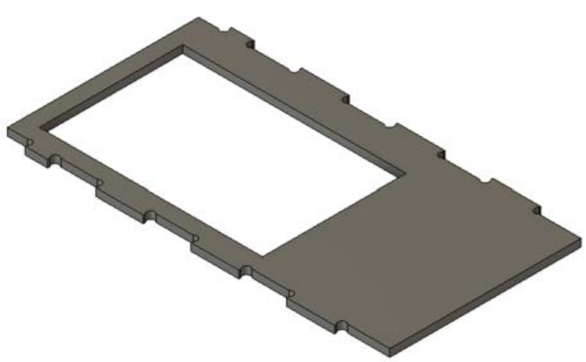
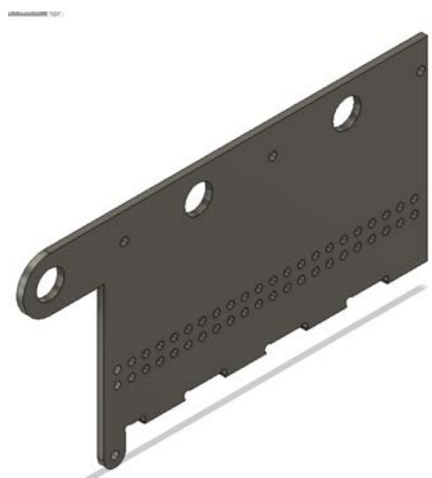
[Matthew, Kelvin, Katelyn]

2. Designing Intake Mechanism

Identify	Brainstorm	Select	Prototype	Evaluate	**Design**	Fabricate

Today, we designed a box to act as the frame for our intake mechanism. However, there were a few requirements we had to meet:
- Holds 2 minerals comfortably
  - Gold mineral is 2”x2”x2” cube
  - Silver mineral is 2.75” diameter ball
- Sorts the gold minerals out via:
  - Hole in bottom for the gold minerals to fall out.
  - Some way to make the minerals upright so that they fall through the hole easier.
- Has places for shaft to go through to run the mechanism.

With these in mind, we designed a bottom plate and a side plate, respectively shown here:

- The inside dimensions of the box are 3” tall by 3” wide by 6” long, to accommodate two silver minerals comfortably, with 0.25” of clearance per mineral in each direction
- 3 shaft holes for whatever method of intake we use, choosing from:
  - Rubber band wheels
  - Compliant wheels

	○ Shaft with zip tie "fingers" coming out of it ● Holes near the bottom of the side plate for zip ties that make the cubes upright to go through ● Gold mineral hole is 3.5" by 2.25" to allow us to drop a gold mineral through with a little bit of clearance. ● Tabs on the sides to make the thing easier to put together ○ Get epoxy, put it on the tabs, and snap the thing together ● Standoff holes on the top for stability reasons ○ Better than just having the epoxy ● Wheel hole on the bottom of the side plate for maneuverability purposes ○ It will be more stable and easier to handle than just dragging the mechanism across the floor. **[Liam]**

	October 14, 2018	4PM-6PM

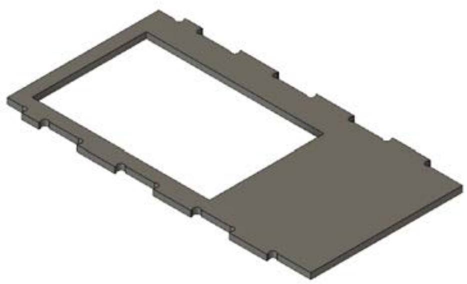
Contributors: Calvin, Ernest, Habtamu, Jeremy, Katelyn, Kaylin, Lauren, Liam, Logan, Taylor

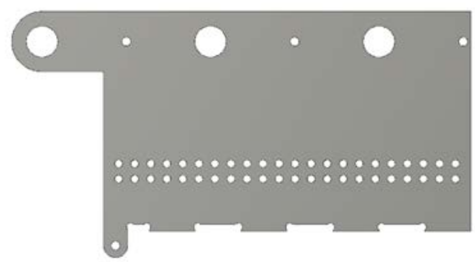
Entries

1. Sorting Box

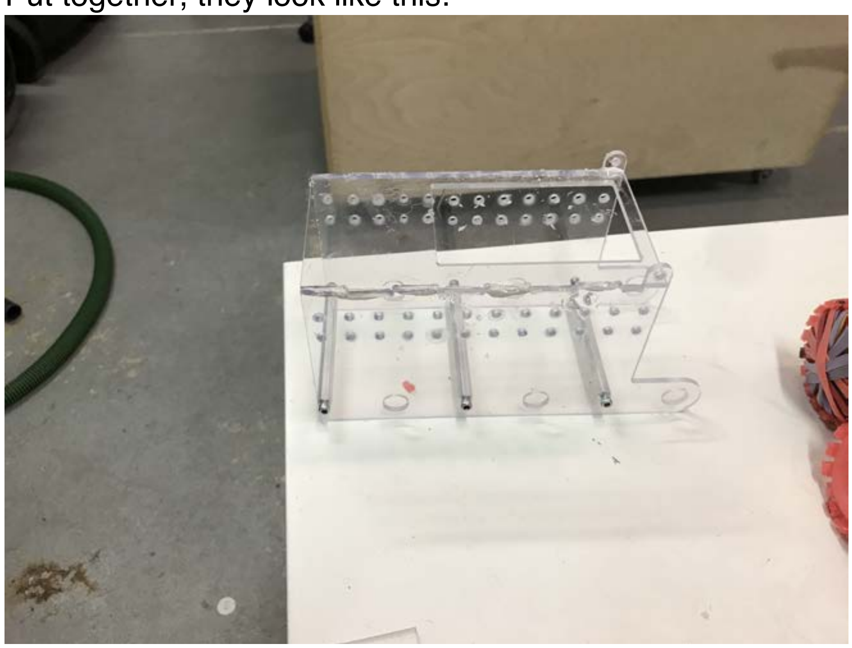
Identify	Brainstorm	Select	**Prototype**	Evaluate	Design	**Fabricate**

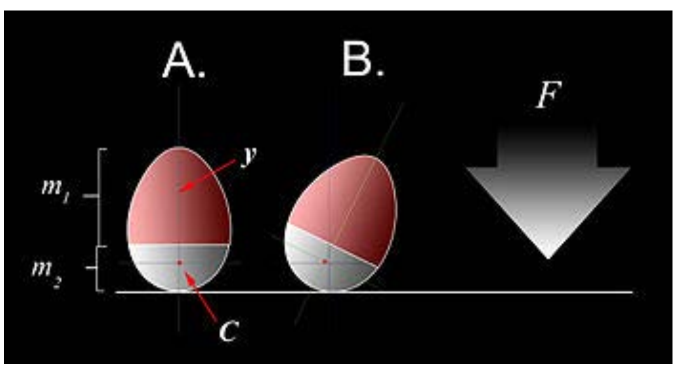
We took a design for our sorting box that was made over the last week and put it into a toolpath for our CNC machine. Respectively, these are our floor plate and side walls.





Put together, they look like this:



<table>
<tr><td></td><td>We have standoffs going between the side plates to make the whole design more sturdy, and our epoxy is in the joints, drying. We used lexand as our material to cut them out of because:
It’s clear, which means the referee will be able to see how many minerals we are controlling at any time, so that we don’t go over the limit and get penalty points
It’s durable, so it will work well on the robot.
Liam</td></tr>
<tr><td>2. Team Marker</td><td>
<table><tr><td>Identify</td><td>Brainstorm</td><td>Select</td><td>Prototype</td><td>Evaluate</td><td>Design</td><td>Fabricate</td></tr></table>
We made a choice as team to make a team marker that would right itself for the reasons of it:
- Being memorable
- Being more consistent
- Less likely to cause damage by landing on the wrong side
We drew inspiration off of the a child’s toy, known as a weeble, that also rights itself. It is from said toy that we choose the egg shape of the team marker.


The ability to right itself comes from the low center of gravity, created by the ballast and the shape of the team marker, and the curved surface of the team marker.</td></tr>
</table>

	The egg shape of the marker means the center of gravity is lower then it would be on a sphere of the same size. By adding additional weight in the lower portion of the egg (our ballast of choice is kep-nuts) we lower the center of gravity farther. The slightly flat section at the very bottom helps to ensure that it does not continue to wobble after it is upright. There is also a bridge that separates the upper and lower section to add support and make adding a ballast easier.  **Liam, Lauren**

	October 19, 2018	6PM-9PM
Contributors: Katelyn, Kelvin, Lauren, Matthew, Kaylin, Liam, Taylor, Hannah, Ernest		

Entries

1. Collector basic coding: interview and prototyping

Identify	Brainstorm	Select	**Prototype**	Evaluate	Design	Fabricate

Before we began programing, we interviewed the build team on how they expected the robots mechanisms to function. We asked them this so we would know what and how many moving part we would have to write code for.

After interviewing them we started a rough program of the following mechanisms:

- stow/deploy servo
- collection/rejection motor

We did this so we would have the skeleton of code when we could collect the actual values need to complete the tasks the mechanisms have to complete.

To create the stow/ deploy servo and collection motor within the code we set the variables tied to the value we have yet to collect to a rough estimate. We did this to make sure the code had no errors in the sense of the outline. We did this so we can have a somewhat functional code by the time the mechanisms are ready to use.
[Programing team] **- [Lauren,Katelyn,Kelvin,Matthew]**

2. Linear Actuator

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

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


- *What we did*
  - We fabricated the first linear actuator and tested it with a motor

- *Why we did it*
  - We needed to see if the lead screw lift would be effective in allowing the robot to lift on and off the lander.

[Build Team] **- [Kaylin]**
</td>
</tr>
<tr>
<td>3. Drop-off Mech</td>
<td>

Identify	Brainstorm	Select	**Prototype**	Evaluate	Design	Fabricate

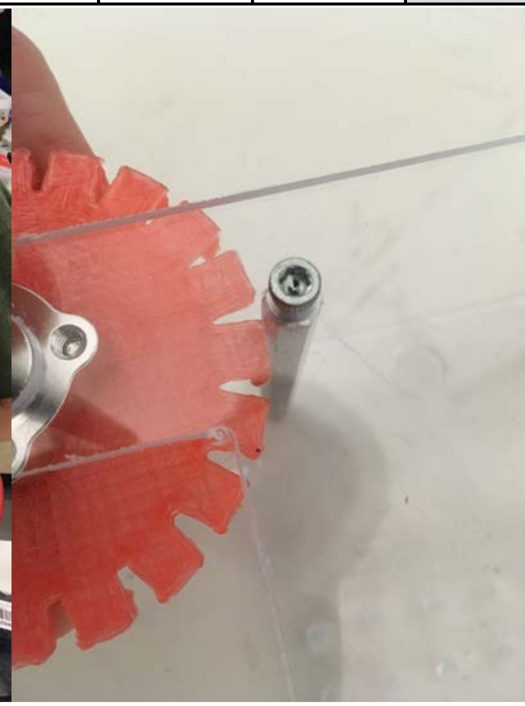
- *What we did*
  - We prototyped a “4 link” system for drop-off for particles
</td>
</tr>
</table>

- *Why we did it.*
  - We need this mech to drop particles off and we wanted to prototype before building.

[Build Team] **- [Kaylin]**

4. Intake Mech

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

- *What we did*
  - We added “rubberband wheels” to the intake mechanism.
- *Why we did it*
  - We added these wheels to grip particles and drag them into the mechanism.
  - We want to be able to collect particles to score point.

However, when we were working on this, we ran into a problem. The rubber band wheels were too big.When we were putting them in, we realized that they ran into the standoffs, as shown in the picture on the right. We didn’t realize this until we had spent a whole practice trying to build them.

Liam

	October 21, 2018	4PM-6PM

Contributors: Caleb, Calvin, Katelyn, Lauren, Matthew

Entries

1. Velocity system: Time vs X

Identify	Brainstorm	Select	**Prototype**	Evaluate	Design	Fabricate

What we did:
- First, created the code for comparing time and velocity.
- Then we copied and pasted this code.
- Finally, we changed it the code to compare time and acceleration.

Why we did this:
- We did this to have a thing that can tell acceleration so we can calculate where we can expect to be because we are using a feed-forward/feedback system.

Programming **- Lauren,Calvin,Caleb,Matthew,Katelyn**

2. Adapting RoadRunner to TNT grid system

Identify	Brainstorm	Select	Prototype	Evaluate	**Design**	Fabricate

What we did:
- First we compared the Roadrunner coordinate system to the TNT coordinate system
- We created an adapter to convert our values to the roadrunner values.

Why we did this.
- We did this to be able to use the roadrunner system without having to remember the conversion factor every time we use a new coordinate within our code.

Programming **- Lauren, Calvin, Caleb, Matthew, Katelyn**

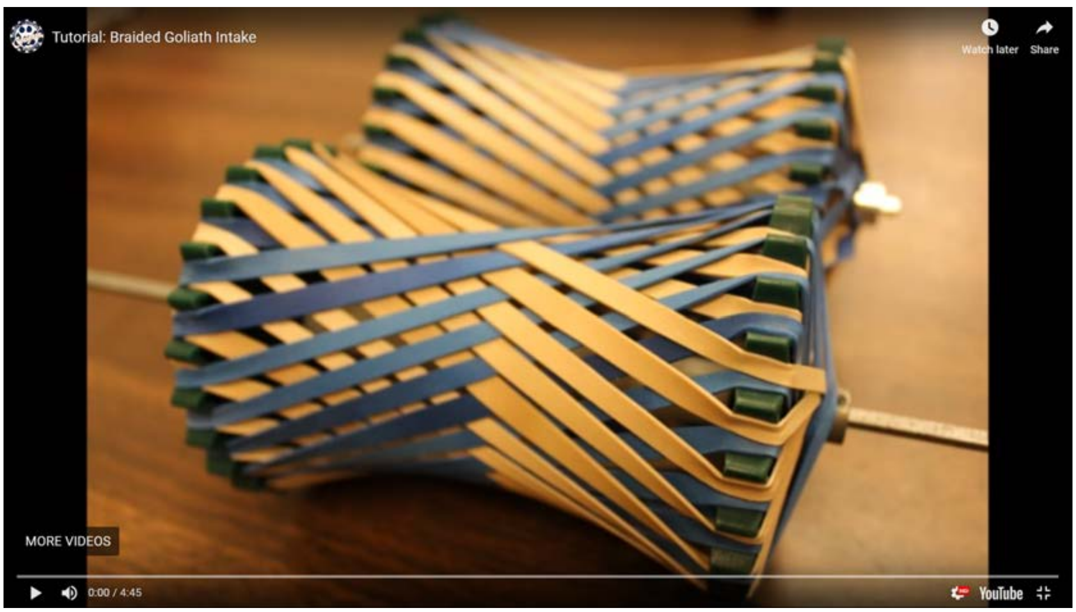
	October 26, 2018	6pm-9pm
Contributors: Liam, Logan, Habtamu, Taylor, Kaylin, Lauren, Katelyn		

Entries

1. Rubber Band intake mechanism.

Identify	Brainstorm	Select	Prototype	Evaluate	Design	Fabricate

We built a rubber band intake mechanism based on this one below:

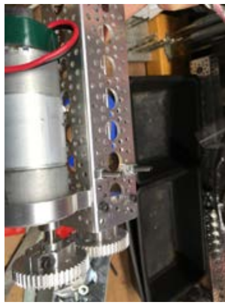


We have settled on this design for our intake mechanism because it is sturdy, flexible,and powerful as an intake mechanism, all at the same time. It's better than compliant wheels and/or "fingers" on a shaft because it's more flexible and reliable than either of those two. We are going to use 8 "teeth" to attach our rubber bands to on each side.

[Liam]

2. New location of pillow block and motor for leadscrew

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

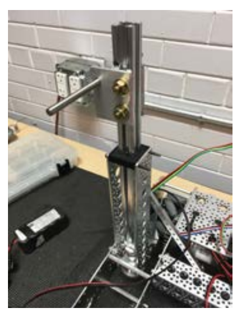


- *What we did*
  - We moved the pillow block for the ascender/defender mech.
- *Why we did it*
  - We did this so we can mount the mech. onto the robot without the pillow block or screws interfering.

[Kaylin]

3. Hanging hook

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

- *What we did*
  - Drilled plates for hanging hook
  - Fabricated first version of hanging hook
- *Why we did it*
  - We did this so we could measure where the hook needs to go so that the robot can latch
  - So the robot has something to latch with

[Kaylin]

	October 28, 2018	4PM-6PM
Contributors: Kaylin, Lauren, Liam, Logan		

Entries

1. Limit Switch and Hard stop

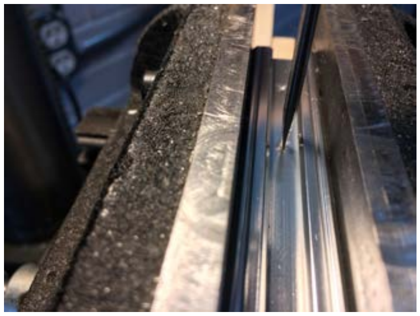
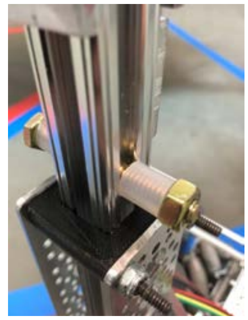
Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

- *What we did*
    - We added a magnet for the limit switch
    - Attempted hard stop
- *Why we did it*
    - We put the magnet for the limit so that the robot knows when ascender/descender is fully down so it knows how many motor revolutions to get to full up so we can unlatch
    - We attempted a hard stop so we don't wreck our mechanism. The holes were drilled in the wrong place so they might have to be re-done

[Kaylin]

2. Hard Stop

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

- *What we did*
    - We cut a new piece of x-rail and drilled new holes for the ascender/descender
- *Why we did it*

We did this so that the hard stop would be in the right place and so the robot can latch correctly.

	November 4, 2018	4:00 - 6:00 PM
Contributors: Caleb, Calvin, Katelyn, Lauren, Matthew		

Entries

1. Autonomous for League Meet #1

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

- Programed descend only auto
    - Set up descend state
        - Checks if started
        - Checks if timed out
        - Checks if busy
- Why- We did this in order to prevent damage to the robot. Timeout specifically ensures this. We also check to see if it gets started or is busy in order to make sure the task gets done before the next state occurs.

    - Responds accordingly
        - If error occurs (timeout) then stop
        - If not move to next state
- Why- We did this to ensure that if an error does occur we can avoid further mishappening. Also, if no error occurs that we fluidly moves on to the next state.

    - Drives off hook
        - Move forward
        - Strafe left
- Why- We did this to make sure that we had complete the autonomous stage, and be completely off the hook for tele-op.

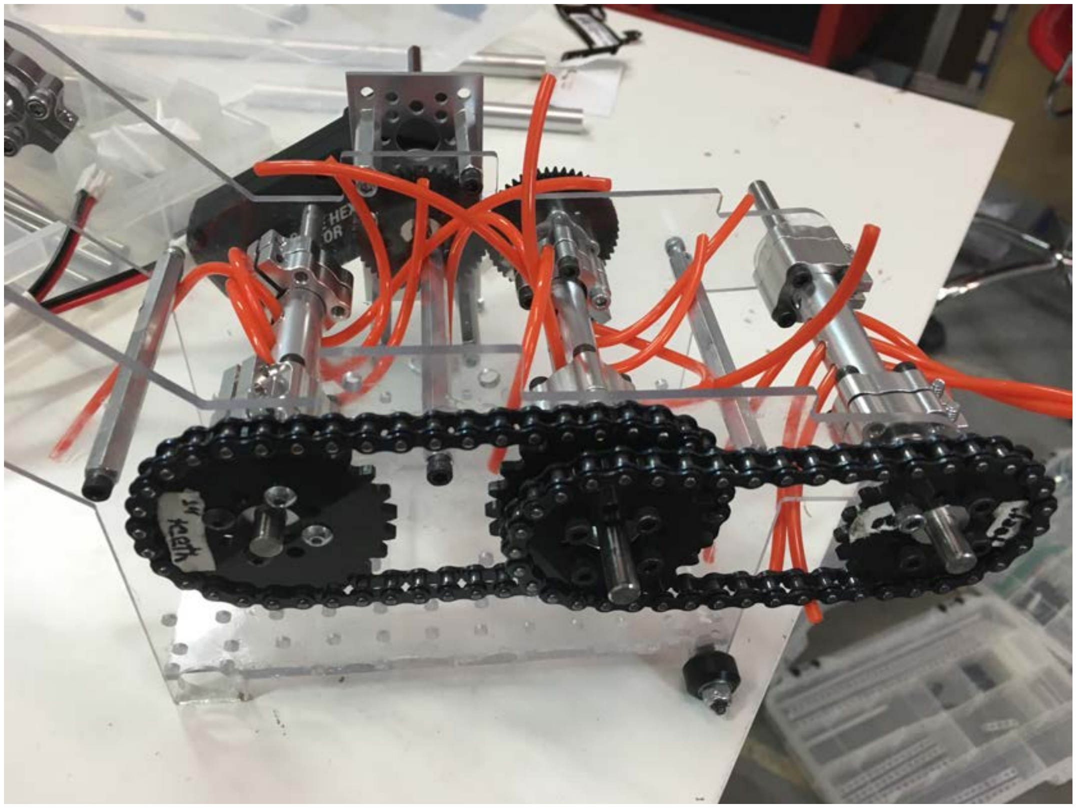
[descend auto] **- [Lauren, Katelyn]**

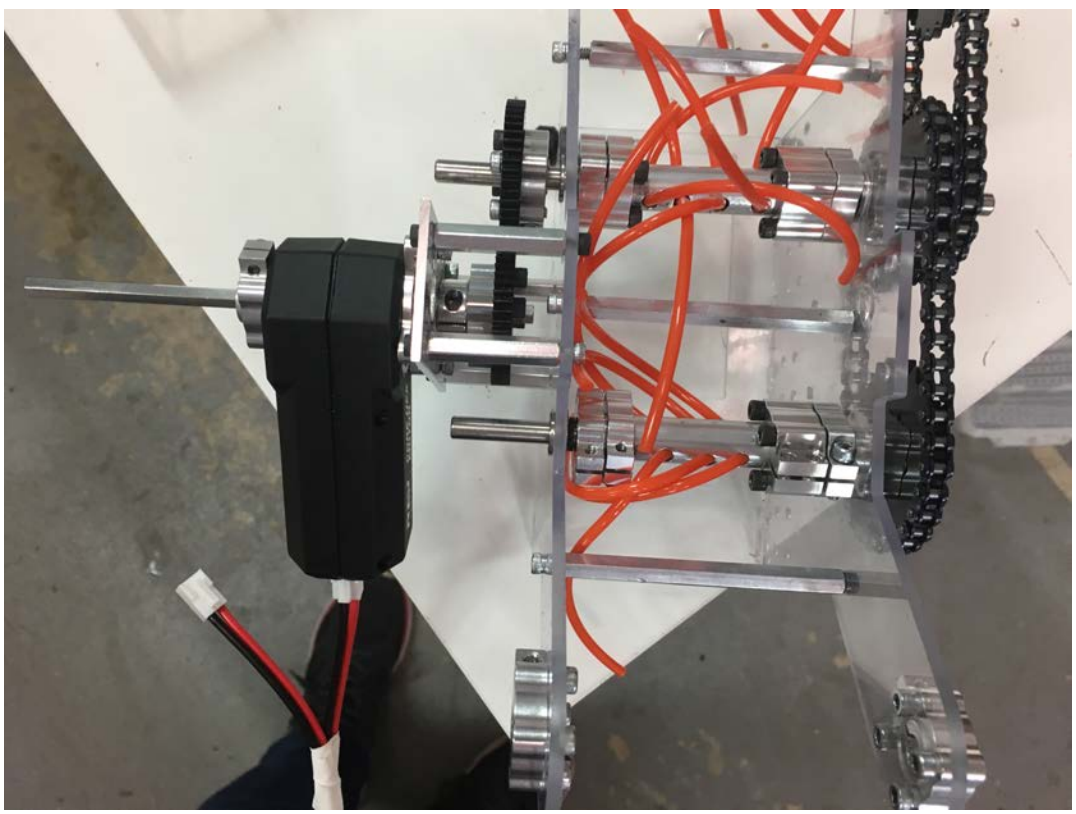
2. Ascender Descender

Identify	Brainstorm	Select	Prototype	Evaluate	**Design**	Fabricate

	• Added hard stop to linear actuator.
	    ○ Drilled hole in the wrong spot
	• Why: hard stops are often more reliable then limit switches because they do not have a chance of programing or electrical error. This was made to serve as a last resort limit switch
	
	• Added magenic limit switch
	    ○ Added magnet to linear actuator
	• Why: this serves as one of our other limit switches. We wanted to have multiple limit switches as a method of checks and balances on this mechanisms. We chose the magnetic limit switch as it can be used to tell when two points meet and was determined to be more reliable than a touch sensor for this mechanisms.
	
	[Lauren]

3. Intake Mechanism	Identify | Brainstorm | Select | Prototype | Evaluate | Design | **Fabricate** • We made the intake wheels into shafts with poly cord going through them • The intake poly cord will grab onto the minerals and pull it in through the sorting box. • We redid the intake mechanism to accommodate a REV hex core motor to drive it • We used two 48T gears and some sprockets to drive the poly cord.





[Liam]

	NOVEMBER 6, 2018	Matthews House
Contributors: Lauren, Kaylin		

Entries

1. Added Number Plates and Sponsorship Stickers

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

- *What we did*
  - We attached our number plates and sponsorship stickers to the side of our robot before our first League Meet
- *Why we did it*
  - We did this to comply with the rules and to thank our generous sponsors for sponsoring our team this season!

- [Kaylin]

	November 9, 2018	6:00-8:00 PM

Contributors: Hannah, Kaylin, Taylor, Katelyn, Habtamu, Liam, Logan, Ernest, Matthew, Kaleb

Entries

1. Drive Team Practice

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

- *What we did*
  - We practiced driving for the upcoming league meet
- *Why we did it*
  - We did this so we can be prepared to compete at the meet

[Kaylin]

	November 11, 2018	4PM-6PM
Contributors: Calvin, Habtamu, Hannah, Jeremy, Katelyn, Kaylin, Lauren, Liam, Logan		

Entries

1. Lessons From the League Meet

Identify	Brainstorm	Select	Prototype	Evaluate	Design	Fabricate

- The robot might've blocked the crater during one of the matches
- Descending off of the hook
    - SDK error
    - Bug that leaves the descender running during descension
- The team members need roles
    - Scouting sheet (see what other teams are doing)
        - Outside our league
        - Volunteer for it

[Liam]

2. Robot Changes

Identify	Brainstorm	Select	Prototype	Evaluate	Design	Fabricate

- Limit Switch Descender (Habtamu/Kaylin)
- Distance sensor on the descender
- Refine hook mechanism for ascend/descend
- Angle of collector
    - Too slow
    - Bad wheels
    - Cubes
    - Collect w/o entering crater
- Size of robot
- Team marker/claiming mechanism (Lauren)
- Finish dropoff

	● More autonomous 　○ Camera mount (Lauren) **[Liam]**
3. Engineering Notebook	(see below)

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Type and Cry**

- *What we did*
    - We got caught up on engineering notebook entries after the first league meet.
- *Why we did it*
    - We were incredibly behind on engineering notebook entries
- *What we Learned*
    - DON'T PROCRASTINATE
    - ENGINEERING NOTEBOOK IS VERY IMPORTANT

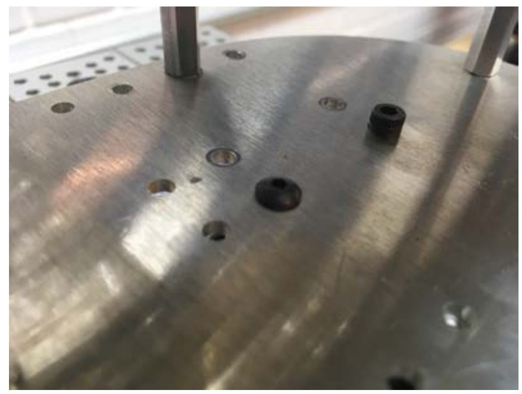
[Kaylin]

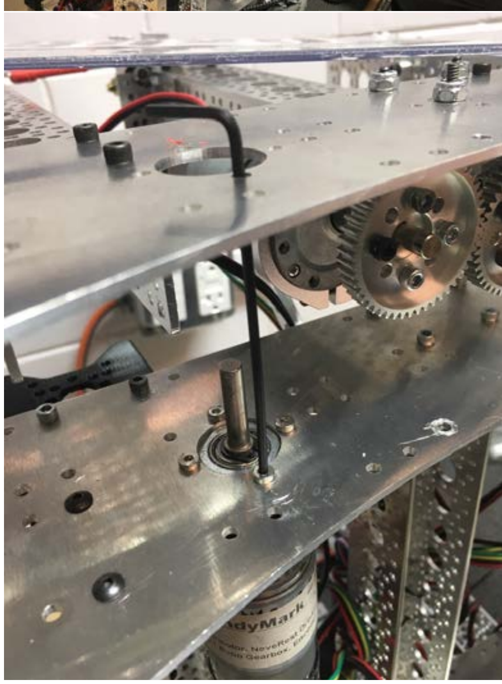
	November 16, 2018	6:00-9:00 PM
Contributors: Habtamu, Hannah, Kaylin, Katelyn, Lauren, Taylor		

Entries

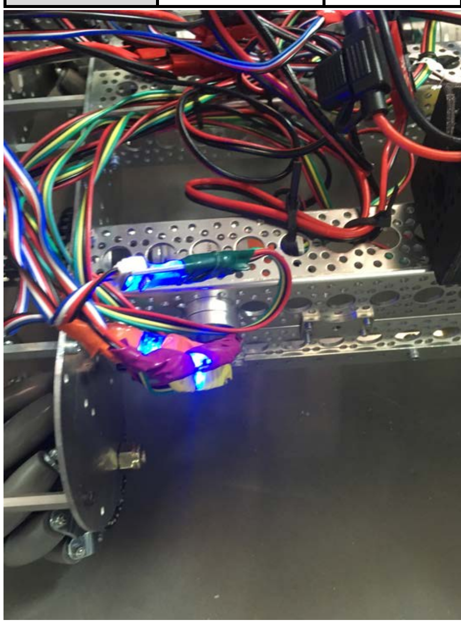
1. Maintaining drive train(s)

Identify	Brainstorm	Select	Prototype	Evaluate	Design	Fabricate





- *What we did*

	○ We made sure all the screws were tight on the motor mounts ○ We made sure all the screws were out of the way of the drivetrain ○ Changed one of the screws to a flathead ● *Why we did it* ○ We did this so the chains would not hit the screws and cause problems on the robot like at the first league meet. ○ We did this to make sure the motors do not fall off. **- [Kaylin]**
2. Cleaned up encoders	**Identify** | Brainstorm | Select | Prototype | Evaluate | Design | Fabricate  ● *What we did* ○ We used electrical tape to strain relief and color-code encoders ● *Why we did it* ○ We did this because we had the encoders in a 3D printed box, but the wires kept coming out ○ Identification **[Kaylin]**

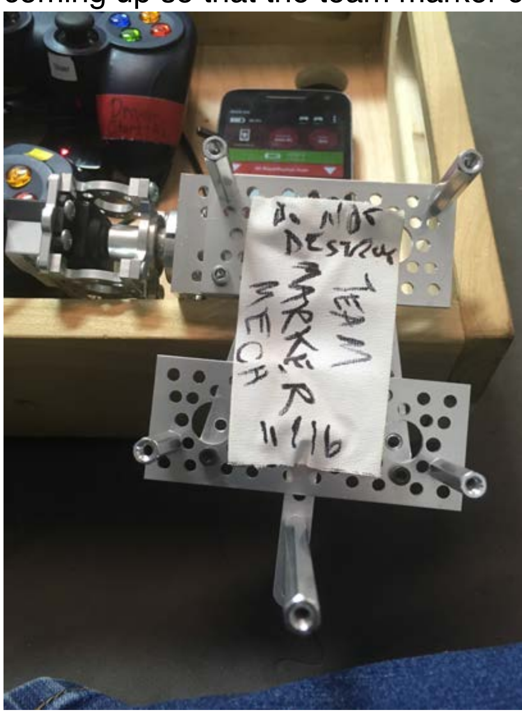
	November 18, 2018	4:00-6:00 PM
Contributors: Calvin, Hannah, Lauren, Liam, Logan, Taylor		

Entries

1. Team Marker Mechanism

Identify	Brainstorm	Select	**Prototype**	Evaluate	Design	Fabricate

Our team marker is going to be dropped from a small arm, with standoffs coming up so that the team marker can rest on its side before it is dropped.



Liam

2. Autonomous Sampling

Identify	Brainstorm	Select	Prototype	Evaluate	Design	Fabricate

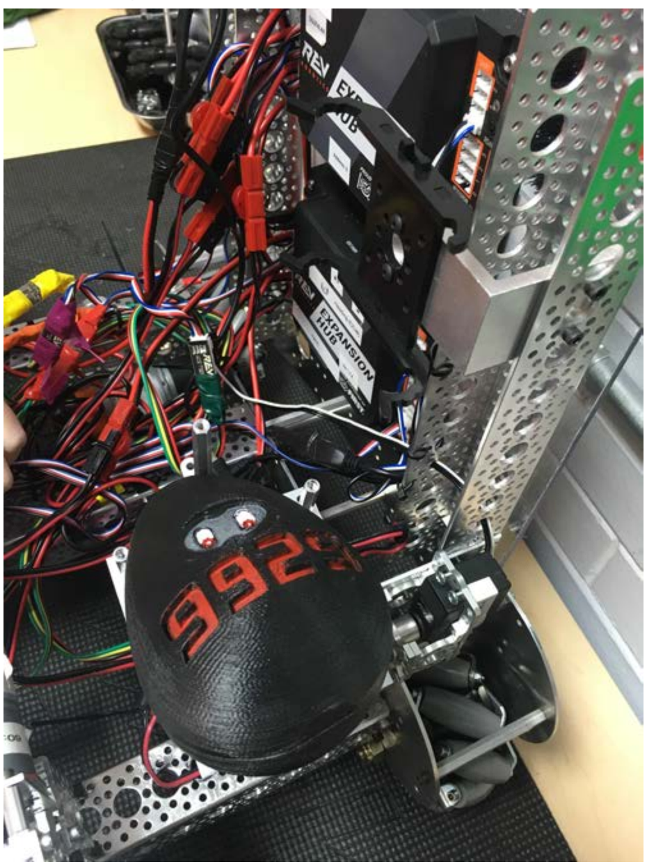
Today the programming team updated the ascending/descending code because at the last league meet it didn't work. During the league meet we had found that the robot, when it descended, would always not unlatch off the

	lander at all. We initially thought that the robot had drove to far forward towards the lander before driving off, and it was noted as such in the code shortly after the match. During testing though we noticed another issue. When using road-runner while strafing it would end on a zig-zag. Since roadrunner is a new library of code for us this year, we had some issues with strafing earlier on when setting it up. But looking at the code we noticed that it all seemed to be in order. That is when we began to wonder if something was wrong with one of the encoders. We looked at the logs and test with the motor tester program, sure enough one of the motor wasn't giving an encoder reading that changed the same way the other encoders did. After noticing this we went through the process of changing out the wire that connects to the encoder, the wire that connects to the motor, the wires that connect to the hub. We almost considered changing out the motor, until, one of us mentioned the level shifters. We had noticed that all of the new wires had had no effect on the movement and reading of the motor. We undid the case that the level shifter was in and connected the wires to a new level shifter. Lo and behold, the motor encoder worked. We then decided to, instead of placing the level shifter in the case, which was a difficult fix for a part that was so vital to reach if it broke, like it did during the league meet. We went back to a method we used last season that seemed to work, using colored electrical tape to hold together the wires and level shifter, as well as color code the wires. After we made this change, and a few slight tweaks to the code for distance values, we achieved multiple autonomous runs that were within an inch precision of each other (results pictured below). We did the testing above so that we could judge our distancing and keep

	 these for future reference when we make our autonomous do more. **Calvin, Lauren**

	November 24, 2018	2:00-4:00 PM
Contributors: Calvin, Hannah, Jeremy, Kaylin, Liam, Logan, Taylor		

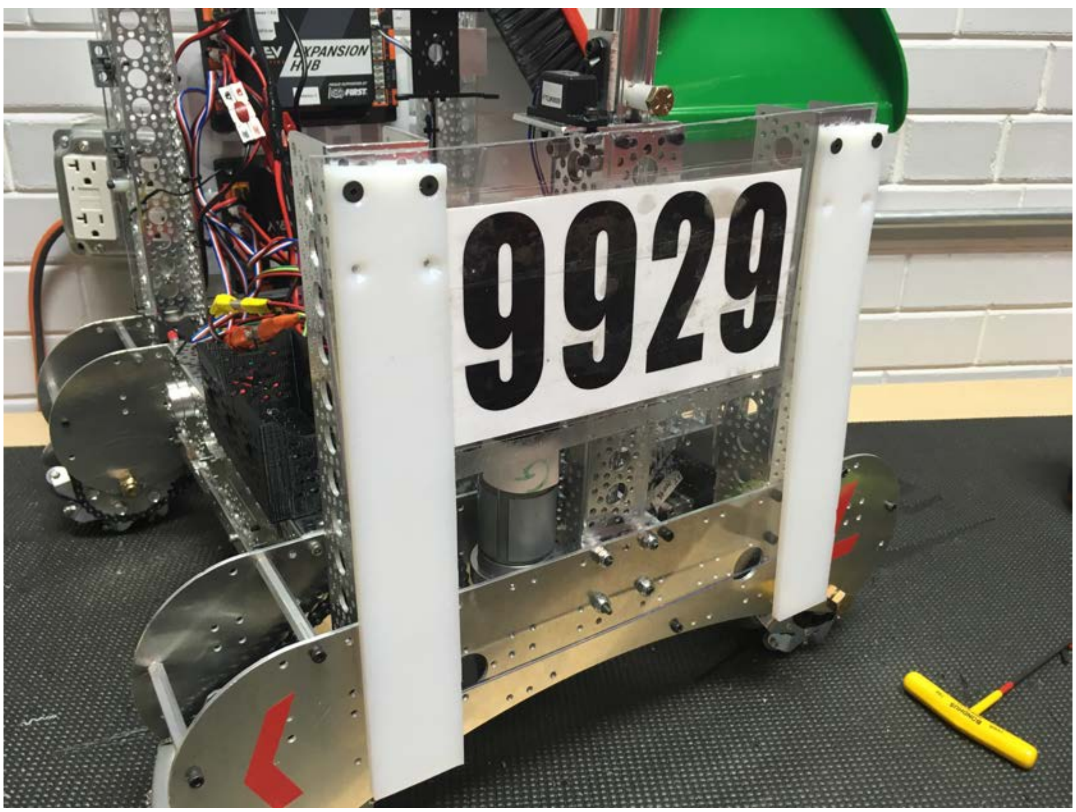
Entries

1. Mounting Team Marker Mechanism	**Identify** · Brainstorm · Select · Prototype · Evaluate · Design · Fabricate Since the team marker mechanism is mounted on a servo, we will mount it using the .770” Actobotics hole pattern found on ServoBlocks. We ended up using a plate attached to the channel on the side of our robot to attach the mechanism.  **Liam**
2. Fabricating Second Lift for	

<table>
<tr>
<td>Scoring Mechanism</td>
<td>Identify | Brainstorm | Select | Prototype | Evaluate | Design | Fabricate

Calvin and Mr Uecker started to complete second set of linear slides for scoring mechanism - then realized v-wheels need different mounting than as-built, ran out of time. Team needs to decide if we will have 2 sides on lift or not.
[Calvin]</td>
</tr>
<tr>
<td>3. Using UHMW Plastic for Sliding on Lander</td>
<td>Identify | Brainstorm | Select | Prototype | Evaluate | Design | Fabricate

Kaylin cut, drilled, mounted, and tested UHMW slides for ac/dc - including in autonomous - descending and unlatching is now much more consistent than wheels or Lexan on Lexan.



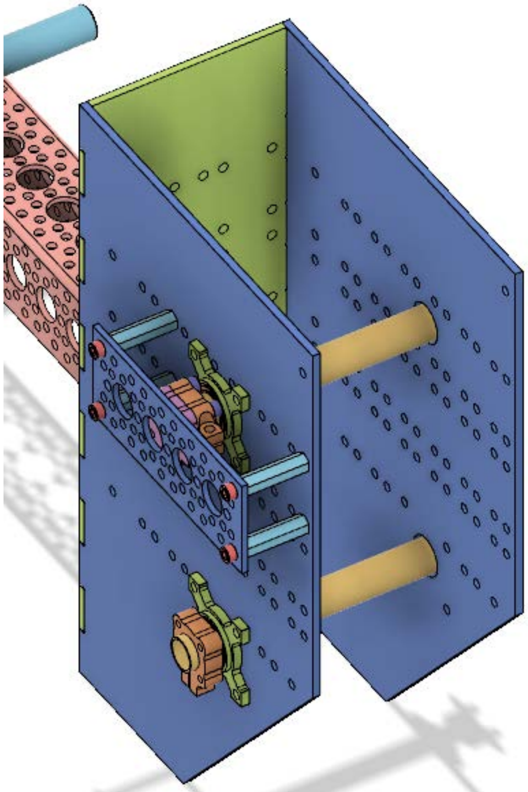
[Kaylin]</td>
</tr>
<tr>
<td>4. Replacing 40:1 lead screw motor with 20:1</td>
<td>Identify | Brainstorm | Select | Prototype | Evaluate | Design | Fabricate</td>
</tr>
</table>

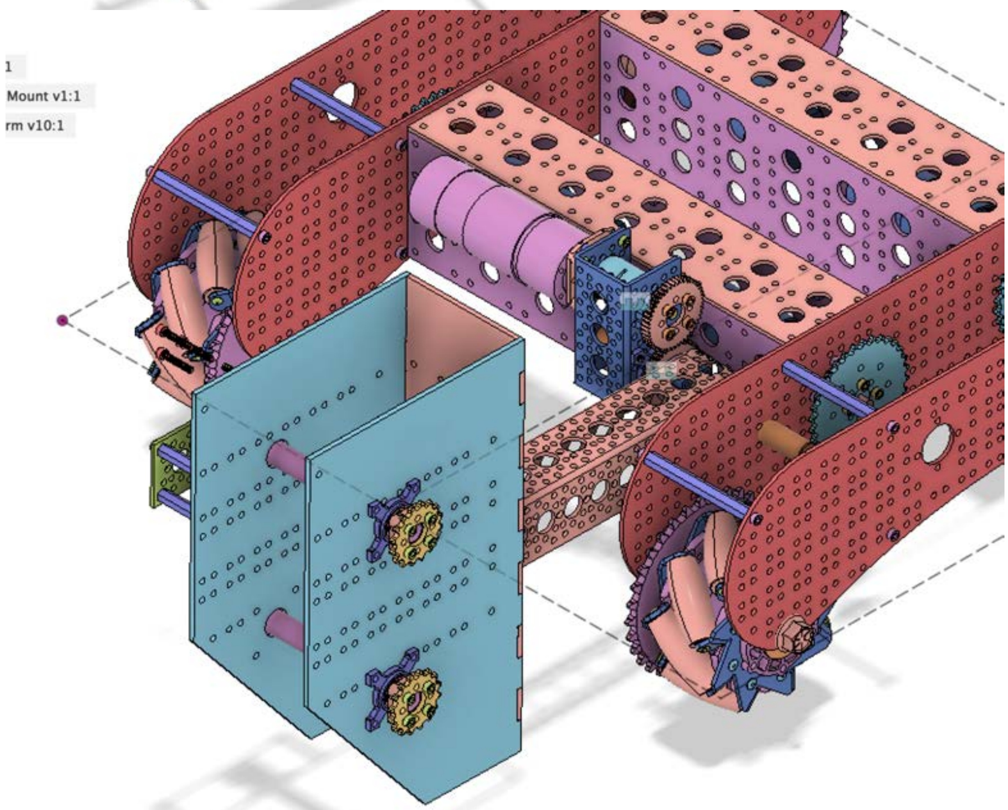
	Replaced nr40 with 20:1 in ac/dc and tested it with teleop - needs code changes for encoders - descent time is now approx 5 sec. Reminder to periodically double-check d-hub tightness. We need to keep in mind access/maintainability - we are running into issues reaching fasteners already **[Kaylin]**

	November 25, 2018	4:00-6:00 PM
Contributors: Calvin, Habtamu, Hannah, Jeremy, Katelyn, Kaylin, Liam, Logan, Taylor		

Entries

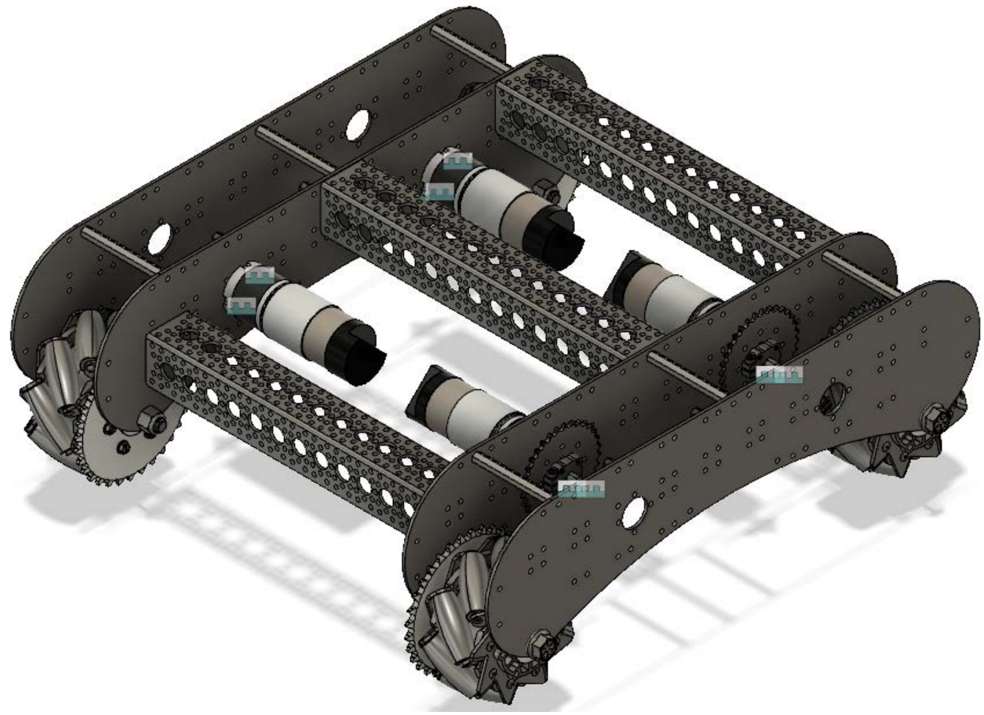
1. New Encoder Counts for Asc/Descender	Identify · Brainstorm · Select · Prototype · **Evaluate** · Design · **Fabricate** When the motor is wired reverse polarity to get correct travel it causes encoders to run in wrong direction. Multiple times testing over-drove and moved gear in lead screw. Really need upper limit switch. **[Lauren]**
2. Machining and assembling new collector	Identify · Brainstorm · Select · Prototype · Evaluate · Design · **Fabricate**





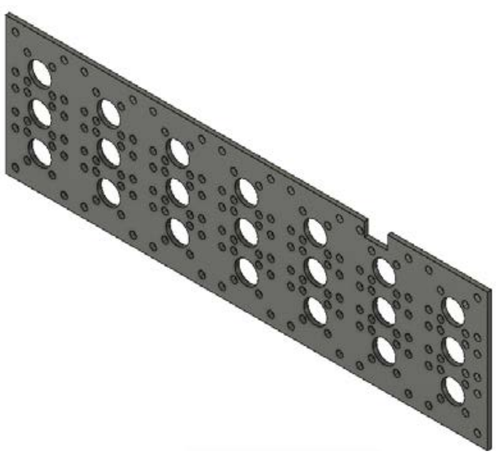
Over the break, we designed a new intake mechanism because of a few

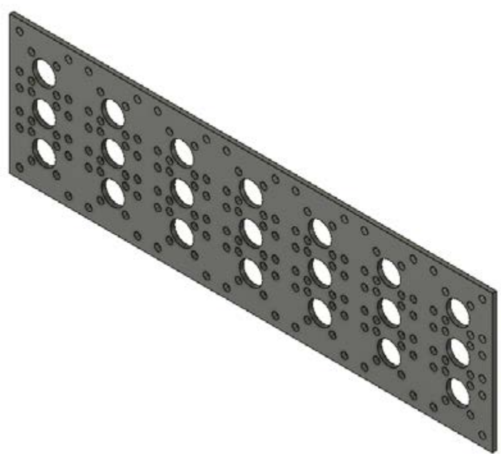
	reasons: • Old mechanism doesn't fit well onto the robot • Old mechanism is too slow • Old mechanism doesn't grab minerals very well. Our new design will have a few key differences: • Mounted on a long arm • Arm is connected to a motor, letting us use a minimal amount of horizontal space (Mechanism would start with the arm straight up, taking up mostly vertical space, which we have plenty of) • Instead of rubber band wheels, the new mechanism will have surgical tubing, attached to the ½" tubes in between the plates, that will act as "fingers" to do a better job of pulling in minerals • Vertical intake, meaning we can drop down onto some minerals to pick them up, rather than trying to find space inside the crater We will make this mechanism out of Lexan, a type of clear plastic, so that the judges can tell how many minerals we are controlling at any time, making us less likely to receive a penalty for having too many. All said and done, this is what we cut out with our CNC machine tonight: **[Liam]**
3. Machining new drive base parts	Identify | Brainstorm | Select | Prototype | Evaluate | Design | **Fabricate** Our current drive base has four side plates, two to each half, with the Actobotics 1.5" hole pattern imprinted on them, and three channels in between the two halves of the base.



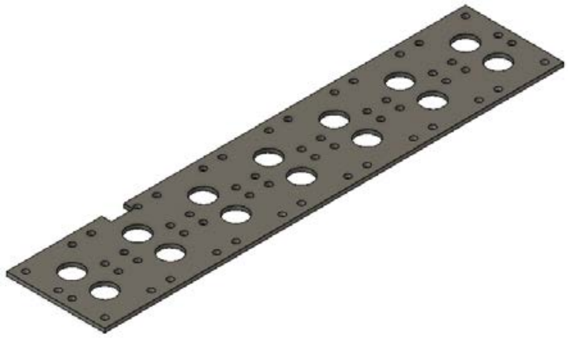
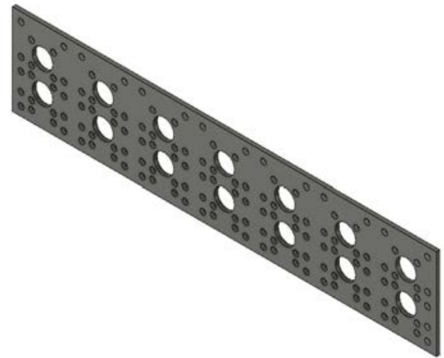
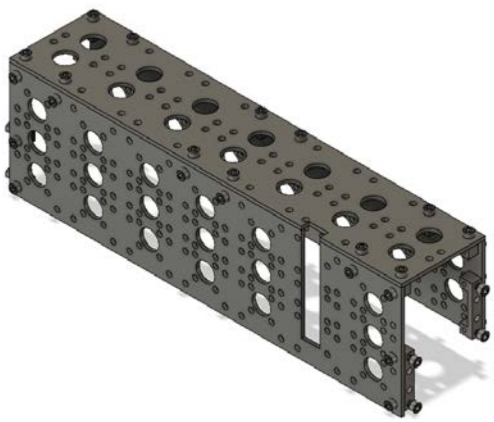
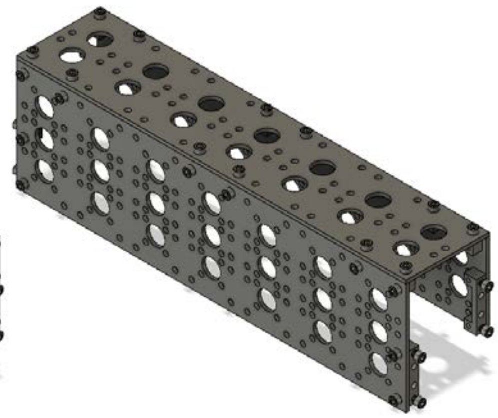
This is good and all, but we have a completely new intake mechanism to attach, and it's about time for some more flexibility in our designs.
The first thing we did was cut out new side plates. Our old ones didn't have enough holes in them for us to not have to cut out new ones every time we change something on the robot. To get around this problem, we cut out new plates with more holes. We used the same 1.5" hole pattern, except each set of it 0.75" apart from the last one, rather than 1.5" apart, how we had it on the old plate.

The second thing we had to do was to make new plates to run in between the new side plates as replacements for the current pieces of channel. They will be larger, so that we have more opportunities to attach things in the future. Here is what we came up with:





These are the front and back plates we will make. One of them has a notch on the top so that there will be room for our new intake mechanism, which has a motor and a gear bringing it to its up and down positions.The notch is there to make space for that gear.
We also made some top plates for further mounting:

<table>
<tr>
<td></td>
<td> 
One of them has a notch in its side to allow to have gears there, just like in the front and back plates.
Put together, these plates will look like this:
 
We will cut and assemble these next practice.
[Liam]</td>
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<tr>
<td>4. Installing attachment links into elevator drive chains</td>
<td><table><tr><td>Identify</td><td>Brainstorm</td><td>Select</td><td>Prototype</td><td>Evaluate</td><td>Design</td><td>Fabricate</td></tr></table></td>
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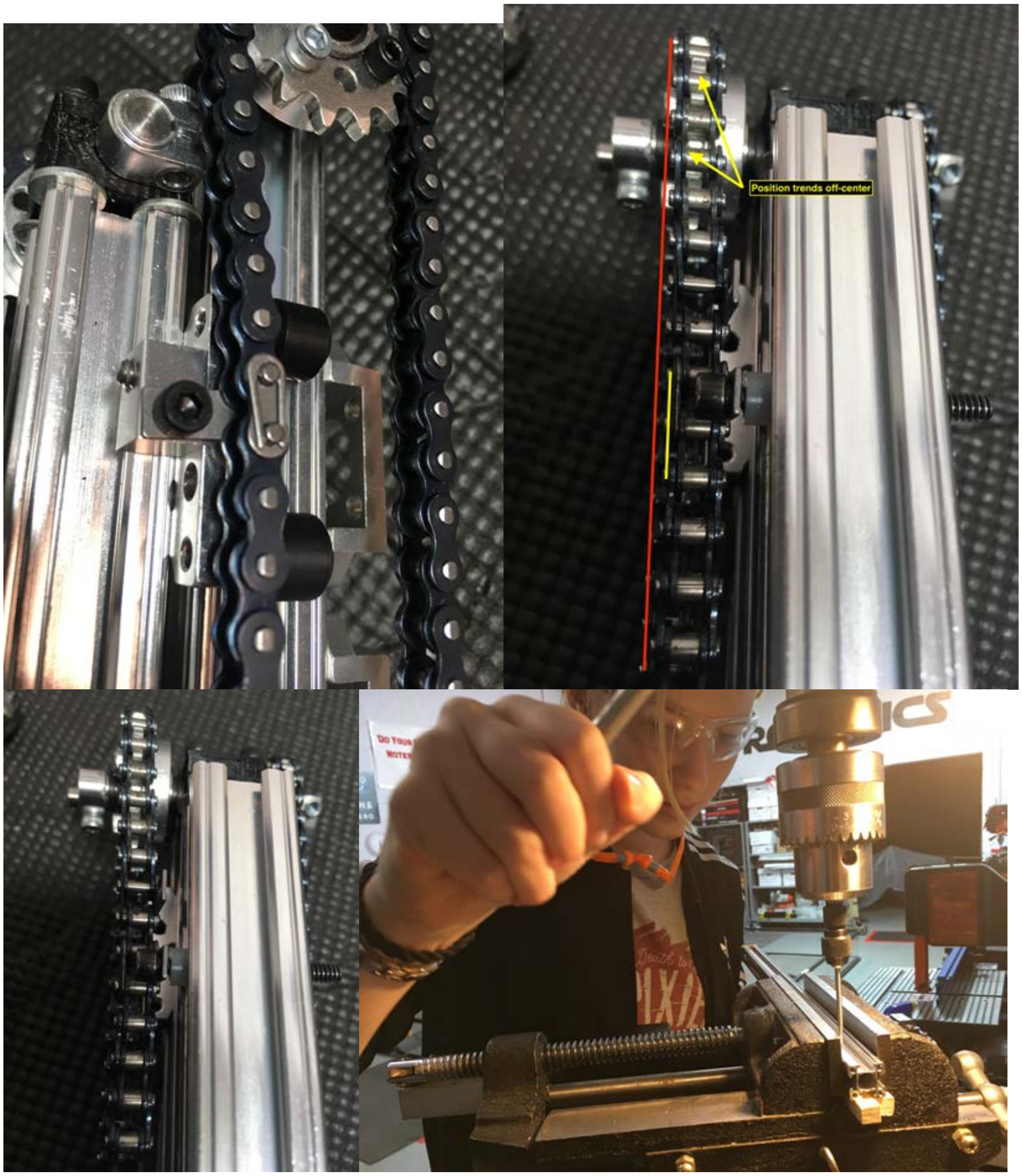


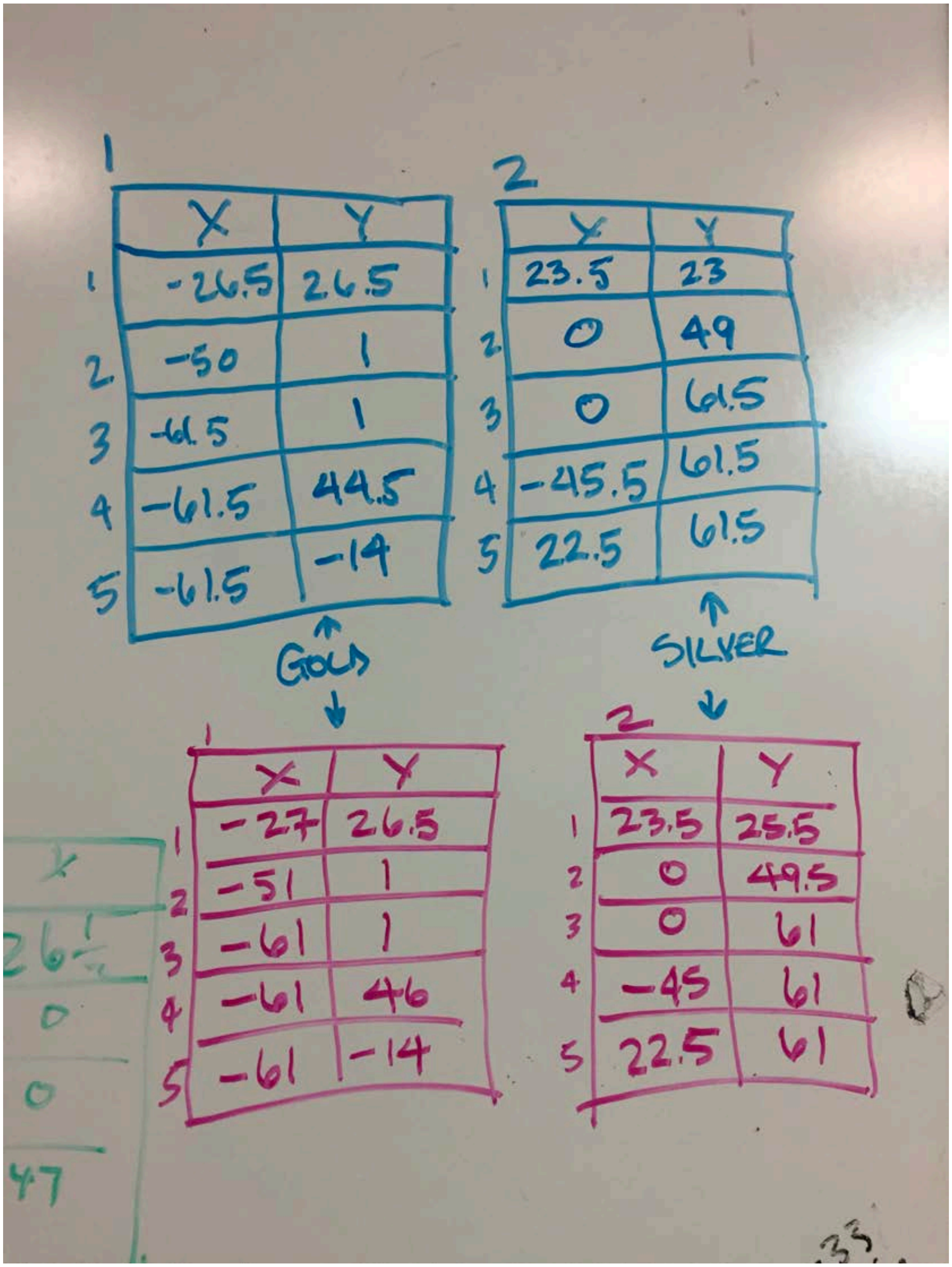
The pictures above show us attaching our chain to x-rail for our lift for the delivery mechanism. The top right picture shows that we need to add some spacers to one of our shafts with a sprocket because the chain doesn't quite line up with it.

[Liam]

5. Planning and Measuring Autonomous Routes

Identify	Brainstorm	Select	Prototype	Evaluate	**Design**	Fabricate

One of the things that we needed to do in order to score points in autonomous was programming the routes that we needed to take. In order to achieve this we first had to plan the routes and then measure out the whole routes that we had planned. While we already had a tool that we made to help us plan autonomous routes, we still needed to measure said routes. We did this using string and tape measurer.



[Calvin]

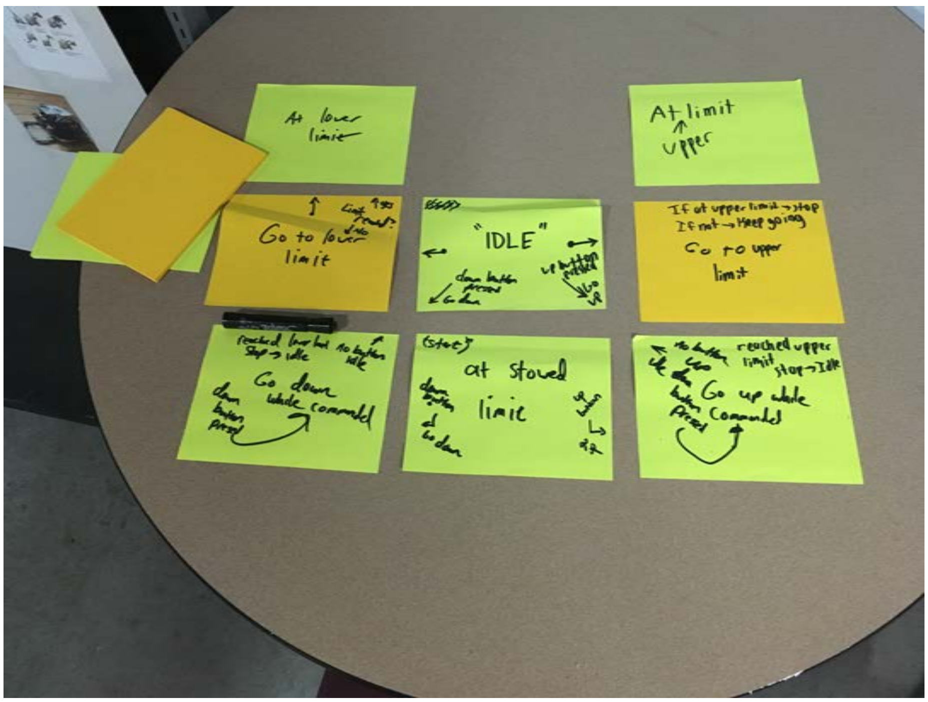
	NOVEMBER 30, 2018	6-9 PM

Contributors: Calvin, Ernest, Habtamu, Katelyn, Kaylin, Lauren, Liam, Logan

Entries

1. Elevator State machine

Identify	Brainstorm	Select	Prototype	Evaluate	**Design**	Fabricate



- Stow state
    - What it is: The original state of the elevator
    - Why we built it: We needed a starting point for our program
- Robot (closed loop) controlled states
    - What it is: States that control the elevator through a program
    - Why we built it: to make things easier on the operator
- Driver (open loop) controlled states
    - What it is : The states that makes us able to control the elevator with buttons

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Why we built it: to use where a human needs to do something
Upper and lower limits

What it is: The points where the elevator cannot go higher or lower
Why we built it: To stop the lift at key points automatically

Emergency stop

What it does: Automatically stops the elevator
Why we built it: in case of an emergency where the elevator is malfunctioning

[Calvin]
</td>
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<tr>
<td>2. Ascender descender debug</td>
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<table>
<tr><td>Identify</td><td>Brainstorm</td><td>Select</td><td>Prototype</td><td>Evaluate</td><td>Design</td><td>Fabricate</td></tr>
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debugged the ascender/descender--it was not ascending

What we did:

First we checked the activity log from today to see when the malfunction occurred, and what it was doing, so we could determine how the bug needed to be fixed.
We were unable to fully debug the issue.

Why we did it

We did this to fix the ascender/descender so it will ascend when autonomous starts.

[Lauren]
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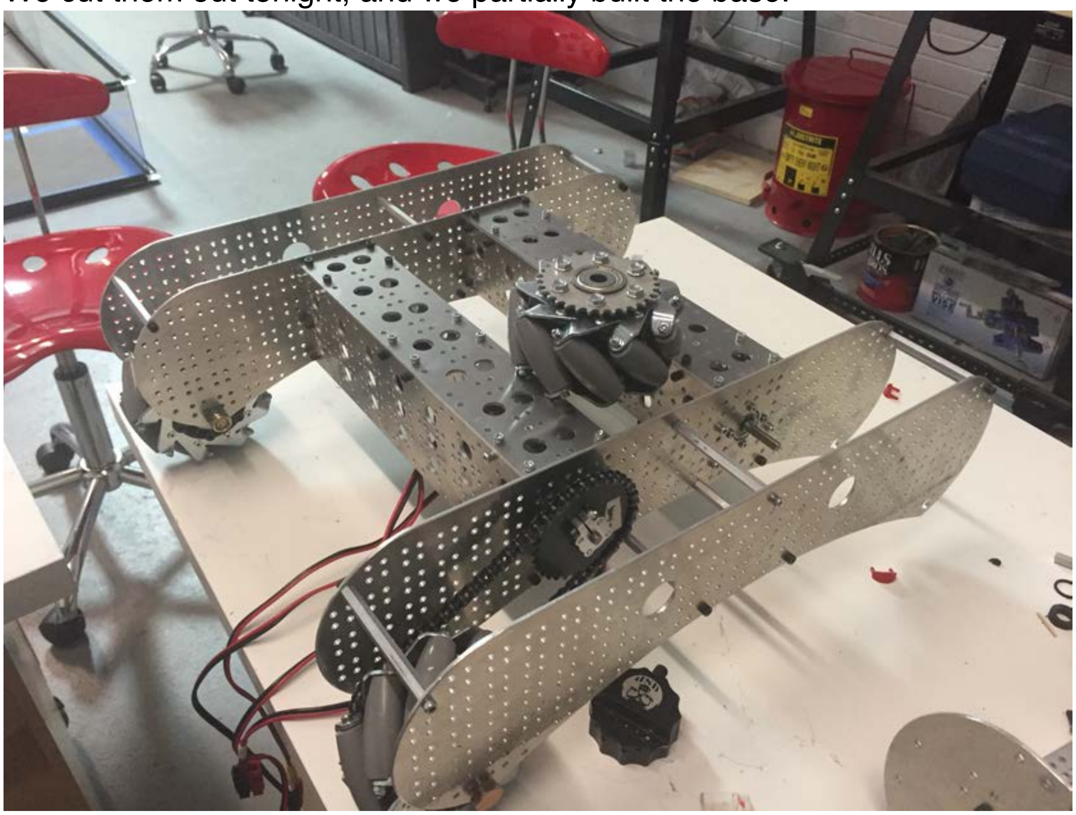
	December 1, 2018	**8-10:15 PM**
Contributors: Liam, Logan		

Entries

1. Assembling New Drive Base

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

Last practice, we made some CAD models for new plates for our drive base. We cut them out tonight, and we partially built the base.

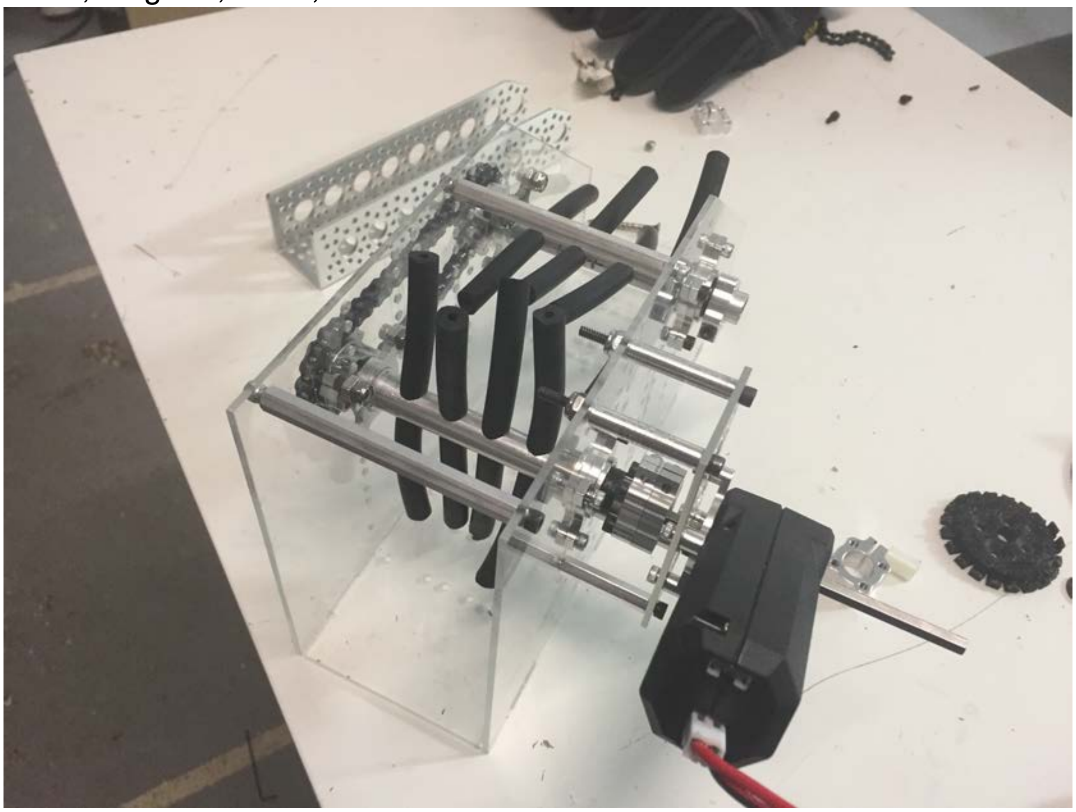


Next practice, we will put the last wheel on, get the chain finished, and attach all of our mechanisms.

[Liam]

2. Assembling New Intake Mechanism

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

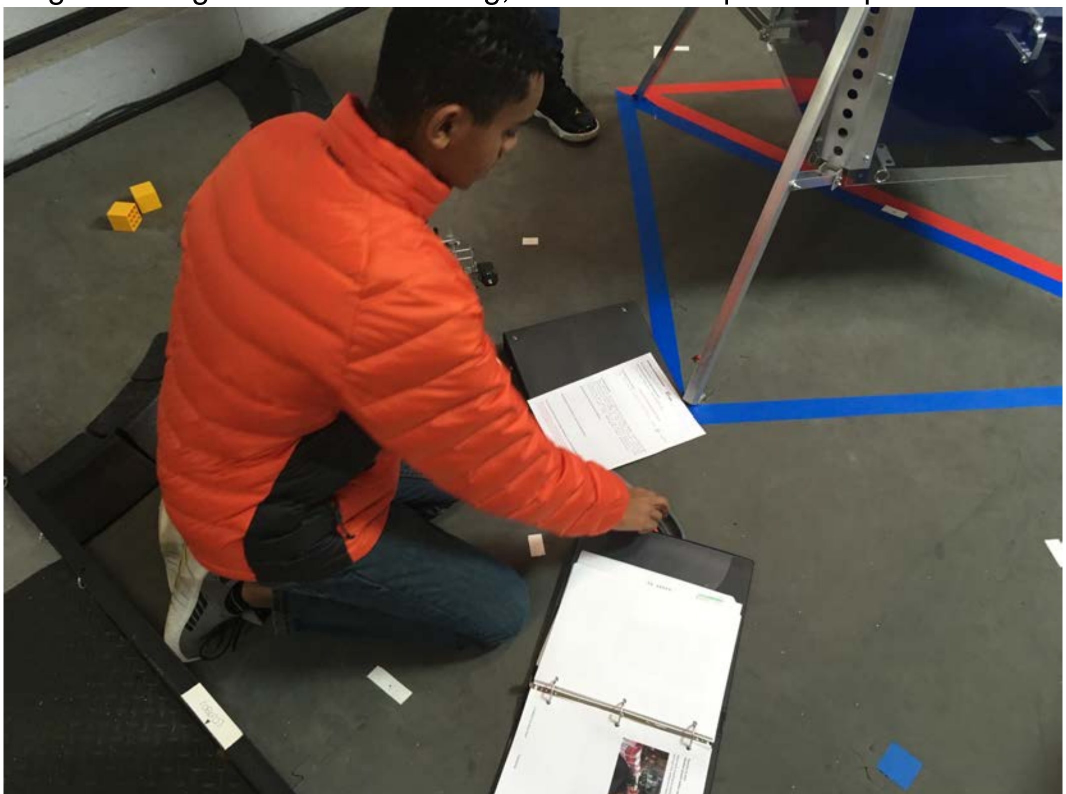
	Last practice, we machined some plates out of lexan for our new intake mechanism. Today, we put them together, attached pillow blocks, sprockets, tubes, “fingers”, chain, and a motor.  Next practice, we will attach this to an arm so that it can be flipped up and down. **[Liam]**

	December 2, 2018	4:00-6:00 AM/PM
Contributors: Katelyn, Logan, Lauren, Matthew, Habtamu, Ernest		

Entries	
1. Measurements for the distance and direction between the steps of the autonomous routes path	**Identify** | Brainstorm | Select | Prototype | Evaluate | Design | Fabricate What we did: We measured and recorded the distance(in inches) and the direction(forward, backward, left, right) and if it had to move clockwise or counterclockwise. Autonomous route #1(Blue) Step 1 to Step 2- move forward 34.5 inches Step 2 to Step 3- move clockwise 45°, then right 9.7 inches Step 3 to Step 4- move backward 45.4 inches Step 4 to Step 5- move forward 68.25 inches Note: This measurement was originally 59.5 inches, because the marker for step 5 for autonomous route #2(Blue) was further back than the step 5 marker for autonomous route #2(Blue). So this was remeasured. Autonomous route #2(Blue) Step 1 to Step 2- Move forward 33.5 inches Step 2 to Step 3- Move counterclockwise 45°, then right 11 inches. Step 3 to Step 4- Move forward 44.25 inches Step 4 to Step 5- Move backward 68.25 Why we did this: We did this because we need to program an autonomous route and we have a limited amount of time, and we can program an autonomous route if we have the relative distance, and to find the relative distance the distance between the steps needed to be found. **Katelyn**
2. Fixing New Intake Mechanism	Identify | Brainstorm | Select | Prototype | **Evaluate** | Design | **Fabricate**

Last practice, we made a new intake mechanism. We put it to the test today and ran into an issue.

The surgical tubing “fingers” that we used to grab the particles were not staying in place. This caused them to hit the bottom of the mechanism and each other, and the motor wasn’t able to operate at full power. We had a similar mechanism with a similar issue in the Velocity Vortex season, and the solution was in the engineering notebook from that season. By referencing this information, Habtamu and Matthew decided to add tape to where the surgical tubing meets the ½” tubing, in order to keep them in place.



	Habtamu and Matthew also noticed that the silver mineral occasionally stalls and will not go through the mechanism, and moves very slow because it spins rather than rolls. We added sandpaper (grip tape) that we used on last season's robot in the bottom of the collector. This makes the ball move faster. Cubes are slower, but they still move. The intake works much better now **[Liam]**

	December 9, 2018	4-6 PM

Contributors: Habtamu, Katelyn, Kaylin, Lauren, Liam, Logan, Taylor

Entries

1. Mineral Door

Identify	Brainstorm	Select	**Prototype**	Evaluate	Design	Fabricate

Our intake mechanism has nothing to keep the minerals inside of it after they are picked up. All we need is a wall that we can bring up and down to stop minerals from coming out when we don't want them to, while still allowing them to go through to the delivery mechanism when we're loading. We came up with a servo attached to the bottom of the intake mechanism via a ServoBlock, with a piece of Actobotics Plate attached to a horn on the servo. This way, the plate acts as a wall and the servo brings it up and down.

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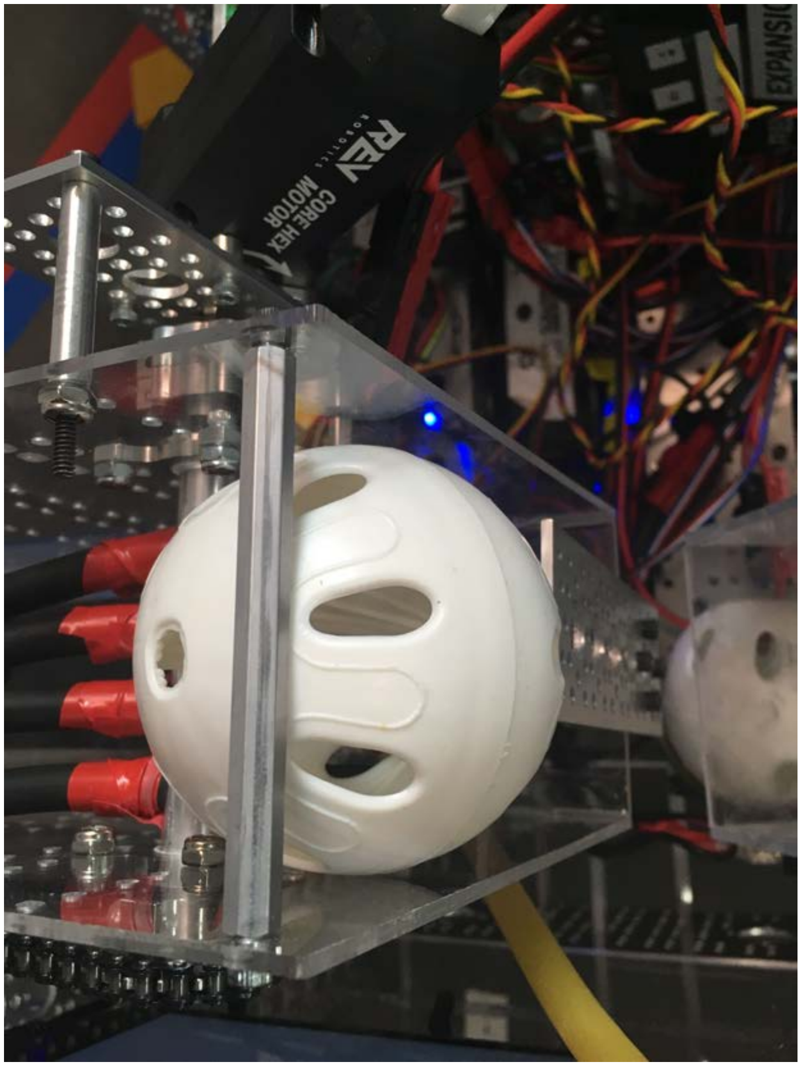

A problem we ran into is that because of this plate, when the minerals reach the end of the intake mechanism, they are pulled up too high and hit the standoff above, making them hard to control. The fix for this problem is to just have a longer piece of plate to keep the minerals in.
[Liam]
</td>
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<tr>
<td>2. Intake Mechanism Mounting</td>
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<tr><td>Identify</td><td>Brainstorm</td><td>Select</td><td>Prototype</td><td>Evaluate</td><td>Design</td><td>Fabricate</td></tr>
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As it turns out, the way we had the intake mechanism mounted wasn’t right. We had a hard stop to make it parallel with the ground at the lowest point. However, this wasn’t low enough to collect minerals reliably. All we had to do was to lower the hard stop enough for the intake mechanism to collect minerals reliably.

[Liam, Logan]
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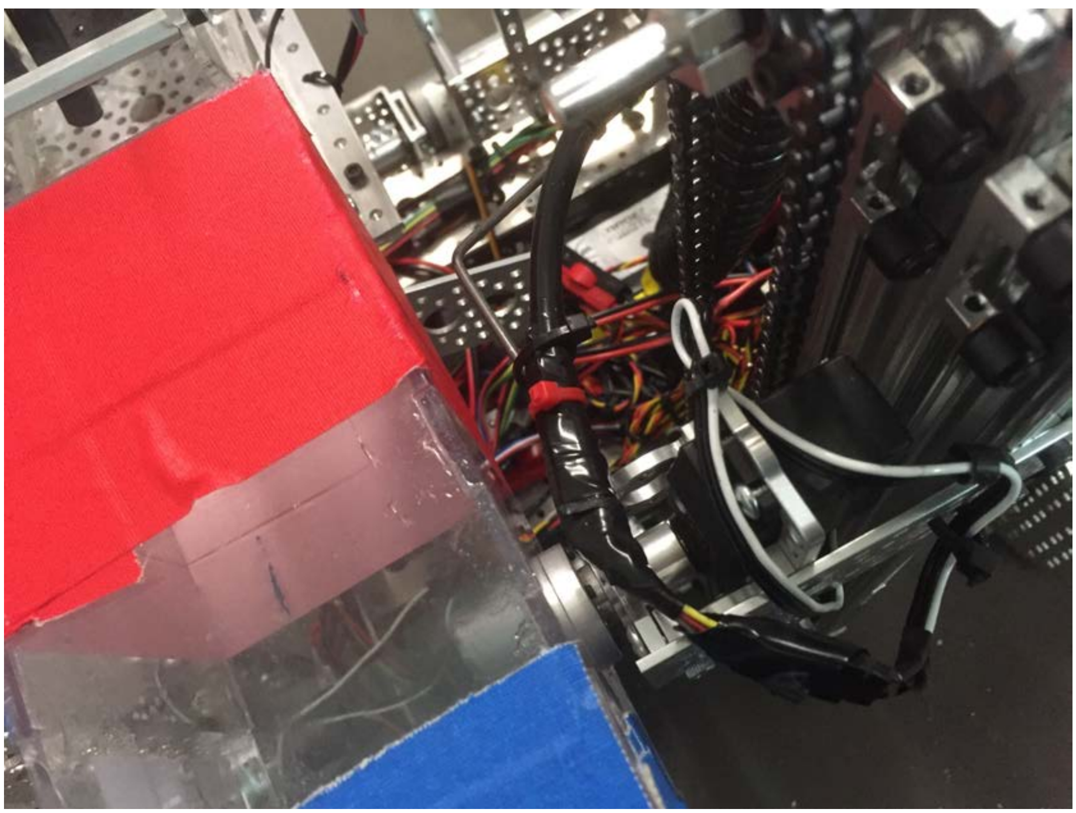
3. Phone Mount Problems	Identify / Brainstorm / Select / **Prototype** / Evaluate / Design / Fabricate The phone was falling out of the mount while we were driving the robot. That's a problem that we definitely cannot have because our intake mechanism is stored right next to where the phone is mounted. We fixed this problem with a few rubber bands. This is a temporary fix; we'll find a better way of mounting the phone in the future.  **[Liam]**
4. Fixing the lift chain	Identify / Brainstorm / Select / Prototype / Evaluate / Design / **Fabricate** One of the chains on the delivery mechanism's lift was too long, but not long enough to take out a full link. We had a few half-links handy, so we took two links out and added a half-link to the chain so that the delivery mechanism

	could run more reliably. It was really hard to get to the chain, and we learned that we have to take off the front plate in order to get to it. We most likely won't have any more problems with it, but it's good to be sure. **[Logan, Liam]**
5. Delivery Mechanism Flipper	Identify | Brainstorm | Select | Prototype | Evaluate | **Design** | **Fabricate** Our delivery mechanism, as it is currently, cannot score points. We can lift it up, but we are unable to make it face the right direction to dump into the crater. How it is now, there is an opening facing the intake mechanism, but no opening on the other end, so as to not drop minerals. This creates an obvious problem—dumping the minerals into the lander is currently impossible. To fix this, Liam and Coach Nelson drilled some holes in the sides of the current mechanism, allowing us to attach it to a servo. This servo was then attached to the lift mechanism, where we then set the angular limits on the servo, making life a little bit easier for the programming team.  **[Liam]**
6. Servo and Motor Wiring	Identify | Brainstorm | Select | Prototype | Evaluate | Design | **Fabricate**

	We have some new servos and motors on the robot that need to be wired up—a REV Core Hex Motor running the intake mechanism and two servos running the team marker and delivery mechanisms. We thought this would be easy enough, but we didn't have good, specific lengths for servo and motor wires, which were always either too long or too short. We eventually got around this problem, and we bundled and routed the wires with zip ties to the REV hub. **[Liam]**

	DECEMBER 15, 2018 (LEAGUE MEET #2)	7AM-2PM

Contributors: Caleb, Calvin, Ernest, Habtamu, Hannah, Katelyn, Kaylin, Lauren, Liam, Logan, Matthew

This entry was created by information collected during the league meet, and authored together as a team at our normal practice scheduled for the following day.

Entries

1. Autonomous Ran Into Wall

Identify	Brainstorm	Select	Prototype	Evaluate	Design	Fabricate

What Happened
During autonomous, the robot got caught on a seam in the wall, spun around and cracked the collector. (note, the collector did crack in this match, whether this is what caused it is now under dispute).

How did we fix it then?
We only fixed the collector. We attempted to fix it with an actobotics plate to span the crack, but we did not have tools that could reach the screws we needed to use so we used gaffer tape instead. This fix held for two matches. We may have been able to fix in the pits -- but we had a two match gap after the break, and a one match gap between our last two matches, so there was not time to disassemble further to gain access to the fasteners.

Why did it happen?

Autonomous purposely hugs the wall to keep from hitting the opposing alliance minerals for sampling to avoid a major penalty. This caused the robot to get hung up on the seam in the wall. Mr. Nelson and Mr. Beezie agree that the collector did not crack at this point. At some point later in the match, the collector cracked. Kaylin thought the arm was caught up and experience a force beyond the design loads.

Why did the collector experience the force? It's part of how our robot collects particles, driving within the crater.

Why did the force crack the collector? The collector is made of polycarbonate, a plastic, and it is at the end of an arm, which amplifies the forces.

How will we try to make it not happen again?

Replace bottom with more appropriate material, or re-design completely.

We didn’t have the correct tools we needed to fix this break -- they were back at the shop. We need a toolbox packing checklist.

We didn’t have tools on hand at all that could make this fix more quickly - these tools have been ordered.

We need to simulate probable breakages and determine whether design changes, or process changes, or different tools will help.

2. Loading Gate Servo Stuck

Identify	Brainstorm	Select	Prototype	Evaluate	Design	Fabricate

What Happened
During tele-op the loading servo was stuck, and we could not load particles for awhile

How did we fix it then?
This happened immediately before end game of our final match, so we did not attempt to fix it

Why did it happen?
We only observed this happen once, we have not been able to reproduce. Mr. Nelson could not observe it being stuck on something, but isn’t sure it wasn’t.

How will we try to make it not happen again?
Provide more clearance for the gate (if the new collector requires one)

More logging around operator controls

Feedback to the drive team about states of the robot

3. Dropped marker short, or just on tape	**Identify** | Brainstorm | Select | Prototype | Evaluate | Design | Fabricate **What Happened** During autonomous in two different matches, the robot placed the team marker either outside the depot (no score), or directly on the tape (scoring, but risky). **How did we fix it then?** We did not attempt to fix it at the time. The marker was deposited in a more secure position in the three other matches. **Why did it happen?** The drop off mechanism is located high in the robot, and tends to roll the team marker The drop off mechanism is on the far side of the depot **How will we try to make it not happen again?** Design a mechanism that drops the marker straight down. Move the mechanism closer to the wall side of the depot Drive further into the depot- this has consequences for dealing with alliance partners. Plan for unreliable autonomous from alliance partners.
4. Lost particle into robot when attempting to use "unsafe" to raise elevator fully	**Identify** | Brainstorm | Select | Prototype | Evaluate | Design | Fabricate **What Happened** During tele-op in one match, the operator needed more reach to score a particle. She used the unsafe switch and commanded the elevator up, which caused the scoring box to tip back to horizontal, losing the particle. **How did we fix it then?** We did not attempt to fix this issue. **Why did it happen?** This is an unanticipated bug. We didn't practice enough with the new mechanism to observe emergent

	behaviors of the software. **How will we try to make it not happen again?** Fix the bug. Practice more.
5. Mineral jammed in collector, when trying to clear, collector moved forward spilling a particle into the robot	**Identify** | Brainstorm | Select | Prototype | Evaluate | Design | Fabricate **What Happened** During tele-op in one match, the operator attempted to clear a particle that had jammed during loading with one particle already loaded in the scoring box. When the collector was operating, it moved forward (the code does this on purpose), and the already-loaded particle fell into the robot. **How did we fix it then?** The drive team agreed to always score the loaded particle first if the robot jammed during loading. The operator tested a process where commanding the collector to stow first, and then asking the collector to run in, would keep the collector in place during an un-jamming operation. This was pure luck, the software team did not account for this in the code (but we should not undo the priority of controls now!). **Why did it happen?** We didn't anticipate needing to run the collector inwards and not be collecting *or* loading. Our collector sometimes jams. **How will we try to make it not happen again?** We're redesigning either the current collector, or evolving it into something different. Software team needs to explore more of the state space - especially in "unsafe" modes. We need to add more sensor feedback on the mechanical positions of mechanisms in the robot.
6. Robot does not consistently park	**Identify** | Brainstorm | Select | Prototype | Evaluate | Design | Fabricate

“in” crater during autonomous	**What Happened** During autonomous - the robot does not consistently score by parking in the crater. **How did we fix it then?** We did not attempt to fix this issue. **Why did it happen?** The robot is moving slowly at the end of the path to the crater and does not have enough momentum to clear the crater rim We may have not had the problem we thought we did - scoring issues at the match had late scores coming in. Mr. Nelson says he saw corrected scores with our team receiving the score for the crater every time we reached it. **How will we try to make it not happen again?** We could make autonomous drive “like Taylor”- we might also consider if we don’t go for crater parking on opposing alliance side. We could make it more obvious with a mechanism breaking the plane.
7. Collector hits vertical channel during deployment	**Identify** | Brainstorm | Select | Prototype | Evaluate | Design | Fabricate **What Happened** During tele-op in many matches (especially as the meet progressed), the operator observed that the collector would strike the vertical C channel to the left of the collector. **How did we fix it then?** We did not attempt to fix this issue. **Why did it happen?** Geometry Vertical members are not staying vertical. **How will we try to make it not happen again?** Wait until we change the collector. Need to be aware during design of new

	collector.
8. We did not have spares for key robot mechanisms at the meet	| **Identify** | Brainstorm | Select | Prototype | Evaluate | Design | Fabricate | **What Happened** While packing for the meet, we did not remember to include Core Hex motors, or gears or sprockets. **How did we fix it then?** We did not attempt to fix this issue. **Why did it happen?** We weren't aware of what we needed for spares **How will we try to make it not happen again?** We need a checklist - priority for key mechanisms, this list needs to be kept up to date. Related to this, we need a similar checklist for tools.
9. While transporting gear to meet, toolbox fell over and landed on top of RC and DS phones	| **Identify** | Brainstorm | Select | Prototype | Evaluate | Design | Fabricate | **What Happened** When packing for the meet, the phones were left in their charging stands and placed on the floor of a van. The toolbox was stored next to the phones, oriented vertically. When going around a corner, the toolbox fell over and landed on top of the phones, bending one of the charging cords. Luckily our two primary phones were not damaged, and the spare phone had the microUSB jack moved but it was able to be moved back and seems to operate normally. **How did we fix it then?** We did not attempt to fix this issue. **Why did it happen?** We didn't anticipate the movement of items when packed. We didn't protect key components of the robot when traveling. **How will we try to make it not happen again?** An easy fix is that the phones are taken out of their charging stands, cables removed and laid flat in the battery box when traveling. A better fix would

	be to have a secure, padded case for the phones. This would also require us ensuring that the case and phones are on the packing checklist since it’s another thing to pack.

	December 21, 2018	6:00 - 9:00 PM

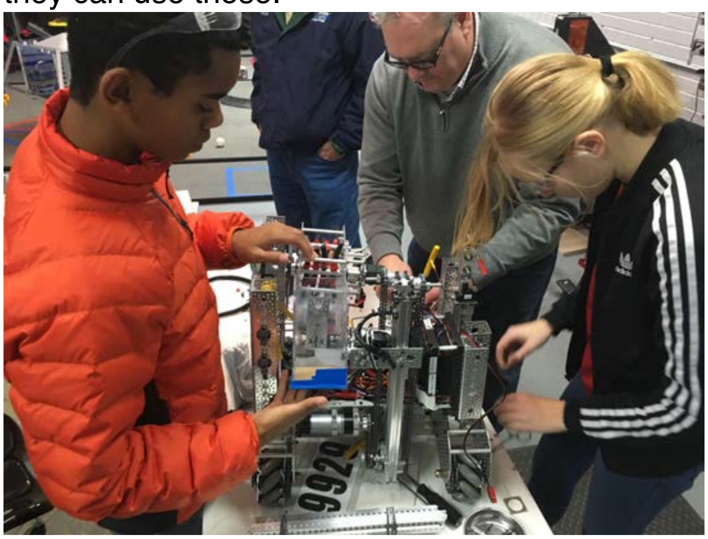
Contributors: Ernest, Habtamu, Hannah, Katelyn, Kaylin, Lauren, Liam, Logan

Entries

1. Limit Switches

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

Limit switches are really useful, especially for our purposes. They help keep motors from burning out by telling them whether or not they have gone far enough. We decided to mount some on the robot to make operation smoother and less likely to cause damage. We mounted one near the lead screw for our lift and two near the up and down positions of our collector mechanism. In case the programming team can't get encoders to work right, they can use these.



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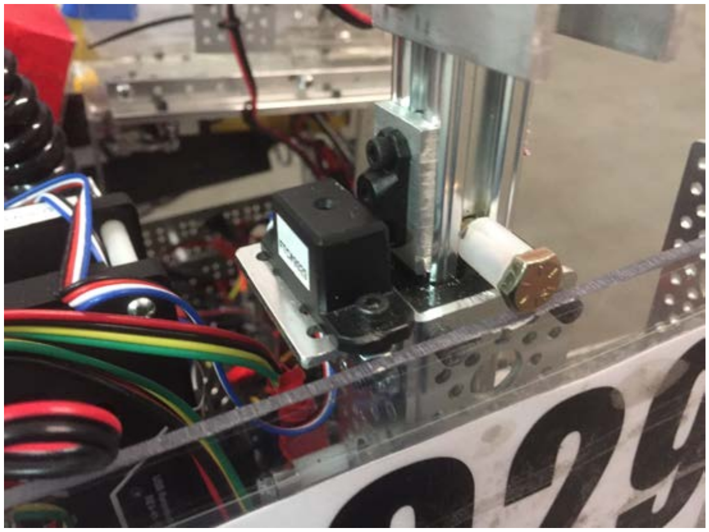
<tr><td></td><td>
[Liam]</td></tr>
<tr><td>2. New Phone Mount</td><td>
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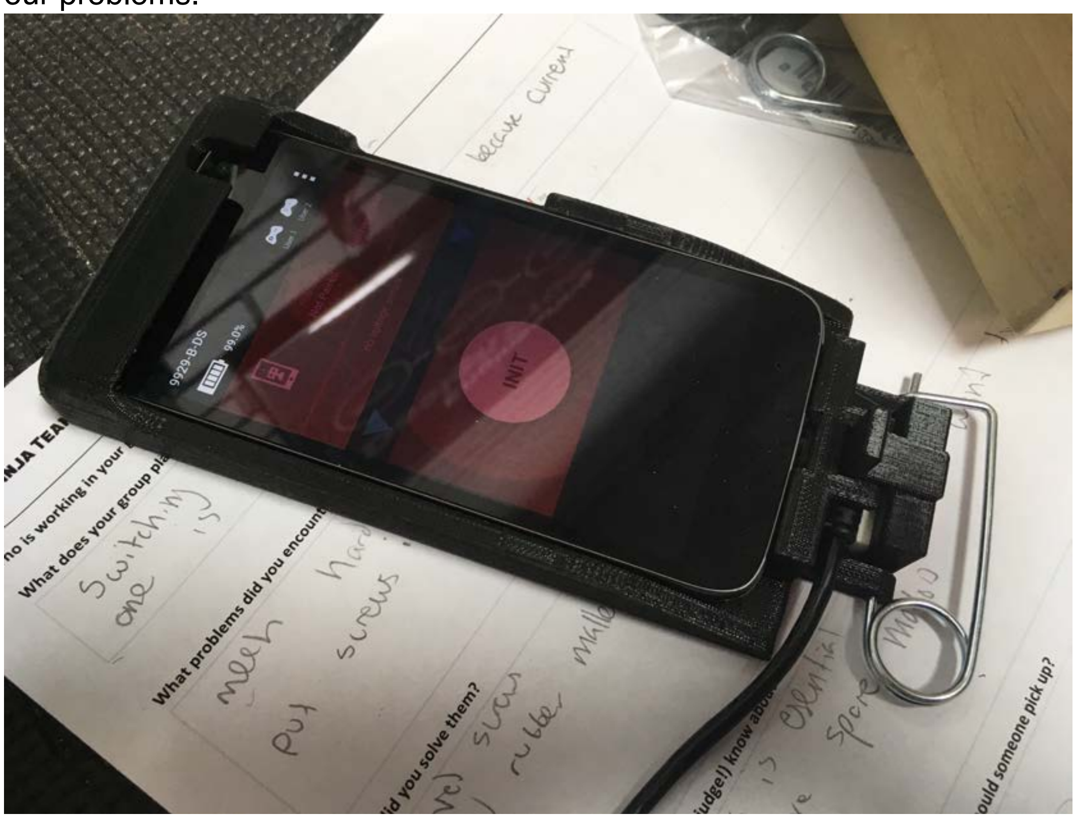
Our old phone mount wasn’t very reliable. The phone falls out consistently when we are driving. However, we found one on the internet that might solve our problems.


We 3D-printed this today and it’s much more reliable than our old phone mount. It holds the phone in place well, it has a hole in the back for the</td></tr>
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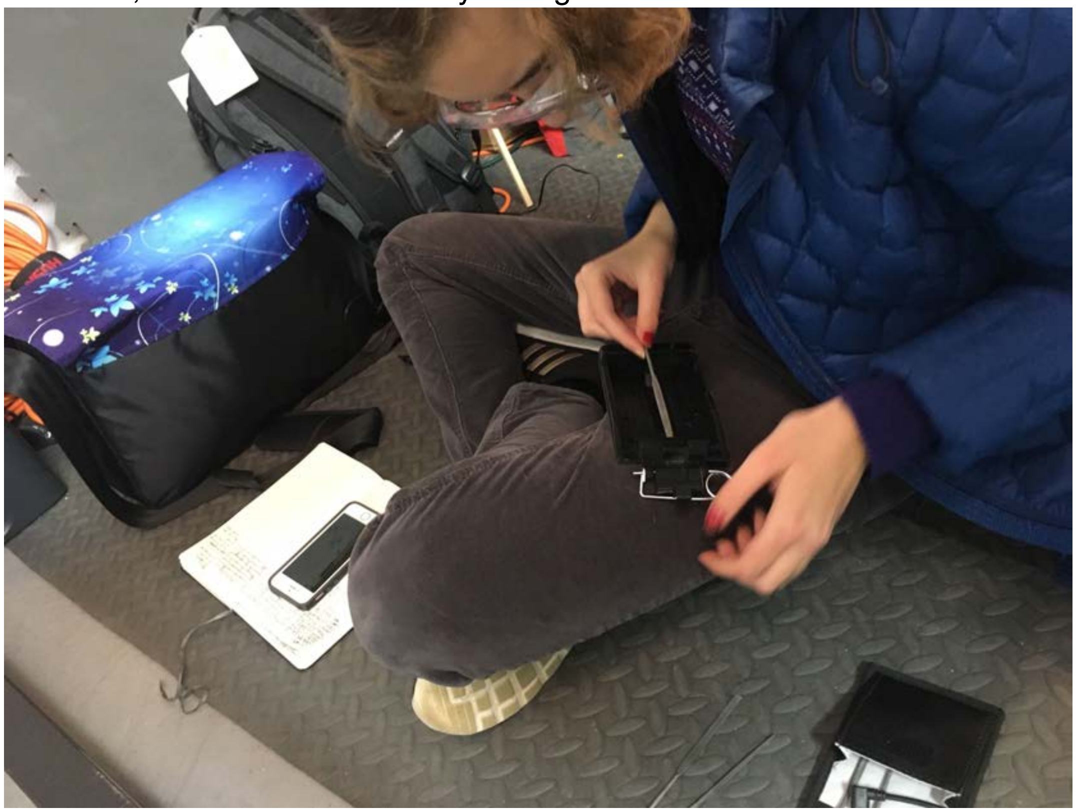
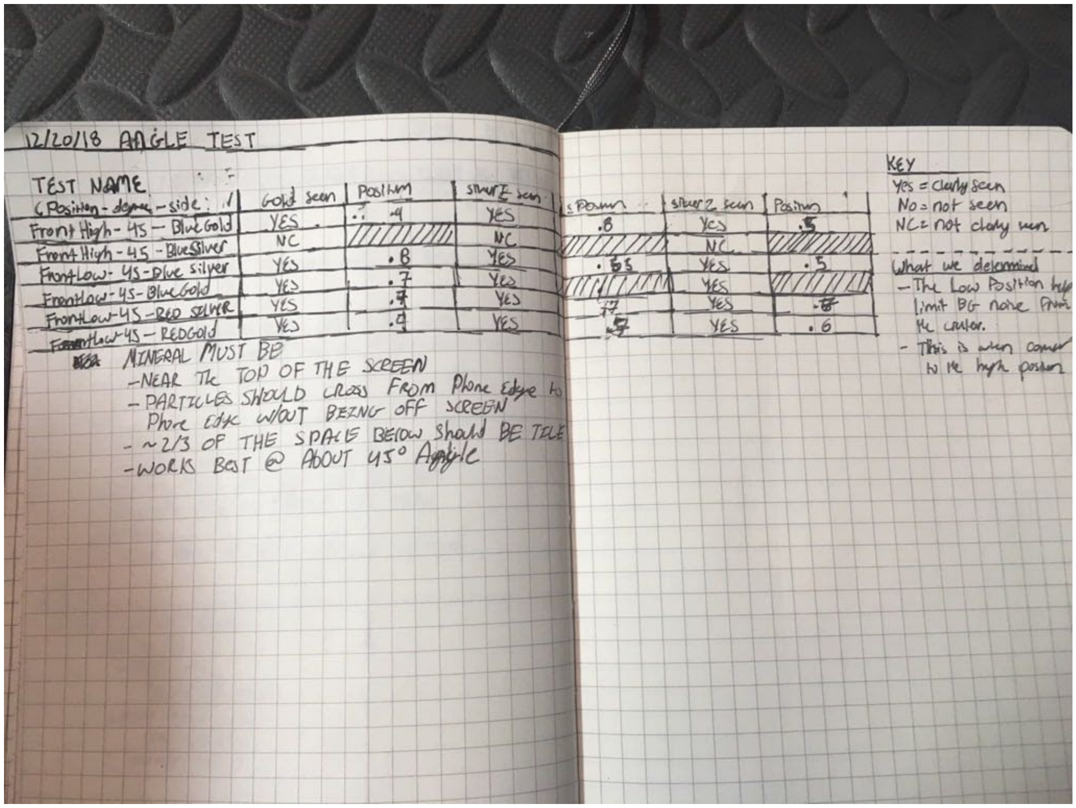
	camera, which we need during autonomous, it has a hole in the bottom for our cable, and it has a locking mechanism that holds the cable in place once it's plugged in. The only problem was that the hole for the cable was a little too small, but we fixed that easily enough with a file.  **[Liam]**
3. Testing Phone Position in Autonomous	Identify | Brainstorm | Select | Prototype | **Evaluate** | Design | Fabricate



We placed the robot controller phone in various positions and angles on the robot and measured how many minerals it could see from the latched position by running the tensor flow sample OpMode. We determined that the phone must be placed such that the row of sample minerals must be near the top of the screen (so that the robot does not detect minerals in the crater), the minerals should not be partial on the screen, and the bottom ⅔ of the screen should be playing field for best detection. It seemed that an angle of 45 degrees downwards worked best.

[Lauren]

4. Switching Lift Motor

Identify	Brainstorm	Select	Prototype	Evaluate	Design	Fabricate

The motor we were using for our lead screw lift mechanism isn't made anymore. That meant it was time for a replacement. We replaced the old motor with a NeveRest Orbital 20, a reliable motor that we've used in the past. This required some changes to the gears used at the bottom of the mechanism along with some shims because of a change in position of the motor shaft compared to the non-orbital motors.

[Liam]

	January 4, 2019	6:00 - 9:00 PM

Contributors: Calvin, Katelyn, Lauren

Entries

1. Moved *handleAscender* to hardware class

Identify	Brainstorm	Select	Prototype	**Evaluate**	**Design**	Fabricate

Today the programing team moved the ability to use the ascender/descender (handled Ascender) from teleop init to the hardware class code that for this season. We did this because we are using object oriented code. In our code we have a section that handles the code used in autonomous init, the code used in teleop init, and the code used in the hardware class. The hardware class typically contains code that deals with the hardware of different mechanisms.

Since object oriented programing allows traits to be inherited, traits in the auto section and the teleop section cannot be seen by the other as they are at a lower level then the hardware class code section.

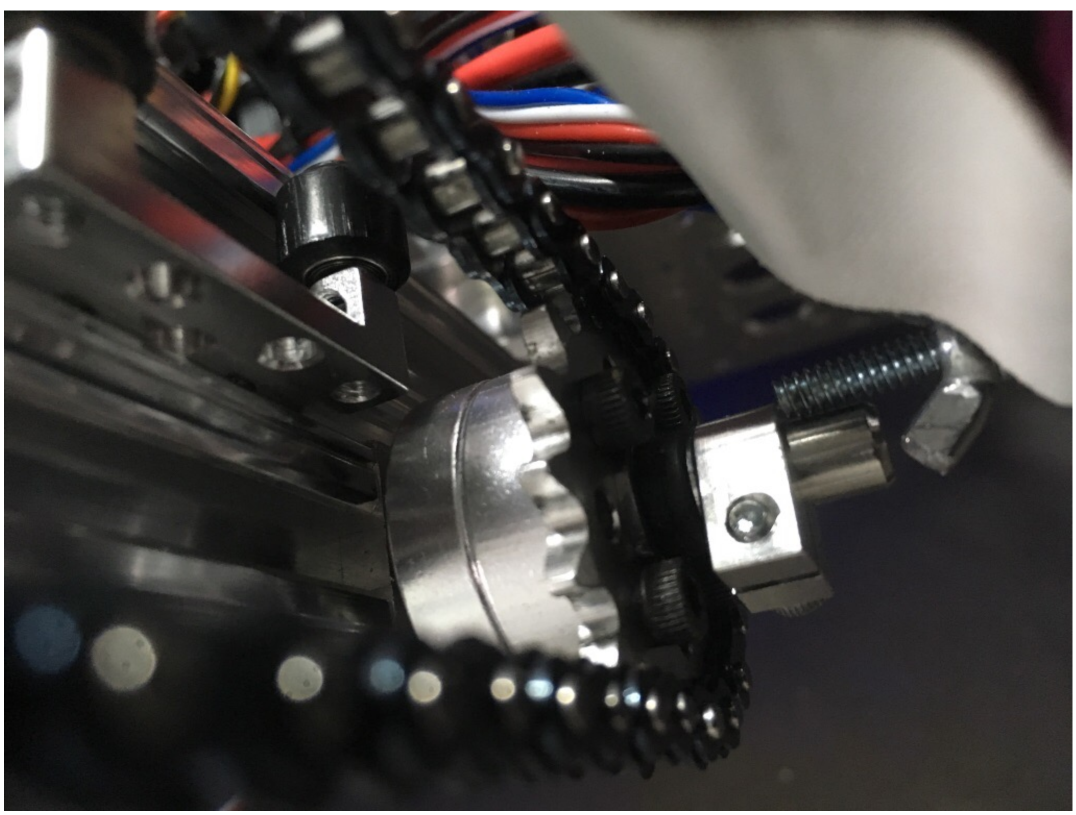
By moving the code to handle the ascender/descender from tele-op to the hardware class, this allows us to use the ascender/descender during the init process in autonomous. This helps us avoid the robot starting the match in the incorrect position.

After changing the code we tested the code of tele-op and autonomous to ensure the movement of this code did not cause any bugs or errors in the running of the robot. We tested both since the code would be inherited to both sections, thus both would have the opportunity of having errors due to this action.
[Entry Text] **- Lauren**

2. Moved Phone Mount

Identify	Brainstorm	Select	Prototype	**Evaluate**	Design	Fabricate

Today the members of the programing team moved the phone mount on the robot. The previous location on the robot was not usable for reading where the samples are on the field. We needed to move the phone to be able to

	read the samples from the lander. To do this we found we need to raise the mount and alter the angle of the mount. By making this change we are able to see 2 samples (left sample slot in reference to to the camera on the robot and center sample slot in reference to the camera on the robot) from the lander. We consider seeing two of the three a reasonable placement as we can discern the third through logic and the process of elimination. We decided that having a robot that was ready to use the code we plan to write for completing sampling during autonomous was needed before we could write the code. We decided this as the code would not be able to run properly without this proper placement. By ensuring proper placement we can better test the code later. Moved Phone Mount **- Lauren**
3. Flipped screw on lower corner of the hub	Identify | Brainstorm | Select | Prototype | **Evaluate** | Design | Fabricate  We also flipped the screw on the lower corner of the hub. This screw is used

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<td>to hold together the two hubs and attach them to the robot. We had to flip the lower screw around because the wing nut on the end was interfering with the lift due to clearance issues. By flipping it to match the direction of the screw above it, it allows for clearance for the lift that is used to deposit particles (typically referred to as elevator).

Flipped Screw on Lower Corner of the Hub - Lauren</td>
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<td>4. Measurements for Autonomous sampling</td>
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<tr><td>Identify</td><td>Brainstorm</td><td>Select</td><td>Prototype</td><td>Evaluate</td><td>Design</td><td>Fabricate</td></tr>
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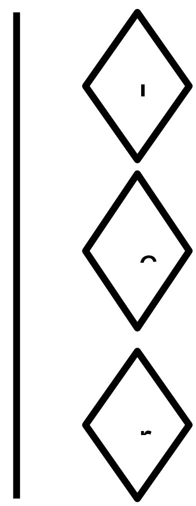

The Programing team measured the angles need to knock off a sample using the wheel of the robot. Using the shortest paths we identified that for the left (in regards to the camera when mounted to the robot on the lander) needs to move forward 4 ½ inches then turn 21 degrees clockwise. The center has to move forward 1 ¾ inches and turn 21 degrees counter clockwise. The rightmost position need to move backwards 12 ½ inches and then turn 21 degrees counter clockwise. These positions are still not set in stone as we are still unable to test them until they are placed into code. We plan to enter these values into the autonomous code and test them, then tweak them as needed.

Measurements for Autonomous sampling - Lauren
</td>
</tr>
</table>

	January 6, 2019	4:00 - 6:00 PM

Contributors: Calvin, Katelyn, Lauren

Entries

1. Safer Handling of Mineral Scoring Box

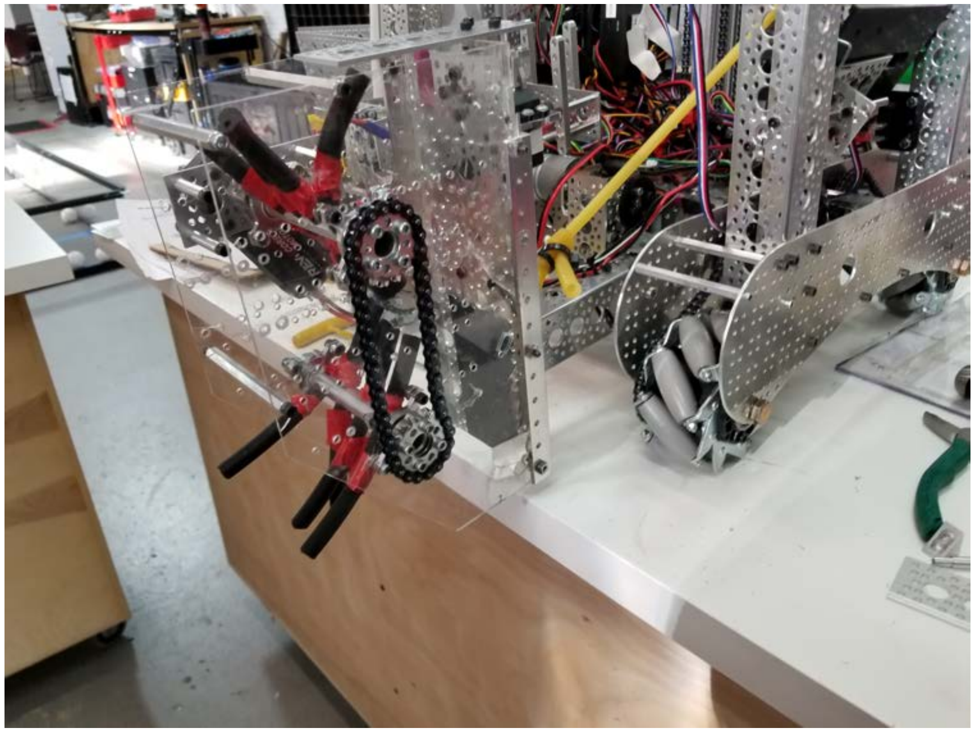
Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

Elevator State	Mineral Box Position
At upper limit	holding
At upper limit - score button pressed	scoring
Auto up	holding
Auto down	holding
Human up	holding
Human down	holding
At lower limit	holding
At lower limit <= 90 encoder	loading
Idle	holding
Idle <= 90 encoder	loading

Fixes item “4. Lost particle into robot when attempting to use “unsafe” to raise elevator fully” from 12/15 notebook entry, which was filed as issue # 27 on GitHub - but needs to be cleaned up to be more understandable (issue #23).

[Lauren]

2. Beginning of Sampling during Auto	Identify / Brainstorm / Select / Prototype / Evaluate / **Design** / Fabricate We started by bringing our VuForia code that runs on a different thread from last season, and bringing in the code from the TensorFlow example to see if it all worked. **[Lauren]**
3. Fixing intake Mechanism	Identify / Brainstorm / Select / Prototype / Evaluate / Design / **Fabricate** During our last meet, we broke the back plate on our intake mechanism. Today, we fixed that with a piece of Actobotics plate. 



[Liam]

	January 18, 2019	6:00 - 9:00 PM

Contributors: Calvin, Kaylin, Lauren, Liam, Logan

Entries

1. Changed code for mineral moving mechanism

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

Today we altered the mineral moving code to prepare for the new mineral mechanism. We did this to improve our scoring of minerals during autonomous. Changes we made to the code were adding states to operate the servo used in the new mechanism and wait stages to our autonomous state machine. We also added a sub-level in the state machine to complete movement to the wall after we move the minerals.

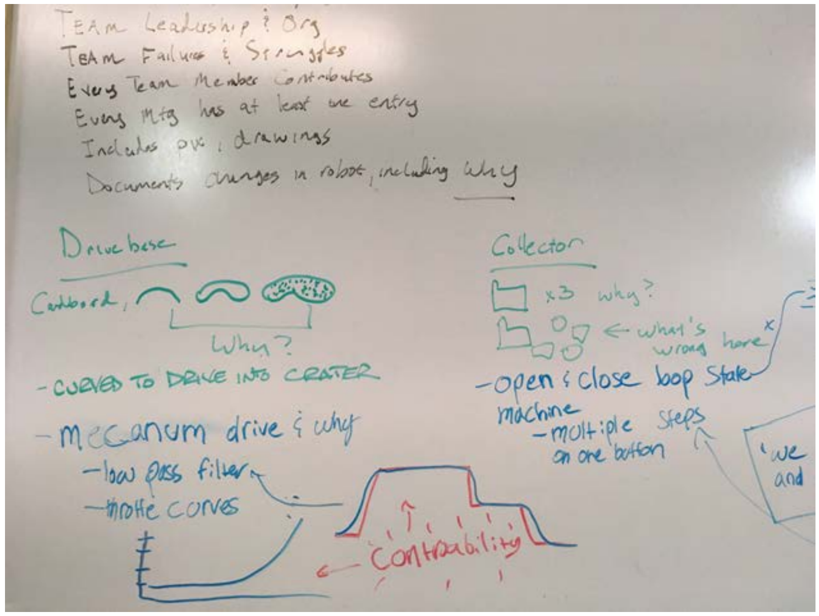
Lauren

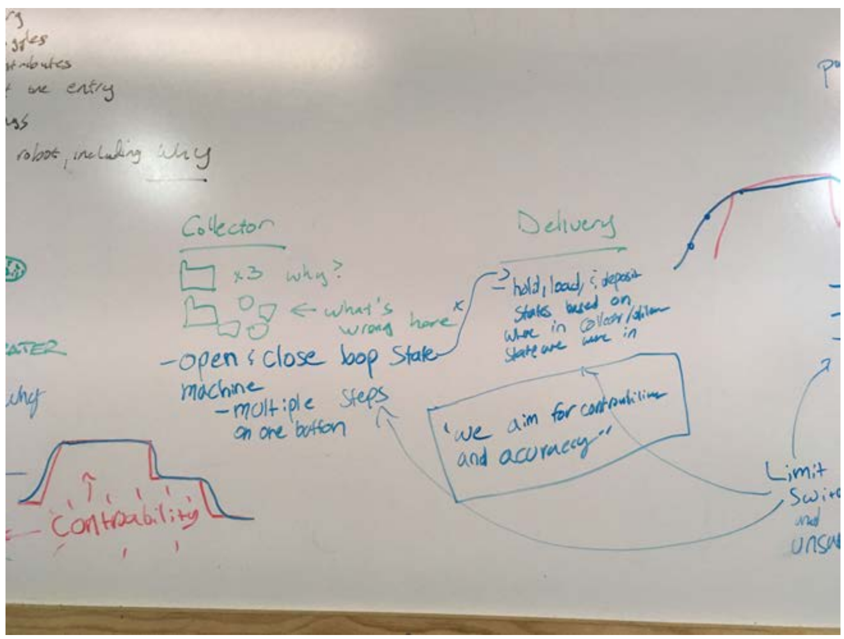
2. Strategy for presentation

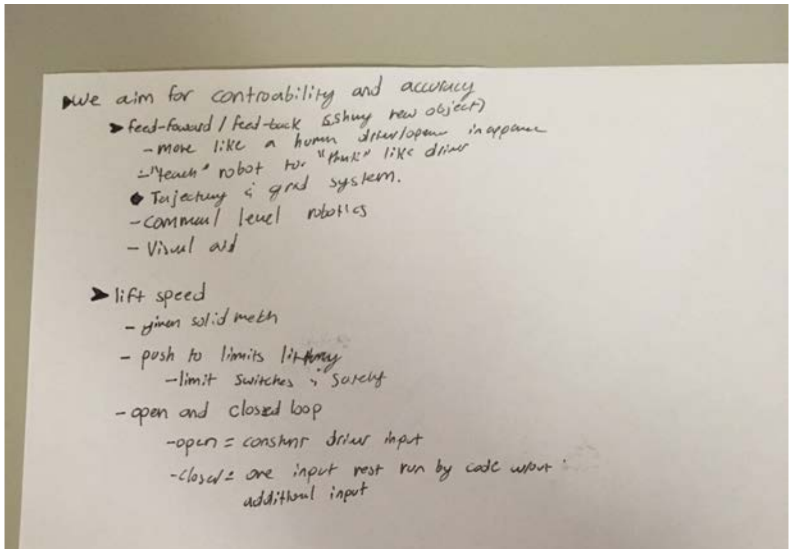
Identify	Brainstorm	Select	Prototype	Evaluate	**Design**	Fabricate

We discussed how the programing team was going to prepare how we would present our code. We came up with a strategy of focusing on the features of our code that fit under our feedforward/feedback system and our elevator state machine.

Here are some notes from the discussion:


Team Leadership & Org
Team Failures & Struggles
Every Team Member Contributes
Every Mtg has at least one entry
Includes pic, drawings
Documents changes in robot, including why
Drivebase
Why?
- CURVED TO DRIVE INTO CRATER
- mecanum drive & why
- low pass filter
- throttle curves
Collector
x3 why?
← what's wrong here
- open & close loop State machine
- multiple steps on one button


Collector
x3 why?
← what's wrong here
- open & close loop State machine
- multiple steps on one button
Delivery
- hold, load, & deposit
"we aim for controllability and accuracy"
Limit

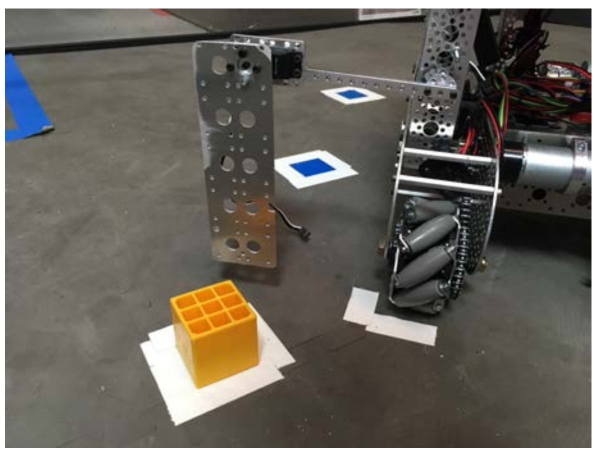


We aim for controability and accuracy
- feed-forward / feed-back (showing new object)
  - more like a human driver/operator in appearance
  - "teach" robot to "think" like driver
- Trajectory & grid system.
  - command level robotics
  - Visual aid
- lift speed
  - given solid meth
  - push to limits lifting
    - limit switches & safety
  - open and closed loop
    - open = constant driver input
    - closed = one input rest run by code without additional input

Lauren

3. Mineral Mover Mechanism - Two Servos

Identify	Brainstorm	Select	Prototype	Evaluate	**Design**	**Fabricate**



	 Our mineral sampling in last meet was less than ideal, so we’re going to try something other than running into the minerals. We decided on a servo with an arm attached to that, and another servo, attached to that arm, with another arm attached to it. The idea is to extend out and down and then knock whatever mineral we need to knock out of the way. **[Liam]**

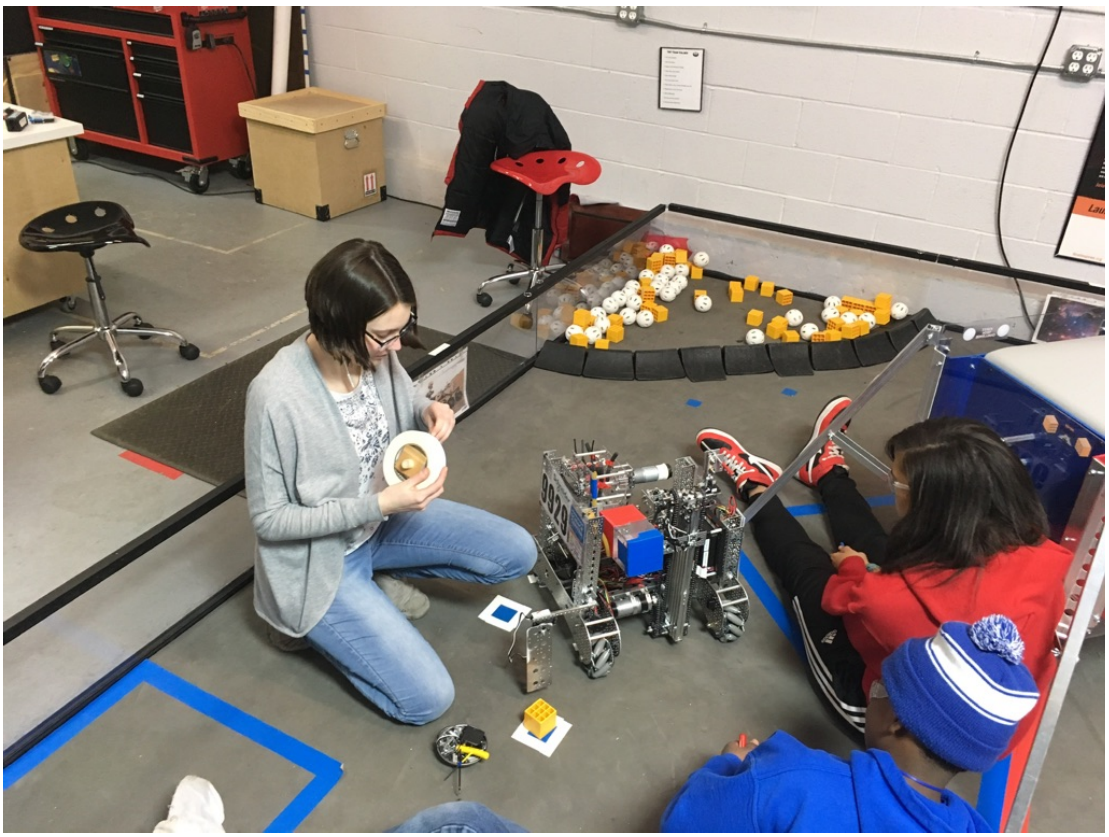
	JANUARY 20, 2019	4:00 - 6:00 PM

Contributors: Calvin, Hannah, Kaylin, Katelyn, Lauren

Entries

1. Measuring existing autonomous position at minerals, adjusting for new mechanism

Identify	Brainstorm	Select	Prototype	Evaluate	**Design**	Fabricate



To make our autonomous code work with the new mineral mover, we needed to find the difference between where the robot gets to with the old autonomous, and where we wanted it to be positioned to use the new mechanism. We placed minerals with an "error" zone around them, ran our existing autonomous and marked the position of the robot over many trials with the minerals in their varied positions.

One issue we found, is that we were using red tape to mark the robot positions, and TensorFlow started to detect these tape marks as gold minerals. We had to switch to using chalk marks that TensorFlow could not see to mark the position of the robot.

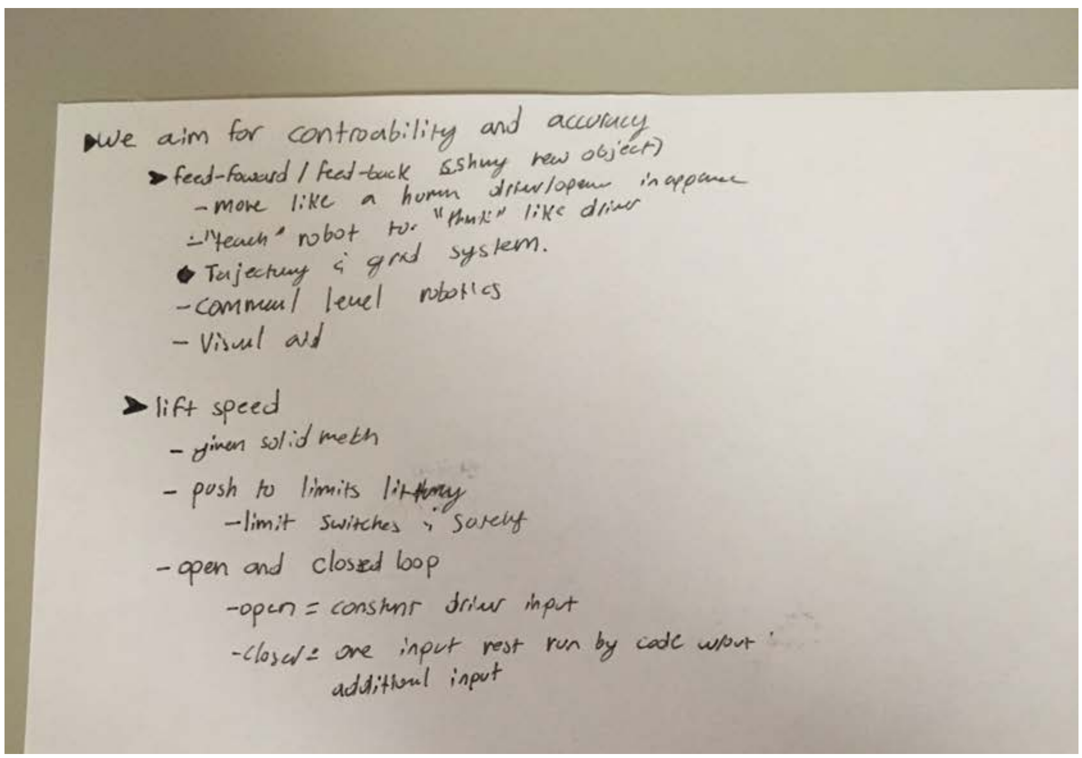
Lauren

2. Strategy for presentation / engineering notebook overview section

Identify	Brainstorm	Select	Prototype	Evaluate	**Design**	Fabricate

We discussed how the programing team was going to prepare how we would present our code. We came up with a strategy of focusing on the features of our code that fit under our feedforward/feedback system and our elevator state machine.

Here are some notes from the discussion:

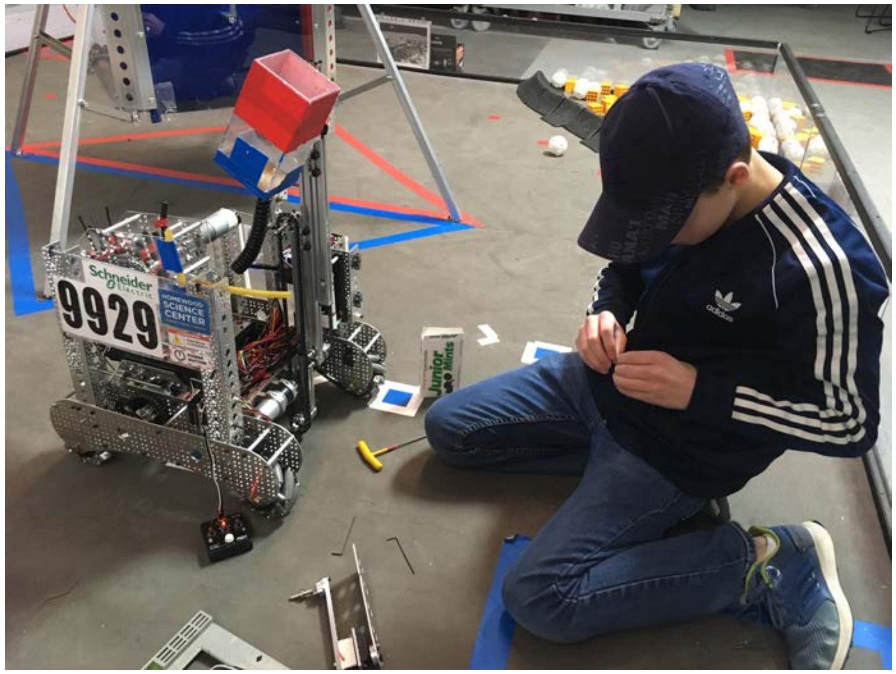


Kaylin

3. Programming, Adjusting Servos for Mineral Mover

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

Our sampling in autonomous is going to use an arm on the side of the robot,

	which is operated by two servos, which had not been configured at the beginning of practice. We reset the angular limits, and then set them to the hard stops parallel and perpendicular to the ground for the first part of the arm, and the second part of the arm just had to stay perpendicular to the ground at all times.  **[Liam]**

	January 24, 2019	7:00-9:15 PM

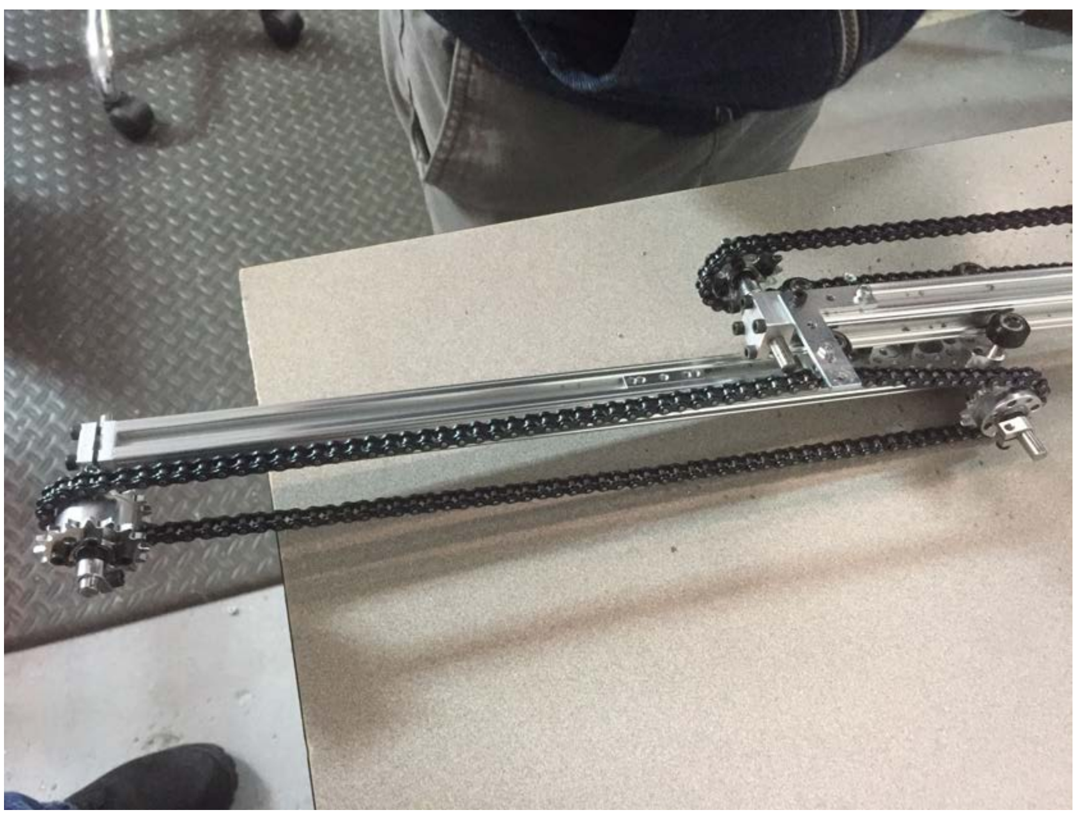
Contributors: Liam, Logan

Entries

1. Intake Mechanism Extender

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

Our new intake mechanism needs to extend into the pit, so we were working on that tonight. We had just gotten some new 16-tooth sprockets, the smallest size on ServoCity's website, and we had to make a new, shorter slider mechanism, because the old one was longer than 18", our length limit. We put the sprockets on and got one stage put together, so we'll finish the rest of it tomorrow night.



[Liam]

2. New Intake Mechanism

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

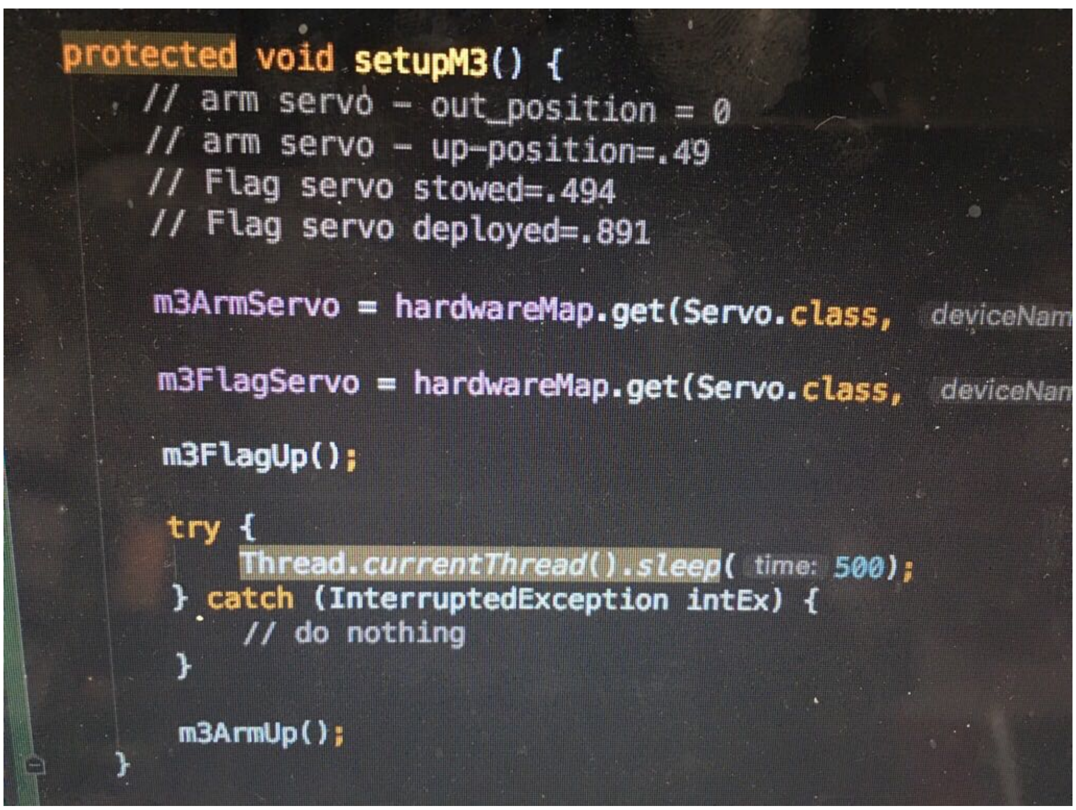
The new intake mechanism needs to have some way of pushing minerals out of itself. When it's in its up position, the compliant wheels will not be in contact with at least one of the minerals, meaning that we cannot eject them if we want to. We still only want to use one motor, so there is one logical solution: Another wheel. We added a wheel in the back of the intake mechanism that pushes the minerals into the compliant wheels in the front. We initially thought that just a wheel would do the trick, but that turned out to barely nudge the minerals. So, we decided to tape standoffs around it. We grabbed two standoffs and some tape, layed the standoffs parallel to the wheel's surface at opposite ends and taped them on.

[Liam]

3. Servo Programming

Identify	Brainstorm	Select	Prototype	**Evaluate**	Design	Fabricate

We programed the "FlagServo" and the "ArmServo" so that we could move on to the next step of sampling, we also set positions for the servos so that they could know where to go.




[Liam, Logan]

	JANUARY 27, 2019	7:00-9:15 PM
Contributors: Katelyn, Calvin, Lauren		

Entries

1. Designing software portion of presentation

Identify	Brainstorm	Select	Prototype	Evaluate	**Design**	Fabricate

Tonight we sat to plan the software portion of the presentation for the league qualifier. We planned out the different portions of our presentation and what we are going to say.

- Segue from build team
  - Elevator
- closed/open loop system
  - open= driver input
  - closed= run completely by case; no driver input- what it senses
- Elaboration
  - Open loop used when closed loop fails/ doesn't work
  - "Safeties" make high speed open loop usable + unsafe
    - Switches black into closed loop controllability
  - Motion Profiling
    - Is what allows us to run autonomous w/ smooth, controlled, and accurate motion
    - Paths and trajectories
      - How you move from one point to another
      - feedback/ feed-forward
- Feed forward/ Feedback
  - feedback= where we have been/ how much we have to make
    - Sense, plan act
  - Feed-forward = where we expect to be; the plan
    - Forward > back = speed up
    - Forward < back = slow down
    - Forward = back = maintain speed unless @ destination
- Elaboration

	● Mission statement ○ We aim for accuracy and controllability ○ Trajectory ■ Path + Time ○ Automate in tele-op= makes drive job easier **[Katelyn]**

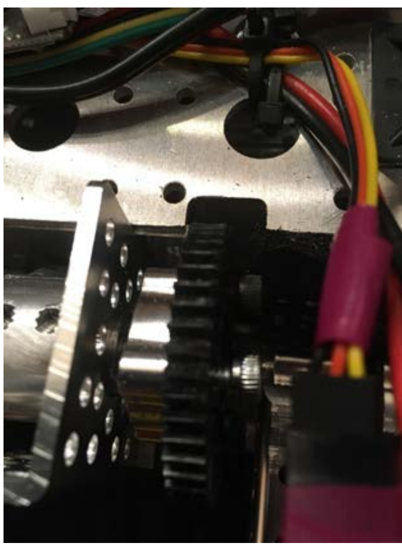
	January 30, 2019	6:00-9:00 PM
Contributors: Kaylin		

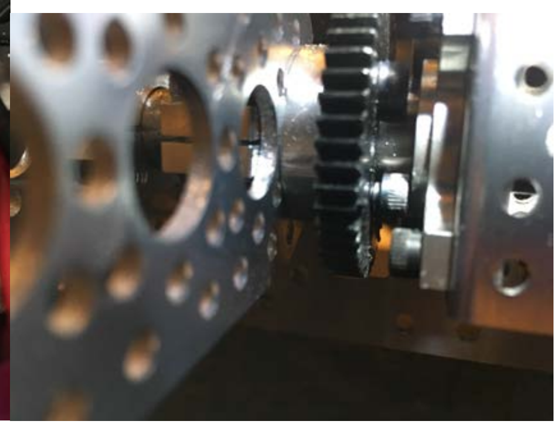
Entries

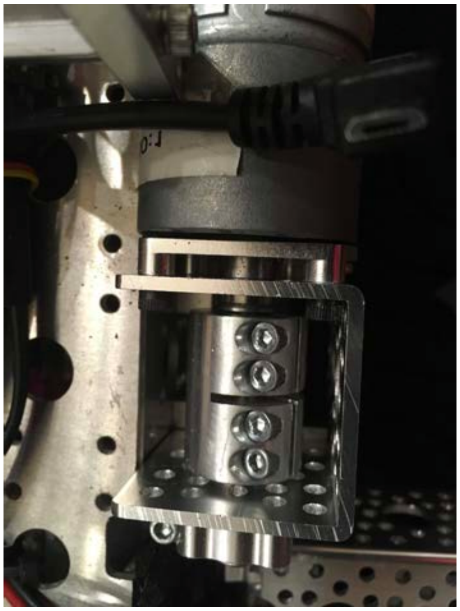
1. Maintenance on collector

Identify	Brainstorm	Select	Prototype	**Evaluate**	**Design**	**Fabricate**

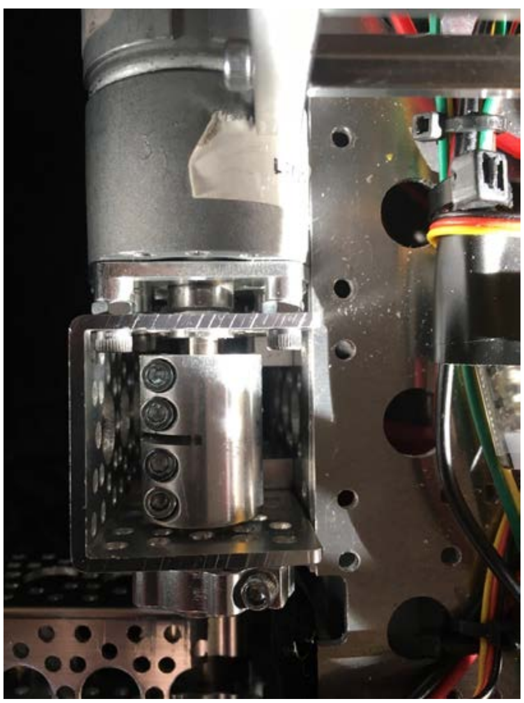
I was working on the robot to change over to our qualifier badging, and noticed the collector had a lot of loose parts – namely the motor was loose, the driving gear had missing teeth, and the screws holding the gears to the hubs were loose.





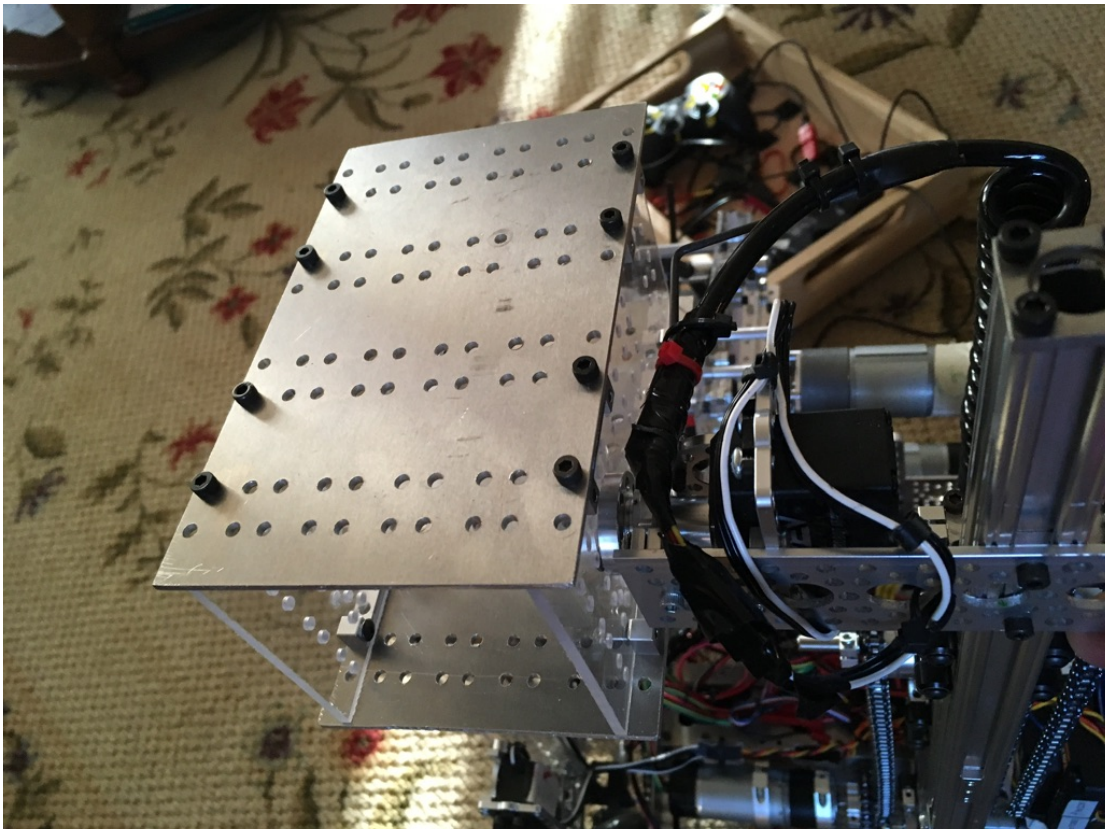


We worked to tighten them and used Loctite where we could to prevent them from loosening as quickly on their own. We also inverted the way bearings were installed so that they would be held in more securely.



[Kaylin]

<table>
<tr><td>2. Install new mineral delivery box</td><td>
<table><tr><td>Identify</td><td>Brainstorm</td><td>Select</td><td>Prototype</td><td>Evaluate</td><td>Design</td><td>Fabricate</td></tr></table>
I installed the replacement mineral delivery box. It is similar in dimension to our existing mechanism and mounts in the same way.


</td></tr>
<tr><td>3. Install new team number plate, sponsor logos</td><td>
<table><tr><td>Identify</td><td>Brainstorm</td><td>Select</td><td>Prototype</td><td>Evaluate</td><td>Design</td><td>Fabricate</td></tr></table>
We tend to wait until league qualifiers to put on our final team number plate and sponsor artwork because of the number of changes on the robot. I took care of this task tonight.
</td></tr>
</table>

	  **Kaylin**

	February 1, 2019	6:00-9:00 PM

Contributors: All

Entries

1. Presentation development / practice	Identify · Brainstorm · Select · Prototype · **Evaluate** · **Design** · Fabricate We spent the entire evening figuring out what we were going to say during our presentation. Team members decided what parts of the robot or team they would speak about, developed scripts, gave the presentation, took feedback from our mentors and other team members and changed the presentation based on that feedback. We repeated this cycle 4-5 times. **[Kaylin]**

	February 3, 2019	4:00-6:00 PM
Contributors: All		

Entries	
1. Presentation development / practice	Identify · Brainstorm · Select · Prototype · **Evaluate** · **Design** · Fabricate We continued to make our presentation better by spending some time making what we were saying shorter and more direct. We gave the presentation multiple times to our mentors, who acted like judges. We also had our mentors ask us questions from the judging rubric so we are prepared at our judging session. **[Kaylin]**

	February 5, 2019	6:00-7:30 PM
Contributors: Kaylin		

Entries

1. Distances for new mineral mover

Identify	Brainstorm	Select	Prototype	**Evaluate**	**Design**	Fabricate

The original measured distances to be used for the new code with the mineral mover were correct. We needed to determine the distance the robot had to drive after moving the mineral to the turn position where it aligns with the wall.

We measured those distances, added them to the code, and tested. We then enabled the rest of the code to test the entire route. Multiple tests were conducted – we did find that moving the gold mineral forward when close to the wall caused an issue where the robot ran into it and got stuck placing the team marker, so we changed the way we moved that mineral to be away from that path.

[Kaylin]

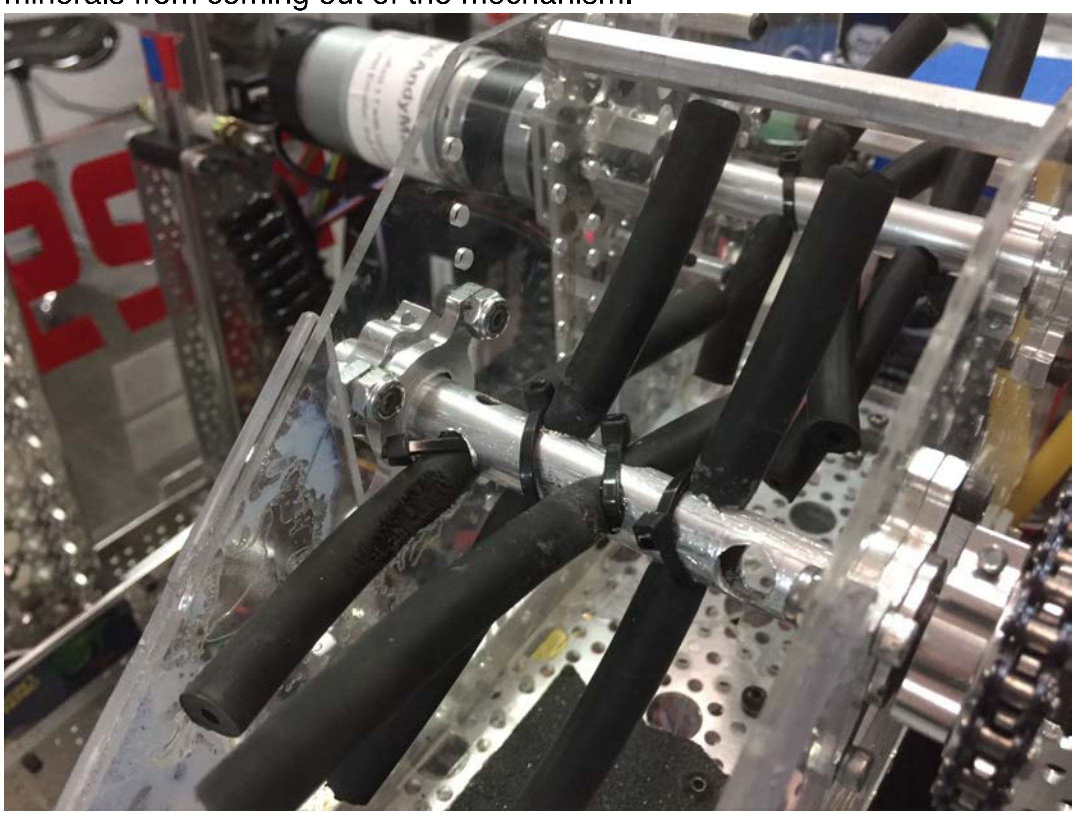
	February 11, 2019	7:00-9:15 PM
Contributors: Liam		

Entries

1. Finger Adjustment for Collector Mechanism

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

At the qualifier tournament, we had some issues with minerals falling out of our collector mechanism due to the fact that sometimes our first set of "fingers" would end up horizontally when the mechanism was up. When we went over the crater, the minerals just slid out of the mechanism. To fix this problem, we made it so that the "fingers" on the intake mechanism are at 90-degree angles to each other so that there is always something stopping the minerals from coming out of the mechanism.



[Liam]

2. Replacing Intake Motor

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

In the league qualifier, we also noticed that we weren't getting enough power or speed in our intake mechanism for our liking. Because of this, we decided to replace the current motor, a NeveRest 20 with a 20:1 gear ratio, with a new motor with a 3.7:1 gear ratio. This ended up getting us remarkably more speed and power.

[Liam]

	February 15, 2019	7:00-9:15 PM

Contributors: Katelyn, Calvin, Lauren

Entries

1. Antigravity for Mineral Scoring Elevator

Identify	Brainstorm	Select	Prototype	Evaluate	**Design**	Fabricate

Today we added an “antigravity” feature to our mineral scoring elevator. We did this because the elevator would start to descend after it hit the top. The code we wrote made sure that it would stay at the top until we told it to move. We did this by adding a voltage(power) to the motor, but just enough to hold it up. We had to switch the motor to run without encoders to do this because the setPower option in out code when running with encoders sets the velocity, not voltage. If we had ran with encoders it would try to increase the height of the encoder position when we had already reached the upper limit, which could damage the lift.

We also found that we needed to add a new feedforward value to make the elevator go all the way up to the lander, without running out of power.

[Lauren, Katelyn]

2. Made solutions for homing paths

Identify	Brainstorm	Select	Prototype	Evaluate	Design	**Fabricate**

- What we did:
    - First we set up paths that the robot could go into
        - “Happy” Path
            - Robot is homed and auto starts
        - “Unhappy” Path
            - Robot is not homed
            - Won’t stop homing
    - Second, set up states in the code to make solutions to the “unhappy” paths.
        - If the robot is not homed, we set up the code so that it starts homing and gives the robot 1 second to home.

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

- If the robot won't stop homing, we timeout after 1 second.
- Then, we set up and executed test, in order to make sure the new code worked and fixed the solution.
  - The results we what we expected, which were that the robot would home after 1 second.
- Why we did it:
  - We did this, because if we are in a scenario that the robot is not homed before a match starts, the robot will home during autonomous.
  - This allows us to still run the autonomous.

</td></tr>
<tr><td>3. Pre- competition Scouting</td><td>

Identify	Brainstorm	Select	Prototype	Evaluate	Design	Fabricate

- *What we did*
  - We looked at videos, social media pages, and stats for teams in our division at state
- *Why we did it*
  - We did this so we could figure out who to market ourselves to at state and see who would be a strong alliance partner

Kaylin

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

Business/Sustainability

This season we were fortunate to be awarded a grant from Schneider Electric once again.

We have a lot of costs that Schneider helped cover:

- Power Tools ($400)
- Robot parts and spares ($1400)
- Competition Registration ($275)
- Robot Game Elements ($450)
- Food and travel ($300)
- Pit-banner sign ($25)
- Stickers/buttons ($75)

We also met Morrison Container Handling Solutions through a contact at the Homewood Science Center. They make machines that move odd shaped things, such as yogurt containers. They came to one of our league meets and talked with the team about the robot and the software. They mentor us in engineering and programming. They also help machine parts that we don't have the capabilities to do in our shop. We look forward to working with them for many seasons to come.

The Homewood Science Center has been invaluable to us for many seasons. They provide us with space to work and have introduced us to our two sponsors. We give back by volunteering at their events, which in turn helps us with STEM outreach.

This season we really reached out to our sister FLL teams. We built a whiteboard in their space that they can use. We also made congratulation signs when they both made it to the FLL State Tournament. We believe it is important to maintain a relationship with our sister FLL teams because over 50% of our FTC team are former FLL participants from those teams.